

# Older People and Social Participation: From Touch-Screens to Virtual Realities

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## ABSTRACT

Since the introduction of the modern internet, computers have assumed a key role in facilitating communication in the developed world. However, until recently many older people have struggled to use ICTs for communication and social participation. This began to change with the introduction of mass market touch-screen computers in 2007, and in just under a decade, the touch-screen has played a major role in addressing some of the technological barriers faced by older users. To highlight the contribution that touch-screens have made in encouraging older people to use ICTs for social participation, this paper presents four detailed cases from two research projects that used iPads with older people. The cases highlight the benefits of touch-screens and the ongoing challenges that prevent some older people from using the devices to their fullest potential. We then consider how emerging technologies, such as virtual and augmented reality, artificial intelligence and virtual assistants, and social robotics, might begin to meet these challenges. Our aim is to stimulate discussion as to how these new technologies might usher in a new wave of social participation by older people.

## Author Keywords

Older People; Ageing; Touch-Screens; Virtual Reality; Augmented Reality;

## ACM Classification Keywords

H5.m. [Miscellaneous]; H5.2 [User Interfaces]: Input devices and strategies

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DOI: <http://dx.doi.org/10.1145/2996267.2996271>

## INTRODUCTION

Communication has been the driving force behind much of the innovation in computing since the first true networked computer systems were introduced in the 1960s. Although initially conceived as a cold war era command and control system, it was communication services, such as e-mail and newsgroups, that proved the most popular use for the embryonic systems that would ultimately become the internet as we know it today [10].

This underlying social characteristic of the internet has meant that researchers have long seen the potential for information and communication technologies (ICTs) to facilitate social participation, a “person’s involvement in activities providing interactions with others, in society or the community” [24:2141]. ICTs are believed to offer particular opportunities for older people for whom social participation is seen as a vital component of healthy ageing [24,32,50]. As ICTs continue to evolve, innovative ways of using technology for social participation will continue to grow. In the coming years, it is likely that technology will be employed for increasingly novel solutions, such as virtual and mixed reality games, to encourage older people to take part in social activities.

Drawing on data from two research projects, this paper uses detailed case studies to illustrate the contribution that touch-screen devices have made in encouraging older adults to interact with each other and with the wider world. The case studies also highlight the challenges that older people face when using touch-screen devices. We will then consider how emerging technologies, such as virtual and augmented reality, artificial intelligence and virtual assistants, and social robotics might be leveraged to break down some of the remaining barriers to older people’s use of technology for social participation.

## SOCIAL PARTICIPATION, OLDER PEOPLE AND ICT

Despite the clear potential for ICT to support social participation, it wasn’t until the early 1990s that the internet began to mature into what is now the dominant

communication system of the age [10]. We might refer to the explosion of ICT-based communication facilitated during this time as the first great wave of ICT-based social participation. For much of the first two decades of the modern internet, however, many users were underrepresented on the web, largely as a result of lack of experience and poor access to ICTs. Older people in particular, many of whom had not used modern computers during their working lives, found it difficult to understand the underlying metaphors and concepts of desktop computing. This has been a major contributing factor to what has come to be known as the 'digital divide' affecting many older users [11,41]. Despite these challenges, researchers continue to see the potential for ICTs to address the physical and geographic limitations that often impact on older people. There has been ongoing interest in examining how new technologies might be used to encourage social participation in this population [7,13,14,27,45].

Arguably one of the factors that has led to the increasing use of ICTs by older people, has been the introduction of touch-screen interfaces into the consumer market, beginning with Apple's iPhone in 2007. The relative low cost, light weight and ease of use of these devices have ushered in what we believe is the second great wave of ICT-based social participation.

Touch screen technologies have advantages over traditional keyboard/mouse/screen interfaces for older people [17,42] and can accommodate some of the age-related physical and cognitive limitations faced by some older people [9,23]. For example, the close proximity of the onscreen keyboard to information on the screen can reduce cognitive load [15]. Touch-screens use direct input, which tends to be easier to learn to use than input devices such as a keyboard and mouse, and touch-screens enable objects such as buttons and text to be enlarged, making them easier to see and to select accurately [9].

We conducted two research projects that illustrate the contribution touch-screen technologies have made in allowing older people who are socially isolated to increase their level of social participation using ICTs. In this paper we provide a brief overview of each project's goals and design; for more information see [2,46-48].

## **IPADS FOR SOCIAL CONNECTION: TWO PROJECTS**

### **Growing Older and Staying Connected**

The Growing Older and Staying Connected project aimed to explore how touch-screen technologies could help alleviate older people's experience of social isolation. The project, a collaboration between human-computer interaction researchers and an aged care service provider in Melbourne, Australia, involved developing and evaluating a prototype social networking tool ("Enmesh"), which was used to share captioned photographs and messages within small closed groups. Working closely with care managers (case workers) from the aged care provider, the project

recruited home and community care clients (that is, clients who were living independently at home) who were identified by their care managers as being at risk of social isolation. Overall, 16 older adults took part in the project. Participants varied in age from 67 to 94 years, but most participants were aged in their 80s and 90s. Only four participants were aged under 80. The project therefore focused on the experiences of the 'oldest old' [28].

We evaluated Enmesh in three field studies, which varied in length from three months to twelve months and employed in-depth qualitative research methods, including multiple visits to participants' homes, semi-structured interviews, observing the technology in use, and creating detailed field notes. The field studies were not traditional ethnographies, but were informed by ethnographic methods [16]. During each study, small groups of clients and care managers used Enmesh to create captioned photographs and messages, which were sent to a shared interactive display that could be viewed by all other members of the group, on their individual iPad screens. In addition, some participants made extensive use of the iPad beyond Enmesh, learning how to access and use the Internet, email, Facebook, and other applications. In this paper, we discuss two exemplary cases that illustrate how some of the participants gained social benefit from their broader use of the iPad.

### **The Supportive Network**

The Supportive Network project aimed to provide ICT access and training to a group of older people who have traditionally been excluded from using technology and to encourage participants to utilize the technology to strengthen their ties to community supports. The participant group were part of a program, operated by a homelessness organization, aimed at supporting older people with histories of homelessness, social isolation and complex needs. Participants were located in rural and regional areas in Central Victoria, Australia. These factors, combined with some unique characteristics, such as many participants having ongoing substance abuse issues, presented unique challenges. The differences between the two project's participant groups illustrate the limitations of defining heterogeneous groups based purely on a single characteristic such as their age [1,20,26,30,49].

The research project involved seven participants aged from 58 to 81 years of age and adopted a Participatory Action Research (PAR) methodology [34]. Over a nine-month period, multiple in-depth interviews, following a semi-structured interview process, were recorded with each participant. These interviews were then transcribed and subjected to further coding and analysis. This data, along with participant observations recorded in researcher journals, formed the basis for comprehensive case studies that detailed the participants' experiences learning to use the iPad, the new social connections facilitated by the technology, and also the usability issues that hampered iPad use.

### Selecting Illustrative Cases

Both projects employed in-depth qualitative research methods, which resulted in the creation of detailed field notes about each participant, or case. We examined the individual cases and compared them across the two projects. It became apparent that, despite differences between the two participant groups and the broad aims of the projects, our participants experienced similar benefits and challenges from using iPads for social participation.

For the purpose of this paper, we selected four exemplary cases, two from each project, to discuss in detail. The cases were chosen because they illustrate the various ways participants were able to increase their level of social participation using touch-screen tablets. In presenting these four cases in detail, our aim is not to provide generalizable findings but to highlight individual experiences of using iPads for social connection. To provide some context to this increased social participation, some background information is presented about each case to illustrate the levels of isolation and disconnect these participants were experiencing at the time of the research. In order to protect their identities, pseudonyms are used for each participant.

## RESULTS

### Growing Older and Staying Connected Cases

#### Beth

Beth was 88 years old at the time of the study. She depended on a walking frame and a walking stick but did not like using them as they made her feel old and frail. Beth, a widow, had travelled extensively with her husband when he was alive. They had no children and her only sister had passed away. Beth considered her daily life as being rather boring, yet she described it with some humour and irony. Beth was bored by seniors' groups and felt she had nothing in common with other seniors: *"They can bore you silly with their tales about their children and grandchildren"*. She loved going out, especially her shopping day every Tuesday. Outside the house she used a very elegant walking frame (*"that's why I bought it"*) that was not approved by her care manager as it did not have any brakes.

Beth had no computer experience, but her friends used the Internet and hence she was able to see the benefits of modern ICT use. She considered attending a class to learn more but had problems getting there.

Beth encountered problems using the iPad due to the arthritis in her hands (other participants in the project encountered similar problems). In particular, the iPad was very heavy to hold. Beth - sitting on a couch holding it in her lap - kept saying: *"it is too heavy for my little paws"*. She needed both hands to lift up the iPad. While holding the iPad up she was not able to use the functions on the touch screen, and she held it in a way that the holding fingers touched the screen and initiated functions involuntarily.

Beth's arthritis in her left index finger caused her nail to be bent in a way that the touch screen did not react to her repeated attempts to tap on the screen. Therefore, she learnt to use the fleshy part on the side of her thumb. Tapping sideways with the thumb meant that aiming for the exact spot was much harder. Hence, she either missed letters on the keyboard or several letters would appear at once. The iPad's text auto-completion feature was confusing to Beth and didn't seem to provide her any support. This led to the feature being turned off by the researcher.

In order to get to Enmesh, participants needed to follow three steps, each requiring a different type of interaction. First they had to turn the iPad on, using a manual button at the top of the device, or by touching the 'home' button under the screen. This was the easiest and most familiar form of interaction for Beth and other participants. Then, participants needed to activate the iPad by sliding their finger across the screen. Many participants, including Betty, had difficulty with this interaction (often Betty would cling to the arrow, sliding it back and forth without letting go). Finally, to open Enmesh participants had to tap on the application icon. This was relatively easy, although some participants had to learn how to tap the screen in a way that activated functions (e.g., not pressing on the icon for too long). Once they learned this operation, participants were able to explore other functions.

Beth enjoyed using the iPad to read online magazines (such as Vogue) and look up information that was of interest on the Internet. Beth had been an avid traveler during her younger days so she was particularly interested in travel-related websites. She researched information about cruises, but this reminded her of activities she was no longer able to take part in: *"It is frustrating to see all the cruises one can book online and I cannot do that anymore"*. Nevertheless, the Internet provided Beth with virtual access to parts of the world that she could no longer physically go to. A friend who was travelling around the world sent her regular postcards. Beth was able to travel vicariously by looking up information about the places her friend had visited. She found photographs and travel information about these places and liked to use the maps feature on the iPad to track her friend's travels.

Beth did not really understand the different sections of the iPad (applications versus Internet versus settings), but nevertheless was very explorative. Once she stumbled on to the airplane mode in settings and got a fright, thinking that this meant she would endanger planes: *"Interesting to see what you can do with it. Yesterday I thought it was in airplane mode and could cause some damage. You shouldn't give a fool like me something like this."* This misunderstanding even caused her to turn on the TV to check if any plane crashes were happening caused by her. She rang the researchers and after being assured she had not done any damage settled in again for an extensive read of the Vogue magazine online.

Despite the initial barriers Beth experienced, using the iPad was ultimately a positive experience for her. In particular, using the touch-screen device to access the Internet provided Beth with a new window to the world. This was more successful for Beth than using Enmesh to communicate with other participants.

#### *Sophie*

Sophie, aged 93 at the time of the research, was one of the oldest participants in the Growing Older and Staying Connected project. Sophie took part in two of the three field studies. Like Beth, Sophie had not used computers before but found the iPad to be a valuable tool for providing her with a new link to the outside world.

Sophie lived alone in a house she had owned for several decades. Sophie had never married or had children, but was close to her nieces and nephews. During the project, Sophie used the iPad to take photographs of a visiting great-niece with a new baby, and used the Enmesh application to share this with other members of the participant group. Sophie embraced the opportunity to communicate with others and share her interests with the group. She used Enmesh to share photographs of her garden and brief quotes and sayings, which she called “Thought of the Day” messages.

Given her advanced age, Sophie had had to give up a lot of the social activities that she previously enjoyed. In particular, she used to attend a book club until all the members “got too old”. With her sight deteriorating, reading was also no longer an option for Sophie. She used a service for the vision-impaired that regularly delivered audio books. However, Sophie was unable to select these books (they were allocated semi-randomly, based on the topics of interest Sophie had selected when signing up for the service). Although happy to receive audio books, Sophie was frustrated at not knowing much about the authors and their work. Being able to access the internet on the iPad overcame this frustration as Sophie was able to do her own research about the books.

Similarly, Sophie used the internet to look up information about the television shows she enjoyed watching. In particular, she enjoyed an Australian television program called “Letters and Numbers” and was delighted to be able to research its history. She was also able to do a lot of research on health problems she was experiencing; she astonished her practitioners by attending medical appointments with the iPad and consulting with her specialists about the information she had found.

Like Beth, Sophie used the maps application on the iPad to travel vicariously and access the outside world. She located the addresses of family members and friends on the map and, although unable to visit these destinations herself, enjoyed being able to find out more about the neighborhoods where her friends and family lived. In particular, Sophie spoke of her nephew who sent her a postcard from a hotel he was visiting in Sydney. Sophie

was able to use the street view on the map to not only locate the hotel, but to see what it looked like and to see the street and area her nephew was visiting.

Outside of the Enmesh application, Sophie used the camera feature on the iPad to take numerous photographs and videos, especially photographs that showed visits from family members. Sophie reported that her nephew had also acquired an iPad and used it to show Sophie the photographs he had taken while on holiday. Although she also enjoyed photographing her garden, by the end of the second field study, Sophie was no longer able to take photographs outside. Holding the iPad up was difficult: her hands would shake and she had no confidence in the photographs that she took.

Sophie’s extended use of the iPad – and the obvious enjoyment she experienced from being able to access information about the world – highlights the value ICTs can provide for facilitating older adults’ societal engagement. For Sophie, the iPad offered both enhanced interpersonal connections – e.g., using the iPad to take and share photographs of family members – and opportunities to enrich her connection to the world.

### **The Supportive Network Case Studies**

#### *Emma*

Emma was 66 years old at the time of the study and estranged from her family, with few friends. Although she had experienced a difficult childhood, Emma was able to complete her education and eventually became a theatre nurse. Though professionally satisfied during this time, she became completely estranged from her family and had few friends. Unfortunately, Emma’s life was thrown into turmoil after she suffered an Acquired Brain Injury (ABI). This incident had a catastrophic impact on Emma’s life. She lost her job as a nurse and was unable to secure work. The behavioral impacts of the ABI further isolated her from any social contacts. Emma drifted around the country without stable housing until she was ultimately referred to a homeless support agency for assistance. With the exception of her case worker, Emma stated that she had no social contacts at all at the beginning of the project.

In the 1980s, before the ABI, Emma had some experience with computers in her work and had an old PC in her dining room; however, at the time of the study, Emma was not using the computer and it had never been connected to the internet. The touch-screen interface and portable nature of the iPad transformed Emma’s relationship with computing. She was quickly able to master the basic concepts of e-mail and web browsing, and with a small amount of practice, became familiar with the basic UI conventions of touch-screen computing such as touching apps to launch them and swiping to initiate actions such as deleting junk e-mail. The portability of the iPad allowed her to take it with her on her trips into the nearest town and she enjoyed browsing for online news and trivia at regular meetings in the town

library. Despite this, Emma did complain about the weight of the device and said that it was a barrier to always having it with her. The intuitive nature of the touch-screen interface transformed computing from a means to print out word processing documents, to an interactive conduit through which Emma could engage more openly with the world and with her interests.

Though Emma was quickly able to master the basics of touch computing, her case highlighted one of the great challenges faced in the study with regards to social participation. How do you assist someone to participate when they lack any social connections? Social networking sites, such as Facebook, rely on the user having at least a small group of friends from which they can begin to grow their social network. The answer for Emma was that although she lacked social connections, she was interested in politics and social affairs, was a talented seamstress, and wanted to communicate in different ways with her worker. During the study Emma learned to use her iPad to foster these interests.

Emma enjoyed learning to communicate using e-mail and used her e-mailing skills to contribute to her local community. Emma travelled exclusively by bus and enjoyed saying hello to her bus driver. The local bus drivers were one of the few peoples with whom she had regular social contact. Numerous studies have affirmed the importance of these brief social encounters for older people living independently in the community [19,39,40,43]. When Emma read in the newspaper that the council was considering changing some of the bus routes in her area, she used her e-mailing and internet searching skills to lobby both the council and her local federal member of Parliament for increased bus services for older people.

Emma was a talented seamstress who had won a number of awards for her work prior to her accident. One of her priorities as she developed her ICT skills was to develop a record of her work. Emma's desire to have her work displayed online was tempered, however, by her concerns over privacy, a commonly raised concern for older people in relation to ICTs [3,5,22]. These competing desires ultimately meant that rather than putting her work online, Emma chose to load photos of her work on her iPad and she worked with the researcher to create a narrated video highlighting her designs and the awards she had won for her work. Emma could then always have these materials with her on the iPad so that she could show her work to anyone she met who might have been interested. This portability, and the ease with which she could play the video, was a key advantage of the iPad.

The iPad also extended Emma's social connections by providing a more convenient way for her to communicate with her social worker. Prior to the study, Emma had relied on phoning her social worker when she needed support. This was problematic as the worker was often visiting other clients and Emma was forced to leave a message on her

answering machine. This was both inefficient and expensive as Emma would often play 'phone tag' with her worker, leaving and receiving multiple messages before getting through. The ease with which she was able to master the touch-screen interface of her iPad meant that Emma was able to switch to e-mail to converse with her worker. This was less expensive and more convenient for Emma and she was able to know that her worker would always receive her messages.

#### *Kent*

Kent was 65 years old at the time of the study and had been referred to the homelessness organization after spending a period of time living in his car. He had left his adopted parents at an early age and had spent his life travelling around Australia working odd jobs and had also spent some time in jail. Kent had a daughter who was now an adult. At the beginning of the project, however, they were estranged. His only significant relationships were with a woman who was also a client of the homelessness service who he had met at a support group and his next door neighbor.

Whereas Emma's case illustrates the way that touch-screens have enabled older people to participate in community and social service organizations – what would be referred to as mezzo level participation in the field of community services – Kent's case highlights the contribution that intuitive touch-screen interfaces can make in relation to personal, or micro level, relationships [12]. His case also highlights the intuitive nature of touch-screens, even for novice users.

Prior to the research project, Kent had not used a computer of any kind and he was extremely nervous about his ability to learn. Three factors in particular led to this nervousness: Kent suffered from formally diagnosed anxiety and depression, he had poor literacy skills due to leaving school at an early age, and he lacked social connections from which he could receive technical support. Despite these reservations, Kent was quickly able to grasp the fundamentals of the touch-screen interface, so much so, that he quickly became one of the most proficient users within the research participant group.

One of the keys to his success was that his early experiences on the device served as motivation to learn. The first task the researcher did with each participant was to ask them about a significant place that they wished they could see again; for Kent, this was his childhood home in Tasmania. Then, using Google Maps and Google Street View, they were shown their significant place. For Kent, the ability to revisit his childhood home, a place that he had not seen since he was a young boy, and rotate with his finger around the neighborhood was magical. Kent had been on the run from his past all his life and now he could reengage with this difficult time, but from the safety of his home. The ease with which this was possible on the iPad was a real turning point as it convinced Kent that learning to use the device was a realistic and achievable goal.

The second motivating factor was his desire to reconnect with his estranged daughter. Kent freely admitted that he had not been the best father. He had tried to reconnect at various times in the past. However, meeting in person, or on the phone, always led to arguments and the relationship breaking down. From the beginning of the project, Kent listed learning to use Facebook as one of his goals. He was aware that his daughter used Facebook and wanted to try and make contact. Although struggling with the Facebook UI, the touch-screen interface of Kent's iPad reduced some of the barriers, such as navigating a file system or learning to use a web browser, that might have proved daunting to a novice PC user.

Once he had successfully signed into Facebook, with little assistance Kent was able to find his daughter's profile and send her a 'friend' request which she accepted. For the next several months, Kent's daughter did not respond to any direct requests to communicate. However, Kent reported that being able to see her status updates was enough. In fact, he believed that this was one of the best aspects of the service. He was able to see that his daughter was ok and feel connected to her in some small way, without dredging up the interpersonal issues that had soured their relationship. As the research project progressed, Kent's daughter did directly message him. This ultimately led to a phone conversation and finally a face-to-face visit. This finding illustrates the potential for ICTs (and social media in particular) to act as conduits through which meaningful social participation can occur.

## DISCUSSION

The four cases described above demonstrate the substantial contribution that touch-screen technologies have made in lowering some of the barriers that previously hampered older people's engagement with ICTs. However, the cases also reveal usability challenges that were common to the participants in both studies, suggesting a need to explore further opportunities that new and emerging interfaces can provide to enhance older people's access to, and experiences of, ICTs.

### Benefits of Touch-Screen Devices

We attribute the success of touch-screen devices in these case studies to two integral elements: *touch* as a form of interaction, and the *screen* as a window to the world.

#### *Touch-screen interactions*

One of the clear benefits of this class of devices is that touch-screen interfaces are relatively intuitive to the novice user, making it possible for those with limited prior computing experience to learn to use the technology. Our participants were not forced to master the intricacies of a file system, nor to learn how to operate a keyboard or mouse, before engaging with the device; they were simply able to touch the applications that they wanted to use. So, for example, Emma and Kent used email and Facebook to

communicate with family and social supports, while Beth and Sophie searched the Internet to locate information that extended their interests. Despite some initial difficulties, they were able to locate and use these functions relatively easily. In addition, Sophie and Emma made extensive use of the photo and video features of the devices, which were also easy to use via the touch-screen interface.

#### *Window to the world*

Through the Internet, the touch-screen devices provided participants in both studies with a sense of connection to the outside world. Beth, Sophie and Kent all used iPads to explore places that they wanted to travel to or to revisit places from their childhood. The device was, in effect, a window to the world, letting them explore and engage with the world in both its spatial and temporal dimensions. For Sophie, the interaction went both ways: she both accessed information and allowed others into her life through the technology. Sharing photos of her gardens and "thought of the day" messages provided others with a glimpse into Sophie's life. Despite these clear benefits, participants in both studies still experienced significant barriers in using their touch-screen devices.

### Touch-Screen Usability Issues

Although the touch-screen tablets are relatively portable, some older participants still struggled with the weight of the device. Emma, for example, stated that the weight of her tablet impacted on her ability to carry it with her, while both Beth and Sophie struggled to hold the device causing usability issues and limiting Sophie's ability to use it to take photographs in her garden.

Similarly, while the intuitiveness of touch-screen interfaces has been instrumental in helping increasing numbers of older people engage with ICT, significant usability issues remain. For our participants, some gestures were less intuitive and this confused them, often causing them to stop using the device until a researcher could 'fix' it. A good example, given by Emma is illustrative of this issue. Having accidentally put the tablet into app deletion mode, she commented: "*It froze. It scrambled. It did the jelly wobbles on me... I couldn't get the cursor on it (and) didn't know what to do... I was really upset when it happened*".

Another participant in the Growing Older, Staying Connected project exclaimed "*This machine has a mind of its own!*" when struggling to understand similar occurrences. These types of usability issues are becoming more prevalent as software vendors strive to add desktop class functionality into their operating systems. 'Improvements' such as menu options that react to the force of one's touch, hidden menus that are activated by swiping up or down on the screen, new and more complex gestures, and attempts to enable multiple applications on one screen, while welcomed by so-called 'power users', can impact severely on a novice user's ability to engage with a device without constant support and additional training.

These and other ongoing issues with touch-screen interfaces raise the question as to whether new technologies are being developed that might begin to address these barriers and thus usher in the next wave of social participation using ICTs. This is this question to which we will now turn.

### **TOWARDS A NEW WAVE OF SOCIAL TECHNOLOGIES**

As demonstrated above, touch-screen devices have opened up a new world of social opportunities for some older adults. Our case studies provide examples of older adults with limited previous computing experience who have found new ways of engaging with the world by using touch-screen devices to communicate and connect. However, we have also noted how the case studies highlight usability challenges that participants in both projects faced. This raises the question; what new or emerging technologies might address the usability issues associated with touch-screen devices, and how might these technologies help to usher in the next wave of technology-enabled social participation for older adults?

Research in three emerging fields - virtual and augmented reality, artificial intelligence and virtual assistants, and social robotics - illustrate the potential that new interaction methods may have in meeting some of these challenges. The following section will provide a brief overview of each of these emerging fields while also noting some of the technological and ethical challenges that they present.

#### **Virtual and Augmented Reality**

Virtual and augmented reality systems are perhaps the most mature of the three emerging fields we have identified. Recent advances in ICT have facilitated the increasingly wide adoption of virtual and augmented reality technology that has the power to immerse the user in a simulated or augmented world [4]. These immersive technologies can provide an unprecedented opportunity for older people to participate, experience, or relive social experiences and activities. Synchronous or asynchronous social interactions can be mediated through new forms of technologies, to create a sense of presence or awareness of other people. Body orientation, gestures, and facial expressions are examples of multimodal interactions that can express intimacy and foster connection between people. Technologies such as virtual reality have the potential to increase a sense of presence by enhancing embodied interaction with others.

A recent project that has begun to explore this potential is the Nacodeal project [37], which uses a wearable augmented reality device, worn around the neck, to provide participants with friendly guidance for daily activities and access to online services. The system aims to increase social interaction and stimulate cognitive process for older people living in an aged care facility. Initial evaluation of the system by focus groups and pilot tests have demonstrated high levels of participant satisfaction and positive feedback.

Though in their infancy, projects such as Nacodeal demonstrate how virtual and augmented reality technologies can address some of the concerns highlighted by the participants in our studies. Limitations such as the necessity to carry touch-screen devices and problems associated with physical limitations, such as those caused by Beth's arthritis, can be minimized with wearable technologies, although these can also be heavy to carry. The ability of augmented reality and virtual reality to facilitate embodied interactions in virtual communities, perhaps via the use of avatars, also offer the potential to transcend physical limitations associated with ageing bodies. Finally, the use of avatars while participating in virtual communities may help to address some of the privacy concerns expressed by older adults such as Emma. There are, however, some issues related to virtual and augmented reality that may limit its benefits, especially for older people. Perceptual issues [21] such as limited field of view of the virtual reality headset and misalignment of virtual objects to the physical world can cause disorientation and motion sickness for the user. Furthermore, echoing the challenges of touch-screen devices, the constraint of having to wear or hold a virtual reality headset can be physically strenuous for older users [37].

#### **Artificial Intelligence and Virtual Assistants**

Artificial intelligence represents a system that can sustain interaction with a human user without being recognized as a computational entity [18]. By comparison, a virtual assistant is a computer-generated system that mimics the behavior of humans [29]. Comparative research [29] has shown that there is no significant difference in the sense of social engagement when interacting with a virtual assistant as compared to a human entity. This finding has paved the way for the application of virtual assistants powered by artificial intelligence in social participation for older people.

Brandenburgh et al. [8], created an ambient system that promotes physical and social activities for older people using a personalized virtual coach. The system provides a tablet interface that reads activity information from a body worn sensor, to provide feedback to the user. The social component of the system allows the user to make appointments with friends and interact with the virtual coach. A feasibility evaluation of the system found an increase in physical activity and decrease in loneliness among the participants.

Research into the use of artificial intelligence and virtual assistants, such as the virtual coach system, highlight the ways in which such systems can utilize speech as a method for interaction with new technologies. An interaction technique such as this has the power to address many of the difficulties highlighted in our studies using touch-screen technology. Removing the need to interact via bodily gestures not only addresses the physical limitation faced by older people such as Beth, but also addresses many of the usability issues – such as accidentally putting a device into

app deletion mode – that were experienced by our participants. A common concern raised about this type of technology, however, is that it may result in further isolation for older adults if it replaces human care [33].

### Social Robotics

A final emerging technology that has received increasing attention in relation to older people is the potential to use social robots to foster interaction and social participation [44]. The role of robots and their criteria for success are much less clear – compared to industrial robots – when used in a social context as a companion (for a review see [35]). Beneficial tasks and goals around socializing are also subtler and less clearly defined. However, some research into the use of social robotics in groups have noted their ability to encourage social interaction [25].

An example of a social robot is the small humanoid NAO robot, which has a wide range of functions. Researchers have explored the social interaction between a group of people with dementia and the NAO robot in a council ageing well program [31]. They found higher engagement was observable when the older adults were able to relate to the robot in what they were doing. Participants connected emotionally and displayed more interactions among each other when the robot was showing human traits such as sneezing, happiness or failure. The results also showed that the integration of robots is promising as long as robot interactions are carefully planned, designed and matched to familiar settings of the older person.

Research into the use of social robots with older people is still in its infancy, but robotics have the potential to address some of the limitations of touch-screen interfaces as identified in our research, such as the need to use physical gestures or hold a physical device. For very isolated individuals – such as Emma who did not have any social connections – social robots may also provide a level of companionship that is not otherwise available. Importantly, however, while robotic technology has been praised by some, there has also been criticism claiming that social robots are patronizing and childish [6,36]. In a discussion of the pros and cons of Human-Robot Interaction (HRI) in elderly care and its impact on human dignity, Sharkey [38:63], points to the risk of “developing robotic ‘solutions’ to the problems of aging that result in a reduced rather than improved quality of life for older people.” (p.63).

### CONCLUSION

Although many older people have traditionally struggled to use computers as tools to facilitate social participation, in the previous decade, the introduction of touch-screen interfaces has contributed to a breaking down of many of these traditional barriers. This paper has highlighted the contribution touch-screen computing has made to older people through the presentation of four detailed case studies drawn from two research projects centered on older people’s use of iPads. Though the touch-screen interface of

the iPads proved beneficial for many participants, the case studies also highlighted some ongoing usability issues faced by participants in the studies. In order to stimulate further discussion, we have then considered how three emerging technologies, virtual and augmented reality, artificial intelligence and virtual assistants, and social robotics, introduce new interaction methods that may address some of the challenges inherent in touch-screen devices. Although ongoing research will be required to ensure that their promise is fully realized, we believe these technologies have the potential to usher in a new wave of ICT based social participation by older users.

### ACKNOWLEDGEMENTS

The “Growing Older and Staying Connected” project was supported by Benetas Aged Care Services, the Melbourne Networked Society Institute, and the Australian Research Council (LP120100022). We thank the Benetas clients and care managers who participated in the project and our colleagues Frank Vetere, Lars Kulik, John Downs, Alan Gruner and Ameer Morgans for their contributions to the project. The “Supportive Network” project was supported by Haven: Home, Safe and La Trobe University’s Building Healthy Communities research focus area. We thank the clients and social workers at Haven: Home, Safe for participating in the project and our colleagues Jeni Warburton, Sue Hodgkin and Jan Pascal for their contributions to the project.

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