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Bridging the generational gap

Designing internet services for technologically-naïve older people using familiar interfaces

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Abstract

Despite advances made in modern electronic devices, their use by older people is significantly lower than for younger people. They experience difficulties using devices due to a combination of physical, cognitive and 'generational' differences. Many studies try to adapt devices to make them more usable, but they do not consider how older people feel in terms of attitudes towards technology or their existing habits. Seven participants were interviewed about their current use of technology, as well as their attitudes to modern technology, and a personal inventory was created for each participant. The interviews generated themes relating to how participants feel that technology is not made for them, barriers to their use, and generational differences as well as arguments against modern technology use and perceived negative aspects of technology. Some design considerations were created and illustrated using features from the most commonly used devices that suited the interviewees' attitudes, behaviours and opinions.

Keywords: interactive devices, older people, generational differences

1. Introduction

The shape and function of many technologies has changed dramatically in the past few decades, with the introduction of smartphones and tablets, and before that came mobile phones and the widespread use of home computers and laptops. One of the most noticeable changes to how technology is used has come from modern touchscreen technology, allowing mobiles and tablets to have a screen that is almost the entire width and length of the device without needing buttons that previous mobile phones needed. Despite the rise of touchscreens, there are also many devices that still exist in people's homes that haven't changed very much over the years. Though televisions might now be thinner and wider, and home phones might be cordless, they are still used in roughly the same way and have a visual resemblance to their predecessors.

1.1 Related Research

The changing of both the input mechanisms and the methods of using modern devices has its own problems. While the use of touchscreens has been widely adopted by younger people, older people can often experience difficulties with using a touchscreen due to physical limitations. In Harada, Sato, Takagi, & Asakawa (2013), the authors noted how elderly people often made incorrect presses on a touchscreen or interacted with the touchscreen without the system registering it as a press. This was identified as a major cause of frustration and confusion for older people and this could lead to them to stop using such devices. Undetected button presses were also observed and this was thought to be due to dry fingers, noted by several of the participants. Nicolau & Jorge (2012) also analysed older participants use of touchscreens to measure errors when typing. They found that inaccuracy of typing was largely determined by hand tremors. The use of tablets rather than mobile phones helped prevent some errors due to its larger size, and the authors also suggest a few other improvements, such as a delay to prevent insertion errors and remapping the keyboard to reduce substitution errors. They did not compare performance to a keyboard, nor did they assess their experience in an in-depth way, instead relying on a 5-point Likert scale, where participants rated both devices very highly, which even the authors thought was surprising considering their difficulties, and is likely not representative of their true feelings, but due to not wanting to be rude to the experimenters.

Docampo Rama, Ridder & Bouma (2001) described two reasons that older adults encounter difficulties with technology. The first reason is a decline in ability due to age-related impairments, but the authors also found that users that had experience with computers and software user interfaces in early adulthood appeared to perform significantly better than those who did not. They attribute this phenomenon to generational theory, which states that experiences a person has before the age of 25 are more persistent than later ones. Williams et al (2016) also outlined some of the challenges of designing for elderly users. For example, they mention how designing for failing vision is an important consideration for elderly users, as well as designing with a decline in cognitive abilities in mind, such as poorer memory. In addition to sensory and cognitive challenges, older users may also find themselves with 'generational' challenges, which means that it can be more difficult to interpret the meanings of icons, for example. They explain how devices and apps that market themselves as 'intuitive' are only intuitive for those who have learned to interact with similar devices and other mobile applications. Elderly people are said to prefer to read a step-by-step manual. This argumentation is compatible with 'generational theory' as outlined by Docampo Rama Ridder & Bouma, where mental models of technology are largely determined by early exposure to similar technologies shapes their expectations of how things work and what they can do.

When it comes to computers and devices, elderly people place a high amount of trust in automated systems and tend to blame themselves when they encounter errors (Ho, Wheatly & Scialfa, 2005, Wallace et al., 2010). This observation is also noted by Norman (2013), who explains how people often blame themselves for errors when encountering a bad design, where the mental model of a user is contrary to the conceptual model of an

object. This is compounded where affordances are not perceived due to lack of signifiers or due to perceived false affordances. He advocates the use of designs where the intended way of using an item is discoverable, which means that the way the item is meant to be used can be inferred from the features of the design. For older people, this can mean that devices have familiar forms to their function, in line with generational theory. The importance of discoverability is shown in Leung et al. (2012), who demonstrated how elderly users are less likely to experiment when trying to learn new technologies. If the functions of a device were more apparent from its form, it would be easier to experiment with. In the absence of such perceived affordances, older people are more likely to want to have instruction manuals to tell them how the device works rather than experiment for themselves.

Despite these problems, there are some older people that do make use of modern technology. Wagner, Hassanein & Head (2010) list what the most common uses of IT are among elderly users, which includes communications, leisure and information-seeking. However, they also list some of the barriers to IT use, which include a lack of knowledge, lack of access or lack of perceived benefits. In Britain in 2013, only 39% of adults over 65 used the internet (Dutton, Blank, & Groselj, 2013), though in 2017 the figure was slightly higher, with 78% of people between 65-74 having used the internet, but it was only 41% for people over 75 (Office for National Statistics, 2017). Jung & Sundar (2016) investigated how elderly people interact with Facebook, and they saw that older people used it as a communications platform, and that using the communicative features of Facebook lead to greater Facebook usage overall. It was argued that they used Facebook to achieve a social presence, particularly with grandchildren. However, many of the questions were close-ended, and only focussed on a limited number of factors.

There have been attempts to adapt modern devices to make them more usable by older people. Ziat et al (2016) created a tangible user interface for touch screens for elderly users. This interface allowed users to interact more easily with a tablet, but some of the functions of the tangible device itself were not evident from its form, which consisted of a selection of different sliders, switches and dials inside a rectangular box, and its effectiveness was not known as it had not been evaluated by older people. Peter et al (2013) used a different approach and utilised novel, multimodal means for elderly users to interact with technology, including an illuminated curtain and a tangible device. The ambient displays were valued by participants as it meant that they did not have to check other, more complicated devices as regularly. However, the devices used for this study lack familiarity, and the function was not always clear from the design. In addition, the results suggested that older people found some of the items were bulky, unwieldy or impractical in one or more ways.

Many of the studies mentioned are an attempt to improve usability of existing devices or to create novel solutions without deep understanding of how older people feel about technology in their life. McCarthy & Wright (2005) outline how "felt-life" at the centre of human computer interaction (HCI) can address issues such as resistance, identity and attachment, all of which are not otherwise addressed with HCI. The authors say that it allows researchers to model people as having preferences, priorities and values, and not focus on making things that are only 'usable'. However, there are some studies that tried to

obtain a fuller picture of older people's daily lives to better understand their requirements. Alaoui, Lewkowicz & Seffah (2012) conducted interviews with 10 older people to understand their needs, particularly with regards to what their daily life looks like, how they communicate with family and friends, how much they use their television, and how much they use new technologies and the internet. Based on these interviews, they constructed three personas and scenarios before creating a mock-up of a television-based communication service. However, they did not evaluate their prototype with older people, and since their prototype uses unfamiliar terminology such as 'signing in' to an online service, it is unclear how older people would have reacted to it.

Rice & Alm (2008) investigated how to design digital television for an older audience with strong considerations to generating user requirements, pointing to criticisms of some HCI methods when dealing with older people, namely that they were one-directional and offered little insight and complaints due to limited understanding of the concepts. They used participatory design in to empower the older people and involve them in the design process via interactive theatre. Using the requirements that they generated, they created a prototype where participants used a simple remote control to interact with a prototype that allowed them to send and receive video messages. Participants were largely positive but were confused by the function of the buttons labelled 'out' and 'in'. While this study took consideration of users' needs, the unfamiliarity of the two of the six buttons led to problems understanding their function, something that might not have happened if they were more similar to buttons on remote controls that the participants owned themselves.

It is the objective of this paper to try to gain a deep understanding of older people's attitudes towards technology as well as their technological habits in order to create a solution that is not only user-friendly, but also enjoyable and compatible with the habits of older people. This paper takes a stance that combines both an in-depth understanding of the target audience's requirements with a design which has a familiar-looking interaction method that will allow the functions to be easily discoverable and similar to technologies in previous decades, an approach which, to the author's knowledge, has not been widely explored.

1.2 Research Question

The present study investigates how older people use technology for the purposes of communication, leisure and information seeking, as these are the most common reasons for technology use for older people, as described by Wagner, Hassanein & Head (2010). It aims to develop a grounded understanding of technology use for this age group, and construct its findings using an inductive, bottom-up approach, meaning that the analysis starts with making specific observations and develops generalisations and theories from them, rather than trying to adapt existing technology. In addition, it creates an inventory of frequently used devices and analyses the most common interaction methods, such as different types of buttons and tallies them in a table. Both the interviews and the inventory are used to create a set of design considerations when designing for older people.

This approach aims to create design requirements that minimise resistance for older people accessing online services such as streaming music services, streaming video services and news websites by creating a device or service with a familiar look and feel to devices

that are commonly used by older people. Without knowing whether this approach can lead to better understanding of older people's technological habits or requirements for technology, then it is possible that researchers will continue to rely on other methods, such as A/B testing, even if the results they generate would be less meaningful and relevant for older people. Instead of trying to refine devices such as smartphones, computers and tablets for older people to make them 'less unsuitable', this paper could potentially be used to create a design that starts with the key requirements of older people in mind.

The research questions of this thesis are:

1. What technologies do older people use and enjoy using, and how can the designs of these devices help older users use online services?
2. How do older people feel about modern technology, such as computers, tablets and smartphones, and what are the barriers to their use?

2. Method

Participants were questioned using semi-structured interviews about what items in their homes they interacted with regularly, as well as their attitude to using modern technology and their perceived barriers to their use. To determine what items elderly people are comfortable using on a regular basis, this study used a method inspired by the Personal Inventory Study outlined by Jung et al (2008). Their study introduced a two-step method that used cards with adjectives on to help users to create a digital ecology by arranging them into groups and talking about the connections between them. This method allowed researchers to gain a good understanding of how technology was used within participant's own homes. The first of the two methods involved creating a digital inventory, and the second stage used the results of the first to construct a map of interactions between devices. This second technique might have been difficult for some of the more technologically-naïve participants, so the second half of the methodology was not used, and the first half was adapted slightly to remove the use of having to write adjectives after a pilot run found that the participant struggled to understand the concept.

The current study started by asking participants to list all the items that they feel that they interact with frequently onto cards, and this was divided into three separate questions, asking which devices in their home were often used for the purposes of communication, leisure, and information seeking. This could include non-electrical items such as newspapers or diaries so that participants could talk about how they use alternatives to electronic devices. The cards are used to create a personal inventory of digital artefacts for each participant, as well as to act as memory prompts during the interview. Participants were then asked about how they feel about these items, how often they are used and how they are used. After talking about their current devices, participants were asked how competent they felt with modern technology, and then asked how they felt about them, and whether they could see a benefit to using them or not.

Photographs of the devices that participants use frequently were obtained after the study, and the different types of interactable elements were categorised based on their form and function, for example, directional buttons on a television remote, or volume up/down

buttons. Buttons and other interfaces from devices owned by at least two participants were tallied and put into a table. This novel approach aims to reveal the nature of the interfaces of devices that participants use routinely, though it was a time-consuming process. Based on the results of this, a set of design considerations was developed that makes use of the features of these devices to create an interface to an internet-based service relating either communication, leisure or information-seeking.

The semi-structured interviews were analysed using a qualitative method outlined by Clarke & Braun (2014), known as thematic analysis. It aims to provide meaning to patterns across a data set, allowing a researcher to rationalise a set of shared meanings and experiences. It also aims to find commonalities between different data items, though the authors note that things that might be common are not necessarily important as they must be important to the topic being examined. Brown and Stockman (2013) examine the use of Thematic Analysis in HCI, and they argue that based upon the type of information needed, researchers could choose to either perform a complete six-step analysis or a partial, three-step analysis. When the goal is to provide a high-level thematic map with an accompanying analytic narrative the six-step method is used, and for a low-level analysis when the goal is to improve functionality and usability then the three-step method is used. The present study will use the six-step method, as the study aims to create a new type of interaction rather than improve existing ones. Using interviews with a thematic analysis allows for a much more in-depth understanding of the thoughts and feelings of participants and allowed the researcher to ask relevant questions when participants started to talk about interesting ideas, though the process is time-consuming and requires more effort than methods such as questionnaires.

The first stage of the Thematic Analysis is familiarising the data, which involves reading the transcripts several times and making general notes. The second stage involves coding the data, and the codes aim to identify specific features of the transcripts that are relevant to the research question. Once one code is identified, the transcripts are searched until all instances of that code were identified. The third stage involves searching for themes, and each theme aims to capture patterned responses that say something important in relation to the research question. They are constructed from the codes, and codes are grouped based upon similarity and overlap. Codes are not exclusive to any one theme, and were often used in multiple themes. Each theme is reviewed for the fourth stage, which involved ensuring that the themes are compatible with the data itself, and ensuring that each theme is neither too broad nor too narrow. The fifth stage involves defining and naming the themes, and the sixth involves writing the report.

2.1 Participants

The seven participants were chosen with purposive sampling, meaning that the participants were chosen because they are above the age of 70 and lived in the United Kingdom. This location was chosen so that nuances in participant's speech could be detected more easily by the interviewer, who was also from the United Kingdom. All participants lived in their own homes and not in retirement homes. Participants were invited to a location where a computer and webcam were already set up and ready to begin

a Skype call. Being able to use Skype was not a prerequisite of the study as this had been set up in advance. Audio recordings were made with a tablet on the participant's side of the interview and were sent for transcription afterwards.

	IM	AG	SG	BP	LM	EV	EDG
Age (at interview)	84	76	78	100	80	78	78
Sex	Male	Female	Male	Male	Female	Female	Female

Table 1: Participants' age and sex.

The participants for this study were all residents of medium-sized towns in the east of England and were aged between 76 and 100 years old (median age: 78), of which three were male and four were female, as shown in Table 1.

2.2 Ethical Considerations

Participants were given informed consent forms which outlined the purpose and the goal of the study and they were free to withdraw at any time. The participants' full names are not used in this paper to protect their privacy. This study exposed participants to no greater risk of harm than in day-to-day life, and the benefits of this study could mean that technology could be more accessible for older people, without some of the negative aspects that older people could be more concerned about, such as use and sharing of personal data. Information gathered for this study was not shared with any third parties and was only used for this study. Each participant received the same treatment and performed the same task as all the others.

3. Results

The results of the personal inventory study are shown in Figure 1, and it shows all devices that the participants used for communication, fun, and getting information. All participants owned and used a television regularly, and most participants owned a home phone and a mobile phone. Only two participants, SG and EV, described themselves as feeling competent with modern technology, and they owned the joint highest number of devices (six), including two of the three tablets. Despite five participants owning a DVD player, only LM used it regularly. BP couldn't use his due to trouble bending down, EDG did not know how to use it, SG preferred to use his PC, and IM and AG did not mention it during the interviews but were found to have one when photographs were taken. Technology that was not used regularly (by each participant's own standards) was not counted in this table. If more than one of each item appeared in a participant's home, only one was counted.

	IM	AG	SG	BP	LM	EV	EDG	Total
Television	✓	✓	✓	✓	✓	✓	✓	7
Home Telephone		✓	✓	✓	✓	✓	✓	6
Mobile Phone	✓	✓	✓		✓	✓	✓	6
Radio	✓	✓					✓	3
Tablet		✓	✓			✓		3
Printer			✓			✓		2
MP3 Player		✓						1
PC			✓					1
Hearing Aid				✓				1
Medical Alarm				✓				1
DVD Player					✓			1
Digital Sewing Machine						✓		1
Security System							✓	1
Total	3	6	6	4	4	6	5	34

Figure 1: Digital Inventories for each participant of items in their home.

The features of the interactable elements of these devices were extracted and an extract of the most common elements are presented in Figure 2. The figure shows that physical buttons of various kinds were the primary mechanism for interacting with most devices, and that touchscreens were not common. Only three participants owned a touchscreen device.

	TV/ Remote (8)	Mobile Phone (6)	Radio (2)	DVD/ Remote (4)	Tablet (3)	Printer (2)	Home Phone (5)	Total
Power/standby	8	3	2	4	3	2		22
Numpad	7	4		4		1	5	21
Up/down	6	3	2	3	3		3	20
Directional pad	8	3	1	4		1	2	19
Colour buttons	7	3	1	1		2	2	16
Mute	8		2	3			2	15
Play, pause etc.	7		1	4			1	13
Menu	8			4			1	13
OK or enter	7			3		1	1	12
Return or back	7			3			1	11
Exit	5			1			1	7
Touchscreen		2			3			5
Home	5							5

Figure 2: Common interactable elements on devices in participant's homes. The number in brackets indicates the number of unique devices in the entire study.

This list in Figure 2 includes items that were not talked about or not used, as these were still 'familiar', even if they were not used. Any identical interfaces that were found in more than one household were counted as only one item in this table (for example, many participants owned one brand of TV remote, which was only counted once). Devices that were only used by one participant are not included, as these tended to be more specialized devices.

3.1 Thematic Analysis

The interviews lasted between 15 and 35 minutes, and transcripts were made from audio recordings. 26 codes were identified through the analysis of the transcripts, and only one was not used to construct a theme. The reports for each theme are as follows:

Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
"Too old for that now": modern technology is not made for older people.	"I wish I could be able to do that": Barriers between desire to use devices and their use.	"We haven't been brought up in this day and age": Generational differences in understanding technology.	"You lose that personal bit, don't you?": The argument for not using modern devices.	"Is technology a good thing?": Wariness towards modern technology.

Table 2: List of themes created from interviews

3.1.1 Theme 1 - "Too old for that now": modern technology is not made for older people.

This theme is about how technology is seen by older people as something that is not intended for them or as something that is not beneficial to them specifically. When participants were questioned about modern devices, they often responded by saying that they were 'too old' to use them, often stating that as they get older and technology progresses that they feel more and more distant from it. In one example, participant IM blames himself for not 'getting into' modern devices sooner.

> IM: You know, I'm old now. And as I said to [neighbour] I should have gone into all this when I had a nice neighbour, across the road, and he was alive, and he always used to say to me in the early days "get a [smartphone]." And I used to say, "what do I want to get that for?", but I wish I had now because all the technology baffles me now.

It is apparent that IM feels that he could have been more knowledgeable about technology now if he had kept up with it when it was new. Participant BP, the oldest participant at 100 years old, also said 'I mean you only find it harder when you get older don't you?', and given his age, one would assume that he has more experience about this issue that the other participants, having seen the gap between his knowledge and technology increase for a longer time. The participants also described how they feel that modern devices were not

explicitly for older people, and many participants said that the benefits that they bring did not belong to them, but to younger people. The following quote is a typical example of how some older people feel that modern devices are not for them.

ABC: How do you feel about devices such as smartphones and computers?

LM: Well, I suppose to people like yourself or my daughter, they're handy for them, but it wouldn't be any use to me.

Despite not seeing the use of modern devices to her, she is aware of some of the benefits of using modern devices, describing how younger people can use them for online banking and shopping. Distancing herself and her peers from the benefits that she knows that the devices can bring suggests an innate belief that technology is primarily for people younger than her. In fact, many participants relied on younger people to help them obtain the benefits of technology, such as IM, who gets his younger neighbour to help him paying bills and printing documents.

IM: I come over to [neighbour] and he puts all my heating bills, you know, he don't pay them, but, he puts that all through the internet, which is a good thing, and he gets my bill for me and he prints it out, and all I have to do is to go up to the town and pay it. That's a good thing. And, like, he sends money to my daughter, which is a good thing.

Even one of the more technically minded participants, who uses a tablet and has used a computer in the past, says that she sometimes needs help from younger people to get the full benefits from technology. EV said '*I mean I have had help from my next-door neighbour and my son. I mean, it's not been all my knowledge because I'd be telling lies.*'

Other participants struggled to see any benefits at all, at least to themselves. When asked how she felt about modern devices, EDG failed to see how technology is beneficial to her or her daughter.

EDG: I don't feel that it's progress. I honestly don't, some of the things that are happening today... I keep saying to [daughter] "well, where is the progress?". There's supposed to be progress, where is it? And she agrees with me because she isn't into computers.

It is reasonable to assume that EDG feels that modern devices are unbeneficial, but also that they come with their own problems, some of which will be further discussed in subsequent themes.

3.1.2 Theme 2 "I wish I could be able to do that": Barriers between desire to use devices and their use.

This theme outlines how many older people can see the benefits of modern technology but are prevented from using them due to a lack of knowledge, physical limitations or due to costs. As mentioned in the previous theme, older people often rely on the knowledge of younger people to help them use technology, and this is largely due to gaps in their own knowledge. Not knowing how to do something is the first barrier to use of technology, as AG says, 'If I can't use it, I don't bother with it'. This is a common problem among the older population, as EV explains:

EV: Nothing's got an instruction book. So, you're sitting there, and if you don't learn, it doesn't get used. So, that's what's holding people back. Not because they haven't got a brain, because they haven't got the knowledge of how to do it.

Despite being relatively competent with tablets and computers, EV explains how the lack of knowledge of how to use something is a major barrier to her peers' adoption of technology. The lack of instruction manuals she mentioned is another barrier to learning, and she recounts how her expensive, modern sewing machine did not come with instructions and how she had to apply to get an instruction manual. The preference older people have for instruction manuals also reduces their desire to use trial and error. Combined with the fear of making errors, this represents a barrier that is hard to overcome. EDG explained how she doesn't use a DVD player because nobody taught her, and because she doesn't have a manual.

EDG: Yeah there's [a DVD player] in there but I wouldn't know how to use it because [relatives] never come in here to show me. Never sit with me long enough.

ABC: Yeah so this… do you… use trial and error or use instruction manuals when you get these devices?

EDG: Oh, I always try to read instructions but sometimes they can be confusing, can't they?

Later, EDG also recalls an incident where she pressed an incorrect button and encountered an error that she could not resolve, an example of how making unresolvable errors can disincentivise learning by trial and error. She said '*Well sometimes I press the wrong button and got something incorrect come up and I've not known how to get back to my program.*'

In addition to the lack of knowledge, sometimes the problems with technology were more physical in nature. For example, SG, who is fairly competent with computers and tablets, found that touchscreens were harder to use than a computer.

ABC: What would make the tablet easier?

SG: If I could put a mouse on it, I think.

ABC: Yeah, okay. So, you have trouble with the touchscreen itself?

SG: Yeah, I've got big fingers, so I have to use a little dabber thing [a stylus].

The small size of devices and buttons themselves were another big factor that made them difficult for older people to use.

AG: Because everything on it is too blooming small. It's got small buttons. And when you're getting old and you've got arthritis, you can't do it. Even the… well, you know what it was like when I used to text [grandson], my fingers were too fat, and I was getting wonderful messages. I knew what I was typing, but the thing didn't. So, everything is too small.

The messages in question contained words or letters than AG had not intended to type, but rather ones that came from mistakes with typing on a tablet. There were other age-related physical problems that hindered technology use, such as how BP was unable to use a mobile phone due to it interfering with his hearing aid.

ABC: Do you have a mobile phone?

*BP: No. No, you can't use them with these *gestures towards hearing aid*.*

He found that mobile phones, unlike his home phones, were impossible to hear with a hearing aid. He also mentions how he is less able to use his hands than he used to be and has problems with writing. This would also presumably be a limiting factor for using a smartphone. In addition to physical factors and the lack of knowledge, the cost of new technology was another barrier, and when combined with the other factors, made it even harder to justify getting new devices.

> *LM: Well, I will be honest with you, I don't need it, and mainly, it's another bill, which I can do without. You know, I think that if I was technically-minded perhaps I would, but I'm not.*

LM states that if she were more familiar with technology that the cost would not be an issue, meaning that cost is seen as a barrier only if there are other barriers that also prevent using new technology. Despite all these barriers, however, there is a prevailing desire to learn how to use these devices, even if the perceived barriers prevent them from making the leap to learning.

> *EDG: ...and [son-in-law] said to [daughter] "You really ought to learn [to use smartphones/tablets/computers]". I said to them the other day that if they did night classes up at the top of the hill at the school where [granddaughter] goes to, perhaps we could have gone together because they used to do night classes there but I don't think that they do now and I wouldn't know where to go to if I wanted to learn.*
> *ABC: So, if you knew where to go...?*
> *EDG: I would go with [daughter] and I would an effort to learn. Irrespective of whether I'd get confused, I'd make an effort...*

Many participants would not know where to look to be able to learn about how to use computers, smartphones or tablets, and combined with the other barriers, it is seen as too much effort by some.

> *IM: I would like to [use devices], don't think about that, I would like to use them, but I ain't got the knowledge now, and I don't want to put myself out.*

While it is clear that IM would like being able to use modern technology, he feels that taking the time to learn would be too much work for too little reward.

3.1.3 Theme 3 - "We haven't been brought up in this day and age": Generational differences in understanding technology.

This theme describes how older people feel that they think differently about how technology works and how they try to make sense of modern technology through metaphors with older technology.

Some older people reveal their mental models through their speech, most notably in this study with AG, who was using an MP3 player to play music, while constantly referring to it as a radio. AG made several references to 'skipping' tracks on her 'radio'.

> *AG: But if it's on there, and I don't like it, I just push the button and fast forward it... is that what you call it? Skip it? If I don't like it, I just... you know...*
> *ABC: What, change the radio station?*
> *AG: Well, if it's... well as I say, mainly what I listen to is the thing that's... and they've got the records on it. You know, just push the button and reject it and go on to the next one. Is that what the word is?*

ABC: So, is this... sorry are you talking about... are you changing the channel when you do that?

AG: No, it's just a... MP3? Is that what you call the little thing... that you... they've recorded...

ABC: Oh, you've got an MP3 player?

AG: Oh, I don't know. It's a little square thing. Like that.

This exchange demonstrates several revealing factors. Firstly, it implies that in her mind AG made sense of the MP3 player full of music that she was given as being like a radio, but with the functionality of a CD/Tape player, referring to skipping and fast-forwarding. She also refers to how the songs were 'recorded' onto the device, like how an audio cassette/VHS tape would be. There are many instances of participants either not knowing the name of something or referring to something as a technology that came before it. In addition to calling her MP3 player a radio, AG also exclusively referred to music tracks as 'records' and also forgot the name of her tablet on occasion.

AG: Well I'll tell you why I can't use the other things. My little... what is it? MP3 is it? No, what's it, the one that I type out... this thing *points to tablet*?

Other participants did this as well, with EV calling her smartphone a flip phone, presumably because it had a screen protector that could be flipped, LM, who played CDs in her DVD player and who talked about having a CD player, though it was later found that she did not have a conventional CD player in her house, and EDG referred to 'tapes' when talking about a DVD player.

EDG: I think [daughter] put [a DVD player] in there but... is that the thing where you can get films on it and you have tapes things and that?

These subtle clues, combined with the idea that modern technology is not made for older people from theme 1, provide some evidence to suggest that modern technology is hard for them to understand, and instead older people fall back on previously learned devices to use as a metaphor for understanding the function of modern devices. This is demonstrated again by both IM and LM, who describe a computer screen as a 'television'. This conclusion supports the study by Docampo Rama, Ridder & Bouma (2001), who suggest that memories made within a person's youth are more persistent, and may explain this phenomenon.

3.1.4 Theme 4 - "You lose that personal bit, don't you?": The argument for not using modern devices.

This theme explains how older people feel that modern technology can be cold and impersonal and how they would rather engage in social interactions wherever possible. Many participants explained how they would rather talk to someone directly than use modern devices. When asked if she used social media on her tablet, AG responded with:

AG: Don't be daft. Facebook. No, Facebook, if I want to talk to someone I'll go on the telephone.

AG's reaction suggests that she thinks that it is absurd to communicate via social media when a telephone can be used instead. This would indicate that AG feels that the telephone has a clear advantage over sending messages on Facebook, the most obvious would be hearing someone's voice and instant communication (assuming the other person picks up

the phone). Some participants also expressed a preference for shopping in high-street shops rather than online.

> LM: I'm a bit old-fashioned, I'd rather go to the shop and look around and buy it rather than do it on a screen.

SG, however, expressed how he does lots of shopping online, and due to difficulty walking, IM would prefer to pay bills online if he could. There is possibly a gender difference in preference towards shopping online, as all participants that preferred to shop in person (AG, LM, EDG) were female, compared to SG and IM who were both male.

Additionally, older people were likely to obtain information, communicate and have fun with something that is familiar to them, in fact, devices were often used most of the time, such as radios and televisions (though not at the same time). IM has his radio on 'all day long', AG alternated between her MP3 player and the television, and SG, who joked about his television, saying 'I don't think it ever goes off'. Participants often described the items that they used regularly as invaluable. This was not just limited to older devices, but also to newspapers:

> IM: I couldn't do without a newspaper each day. I go out in the mornings to get a newspaper, and I would be, sort of... done without it. I love looking at the newspaper and getting, like, the news and that.

Other participants also had items that they valued very highly, including BP who 'couldn't do without' his, television, newspaper and hearing aid, LM would be 'lost without' her home phone and describes the TV as her 'companion', and EDG describes her home phone, her diary and a home alarm system as a 'godsend'. However, EV, being more competent with modern technology, also says that she 'wouldn't be without' her tablet and doesn't 'know how people worked without WiFi before'. These statements all suggest a great degree of satisfaction with how they currently use items around the home, which might also be another reason that older people don't feel the need to use more modern devices, adopting an 'if it's not broke don't fix it' attitude towards their current habits. Despite this, many complained about how current broadcast media (TV or radio) was either repetitive, boring or annoying, often choosing to switch it off in that case. Many older people also had mobile phones, though being able to call from any location didn't necessarily mean that they would make use of them.

> AG: I don't... to be honest I don't use [mobile phone] much. But it's there for an emergency isn't it?

In fact, all participants viewed the mobile phone as being there 'just in case' and didn't make calls on it, apart from BP who could not use a mobile phone due to interference from his hearing aid. Despite this, AG, LM and EDG all described using their home phones regularly. AG attributes this to the mobile being too small to use properly, and LM and EDG described the increased cost as the problem. When the option was available, most participants preferred to use a larger and less mobile device, such as a home phone instead of a mobile (which tended to have larger buttons for most participants) or in SG's case, a computer instead of a tablet.

SG: [The tablet is] interesting, I quite enjoy playing a few games on it and things like that, but information stuff I'm having a bit of trouble with. Trying to get information out of it and things like that, I find it easier, as I say, on a computer.

When pressed to suggest what would make a tablet easier to use, SG suggested a mouse, and later, a keyboard, essentially turning his tablet into a computer. EV also shunned the touch-screen interface of a satnav for a printed map, which might suggest that touchscreens are not ideal, however EV did replace her PC with a tablet, though this was mainly due to The PC requiring updates and getting viruses regularly.

3.1.5 Theme 5 - "Is technology a good thing?": Wariness towards modern technology.

This theme lists concerns and fears that older people have about new technology, and how they see it as being harmful to themselves or society in various ways. Some of the participants felt afraid of modern technology, and felt that it was, at least in some ways, a bad thing. IM said that he felt 'afraid' of modern devices, and EDG said that modern technology 'frightens me to death sometimes'. While EDG does not explicitly say why she is afraid, it could be linked to the revelations about use of personal data by Cambridge Analytica that were in the news at roughly the same time as the interviews, especially given that she references 'some of the things that are happening today'. This story, in addition to other similar abuses of technology that make the news probably contribute to older people's apprehension towards it. IM also felt that technology was bad in some ways:

IM: I think the computer is terrible. It's as good as it is bad. And I know that you can get good things come off it, like I'm talking to you now [via Skype]. But there's been some nasty things happen as well. And that's what I think about the computer and technology. In one way it can be good, and in another it can be bad, can't it?

In addition, some feel that technology is a threat in other ways, such as how some participants felt that online shopping was a threat to the high street shops. LM believes that online shopping is largely responsible for shop closures:

LM: I know it's easy, you just sit in front of the television and you look it up, but the only thing is that it is doing shops out of business. I mean in [town] there must be about three or four shops that have shut mainly, I think, through that.

AG also believes that online shopping is harmful for the high street shops. She is particularly concerned with automation replacing people's jobs.

AG: I suppose that's a good idea, but if everybody did everything online we would end up with no shops because nobody would go to the shops, would they, so you'd have people out of work because there is no shops, going to the bank, if you didn't go to the bank the banks would shut down wouldn't they, yes? So, all this communication and this online stuff must have a downside to it.

Later, she also voices her concern about driverless cars, and how automated systems were to blame for a neighbour's long wait in the local hospital's accident and emergency department.

AG: I mean this is the thing where computers and all this lark has taken over, and they're not doing a good job of it are they? Because nobody is going to be as good as a person. Sorry, but I don't think so.

These statements reveal a deep mistrust of technology and a feeling that automation and 'robots' are threatening to her preferred way of life. Even if there were other factors that contributed to shops closing or long wait times at the hospital's accident and emergency department, a few participants chose to blame technology. EDG felt afraid of people using technology to store information because she was worried that the computers might break down.

> EDG: I've heard that sometimes the computers break down and they lose all their information. Don't they? So, I can't see where it's truly advantageous. I mean people log things on don't they… is that the expression? They log it all on and then they lose it…

It is apparent that some of the fears about modern technology come from either traditional media stories, such as TV or newspapers, or a lack of in-depth knowledge. EV talked about how her fear of making errors in the past was mediated by a lack of knowledge of the outcome of her actions.

> EV: …my son said you can't do nothing wrong. You know, if you press a button, it won't go wrong on you. Even if you delete something you can go and find something and put it back. So, it's like I do have a go now, and sometimes it takes you somewhere you haven't been before.
>
> ABC: Before that, were you more afraid to use trial and error?
>
> EV: Oh yeah, I just wouldn't use it. Yeah, I wouldn't use it because I didn't know what would happen.

To those who are not as knowledgeable about technology, this can create a cycle of being afraid of making errors because of a lack of knowledge, thus preventing learning by trial-and-error and reinforcing their lack of knowledge. Fortunately for EV, the knowledge that her son gave helped to break the cycle, leading to her having relatively high knowledge of technology, and consequently being a frequent user of devices.

4. Discussion

The research question aimed to both identify current trends among older people's current use of technology, as well as to understand their attitudes towards modern technology. The first question was divided into three parts, communication, leisure and information gathering, the main reasons that older people use the internet as described by Wagner, Hassanein & Head (2010). Most participants in this study, however, used alternative methods for these three purposes.

For communication purposes, most older people had a mobile phone, though they rarely used it, instead keeping it around 'just in case'. If our sample wanted to call people to talk, most of them did so in their own home most of the time. This is partly due to the extra cost of having a mobile, but mostly down to personal preference.

All the participants used a television for leisure, but few used DVD players. A similar story is true for radio users, who did not tend to use CD players often. There was a trend towards broadcast media, although many participants found that repetitive, but settled

with it instead of seeking alternatives. The television remote control was the primary input mechanism among the participants.

Many older people relied on newspapers, television and radio for receiving information. Only two said that they actively sought out information, while the others only passively received it. A calendar was also commonly used to display information about upcoming events, appointments and birthdays.

In our sample of older users, only two felt confident with using modern technology, with many choosing to use familiar devices that they felt met their needs well enough. They were aware that the technology exists, but often didn't use it themselves due to perceived barriers. Of the three touchscreen users, two experiences difficulties such as the ones outlined by Nicolau & Jorge (2012).

## 4.1. Design Considerations for Older Users

From the interviews and personal inventory studies, a set of design considerations were created for designing for older users. The design considerations were heavily inspired by the generational challenges described by Williams et al (2016), as well as generational theory as described by Docampo Rama, Ridder & Bouma (2001). Many of the most-often used devices are very similar in appearance and function to devices that the participants would have used in their youth, such as telephones.

The design considerations are intended to minimise barriers to accessing online services used for communication, leisure and information seeking, as well as to be a 'good fit' for how older users currently use technology. Table 3 summarises observations from the study and how to design more suitable devices for older people.

Observation	Design consideration
Touchscreens are not intuitive or particularly usable for many older people	Use buttons where possible, especially if they are familiar and common to other devices
Older people often use metaphors to understand technology	Take advantage of metaphors to create services that mirror more traditional devices
Older people can struggle with small buttons and devices and often don't use small devices outside of the home	Make devices larger and easier to see and use, with larger buttons, even if devices are less mobile
Older people can be very wary about their personal and financial data	Do not ask for personal data, and use gift card redemption if money is required for a subscription service
Older people often prefer to communicate in a more personal way	Ensure that all communication services are at least as personal as a phone call
Older people are unlikely to experiment with or use devices they don't understand	Ensure that every device comes with an instruction manual

Table 3: Observations and related design considerations

Firstly, touchscreens should not be considered as inherently 'intuitive' to those who did not have access to computers in their youth. Unless they have used technology such as a computer for many years, many of the older people in the sample lacked the mental models of computers that younger people have. They can also be a source of frustration, as noted in Harada, Sato, Takagi, & Asakawa (2013). Only three of the seven participants used touchscreens, and two of them experienced physical difficulties with them and had trouble typing with them, especially if they were small, such as in smartphones, which is also consistent with Nicolau & Jorge (2012). Instead of using touchscreens that can be difficult for older people to use, the interface should use buttons present in most television remotes, as shown in Figure 3, as all participants could use televisions, and used them regularly. Many devices also featured 'media control' buttons common to CD players, DVD players, tape players and some remotes, such as play, pause, skip, fast forward and stop.
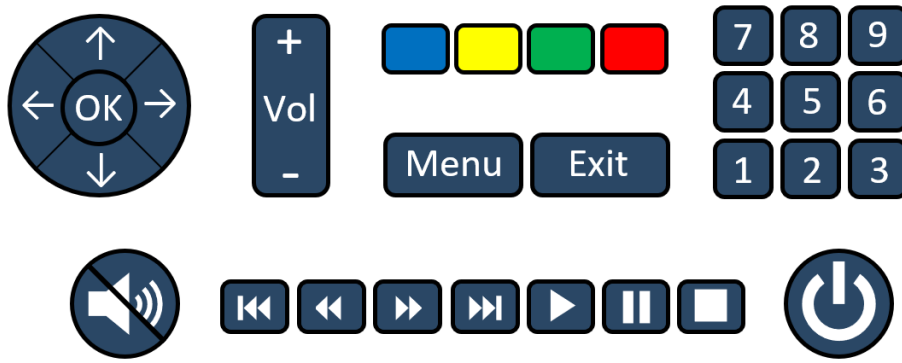
Figure 3: Common buttons found in older people's homes. From left to right: directional pad with okay button, mute, media controls (skip back, rewind, fast forward, skip forward, play, pause, stop), coloured buttons, menu button, exit button, a numpad and standby/power off button.

The familiarity of these types of buttons is so widespread among older people that there should not be any significant barrier to understanding their function, which would encourage learning by trial-and-error that some older people are afraid to do with more complex devices, as noted by Leung et al. (2012). In addition, they are easier to use for people with arthritis than touchscreens.

Secondly, technologies should attempt to make use of metaphors that describe their function in terms of older technologies, such as any music player being described as a radio, much like how AG described her MP3 player. This can include calling online streaming of non-live media a 'broadcast' or a 'station'. By doing so, it gives older people a familiar mental framework of what the service does and how they can interact with it, overcoming some of the generational challenges described by Williams et al (2016).

Based on the interviews, participants often watched or listened to media that was being broadcast and didn't often seek their own choice of entertainment, evidenced by low use of DVD and CD players. If they did, however, an on-screen keyboard could be controlled with a directional pad and an okay button if participants want a specific song or program, which should change the current 'station' to the one that they searched for, and should continue playing a computer-generated playlist until a different station is selected.

The third consideration is to make devices relatively large and with large buttons. As most older people prefer to use technology while at home, mobility of the devices should not be a priority. Many older people have difficulty in using small buttons or reading small text, which can lead to devices not being used. Another advantage of being in a fixed location is that it can be powered through electrical outlets and not rely on a battery, which is compatible with how older people often use media devices for many hours everyday.

The fourth consideration is that older people often do not trust technology with their personal data. Efforts should be made to ensure that older people do not need to enter personal information to be able to use devices to their full potential. This also includes not needing older people to enter bank or credit card details to pay for subscription services. Instead, if a subscription is required, older people should be able to purchase gift cards in

stores and activate them through their devices, using a numpad to enter the codes. While this is not intuitive, it at least gives older users an option to pay without entrusting their personal data to a machine that they might not trust, but it is also entirely optional.

The fifth consideration is that our sample often prefer to communicate in a highly personal way. This means that they would rather use a telephone than send text messages or emails. Any new device that would be less personal than a phone would not be used when a phone is available. Considering this, devices need to be at least as personal as calling someone on the phone, and it would also need to be at least as cheap as a home phone to use. There are many apps that allow users to communicate with calls or video calls, and many are either free to use or cheap, which would provide advantages over conventional phones. With the added functionality of video calling and messaging, it may be enough for older users to consider using the new device instead of a phone.

The final consideration is that all devices should come with instruction manuals. Participants sometimes remarked that nothing comes with manuals any more, and one had to search online to find a manual. Even if the interface is designed to be simple, having a manual gives the users more confidence to use the device, as lack of confidence and a fear of errors was determined to be a barrier to the use of technology, consistent with the findings of Leung et al. (2012). In the absence of a manual, devices go unused unless they are able to ask other people, mostly younger people, how they work.

4.2 Illustrated Design Considerations

Using the design considerations previously mentioned, and some of the design principles such as discoverability and perceived affordances from Norman (2013), a design for a simplified online service was created. It uses a remote control device that features many familiar buttons, as well as a few new and specialised buttons for radio, news, phone and internet. It was designed to be connected to any regular television as its screen, and the only other hardware it would require is a webcam mounted on the top of the television for the video calling service.

Figure 4: Design for accessing streaming music services via a television and remote control interface.

When the radio button is pressed on the remote, this interface appears and immediately begins playing whichever station was last playing. Users can change the station by pressing the channel up or down buttons, or typing in the station number that they want directly, as well as by using the directional pad and pressing okay or play when a different station is selected. The channel list features both existing radio stations (1-99) as well as automatically generated streaming playlists (101+), such as those used by Spotify or Last.fm. Additional 'stations' can be created by searching, which is initiated by pressing the blue button as instructed, and then using the directional pad and okay to type out a search query, which attempts to generate suggestions based upon what is being typed (autocomplete). Users can navigate to these suggestions using the directional pad and select them, which adds them to the radio station list.

As the music is streaming, users can pause the current song or skip to the next as though it were a CD or tape player, which is something that older people would likely have had some experience with. The service would be free, but come with adverts. If users wish to listen advert-free, then they will be able to redeem gift cards by inputting the numbers via their remote. Of course, users will be given a physical instruction manual that explains each step in a simple and easy-to-follow manner.
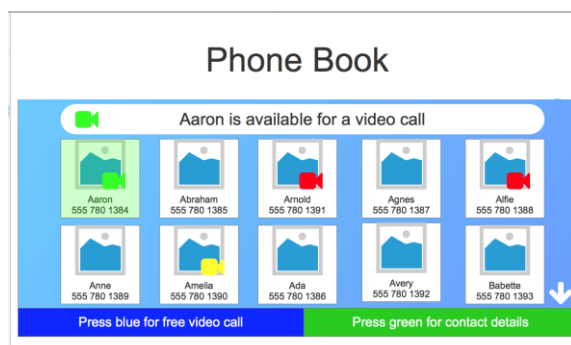

Figure 5: A video phone app

Figure 6: A news app

For communication, pressing the 'phone' button would bring up a list of contacts, and display the status of contacts who have video calling capabilities. The menu could be explored with the directional pad, and pressing okay or green would open a particular contact, which would display phone numbers and other information, and if video calling is possible, pressing blue would allow the user to create a video call, using the television-mounted camera.

News could also be collated in a similar way. By pressing news, a list of headlines from one online news source would be displayed, and the source can be changed by pressing the channel up/down buttons. The headlines can be navigated with the directional buttons, and an individual news story can be selected with the okay button. Users can return to the headlines by pressing back or news again.

4.3 Implications

By designing digital devices in this way, it could serve as a more accessible introduction to the internet for older people than tablets, which as Harada, Sato, Takagi, & Asakawa (2013) mention can cause frustration due to difficulties with the touchscreen interface. It allows older people to access online services that would previously be too difficult for them to access, either on a computer, smartphone or tablet. For example, older people could be able to access video calling services to contact younger relatives also on the service, access streaming media as an alternative to broadcast media, which participants often expressed dissatisfaction with, though they often just put up with it due to a lack of alternatives, or find news articles without waiting for the news broadcasts, or waiting for the newspaper the following day. Other applications could also be developed that use a television-style remote control to allow older people to do many other tasks that would have previously been inaccessible except by learning how to use a tablet or computer.

The design might have a wider audience than just those older people alone. While some of the specifications are specific to addressing generational differences, the button-style interface might be easier for people with problems with fine motor control to use than a touchscreen, such as those with Parkinson's disease. Additionally, the simplicity of the interface could make it suitable for people with learning difficulties, people with dementia or people that are less knowledgeable about technology in general.

Some of the design considerations could also be used in technology that is not designed specifically for older people. For example, tablets were described as having buttons that were too small to use by older people, and by making them larger it could increase their usability by older people and expand the market for such devices to include them.

4.4 Limitations and Further Studies

The biggest limitation of these design considerations is that they have not been evaluated by older users due to time constraints. Despite the proposed solutions being based upon resolving the problems faced by older people, there is no guarantee that they

would be adopted and used by older people. Future studies could evaluate a prototype similar to the design presented in this paper to determine if the conclusions match up to the needs of the older users. This could be done using observations of participants who are given the prototype, an instruction manual and some tasks to perform without help from the experimenter. This will allow the experimenter to see if the prototype and the manual are easy and intuitive for older people to use.

Results from the thematic analysis are based on only seven individuals from a geographically similar location and ethnic origin, so may lack generalisability among the general population and may fail to consider cultural differences. Further studies could consider a wider range of cultural backgrounds to get a better picture of this problem globally.

Additionally, the thematic analysis yields themes are constructed by just one researcher, which might introduce personal biases into the results. However, many of the observations are consistent with the findings of the relevant research, which strengthens the results of this study. The interviews via Skype were largely unproblematic, except for participant BP who had to have questions repeated due to his poor hearing, and sometimes some minor connection issues affected the quality of the call, though the participant's responses were captured with a smartphone on their side so most of their comments were captured, though there were some minor skips in the recording for a few participants.

The designs may also be considered as a step backwards by older people who use computers and tablets regularly, although they are not considered to be the target audience. Despite this, the simplicity of the design might also appeal to other less technologically-savvy groups, or possibly even people with mild cognitive impairments or early stage dementia.

Another limiting factor could be that the conclusions made in this study will eventually become invalid when older people will have been more likely to use computers, smartphones and tablets in their youth. However, if we consider the generational effect noted by Docampo Rama, Ridder & Bouma (2001), then the last generation to have likely not had experience with modern-style desktop computing (e.g. Windows 95) by the age of 25 would be born in 1970 and would be considered as 'older people' when they become 65 in 2035, which is further ahead in time than the expected product lifespans of many other products, and not a limitation to these designs alone. For smartphones and tablets, this date becomes even later. The interviews also did not ask if participants were experienced at using computers at work, which some of them might have done, which could affect their familiarity with computers. While the technologies used in the future will inevitably change, the methodology behind this study could still be used to determine requirements for future generations of older people.

5. Conclusion

The objective of this thesis was to answer two research questions, namely to understand what devices older people use and enjoy, how the features of these devices can inspire the

design of internet-connected services for older people, as well as identifying attitudes towards the use of smartphones, tablets and computers. To answer the question, a semi-structured interview was performed with seven participants aged over 75 asking them about their use of technology in daily life, as well as their attitudes towards modern devices. In addition, an inventory of digital devices in their home was created, with accompanying photographs. Using thematic analysis of the transcript, five themes emerged, which were the feeling of technology not being made for them, perceived barriers to use of modern technology, generational differences in understanding how technology is supposed to be used, a preference for not using technology in certain circumstances, and a wary attitude towards newer technology in general. The personal inventory study found that all the sample used a television regularly, and that most devices that were used had many similar physical buttons and that very few of the devices that were used featured touchscreens.

Based on these results, a set of design considerations were made, which included using more physical buttons where possible, using metaphors to signify the purpose and affordances of the system, making devices larger in general, not requiring personal data, promoting more personal communication and providing a physical instruction manual. A simple design mock-up of a television based service was created with these considerations in mind, which could be controlled using a remote control similar to one found in the participants' houses. The sample is small and from only one small area of the UK and may not be generalisable to the general population. This system was designed to be tailored for older people, and to challenge the idea that mobile touchscreen technology is considered intuitive for older people, and to encourage designers to design for the needs of older people first, rather than try to adapt mobile apps to their needs. Further research can help to assess the viability of the designed prototype to test whether the design considerations are truly beneficial to older people.

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