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VICON

Virtual User Concept for Inclusive Design of Consumer Products and User Interfaces

Deliverable Report

D1.1: Beneficiary's needs and environment field study

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Deliverable abstract	The beneficiary's needs and environment field study identifies and describes key usability issues that people have when using specific consumer product types. The research focuses upon people with one of three common impairments and people showing combinations of these impairments.

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Executive summary

Detailed ethnographic research was carried out on a group of 58 elderly people who had a range of mild-to-moderate impairments; these users were identified as the beneficiaries of the VICON project.

Three types of World Health Organisation's (WHO) International Classification of Functioning, Disability and Health (ICF) were focussed on; hearing impairment (b230), vision impairment (b210) and manual dexterity (b710/730). The research comprised of a combination of interview and observational techniques and investigated the main usability problems which these specific users encountered when using their washing machine and mobile phone in a typical use environment.

No significant differences were found between the results for each of the user groups, so the results have been combined to indicate the main usability problems encountered by 'typical elderly people'.

The main problems which the user group encountered were:

Washing machines

- Removing and replacing the detergent dispenser
- Cleaning the detergent dispenser
- Cancelling a wash programme
- Labelling of the controls
- Cleaning the filter

Mobile phones

- Turning the phone on or off
- Making a voice call (specifically related to using the controls)
- Hearing and understanding speech during a call
- Adjusting the volume
- Using the main number controls
- Using the additional controls
- Understanding and reading the labelling
- Understanding the features and menu functions
- The keypad lock function

Users were asked to use the Doro PhoneEasy®410gsm phone to see how this specially designed product compared with their existing phone. The results showed that this phone proved to be a

significant improvement over normal, mainstream products and that; as a result, most of the problems which users reported on their mobile phones can be solved by following inclusive design principles and by focussing ones efforts upon the needs of people who might have mild to moderate impairments. What's more, the Doro phone is proving to be commercially viable.

Other findings of the research included:

Many elderly users did not use SMS text messaging nor add contact details to the phonebook on their mobile phone

Elderly users did not have problems recharging their mobile phones. Many were well prepared for this regular, but potentially tricky, task and had developed it into a routine.

Introduction

Task 1.3 aims to identify and describe key usability issues that people encounter when using specific consumer product types. These people are defined as the beneficiaries of VICON as they will benefit for the outcomes of the project. This group of 'users' should not be confused with the end users of VICON, who are designers and manufacturers.

The research will focus upon beneficiaries with one of three common impairments and people showing combinations of these impairments. These two groups are defined in the *Description of Work* (DoW) as;

- Users with one minor developed physical impairment such as visual impairment, auditory impairment, dexterity impairment.

- Elderly users with age related impairments – usually a combination of mild to medium of under 1 mentioned impairments. These can also be referred to as multiple sensory impairments.

The levels of impairment severity covered by this research will be mild to medium (as opposed to severe or profound) and these will be determined for each participant during the research process. The three forms of impairment will be visual, hearing and manual dexterity. These impairments were chosen because of the commonality of the afflictions, the effect it has on using consumer products (touch, sight and hearing, are the primary senses used when interacting with an inanimate object) and the partners involved in the project (RNID are experts in hearing loss, NCBI are experts in visual loss).

The consumer products to be investigated in detail will be washing machines and mobile phones. These are the two reference products that will be considered and re-designed using the VICON system in a later stage of the project.

The research will involve carrying out detailed ethnographical studies of the participants in their own home, or other typical use environments. The most important aspects of this research will be identifying key problem areas, looking for commonality within and between impairment groups and differing products, and presenting this information in an accurate but accessible and usable format.

The whole focus of this study and deliverable is on the beneficiaries and their needs as described in the description of work. However as there are two user groups in this project; beneficiaries and users (designers) we have included a brief study of VICON's Industrial partners' design methodologies in APPENDIX A.

1 Ageing and impairments

As referenced in the Introduction, the field study will focus on two VICON beneficiary user groups of people:

- Users with one minor developed physical impairment such as visual impairment, auditory impairment, dexterity impairment.
- Elderly users with age related impairments – usually a combination of mild to medium of under 1 mentioned impairments. These can also be referred to as multiple sensory impairments.

However, these two groups of people are not mutually exclusive, due to the type and severity of the impairments that the field trial is focused on; minor or mild to medium visual, auditory and manual dexterity impairment. These three impairments are all far more common with older people (65+) and the most common variants of these impairments are directly related to ageing; such as presbyacusis which is age related sensorineural hearing loss. For these reasons this study will be biased towards age related types of visual, auditory and manual dexterity impairments, and elderly users.

In this section the various types of hearing, vision, dexterity impairments will be reviewed as well as the ageing in general.

1.1 Ageing

The life expectancy of the world population has increased steadily over the last 60 years. In the US the estimated life expectancy (ELE) has increased by 14.3 years to 77.6 from 1943 to 2003. Currently the estimated life expectancy is 78.24 years in 2010[1].

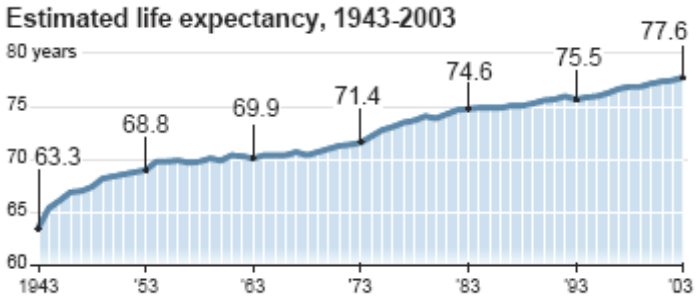


Figure 1 – Estimated life expectancy in USA, 1943-2003[2]

The global estimated life expectancy now stands at 67.2 (from 31 in 1900), but this figure does not highlight the varying geographical differences. The difference between the country with the highest ELE (Monaco, 89.78) and the lowest ELE (Angola, 38.48) is over 57%. Wealthy western countries tend to have the higher ELE than those of poorer developing countries. For example the average ELE of four of the VICON partners (UK, Ireland, Germany and Sweden) is 79.41, 18% higher than the global ELE.

Life expectancy has increased globally and is estimated to continue to increase, despite the deviation between wealthy and poorer countries. The repercussions of this trend are that the worldwide proportion of elderly population has increased.

[1] https://www.cia.gov/library/publications/the-world-factbook/rankorder/2102rank.html
[2] US Centers for Disease Control and Prevention

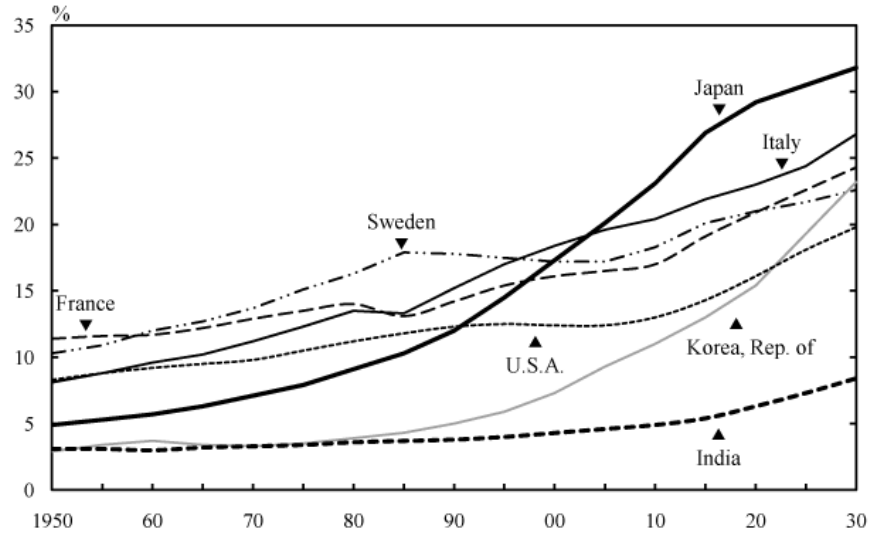


Figure 2 – Proportion of elderly population by country (aged 65years and over)[3]

The graph above shows the proportional change of elderly (65+) population in a selection of countries between 1950 and 2030 (*2005-2030 is an estimate). All the countries listed have had a net increase, but the rate and size of increase varies considerably.

This data indicates that the proportion of population who are over 65 is increased over the last 60 years and forecast to continue to increase in the near future. This ecological change is predicted to have a dramatic affect on individual country's health care and social policies.

"The increase in the number of old people in the world will be one of the most profound forces affecting health and social services in the next century."

Dr Hiroshi Nakajima Director General WHO May 1996[4]

Much has been speculated about the additional pressure the increase on the *dependency ratio* will have on health provisions and carers[5]. However, as well as a proportional increase of people who need specialised care there will be a larger increase of people with milder age related impairments. Therefore it will be important to maintain the level of accessibility to products and services that they use on a regular basis so that they do not need any specialists care; which will be under increased pressure. Maintaining the accessibility of household goods will also promote independent living, meaning that people will be able to live longer in their own home.

In VICON we will be focused on two household products; a washing machine and a mobile phone both of which as essential for quality independent living.

- **Washing Machine:** Regular clean clothes and linen is a hygienic necessity, which helps maintain a healthy lifestyle. Cleaning your own clothes can also been seen as empowering and a sign that you can 'look after yourself'. Also certain items of clothes, such as undergarments can be intimate to the person and they may not want another person washing or handling them.

[3] Statistics Bureau, MIC; Ministry of Health, Labour and Welfare; United Nations.
[4] http://www.who.int/global_health_histories/seminars/presentation07.pdf
[5] Tipping Point for Care – Carers UK

- **Mobile Phone:** A telephone is an excellent method to access information and one-to-one conversation without the need to travel. Regular communication to other is paramount to heeding social isolation and regarding as a 'window into the world' (similar as a television and the internet). A mobile phone has more benefits to a domestic phone as it allows to the user to contact people and services in any location (dependant on phone coverage); this is especially important to seniors who has a higher risk of accidents, who may need to contact help.

1.2 Hearing impairment[6]

1.2.1 ICF Definition[7]

b230 Hearing functions

Sensory functions relating to sensing the presence of sounds and discriminating the location, pitch, loudness and quality of sounds.

Inclusions: functions of hearing, auditory discrimination, localization of sound source, lateralization of sound, speech discrimination; impairments such as deafness, hearing impairment and hearing loss

1.2.2 Types of hearing impairment

The vast majority of older people with noticeable or measurable hearing impairment will be caused by presbyacusis (1.2.2.1) which is age related sensorineural hearing loss. However it is also possible for the person to have a mixture of different types of hearing impairment. This could be presbyacusis with additional sensorineural hearing losses (1.2.3), additional conductive hearing losses (1.2.4) or 'mixed' (sensorineural & conductive) hearing impairment.

1.2.2.1 Presbyacusis[8]

This type of hearing impairment is sometimes referred to as sensory, cochlear, neural or inner ear hearing impairment.

It is most commonly caused by changes in the inner ear that occur as you grow older. There is no known single cause for presbyacusis; there are currently four discovered types:

- Sensory presbyacusis; caused by loss of sensory elements in the basal (high-frequency) end of the cochlea with preservation of neurons.
- Neural presbyacusis; caused by loss of cochlear neurons
- Striatal presbyacusis; caused by loss of the stria vascularis with aging.
- Cochlear conductive presbyacusis; caused by thickening of the basilar membrane caused by deposition of basophilic substance

[6] Within this section and the rest of the document the following terms will be used; 'Hearing impairment', 'Hearing Loss' and 'Deafness', these term all have similar definitions. Different organisations use different terms, it is simply an issue of semantics.
[7] World Health Organisation
[8] Also known as 'Presbycusis'.

Other factors such as genetic predisposition or environmental factors (noise levels) affect the prevalence and level of presbyacusis hearing impairment in the older population.

Presbyacusis affects high frequencies more than lower ones. This process starts happening early in life with young adults losing the ability to hear very high frequency tones above 15 or 16kHz by the age of 30. Although this process starts early it is only when the person is older (50+) that it will becomes noticeable and can negatively affect a person's quality of life.

1.2.2.1.1 Presbyacusis audiogram

Below is a typical audiogram of an older person with severe presbyacusis. An audiogram is the standard representation of a person's hearing derived from a series of pure tones tests carried out by an audiologist. Audiograms are laid out with frequency in hertz (Hz) on the horizontal axis on a logarithmic scale, and a decibel (dBHL) loss on the vertical axis. The lower the line on the Y-axis the greater the hearing impairment of the corresponding frequency on the x-axis.

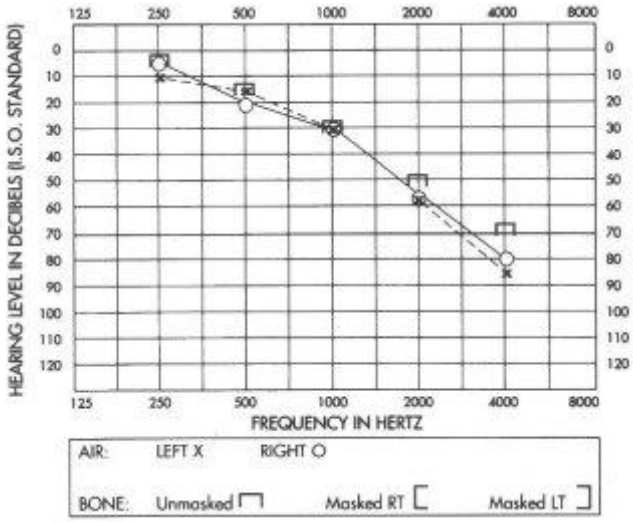


Figure 3 – Presbyacusis audiogram[9]

An audiogram of a person with 'normal' hearing would be a relatively horizontal line fluctuating between -10dBHL and 15dBHL.

The audiogram above of presbyacusis has a distinct shape curving down from 'normal' hearing levels at 250Hz to 80dBHL loss at 4KHz, this is commonly referred to as a 'ski slope' hearing impairment (because of its shape). There is little or no hearing impairment in the low frequencies, moderate losses in the mid frequencies but considerable loss in the higher frequencies.

This example is of a person with severe hearing impairment (see: 1.2.6 for definitions of hearing impairment levels). Everybody's audiogram is unique to themselves, similar to a fingerprint; however people with high frequency hearing loss will have a similar 'ski slope' curve. For people with only a moderate hearing impairment the curve will be shallower and less steep, for somebody with a profound hearing impairment the curve may hit the bottom of the chart and plateau.

Below is an audiogram of ordinary sounds, such as 'birdsong, piano, etc; which are approximately positioned pictorially according in their dB volume and frequency. As well as these sounds a

[9] Original image sourced from: http://www.hearing.com.au/

'speech banana' (by a large banana shape) and certain phonemes such as 'th', 'ch' and 'k' are also located on the audiogram.

A speech banana represents the range of conversational human speech on an audiogram; its name is derived from its shape.

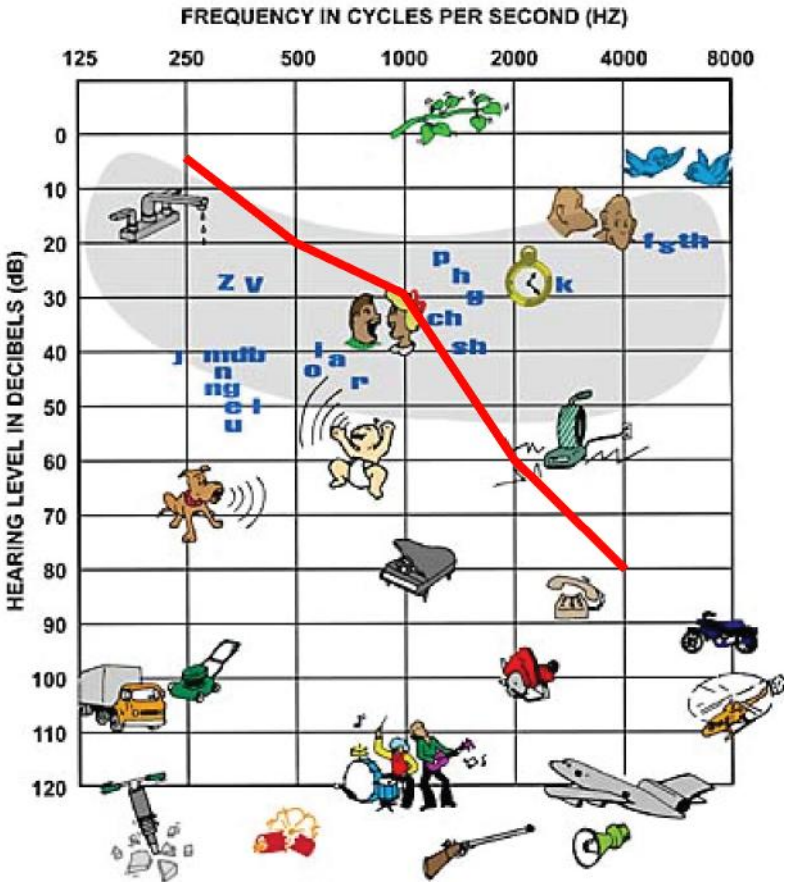


Figure 4 – Audiogram of ordinary sounds superimposed with the presbyacusis audiogram[10]

The presbyacusis audiogram from the previous diagram (Figure 3) has been superimposed on the audiogram of ordinary sounds with a thick red line. The line separates the sounds that the person can hear, everything above the line cannot be heard and everything below can.

Sounds like the vacuum cleaner and birdsong are above the line and therefore we can assume that they cannot be heard by the person with presbyacusis. More importantly the 'speech banana' has been split in half by the audiogram. This means that some speech sounds or phonemes will not be heard. Typically the phonemes that a person with high frequency hearing impairment cannot hear are sibilance, such as; s, sh, ch, z, j. Sibilance are consonants, most constants sounds range from 100Hz to 10KHz as opposed to vowel which are predominantly lower frequencies (300-600Hz). Therefore a person with high frequency hearing impairment are likely to be able to hearing vowel

[10] Original image sourced from: http://www.advancedbionics.com/Your_Journey_to_Hearing/Children/Learning/Hearing_Loss.cfm?langid=1

sounds but not high end constant sounds. This creates the phenomena of a person hearing 'mumbling' instead of clear speech, if an older person increasing complains that people are mumbling it is likely that they have noticeable presbyacusis.

1.2.3 Additional causes of sensorineural hearing impairments

Damage to the cochlea occurs naturally as part of the ageing process (presbyacusis) – but there are many things that cause sensorineural hearing loss, or add to it, such as:

- Regular and prolonged exposure to loud sounds. These sounds do not necessarily have to be unpleasant – for example, exposure to loud music can be just as harmful as exposure to loud machinery. Even short term exposure to loud sound can cause temporary deafness.
- Ototoxic drugs – some medicines are harmful to the cochlea and/or hearing nerve. These include drugs that are used in the treatment of serious diseases such as cancer but also include certain types of antibiotics
- Certain infectious diseases, including Rubella
- Complications at birth
- Injury to the head
- Benign tumours on the auditory nerve - although rare, these can cause hearing loss
- Genetic predisposition – some people are especially prone to hearing loss.

Sensorineural hearing loss not only changes our ability to hear quiet sounds, but it also reduces the quality of the sound that is heard, meaning that individuals with this type of hearing loss will often struggle to understand speech. Once the cochlea hair cells become damaged, they will remain damaged for the rest of a person's life. Therefore sensorineural hearing loss is irreversible and cannot be cured – at least at the present time.

1.2.4 Additional causes of conductive hearing impairments

Conductive hearing loss is the result of sounds not being able to pass freely to the inner ear. This usually results from a blockage in the outer or middle ear, such as a build-up of excess ear wax or fluid from an ear infection (especially common in children). It can also happen as a result of some abnormality in the structure of the outer ear, ear canal or middle ear – or be due to a ruptured eardrum.

A condition known as otosclerosis (which results in the abnormal growth of bone in the middle ear) can cause severe conductive hearing loss. The excess bone prevents the ossicles in the middle ear from moving freely.

The result of this type of hearing loss is that sounds become quieter, although not usually distorted. Depending on its cause, a conductive hearing loss can either be temporary or permanent.

Conductive hearing losses can often be corrected with medical management, or minor surgery.

1.2.5 Demographics of hearing impairment

In the UK alone there are nine million people[11] who have a hearing impairment of some degree, which works out at one in seven of the population. Assuming that the proportion of elderly people is similar across Western Europe (as well as the standard of living and noise pollution levels), it can be assume that there will be a similar number of people with a hearing impairment.

Level of deafness[12]	Number of people (1000's)	Percentage
Mild deafness	4830	54%
Moderate deafness	3439	38%
Severe deafness	549	6%
Profound deafness	149	2%

Table 1 – Break down of the estimated 9 million deaf and hard of hearing in the UK

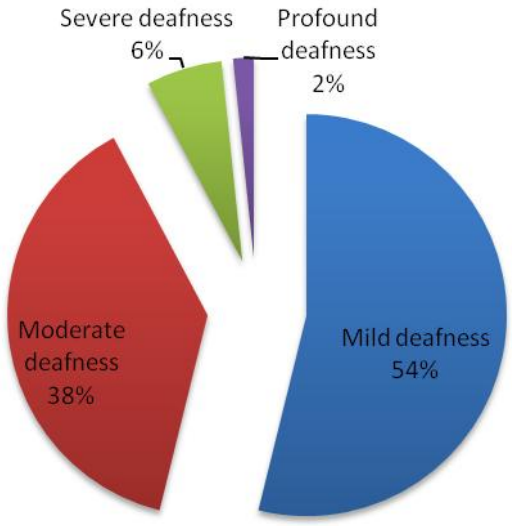


Figure 5 – Break down of the estimated 9 million deaf and hard of hearing in the UK

The figures and graphics above clearly illustrate the *diminishing returns* of people with hearing loss as the severity of the hearing loss increases. The grander the hearing loss the smaller the group becomes. The diversity of size of the opposing groups is particularly large; there are 26 times more people with mild deafness than a profound deafness.

[11] A David, Hearing in adults, 1995
[12] Definitions of levels of deafness are discussed in 1.2.6

Level of deafness	Age		
	16-60	61-80	81+
Mild deafness	4.6%	28.1%	18.4%
Moderate deafness	1.6%	16.5%	57.9%
Severe deafness	0.2%	1.9%	13.2%
Profound deafness	0.1 %	0.4%	3.6%

Table 2 – Estimated percentages of the UK population who are deaf or hard of hearing[13]

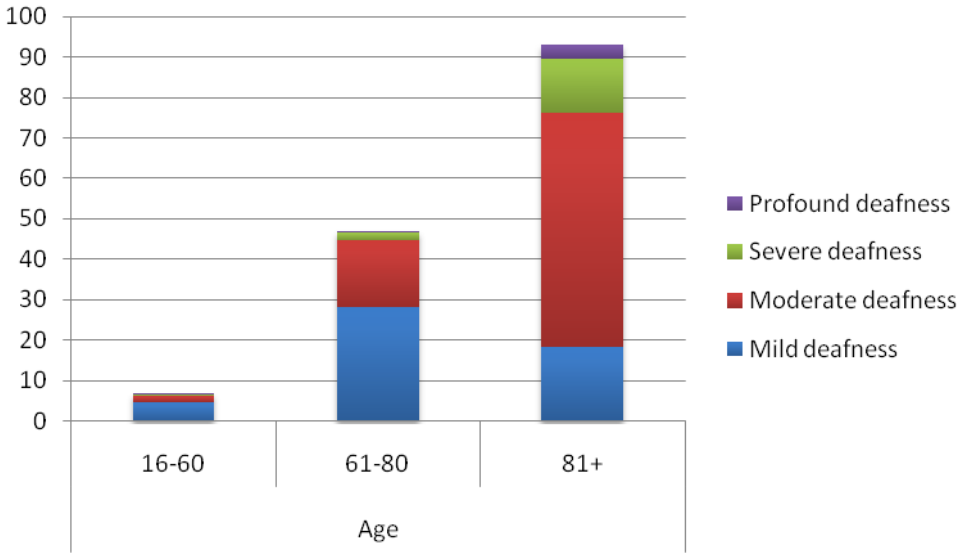


Figure 6 – Estimated percentages of the UK population who are deaf or hard of hearing

The figures and graphics above clearly illustrate the increasing percentage of people (within an age group) with a hearing loss as the age group increases by age. Although the population is only split within 3 groups (excluding those under 16), there is a clear pattern of proportional increase in hearing loss as the population ages. Every level of hearing loss (mild, moderate, etc.) increases in size as the groups gets older, except for the mild deafness in 81+. It is assumed that this phenomenon is caused because the majority of people who have mild or no deafness or between 61 and 80 will have a moderate deafness when they are 81+ (nearly 60% over 81 have a moderate hearing loss).

1.2.6 Definition Hearing impairment

Hearing impairment is the total or partial loss of hearing in one or both ears. There are different levels of hearing impairment. The levels of impairment can be mild, moderate, severe or profound.[14]

[13] A David, Hearing in adults, 1995
[14] Deafness and hearing impairment http://www.who.int/mediacentre/factsheets/fs300/en/

1.2.6.1 Definition of hearing impairment levels:

As hearing impairment describes a broad range of hearing impairment, from a minimal unnoticeable loss to actual deafness, there are different levels of severity for hearing impairment. There are normally four different categories, which are commonly labeled (from least to greatest hearing impairment) mild, moderate, severe and profound. The use of this terminology is common throughout Europe and North America, but it is often used with a range of suffixes, such as; hearing loss, hearing impairment or deafness. Despite the different suffixes it is to be assumed that they mean the exact same thing, for example, mild hearing loss, mild hearing impairment and mild deafness are all equal.

These different categories can be scientifically defined, usually by measuring the 'average' pure tone hearing threshold levels (dB). These levels will be measured by a qualified audiologist during a pure tone assessment.

The British Society of Audiologists (BSA) definitions are in Table 3.

Audiometric Descriptors	Hearing Loss (dB)*
Mild hearing loss	20-40
Moderate hearing loss	41-70
Severe hearing loss	71-95
Profound hearing loss	In excess of 95

Table 3 – BSA's Audiometric Descriptors and Hearing Loss

**Audiometric Descriptors are based on the average of the pure tone hearing threshold levels at 250, 500, 1000, 2000 and 4000 Hz*

0dB reference based on assessments of a large group of people considered as having 'normal' hearing

As well as scientific definitions, other organisations also have functional definitions for these different levels. The Royal National Institute for Deaf and Hard of Hearing People (RNID) expands on the BSA's definition with some functional descriptors[15] in Table 4.

Deafness Descriptors	Definitions of deafness
Mild deafness	If you have mild deafness it can cause some difficulty following speech, mainly in noisy situations. The quietest sounds you can hear are 25 to 39 decibels.
Moderate deafness	People with moderate deafness may have difficulty following speech without a hearing aid, and find the quietest sounds they can hear are 40 to 69 decibels.
Severe deafness	People with severe deafness rely a lot on lipreading, even with a hearing aid, as the quietest sounds they can hear are 70 to 94 decibels. British Sign Language (BSL) may be their first or preferred language.
Profound deafness	The quietest sounds that profoundly deaf people can hear average 95 decibels or more. BSL may be their first or preferred language but some prefer to lip-read.

Table 4 – RNID's definitions of deafness

[15] Describing deafness
http://www.rnid.org.uk/information_resources/aboutdeafness/meaning_of_deafness/

The European Group on genetics of hearing impairments (EGGHI) hearing impairment levels[16] are defined in even greater functional detail in Table 5.

Hearing loss Descriptors	Definitions of hearing loss
Mild hearing loss	On average, the most quiet sounds that people can hear with their better ear are between 25 and 40 dB. People who suffer from mild hearing loss have some difficulties keeping up with conversations, especially in noisy surroundings.
Moderate hearing loss	On average, the most quiet sounds heard by people with their better ear are between 40 and 70 dB. People who suffer from moderate hearing loss have difficulty keeping up with conversations when not using a hearing aid.
Severe hearing loss	On average, the most quiet sounds heard by people with their better ear are between 70 and 95 dB. People who suffer from severe hearing loss will benefit from powerful hearing aids, but often they rely heavily on lip-reading even when they are using hearing aids. Some also use sign language.
Profound hearing loss	On average, the most quiet sounds heard by people with their better ear are from 95 dB or more. People who suffer from profound hearing loss are very hard of hearing and rely mostly on lipreading, and/or sign language.

Table 5 – EGGHI's Hearing loss definitions

The similarities between these three organisation's definitions indicate that there is a consensus for the four hearing impairment levels.

1.2.6.2 VICON's definitions of hearing impairment

The level of impairment that we will be covered by VICON is defined as "mild to medium". Medium hearing impairment is not a recognised category of hearing impairment, however as one of 'Moderate's dictionary definitions is "of medium quantity, extent, or amount "[17], the study defines a medium hearing impairment as the same as moderate hearing impairment.

Hearing impairment Descriptors	Definitions of hearing impairment	Hearing impairment (dB)*
Mild impairment	People who suffer from mild hearing impairment have some difficulty following speech and keeping up with conversations, especially in noisy surroundings.	20 – 40
Medium impairment	People who suffer from moderate hearing impairment have difficulty following speech keeping up with conversations when not using a hearing aid or other amplification equipment.	41 – 70

Table 6 – VICON's Hearing impairment definitions

**Audiometric Descriptors are based on the average of the pure tone hearing threshold levels at 250, 500, 1000, 2000 and 4000 Hz*

0dB reference based on assessments of a large group of people considered as having 'normal' hearing.

[16] European Group on genetics of hearing impairment. Martini A (Ed.), European Commission Directorate, Biomedical and Health Research Programme (HEAR) Info letter 2, November 1996, 8.
[17] Moderate: "of medium quantity, extent, or amount: *a moderate income.*" http://dictionary.reference.com/browse/moderate

1.3 Vision impairment

1.3.1 ICF Definition[18]

b210 Seeing functions

Sensory functions relating to sensing the presence of light and sensing the form, size, shape and colour of the visual stimuli.

Inclusions: visual acuity functions; visual field functions; quality of vision; functions of sensing light and colour, visual acuity of distant and near vision, monocular and binocular vision; visual picture quality; impairments such as myopia, hypermetropia, astigmatism, hemianopia, colour-blindness, tunnel vision, central and peripheral scotoma, diplopia, night blindness and impaired adaptability to light

1.3.2 Vision and vision impairment

The eye is, in effect, a complex optical instrument that provides the brain with approximately 80% of the sensory information that we need to interact with our world. Like a camera, it has a combination of optical components (cornea and crystalline lens) which help focus light, an aperture stop (iris/pupil) which controls the amount of light entering the eye, and a photo sensitive layer (retina) which captures images of the world we see and sends information about these images back to our digital capture and storage system (brain).

In order to see clearly, the optical components must be of a power such that images are focused sharply on the retina. Any deviation from perfect focus is referred to as "refractive error" resulting in a blurred image which requires an optical correction (spectacles or contact lenses). Damage or disease (cataract, glaucoma, AMD, diabetic eye disease, retinitis pigmentosa) affecting any of the eye's constituent parts will also reduce the clarity of the image or the quality of the messages sent to the brain. The impact these conditions have on vision is dependent on the extent of the damage or disruption and on the anatomical (structural) and physiological (functional) characteristics of the tissue affected. Cataract, for example, causes us to have blurred vision, glare sensitivity and a reduction in contrast detection. Glaucoma and retinitis pigmentosa both cause our panoramic visual fields to constrict whereas diabetic maculopathy and age related macular degeneration cause disruption of our central vision and associated reading impairment.

In Ireland, according to the 2003 blind register, the current overall prevalence rate of impaired vision runs at 0.22% and, of those newly registered, 40% are 80 years old or older.

[18] World Health Organisation

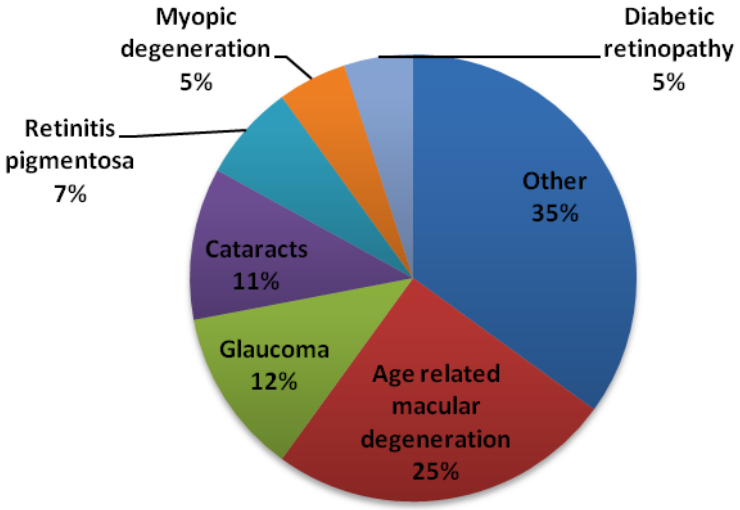


Figure 7 – Main causes of newly registered blind people in Ireland in 2003.

A comparison of data collected in Ireland in 2003 with the 1996 blind register suggests a 113% increase in age related macular degeneration and a 120% increase in diabetic retinopathy[19] in the period of seven years.

It is now universally agreed that data obtained specifically from national registers of blindness and vision impairment significantly underestimates the true prevalence of vision impairment in general and of low vision in particular[20] [21].

The number of people affected by blindness or vision impairment in Ireland will grow enormously over the next twenty years. The number of blind people in the Republic of Ireland (using World Health Organisation definitions) aged 55 years and over is likely to increase by 170% between 2006 and 2031.The number of people who are vision impaired in Ireland (using World Health Organisation definitions) aged 55 and over will increase by 180% between 2006 and 2031.

We will now describe in more detail the eye conditions that contribute to low or impaired vision in older people.

1.3.3 Optical/Refractive Errors: Why People Wear Glasses

When a patient becomes aware of the fact that their vision is no longer as clear as they expect it to be, the first question that should be asked is "Could the poor vision be caused by a refractive error/would new glasses help?" Uncorrected refractive error causes blurred vision at either distance, near (close up) or both and is often associated with eyestrain. There are different types of refractive error but, irrespective of the cause, the extent of blur is directly related to the magnitude of the error.

Short-sighted individuals (myopes) have blurred, uncorrected distance vision but often surprise themselves by seeing clearly at near without glasses. When glasses are prescribed for teenagers, they are usually to correct short-sightedness.

Uncorrected long-sighted individuals (hypermetropes) have to work their intraocular muscles hard

[19] Munier et al 1998, Kelliher et al 2006
[20] Robinson et al 1994
[21] Kelliher et al 2006

to see clearly at any distance, although the effort required is generally greatest at near. Those with astigmatism, often described as the rugby ball effect, have blurred unaided vision at all working distances. An additional complication of refractive error is that all of us, as we approach our mid-40s, begin to lose focusing power with the result that reading becomes more problematic. This condition, often remedied by simple reading glasses, is referred to as presbyopia (age-related long-sightedness).

Presbyopia is an age-related condition in which the ability to focus on near objects decreases. When focusing on near objects, the ciliary muscles at either side of the lens of the eye tighten causing the lens to change shape. This allows it to become thicker and more curved bringing light rays and close objects into sharp focus on the retina. This is called accommodation. To focus on objects in the distance, the lens returns to its natural resting state. As we age, the lenses gradually lose their elasticity and flexibility. The ability of the eye to accommodate becomes reduced and near vision becomes blurred.

There are five types of age-related long-sightedness[22]:

- Incipient presbyopia is presbyopia in its very early stages. Reading small print or doing close up work requires a little extra effort.
- Functional presbyopia is the gradual loss of the eyes ability to focus on near objects. The person begins to noticeably struggle to focus on near objects.
- Absolute presbyopia is when the eyes can no longer focus on near objects. The lens in the eye is no longer able to focus light rays of near objects on the retina.
- Premature presbyopia is when symptoms of presbyopia begin earlier than usual (before the age of 40).
- Nocturnal presbyopia is difficulty focusing on near objects in dim light.

Presbyopia can result in blurred vision when looking at objects close up, it can affect a person's ability to read or carry out close work, and a person may need brighter lighting when reading.

Irrespective of the cause of refractive error (myopia, hypermetropia, astigmatism or presbyopia), the resulting blur can be corrected optically using spectacles, contact lenses or refractive surgery. The merits of all 3 types of correction vary and need to be considered on an individual basis.

Although it is now widely recognised that the prevalence of uncorrected refractive error increases with age, as changes occur to the optical components within the eye, most of the early epidemiological studies on vision impairment overlook the significance of this. There is no data currently available on the prevalence of uncorrected refractive error in Ireland. If, however, one were to extrapolate from existing international data, it could be anticipated that 2.2% of the population (30,000) aged 45 years and older would have impaired vision as a result of uncorrected refractive error.

[22] http://hcd2.bupa.co.uk/fact_sheets/html/presbyopia.html

1.3.4 Cataracts

The eyes' crystalline lens is responsible for focusing light rays entering the eye sharply on the retina. In its normal state, the lens is transparent but as it ages it becomes cloudy or opaque. Ageing is the commonest cause of cataract although it may occur secondary to trauma, inflammation or in association with other diseases which can affect vision (i.e. diabetes). It is the opacity, or clouding, within the lens that is referred to as cataract.

Figure 8 – How someone with cataracts might see their television screen.

As one would expect of any opacity or optical defect within a lens, cataract results in a deterioration of vision. It is associated with symptoms of blurring, haze and changing refractive error and eyestrain. It is when undertaking detailed visual tasks such as reading, face recognition or driving, particularly when in the presence of glare, that difficulties arise and symptoms are most apparent. Most individuals experiencing cataract will be aware of the fact that vision in one or both eyes is not as good as it was. The fact that the condition is slowly progressive often disguises this and the individual may not be acutely aware of the impairment until it is fairly advanced. The impact cataract has on the subject's quality of life is directly linked to the extent of the cataract and the visual requirements of the individuals. Risk factors include age, diabetes, ocular injury, steroid use, ocular inflammation and ultraviolet exposure. Most importantly, for treatment to be effective we must ensure early detection and diagnosis.

In Ireland an estimated 24.4% of those over the age of 85 are likely to have significant cataract and 1.2% will be severely vision impaired as a result.

1.3.5 Glaucoma

Unlike many of the other leading causes of vision impairment, glaucoma is essentially symptomless in the early to moderate stages of the disease process. In considering the mechanism of the disease one must now consider the optical instrument in question (eye) as a dynamic soft shell camera, the structure and shape of which is maintained by fluid pressure from within. The fluid (aqueous humour) responsible for maintaining the delicate pressure balance within the eye is also responsible for much of the internal nourishment of the system and is, as a result, continually drained and replenished. When the balance between production and drainage is such that the pressure within any given eye (intraocular pressure) rises to a point that damage is caused at the optic nerve head (the wiring cable), the condition is called glaucoma.

Surprisingly, up to 40% of optic nerve head fibres can be damaged or destroyed in the two leading causes of glaucoma (primary open angle and normal tension glaucoma) before the patient will notice any loss of vision. The process resulting in damage is irreversible. Other causes of glaucoma (acute closed angle and secondary glaucoma), which are associated with both pain and visual symptoms (haloes and blur), are relatively rare by comparison.

In contrast to those conditions which cause a loss of central vision (AMD and Diabetic Maculopathy), glaucoma causes a progressive loss of our peripheral or side vision (visual fields) and a reduction in our ability to see low contrast targets (contrast sensitivity). Diagnosis of the

condition involves an assessment of peripheral retinal integrity (visual fields), intraocular pressures (tonometry) and a detailed assessment of the shape and appearance of the optic nerve head (topography, retinal imaging/photography). Risk factors include age, family history, myopia, ethnicity and the presence of systemic disease including diabetes and cardiovascular diseases.

1.3.6 Age Related Macular Degeneration (AMD)

In considering the camera analogy, we now turn our attention to the light sensitive film (retina) or, more appropriately in the digital age, the electronic plate or microchip onto which light is focused (transferred) at the back of the camera (eye).

Figure 9 – How someone with macular degeneration might see their television screen.

In the case of age related macular degeneration, which affects those 50 years and older, damage is confined to the central part of the film (the macula) on which images of what is of primary interest to the observer are focused, (i.e. those objects on which we have fixed our gaze as opposed to those which are of secondary interest and are positioned in our peripheral fields of vision). The condition is almost always bilateral (affecting both eyes) although the eyes may be affected to different extents and at different times.

The symptoms (distortion and blur) experienced are very disturbing and have a hugely detrimental effect on reading, driving, face recognition and many of the tasks we take for granted when undertaking life's daily activities. The rate of onset of symptoms and the relationship between distortion and blur are largely dependent on whether the condition is wet (characterised by fluid accumulation at the macula) or dry (solid deposits and scar tissue). The wet form is treatable if detected early enough whereas the dry form, which accounts for almost 90% of the condition, is not[23].

Patients with either form of the condition often benefit greatly from the provision of low vision aids and rehabilitation/social support services. Risk factors include age, smoking (smokers are 3-4 times more likely to develop the condition than non-smokers) and a family history of the condition. Risk factors can be reduced through stopping smoking and improving the dietary intake of fish oils and fresh fruit and vegetables rich in Vitamins C and E. Anti-oxidant vitamin supplements may also be important in this respect.

1.3.7 Diabetic Eye Disease

Diabetes is now a common disease the World Health Org estimates World prevalence of diabetes in 2000 as 2.8%[24].There may, however, be as many again who have the disease and as yet are unaware of it. The condition occurs either because the body lacks insulin or because its ability to utilise it is impaired. Of the two types of diabetes, "insulin dependent (type 1) diabetes" tends to manifest itself in the teens and twenties whereas the most common age of onset of "non-insulin dependent (type 2) diabetes" is in the 50s, 60s and 70s. When considering the impact that diabetes has on the eye, one must remember that it is in fact a "whole body disease" affecting the vascular system.

[23] Brown & Regillo 2007
[24] http://www.who.int/mediacentre/factsheets/fs312/en/

The principal ocular effect is, however, "retinopathy" which, once again, is synonymous with damage to the film in the camera. The damage inflicted differs from that resulting from either AMD or retinitis pigmentosa in that it can affect both central and peripheral vision. The effect on the individual can include central blur, distortion, field loss and a reduction in both low contrast vision and colour vision. Treatment is available using high powered lasers but this is dependent on early detection and timely intervention. Those affected often find that their spectacle correction needs more regular change than would be expected in non-diabetics.

Of particular note is the fact that, whereas 25% of those affected by diabetes will exhibit signs of retinopathy within 5-10 years of age of onset, this figure rises to 90% by 30 years. Risk factors for sight threatening retinopathy include poorly controlled diabetes, high blood pressure, obesity and high lipid and cholesterol levels[25]. Approximately 8-10% of all diabetics suffer potentially sight threatening maculopathy or proliferative retinopathy. This is a fact which is of great importance given the dramatic increase in diabetes in developed countries.

1.3.8 Definition of vision impairment

The term vision impairment is typically used to include both low vision and blindness.

Blindness refers to those whose vision is so significantly impaired that they are unlikely to be able to make use of residual vision.

The term low vision essentially describes a degree of vision impairment likely to impact quality of life and yet with which some residual vision is retained.[26]

1.3.8.1 Definition of vision impairment levels

A wide range of tests exists to assess or measure vision or vision impairment. Assessment of visual acuity is the most familiar method, but others include methods of assessing colour vision, degree of muscular movement, focussing ability and field of vision. Other examinations serve to detect or diagnose particular eye diseases or conditions that are typically associated with some form of vision impairment. It is, therefore, very difficult to develop a simple method to quantify degree of vision impairment.

A standard method of testing for visual acuity (the ability of the eye to detect fine detail) is the Snellen eye test[27], where a series of individual letters, decreasing in size, are presented on a wall chart and the person is asked to read the chart from a specified distance.

The resulting measure of visual acuity (VA) indicates an individual's ability to read the chart relative to someone with perfect visual acuity. For example, a VA of 20/20 represents perfect visual acuity whereas a VA of 3/60 means that the individual is able to see detail from 3 feet away the same as a person with perfect visual acuity would see from 60 feet away.

[25] Kohner 2008
[26] Jackson, A.J. and O'Brien, C. (2008). Eyes on the Future Ireland 2008.
[27] Tucker, J. and Charman, W.N. (1975). The depth-of-focus of the human eye for Snellen letters. American Journal of Optometry and Physiological Optics, 52: 3-21.

There are essentially 3 categories of blindness, as defined by the World Health Organisation (WHO)

1: Visual Acuity < 3/60 to 1/60

2: Visual Acuity < 1/60 to light perception

3: No perception of light

A fourth category is included to cover those cases of un-recordable vision.

WHO sub-classifies low vision into 2 subdivisions:

1: Visual Acuity < 6/18 to 6/60

2: Visual Acuity < 6/60 to 3/60

1.3.8.2 VICON's Definition of vision impairment

In the VICON project, any selected method of assessment would be hampered by the variation in testing conditions, as the field trials took place in each of the user's homes. In order to be accurate, the standard Snellen test must be performed at a particular distance from the eye chart (which a user's house is not likely to cater for) and at a particular light level (which is impossible to control for at the user's home).

As a result, a simple reading test was developed to allow the authors to categorise or distinguish between users, rather than to quantify level of vision impairment. For more information of the reading test conducted please go to section 2.1.3.

1.4 Manual dexterity impairment

1.4.1 ICF definitions[28]

There are two ICF definitions for manual dexterity; b710 and b730.

b710 Mobility of joint functions

Functions of the range and ease of movement of a joint.

Inclusions: functions of mobility of single or several joints, vertebral, shoulder, elbow, wrist, hip, knee, ankle, small joints of hands and feet; mobility of joints generalized; impairments such as in hypermobility of joints, frozen joints, frozen shoulder, arthritis

b730 Muscle power functions

Functions related to the force generated by the contraction of a muscle or muscle groups.

[28] World Health Organisation

Inclusions: functions associated with the power of specific muscles and muscle groups, muscles of one limb, one side of the body, the lower half of the body, all limbs, the trunk and the body as a whole; impairments such as weakness of small muscles in feet and hands, muscle paresis, muscle paralysis, monoplegia, hemiplegia, paraplegia, quadriplegia and akinetic mutism

1.4.2 Manual dexterity

Dexterity can be defined as the skill in performing tasks especially with the hands, either individually or together, that are intricate in nature. For example, fine motor skills such as writing, knitting, sewing, entering a key into a lock, etc, rely on manual dexterity[29]. Age related manual dexterity impairments are usually identified by slow and clumsy movements typically in object manipulation tasks.

While the mechanisms and causes responsible for age-related changes in dexterous function are currently unknown, it is evident that a decline in manual dexterity is commonly reported in healthy older compared to younger aged adults[30].

One of the reasons to explain reduced dexterity with increased age is reduced sense of touch. That is, the participant might be less able to use haptic feedback when interacting with objects, and as a consequence, the speed and precise control of movement is reduced. Another common explanation for the cause of reduced dexterity with increased age is reduced strength, in a young adult, 43% of body weight is muscle which reduces to about 25% of body weight with age (70)[31]. A final explanation for the cause of reduced dexterity with increased age could be that the ability to visually attend and select objects for action is slowed[32]. Therefore, with slowed selection, subsequent dexterity is slowed.

As well as the above reasoning, there are a number of age related conditions that can adversely (sometimes suddenly) affect a person's manual dexterity. The most common of these are listed below.

1.4.2.1 Arthritis

Arthritis is a Greek word that literally means 'inflammation of the joints' (*artho-,* joint + i*tis*, inflammation), and is a group of over 200 conditions[33] that involve damage to the joints of the body. It is most commonly associated with older people but it can affect anyone of any age, however the vast majority are elderly. The prevalence rate in woman (227/1000) is twice that of men (113/1000).[34]

Below are some brief descriptions of the two most common types of arthritis.

1.4.2.1.1 Osteoarthritis

Osteoarthritis is the most common form of arthritis in the UK, with an estimated 8.5 million people affected by the condition[35]. It can affect anyone of any age, though it's more common in people

[29] Bernstein, 1996, On Dexterity and its Development
[30] Hackel ME et al, 1992, Changes in Hand Function in Aging Adult as Determined by the Jebsen Test of Hand Function
[31] http://fcs.tamu.edu/families/aging/aging_simulation/dexterity.pdf
[32] Movement specification time with age. Experimental Aging
[33] http://www.arthritiscare.org.uk/AboutArthritis/FAQs/Typesofarthritis
[34] Arthritis Care Fact Sheet: The impact of Arthritis, July 2007
[35] http://www.nhs.uk/conditions/osteoarthritis/Pages/Introduction.aspx

over the age of 45. It can also be triggered after an injury to a joint - sometimes many years later. Not all the causes are known but the most common factors included; genetic predisposition, being overweight and injuries. The hands, knees, hips, feet and spine are usually affected.

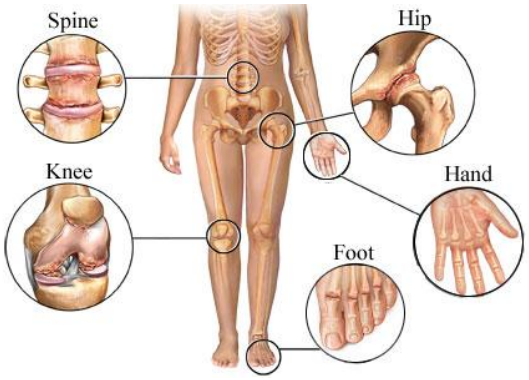


Figure 10 – Joints often affected by osteoarthritis[36]

1.4.2.1.2 Rheumatoid arthritis

Rheumatoid arthritis is the most common inflammatory arthritis affecting 0.8 percent of adult population worldwide.[37] People of any age can develop it, but it's most common between the ages of 30 and 50. The estimated incidence rate in woman (54/100,000) is twice that of men (25/100,000) in the United States[38] It usually starts in the wrists, hands or feet. If it continues, it can spread to other joints and affect other parts of the body.

Figure 11 – Hands affected by rheumatoid arthritis[39]

1.4.2.2 Gout

Gout is caused by uric acid crystals forming in the joints, which is extremely painful. It usually affects the base of the big toe, but can sometimes affects hands or wrists.

1.4.2.3 Stroke

A stroke is caused by the interruption of the blood supply to the brain, usually because a blood vessel bursts or is blocked by a clot. This cuts off the supply of oxygen and nutrients, causing damage to the brain tissue.[40] This damage will affects other body functions, as the brain controls

[36] Nucleus Communications, inc, 2005
[37] Rindfleisch JA, Muller D, Diagnosis and Management of Rheumatoid Arthritis, 2005
[38] Firestein GS. Etiology and pathogenesis of rheumatoid arthritis.
[39] http://nihseniorhealth.gov/arthritis/toc.html
[40] Stroke, Cerebrovascular accident, WHO,http://www.who.int/topics/cerebrovascular_accident/en/

everything the body does, for example; if a stroke damages the part of the brain that controls how the hand moves, hand movement will be affected.

Anyone can have a stroke, including babies and children, but the vast majority - nine out of 10 - affect people over 55[41]. This risk will continue to rise with age, as arteries harden and become 'furred up' by a build-up of cholesterol and other debris (atherosclerosis) over many years[42].

A person who has had a stroke may experience weakness of paralysis on one side of the body (hemiplegia), thus affecting manual dexterity.

After a stroke, strength or movement in the hand and arm can be difficult to regain. This is because there is a very complex series of electrical 'messages' that pass from the brain to the hand to control fine movement, such as holding a pen and writing or picking up and manipulating objects with the fingers. In time, less complex movements, such as lifting the arm up and down, may become possible, although the brain is sometimes unable to compensate enough to regain the control and strength necessary for more complicated movements[43].

1.4.2.4 Parkinson's disease

Parkinson's is a progressive neurological condition that often impairs the person's motor skills, speech and other functions.[44] It affects one person in every 500[45] . Average age of onset is around 60 years[46], the risk of getting Parkinson's increases with age, it. Parkinson's has three main symptoms:

1.4.2.4.1 Tremor

Usually begins in one hand or arm and is more likely to occur when the part of the body affected is at rest. Tremor will usually decrease or disappear when the affected part is being used and often becomes more noticeable when a person with Parkinson's is anxious or excited. About 60-70% of people with Parkinson's have a tremor[47].

1.4.2.4.2 Muscular rigidity or stiffness

This is a common early sign in untreated people with Parkinson's. People may experience problems turning round, getting out of chair, turning over in bed, or making fine finger movements, such as fastening a button, because of rigidity.

1.4.2.4.3 Bradykinesia

This means slowness of movement. People with Parkinson's often find that initiating movements becomes more difficult or that it takes them longer to perform movements. Lack of co-ordination when making movements can also be a problem.

1.4.2.5 Definition of manual dexterity impairment

VICON focuses on users that are classified under the WHO ICF [1] categories of b710 and/or b730. This means that the project targets users who display reduced mobility in joints of the arms or

[41] The Stroke Association http://www.stroke.org.uk
[42] The Stroke Association, "What is a Stroke"
[43] Physical effects of a stroke, 2009, http://www.stroke.org.uk/document.rm?id=852
[44] Jankovic J (April 2008). "Parkinson's disease: clinical features and diagnosis".
[45] http://www.parkinsons.org.uk/about-parkinsons/what-is-parkinsons.aspx
[46] http://www.ninds.nih.gov/disorders/parkinsons_disease/parkinsons_disease_backgrounder.htm
[47] Dr Peter Bain , http:// www.parkinsons.org.uk/docs/is_tremor.doc

hands (b710), reduced mobility in the muscles of the arms or hands (b730), or both (b710 and b730), to such a degree that the movement and control of the hands and/or fingers are impaired in some way.

1.4.2.5.1 Definition of manual dexterity impairment levels

Methods of assessing manual dexterity include focusing on gross and fine manual dexterity, motor coordination, grip strength, tactile recognition, two-point discrimination, and touch/pressure thresholds (e.g. [2]), among others.

Unlike hearing and vision, manual dexterity cannot be easily measured in the field in a quantitative manner. Due to the large degree of variation in the above methods, and the inability of these assessments to consider factors such as pain, discomfort, weakness, and environmental factors such as temperature, it was decided to perform a subjective, rather than objective, investigation of manual dexterity. Observations of the user's manual dexterity (where particular limitations of movement, or obvious physical impairments were observed) were also noted by the investigators.

1.5 Multiple impairments

The focus of this research is to investigate users with multiple impairments (combinations of the three), as well as those with just one.

1.5.1 Proportion of multiple impairments

Within this section many types of the three impairments have been covered. The majority of these have corresponding statistics which emphasise the prevalence of the said condition, often linked to a certain age group. For example; it is estimated that 9 million people have a hearing impairment in the UK, 8.5 million have Osteoarthritis and one in three over 65 has cataracts[48]. These figures show that these conditions clearly affect a large proportion of the population; however they don't tell us how many people have more than one impairment.

These impairments are not mutually exclusive and can affect people in different combinations and levels. The Venn diagram (Figure 12) shows the three impairments hearing (magenta), vision (cyan) and manual dexterity (yellow) and four possible combination; H&V (Blue), H&MD (Red), V&MD (Green) and H&V&MD (black). It is not uncommon for somebody to have more than one age related impairment. Assuming that the statistical chances of having cataracts is the same with or without a hearing impairment (and vice versa) we can assume as 33.3% of over 65 have cataracts and around 50%[49] have a hearing impairment. Therefore, 16.2% of all over 65s will have a hearing impairment and cataracts, a form of vision impairment. Therefore this combination affects one in six people in the UK over 65, not a small proportion.

[48]Dr Rob Hicks, Cataracts,
http://www.bbc.co.uk/health/physical_health/conditions/cataracts1.shtml
[49] 46.4% between 61 and 80,
Demographics of hearing

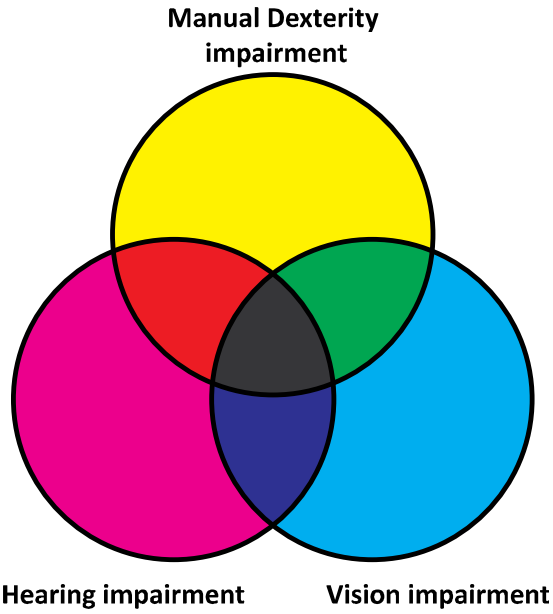


Figure 12 – Venn diagram of vision, hearing & manual dexterity impairment

The solution above was calculated assuming that these statistics are the same throughout the over 65 age group. However, as both these impairments are age related this is not correct. As people get old their chances of having these conditions keeps on increasing, for example, 46.4% of people between 60 and 81 have a hearing impairment compared with 93.1 for 81 and over. Therefore the chance of them having a combination of impairments also increases. Not only this, but as a person ages the severity of an impairment also increases (see Figure 6, for example of hearing impairment).

1.5.2 Effects of multiple impairments

Human senses are the physiological capacities within person that provide inputs for their perception. Traditionally[50], humans are attributed to having five senses, these are sight, hearing touch, smell and taste. These are used to perceive outside stimuli. These senses are not used individually and are combined to assist our perception of the outside world. For example, a person would use sight, touch, smell and taste to perceive a piece of food that they were eating (not just taste). If a person loses a sense or if it is heavily impaired, then they will tend to rely on another, an extreme example of this is a blind person using a stick to 'touch' the environment and see what's there. The previous example was conscious but majority of cases it is an unconscious action, for example when a person who is losing their hearing is talking to another person face to face they will rely more and more on lip-reading to support their hearing. This is most common for mild to medium impairments where the mind will rely on other senses to cope; we can assume this is one of the reasons why an impairment has to get to a certain level of severity before a person becomes aware of it.

Having more than one impairment stops this 'coping' mechanism from working and therefore a combination of impairments is more disabling then all the impairments individually (i.e. '*greater than a sum of their parts*'). For example a mild vision impairment would be more detrimental for a person who already has a hearing impairment and relies on lip-reading, then for somebody with good hearing.

[50] http://plato.stanford.edu/entries/aristotle-psychology/

Most modern consumer products that alert the user use more than one method, a microwave will bleep and flash; this is standard as it is basic best practice for interface design. The methodology is affect to people with one or no sensory impairments, but is still problematic for those with dual-sensory impairments.

This is not just exclusive to devices that have been designed to have multi-sensory interactions; it is also applicable to basic mechanical devices. For example the task of hammering some nails into a piece of wood seems extremely basic, but it involves a collection of senses. Not only do you use your sight to aim up the hammer, but you use your hearing, touch and sight to check the nail has been hit correctly.

1.6 Further definitions

A number of terms are used throughout the original document of work and project, below are the definitions that were used in the field study and how they were derived.

1.6.1 Definition of elderly

The term elderly (also known as 'old age' or 'older people') is used to describe the last period of time in human life. Similarly to other periods in life; childhood and adolescence for example, it is impossible to have an absolute chronological definition. There are many objective and subjective factors that can separate somebody from being 'elderly' from somebody who is biologically old. For example chronological age does not correlate perfectly with 'functional age' i.e. two people may be the same age, but differ in their cognitive and/or physical capacities.

The research study in VICON is focusing on people with different impairments therefore there would be an advantage defining the term elderly by' functional age'. This however is relatively impractical, as it would require us to definite at what 'functional age' are people elderly and to assess them before they can be categorised. In stark contrast chronological data is easier to obtain and process.

Neither the World Health Organisation nor the United Nations has a standard numeric definition[51], but the UN agreed cut-off is 60+ years to refer to the older population. One of the reasons for the lack of any standard criterion is the large divide of quality of life and life expectancy in developed compared to developing countries.

As the VICON study is being based in Western Europe (UK, Germany and Ireland) it can be assumed that the most appropriate definition will be that for a developed country. The most reliable biological age for defining the start of old age in these countries can be assumed to be the age at which the state will first offer a pension. At the moment all three countries pension ages are set at 65 years (65 for men and 60 for women in the UK). Therefore we use this data to assume that the start of becoming 'elderly' will also be at the age of 65.

It should be noted that both the UK[52] and Germany[53] have started ongoing rolling plans to increase the pension age; it will increase to 66 by 2024 in the UK and increase to 67 by 2029 in Germany. An option to increase your working age from 65 to 67 is already law in Sweden and the pension system is constructed so that you receive a greater annual pension as an incentive, if you work these extra two years. This indicates that people's life expectancy and' functional age' in developed countries has increased and is increasing overtime.

[51] Definition of an older or elderly person http://www.who.int/healthinfo/survey/ageingdefnolder/en/index.html
[52] State Pension Age Calculator http://www.pensionsadvisoryservice.org.uk/state-pensions/state-pension-age-calculator
[53] German plan to raise pension age http://news.bbc.co.uk/1/hi/business/6159233.stm

1.6.2 Definition of a washing machine

For the purposes of this research only front-loading washing machines shall be included. The reasons for this are that they account for over 90% of European washing machine sales and usability issues, and modes of operation, differ greatly between front and top-loading washing machines. [54]

1.6.3 Definition of a mobile phone

For the purposes of this research any currently used mobile phone will be deemed suitable. This will include a wide range of products from simple phones with monochrome screens to sophisticated smart-phones with full keypads or touch sensitive screens. Key issues related to the use of mobile phones will be portability and the need for compact size and weight, therefore only mobile phones will be considered. Similar cordless phones, either analogue or DECT, will not be suitable for this research because they are larger in size, most do not have texting capabilities, they usually have more limited features and can only be used within close proximity to their base unit.

[54] http://en.wikipedia.org/wiki/Washing_machine

2 Methodology

2.1 Impairment assessment

2.1.1 Impairment definition in regards to capability

The definitions for the different levels of impairments (mild, moderate, etc) have to be broad because of the size of these categories and the range of differing abilities they will cover. People within these categories will have varying levels of capabilities which might or might not be directly related to the impairment itself or the product being used. Therefore it is not possible to directly correlate a level of capability to a level of impairment.

However as capability is an important factor in regard to this study, the methods of assessing each user will incorporate pragmatic checks that directly measure a user's capability in a specific area related to product use or interaction. For hearing impairment, this will involve testing the intelligibility of speech with background noise, for visual impairment we will determine how small a font size a person can read on a printed page and for manual dexterity impairment users will be asked whether or not they have problems with holding and gripping various everyday items

2.1.2 Hearing

Hearing impairment was assessed using two separate methods, an objective and a subjective assessment.

2.1.2.1 Objective hearing assessment

A simple *Speech-in-Noise* was used as part of the objective hearing assessment. As the name implies, a Speech-in-Noise test will give an indication of how well a person can understand speech in a noisy environment.

A person with a hearing impairment will often be less able to understand speech, especially in noisy conditions. This is especially true for people who have a sensorineural loss – which is by far the most common type of hearing impairment. As such, Speech-in-Noise tests can provide valuable information about a person's hearing ability, and can be used to detect the presence of a sensorineural loss.

The various background noises that are present in day-to-day life can sometimes make listening difficult – especially when trying to understand speech. In this respect, Speech-in-Noise tests are designed to mimic real-life circumstances.

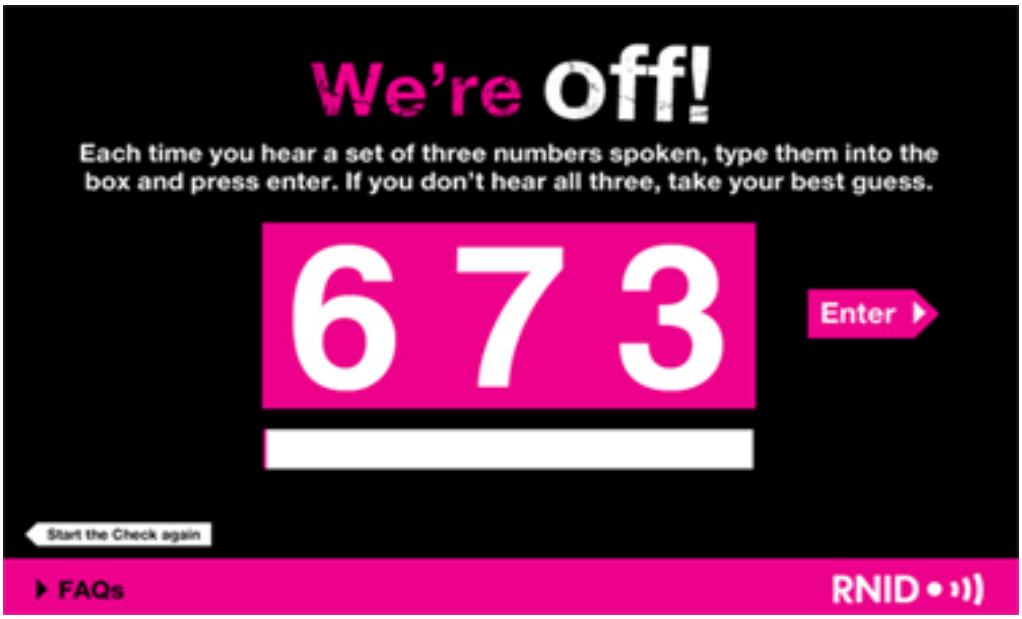


Figure 13 – Screen-grab of the Facebook version of the online hearing check

The test used originated from the HearCom FP6 project[55] and involves the user listening to a series of 3 digits with white noise in the background. The user has to enter the digits they think they have heard to progress, as they progress the volume of the background noise adjust accordingly (louder if the previous test was passed, quieter if the previous test was failed). The user has to enter between 25-31 sets of digits (dependant of the user's success at the test) before the test finishes. After the test finish it will give the user three results:

- Your hearing **is within** the normal range.
- Your hearing **may be below** normal.
- Your hearing **is below** normal.

The original test is designed to generate more false negatives (Type II statistical error[56]) than false positives. Hence we can assume that the test will miss a number of people who have a measurable sensorineural hearing impairment.

2.1.2.2 Subjective hearing assessment

A subjective hearing assessment was also used to assess people's hearing. This assessment can be found in Annex A of APPENDIX B .

2.1.2.3 Overall assessment

Both tests were taken to establish the level of hearing impairment.[57] Table 7 below illustrates how the impairments were calculated.

[55] Hearcom http://hearcom.eu
[56] http://en.wikipedia.org/wiki/False_positive#Type_II_error
[57] Except in certain areas in Germany were the German hearing check test wasn't available (due to no internet access), these are noted at 'Not taken' in the table.

VICON Impairment	Q1	Q3					Hearing Check
		1	2	3	4	5	
Normal Hearing	No	x					Passed
Normal Hearing	No	x					Not taken
Mild	No	x					Failed
Mild	No		x				Passed
Mild	No		x				Not taken
Mild	No			x			Passed
Medium	Yes		x				N/A
Medium	Yes			x			N/A
Medium	No		x				Failed
Medium	No			x			Failed
Medium	No			x			Not taken
Medium	No				x		Passed
Medium	No					x	Passed
> Medium	Yes				x		N/A
> Medium	Yes					x	N/A
> Medium	No				x		Failed
> Medium	No				x		Not taken
> Medium	No					x	Failed
> Medium	No					x	Not taken
N/A[58]	Yes	x					N/A

Table 7 – VICON impairment by objective and subjective assessment

2.1.3 Vision

Vision impairment was assessed using two separate methods.

2.1.3.1 Subjective vision assessment

One – the subjective method – involved asking the user a series of questions relating to vision and vision impairment. The incidence and severity of visual impairment increase with age[27]. Changes in the physical structure of the eye affect several aspects of visual functions, including (from [27]):

- loss of visual acuity (the image appears indistinct),
- loss of near and/or distance vision (inability to accommodate changes of focus),
- reduced field of vision (inability to see things to the side, top or bottom of where looking),
- perception of colour, including age-related yellow vision (inability to distinguish colours),
- depth perception (inability to judge distances),
- speed of adaptation to changing light levels (temporary inability to see whilst eye adjusts to different lighting levels, for example on entering a building), and
- sensitivity to light; generally, older persons need more light to read than they did at 20 years of age.

[58] Nobody was allowed to answer yes for Q1 and 1 for Q3 as they are contradictory answers.

The subjective section of the questionnaire was based on the above information from CEN Guide 6[59]; this section is in Annex B of APPENDIX B.

2.1.3.2 Objective vision assessment

In the VICON project, any objective method of vision assessment would be hampered by the variation in testing conditions, as the field trials took place in each of the user's homes. In order to be accurate, the standard Snellen test must be performed at a particular distance from the eye chart (which a user's house is not likely to cater for) and at a particular light level (which is impossible to control for at the user's home).

Accordingly, for the second assessment method – the objective method – a simple reading test was developed to allow the authors to categorise or distinguish between users, rather than to quantify level of vision impairment. The user was asked to read from Figure 1 both with - and without - glasses (if relevant). The paragraph number (labelled consecutively Para 1 to Para 7 as you read down the page) that the user was capable of reading to was recorded.

[59] CEN/CENELEC Guide 6

Figure 14 VICON test text. Sample of English text used to classify users vision impairment as 'Mild' or 'Moderate' (Please note: the text in this image is smaller than the actual size used)

US Congress votes to clear historic health care bill

The United States Congress has voted to approve legislation that would provide medical coverage to tens of millions of Americans and restructure the US health care system.

The Democratic-controlled Congress approved historic legislation last night extending health care to 32 million uninsured Americans and cracking down on insurance company abuses, a climactic chapter in the century-long quest for near universal coverage.

"This is what change looks like," President Obama said a few moments later in televised remarks that stirred memories of his 2008 campaign promise of "change we can believe in." "We proved that we are still a people capable of doing big things," Mr Obama said later in the White House East Room. "We proved that this government — a government of the people and by the people — still works for the people.

The bill cleared the House on a 219-212 vote. Republicans were unanimous in opposition, joined by 34 dissident Democrats. A second, smaller measure - making changes in the first - cleared the House shortly before midnight and was sent to the Senate, where Democratic leaders said they had the votes necessary to pass it quickly. The vote was 220-211.

President Obama's young presidency received a badly needed boost as a deeply divided Congress passed legislation touching the lives of nearly every American. The battle for the future of the health insurance system - affecting one-sixth of the economy - galvanised Republicans and conservative activists looking ahead to November's midterm elections.

Far beyond the political ramifications - a concern the president repeatedly insisted he paid no mind - were the sweeping changes the bill held in store for Americans, insured or not, as well as the insurance industry and health care providers that face either smaller than anticipated payments from Medicare or higher taxes.

The nonpartisan Congressional Budget Office said the legislation awaiting the president's approval would extend coverage to 32 million Americans who lack it, ban insurers from denying coverage on the basis of pre-existing medical conditions and cut deficits by an estimated $138 billion over a decade. It realised, the expansion of coverage would include 23 per cent of all eligible individuals under the age of 65.

Figure 14 – VICON test text

2.1.3.2.1 Classification of results

The following method of classification was used to divide users into the categories of 'Mild' and 'Moderate'. Please Note: If the reading test was carried out both with and without glasses, the better result of the two should be used in this classification.

User's vision impairment should be defined as '**Mild**' if any of the following conditions are satisfied:

With spectacles: (if applicable)

Para 1	Yes
Para 2	Yes
Para 3	No
Para 4	No
Para 5	No
Para 6	No
Para 7	No

Para 1	Yes
Para 2	Yes
Para 3	Yes
Para 4	Yes
Para 5	Yes
Para 6	Yes
Para 7	Yes

OR

Without spectacles: (if spectacles not worn for reading, or if user does not wear spectacles at all)

Para 1	Yes
Para 2	Yes
Para 3	No
Para 4	No
Para 5	No
Para 6	No
Para 7	No

Para 1	Yes
Para 2	Yes
Para 3	Yes
Para 4	Yes
Para 5	Yes
Para 6	Yes
Para 7	Yes

User's vision impairment should be defined as '**Moderate**' if any of the following conditions are satisfied:

With spectacles: (if applicable)

Para 1	No*
Para 2	No
Para 3	No
Para 4	No
Para 5	No
Para 6	No
Para 7	No

Para 1	Yes
Para 2	No
Para 3	No
Para 4	No
Para 5	No
Para 6	No
Para 7	No

** user cannot read font size 12 point Arial, but does use vision when using mobile phone and washing machine (i.e. can read text on menus of phone or programme guide of washing machine)*

OR

Without spectacles: (if spectacles not worn for reading, or if user does not wear spectacles at all)

Para 1	No*
Para 2	No
Para 3	No
Para 4	No
Para 5	No
Para 6	No
Para 7	No

Para 1	Yes
Para 2	No
Para 3	No
Para 4	No
Para 5	No
Para 6	No
Para 7	No

** user cannot read font size 12 point Arial, but does use vision when using mobile phone and washing machine (i.e. can read text on menus of phone or programme guide of washing machine).*

2.1.3.2.2 Justification for distinction between 'Mild' and 'Moderate'

The NCBI "Make it Clear guidelines"[60] and "The RNIB Clear Print guidelines"[61] for printed text both recommend an absolute minimum font size of 12 point for the majority of readers to be able to read printed text.

As a result, for the purposes of the VICON project, the 12 point font size was used as a cut-off point for classifying users as Mild (able to read smaller than 12 point font size) versus Moderate (unable to read smaller than 12 point font size).

2.1.4 Manual dexterity

A subjective assessment was used to assess people's manual dexterity. This assessment can be found in Annex C of APPENDIX B .

A method of classification of users' manual dexterity ("No manual dexterity impairment detected", "Mild", "Moderate" or "Severe") was developed (see Table 8)

Table 8 Method of Classification of Manual Dexterity Impairment

Answers to Q14 – Q17	Classification	Code
All answers = "No"	No manual dexterity impairment detected	0
Highest score = At least one "Mildly" (and no "Moderately" or "Strongly")	Mild	1
Highest score = At least one "Moderately" (and no "Strongly")	Moderate	2
Highest score = At least one "Strongly"	Severe	3

Table 8 – Method of Classification of Manual Dexterity Impairment

2.1.5 Impairment categories

The users will be placed into four different impairments categories based on the individual impairment assessments. These categories are as follows:

- class A – multiple equal level impairments
- class B – more pronounced hearing impairment
- class C – more pronounced visual/visual acuity impairment
- class D – more pronounced manual dexterity impairment

Users where none of the impairments have a higher degree, in the assessments, as the others are classified as class A. Users who had a have an impairment at a higher degree to the others, in the assessments, are classified as class B, C or D accordingly.

[60] NCBI Make it Clear guidelines http://www.ncbi.ie/services/services-for-organisations/making-written-documents-accessible-to-all
[61] RNIB Clear Print guidelines http://www.rnib.org.uk/professionals/accessibleinformation/text/Pages/clear_print.aspx

2.2 Field study

2.3 Qualitative versus quantitative research

There are two overarching methods to record research; qualitative and quantitative. Both methodologies have their positives and negatives; the correct or preferred method depends on the objectives of the project and how the findings are going to be used. They are not always mutually exclusive and many research methodologies have elements of both.

2.3.1 Qualitative research

The definition of qualitative is a non-numerical data collection or explanation based on the attributes of the graph or source of data. A common method of collecting qualitative data from product user, especially those with impairments[62] is an observational ethnographical study.

2.3.1.1 Ethnography[63]

The emphasis in ethnography is on studying an entire culture. Originally, the idea of a culture was tied to the notion of ethnicity and geographic location, but it has been broadened to include virtually any group or organisation. Ethnography can study the "culture" of a business or defined group.

Ethnography is an extremely broad area with a great variety of methods. However, the most common ethnographic approach is participant observation as a part of field research. The ethnographer becomes immersed in the culture as an active participant and records extensive field notes.

A standard ethnographical study of a person using a physical product would be a direct observational study. These studies are commonplace for reviewing computer interfaces (GUI, etc.) and are becoming more frequently used for physical products. The user would be set a list of tasks to complete with the product; they would then be observed carrying them out. The study can be finished with an unstructured interview when the researcher can casually talk to the user about the tasks, while taking notes.

2.3.1 Quantitative research

The definition of quantitative research is use of sampling techniques (such as questionnaires and surveys) whose findings may be expressed numerically, and are amenable to mathematical manipulation.

2.3.1.1 Questionnaires

A questionnaire is a common research instrument consisting of a series of questions and other prompts for the purpose of gathering information from respondents. In the vast majority of cases the questionnaire is self-completed by the subject with no outside influence.

There are two types of questionnaire questions; ones that measure separate variables, and ones that are aggregated into either a scale or index. There is a third type of question where the subject is allowed to expand on an open question with no written restrictions.

[62] Based on RNID and NCBI's past research
[63] Social Research Methods www.socialresearchmethods.net

Questionnaires are a very cheap method of research and are normally mailed out to subjects for them to complete by themselves. They are usually used when the research has some simple statistical data they want to record via easy to understand questions. For example; Q:How old are you? – This question cannot be easily reinterpreted and the answer is in a numeric form that can be mathematically manipulated for statistical use.

2.3.2 Selecting the best methodology

Although questionnaires would undoubtedly generate the largest collection of data, the data it collected would be of questionable quality.

Previous experience of RNID, when working with these demographics, indicated that nearly one third of the subjects entered an incorrect answer to the personal objective questions because of a misinterpretation or mistake. A greater amount entered the wrong answer when indicating how impaired they are; they typically provided an overestimate based on RNID's definitions. People also self-selected questions that they wanted to answer and skipped questions that had little interest for them.

The is also a phenomenon of subjects grossly understating how many issues they had with a product/service, within self-completed questionnaires, because as humans we are conscience about the way others view us and want to make an good impression. Two surveys carried out in Ireland, found two very different estimates of prevalence of disability among the Irish population. The Irish Census of Population 2006 estimated prevalence of disability as 9.3%, while the National Disability Survey 2006, estimated the prevalence of disability in Ireland as 18.5%. The likelihood of people self-reporting a disability, or a difficulty in carrying out an every day activity, was considerably influenced by how the questions were worded [Sources: 'Census 2006: Volume 11 – Disability, Carers and Voluntary Activities, Central Statistics Office, Ireland, 2006'; and 'National Disability Survey 2006: First Results, Central Statistics Office, Ireland, 2006'].

It was decided because of these two strong reasons that a self-competed questionnaire would not be the right methodology to use for this study.

As the study was taking place over three countries, by three different reviewers and in two languages it was important that they studies were consistent. The benefit of a questionnaire is that it is tightly structured which aids to constancy, whereas unstructured observational studies would not be so consistent – but the observational data would be richer with far less inaccuracies.

It was decided that the study's methodology would be a combination of a task list, questionnaire and observational study. The user would be given a list of tasks and observed, with written notes going down on the questionnaire. The subject would also be informally interviewed using the questionnaire as blueprint for the discussion.

Although this methodology would mean we could not cover that many subjects (observational studies usually have 20-50 subjects) it would produce real tangible data that can be utilised within VICON.

2.3.3 Final methodology

The main research methodology employed was detailed observational studies carried out in the participants own home environment. This methodology was used because when looking at the main usability problems associated with specific products, an inherently qualitative study, it is vitally important to reduce the number of experimental errors. As a result it is important to only use products that the users are familiar with and that they have already learnt to operate, and that they use such products for tasks that they regularly carry out and in environments that are familiar to them.

The importance of using the participants own products are that they have already had sufficient time to learn how to use them, so any usability problems that now exist will be significant and ones which the user has not been able to overcome easily. If they were asked to operate and assess a totally new product then the main part of the research would focus upon how intuitive the product is, how quickly a user can learn to use the product and how good any instructions are. Similarly, if you introduce the user into a laboratory environment, or one which they are unfamiliar with, you will immediately be introducing other variables into the research.

By testing a participants existing products, used for tasks they regularly carry out and in their own environment, we should obtain an accurate indication of which aspects of normal operation cause major usability issues in normal use.

The research methodology involved detailed questioning and observation of a relatively small number of participants, 58 in total. The reason for this is that in order to identify the key usability issues a researcher will not only need to ask the opinion of the participant but also observe where problems occur, record events and encourage greater feedback from the user.

Initially it had been suggested that questionnaires could be used as part of this study. They could have given the research team results from a larger user group but the depth and quality of information collected was considered to have been much lower and thus less appropriate to this specific research task.

The main research partners involved in task 1.3 were RNID, NCBI and FIT. The partners first agreed upon how the severity of the specific impairments will be defined and measured during the research programme. See section 0.

The next task was to design the main observational research methodology; this task was mainly carried out by RNID with collaboration from the other research partners.

2.3.4 Environments

It was considered important that the research should be carried out in suitable environments.

For a washing machine this should be in the user's home as it will introduce usability issues related to lighting, ambient noise, heating and the availability of space to access and use the product.

When using a mobile phone the environment could make a considerable difference to the usability issues encountered when using the product. For practical reasons it was decided that each user should carry out tasks using their mobile phone in their normal domestic environment. However, whenever possible it was suggested that the user should be observed using the phone in both low and high lighting conditions. Additionally the user should be observed using the product in both a static and mobile environment, so the users were encouraged to use their mobile phone both indoors and outside.

2.3.5 Selection of participants

It was agreed that the observational research should use a relatively small number of participants who will be observed and interviewed in detail. It was suggested that the user groups comprise:

i. Hearing impaired participants, approximately 10-15 people
ii. Visually impaired participants, approximately 10-15 people
iii. Manual dexterity[64] impaired participants, approximately 10-15 people
iv. Elderly participants exhibiting low levels of visual, hearing and manual dexterity impairment - each main research partner to carry out research on a group of 10-15 people

[64] Manual dexterity but also other minor dexterity impairments that may affect the handling of machines and the specific product-types on test.

So in practical terms

- Each of the three research partners (RNID, NCBI and FIT) attempted to recruit 20-30 participants for this research, the majority of whom are likely to be elderly.
- Most of these people will have multiple mild to moderate impairments but out of the total number (60-90) 10-15 will have a more significant hearing impairment, 10-15 will have a more significant vision impairment and 10-15 will have more significant problems with manual dexterity. These more significant impairments being defined as at least moderate in severity.
- In selecting participants we will need to screen for people with cognitive issues which might affect their ability to use a mobile phone or washing machine. Those with severe cognitive problems should be excluded from the research.
- Other potential participants which should be excluded from this research will include those with severe, or profound, impairments or those with other conditions which directly affect the way that they use, or interact with, the product-types being investigated here.

The research partners identified suitable participants either through existing contacts or by using associate partners of the VICON project.

It was emphasised that researchers should only visit participants who are suitable for this research because observational research is very time consuming and it would be impolite to arrange an appointment with someone and then inform them that they were not suitable for this research.

The researchers will also needed to check that the potential participants regularly use the specific product-types and determine what kind they currently use.

2.3.6 Tasks

The researcher directed the participant to carry out specific tasks related to the everyday use of the products, made objective observations and asked relevant questions. This procedure followed the standard questionnaire/methodology (see APPENDIX B, APPENDIX C and APPENDIX D) formulated before and during the pilot research.

These major tasks are all related to the normal use of a product and aim to carry out specific functions in the most logical or practical order.

Typically these major tasks:

- Ask the user to perform certain typical tasks in a logical order
- Observe what the user actually does and any usability issues related to carrying out the task. This will involve recording the steps taken, usability issues and any obvious mistakes/successes (for example spilling washing detergent)
- Ask the user how easy/difficult they found the task. Explore this in detail, including them talking you through the process, if there were particular problems or if it is deemed relevant.
- The observer needs to investigate how much each usability issue is down to the specific impairment/s of that user as opposed to being more specific to product design or environmental factors.
- Observations were recorded in written, abbreviated form.

2.3.6.1 Washing machine tasks

When carrying out observational research on washing machines the following major task areas were investigated:

- Open and closing the door
- Loading the washing machine
- Unloading the washing machine
- Using the detergent dispenser
- Cleaning the detergent dispenser
- Using the main controls
- Using the minor controls
- Displays and labelling
- When the wash has finished
- Cleaning the filter

In order to ensure that all results were comparable, each researcher used 9 large, adult-sized white T-shirts as a standard wash load and provided washing detergents (in all forms) and conditioner.

2.3.6.2 Mobile phone tasks

When carrying observational research on mobile phones the following major task areas were investigated:

- Turning the phone on and off
- Making a voice call
- Receiving a voice call
- Performance during a voice call
- Sending an SMS text message
- Receiving an SMS text message
- Keys and controls
- Main display
- Adding contact details to the phonebook
- Recharging the phone
- Doro 410gsm

2.3.6.2.1 Doro PhoneEasy®410gsm

For mobile phones it was considered likely that the majority of users would have a standard phone. It was therefore suggested that after observing them using their own phone they should be introduced to a modern, 'accessible' phone such as the Doro410gsm phone to see how well they can use this specially designed product.

They were asked to make a voice call and send a text message using this phone. Questions were asked and observations were made to investigate how they might react to this new phone which has been specifically designed for elderly people and those with vision, hearing or manual dexterity impairment.

2.3.7 Quantitative data

In addition to the qualitative data (replies to questions and observations by the researcher) a small amount of quantitative data was also collected. This took the form of:

Washing machine

1. Number of attempts to set wash programmes
2. Number of attempts to cancel an incorrect wash programme
3. Number of attempts required to use minor controls

Mobile phone

1. Time taken to send a text message and number of mistakes made
2. Could the respondent add contact details to their phonebook successfully
3. Time taken to add contact details to the phonebook and number of mistakes made

2.3.8 Personal information

Questionnaire 1 was used to collect personal information from each participant, find out how often they use their washing machine and mobile phone and determine their levels of impairment .See APPENDIX B for this section of the questionnaire and APPENDIX E for a summary of participant information and the models of washing machine and mobile phone that they used in this research.

2.3.9 Environmental and product information

At the beginning of questionnaires 2 (washing machine) and 3 (mobile phone) (see APPENDIX C & APPENDIX D) there was a section where the researcher could collect all relevant information about the products used and the environment(s) in which the tests were carried out.

Questions on the products included make, model, approximate age, condition and any other comments. For the environment the observer was instructed to make as many relevant observations/comments as possible.

Finally a record was made of whether or not the participant was wearing spectacles or hearing aids.

2.3.10 Pilot testing and final methodology

Once the methodology had been devised by RNID a pilot test was carried out using two participants who had already been recruited to take part in the main trials. As a result of these pilot tests a number of changes were made and the final methodology was produced and agreed by all research partners. The final questionnaires are given in Appendices A, B and C.

In the final methodology, the researcher:

1. Introduced him/herself and briefly introduced the VICON project
2. Worked through the personal, washing machine and mobile phones methodologies
3. On completion of each questionnaire, the researcher checked with the user that the tasks were realistic and asked if there was anything else they might wish to add.
4. Whilst with the respondent, the researcher took photographs of the washing machine, mobile phone and the environments where the assessments were carried out.
5. Finally the participant was thanked for their participation and offered a small token of gratitude.

3 Results

3.1 Personal information

3.1.1 Gender of the participants

Total number of respondents = 58

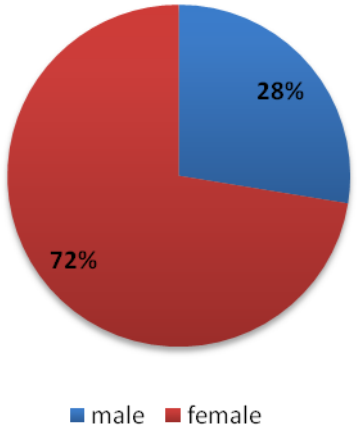


Figure 15 – Gender of participants

3.1.2 Age groups of the respondents

Total number of respondents = 58

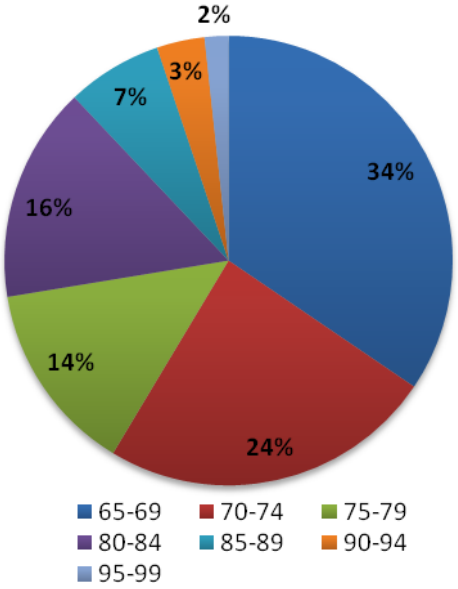


Figure 16 – Age groups of participants

3.1.3 Hearing

Total number of respondents = 58

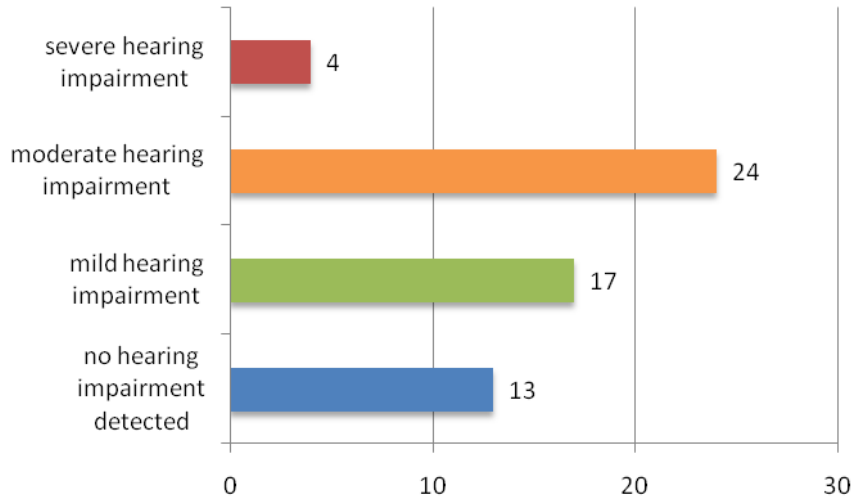


Figure 17 – Number of persons with hearing impairments in sample

3.1.4 Vision

3.1.4.1 Classification of visual acuity

Total number of respondents = 58

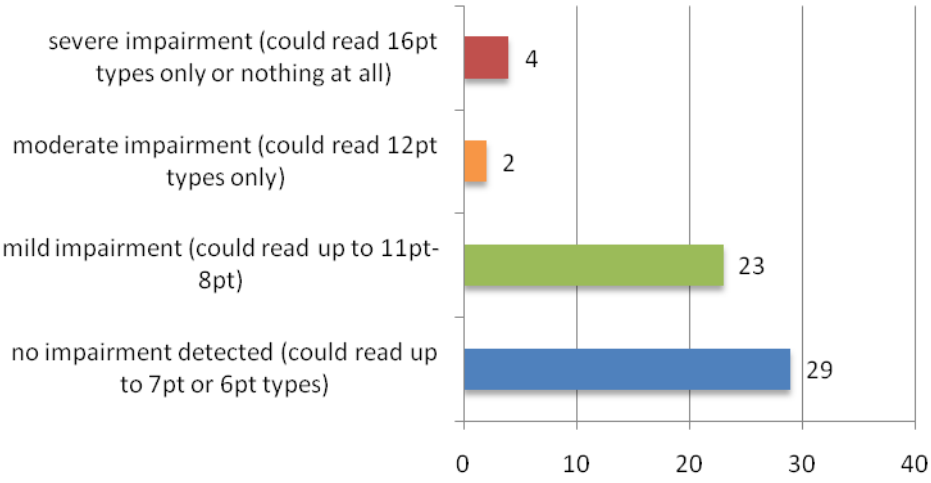


Figure 18 – Classification of visual acuity

3.1.4.2 Number of people with visual impairments

Total number of respondents = 58

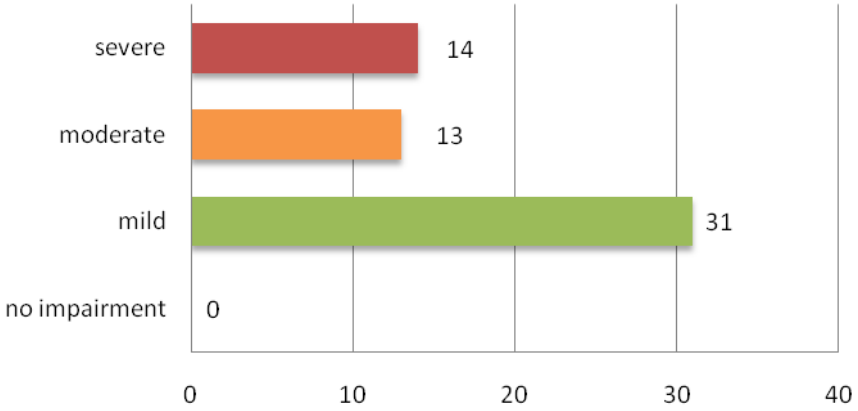


Figure 19 – Number of persons with visual impairment

3.1.4.3 Analysis of the Vision Assessments

When deciding which vision assessment was most appropriate for the analysis, the following two factors influenced the selection:

(1) the vision (or vision impairment) of each user could not be described by the investigators (unlike manual dexterity where, for example, stiffness in hands, difficulty gripping, etc. could be more easily observed and noted during the field trials), and

(2) when using a mobile telephone and washing machine, ability to read the text (e.g. labels, menus, instructions, alerts, etc.) on the product appeared to be the most critical **visual** feature of both products.

It was decided, therefore, for the purposes of the analysis of the findings, to use the data collected from the **objective** vision assessment (i.e. the reading test). As, although not providing a thorough assessment of vision, this method provided more reliable and relevant results than the subjective interview questions.

3.1.5 Manual dexterity

Total number of respondents = 58

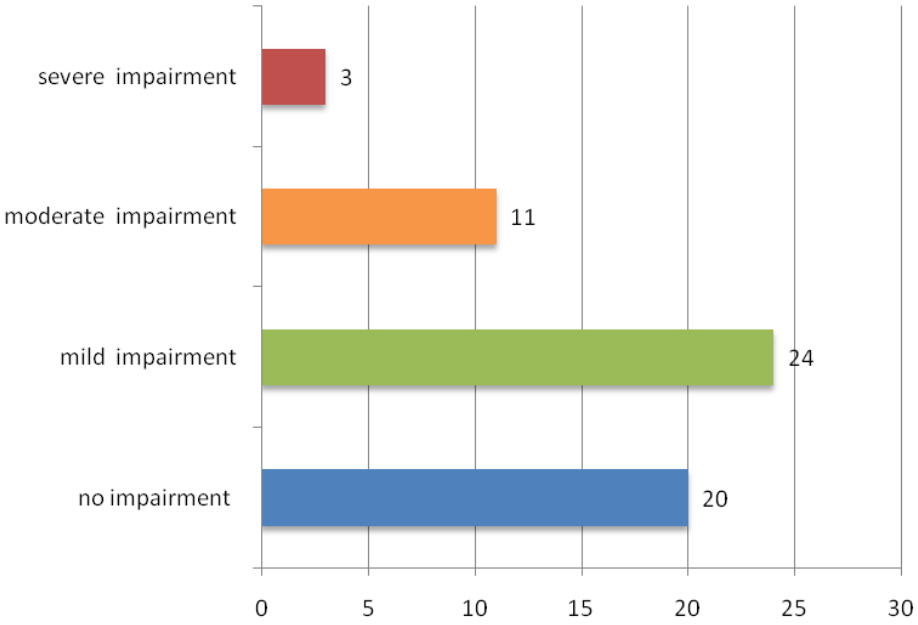


Figure 20 – Number of persons with manual dexterity impairments

3.1.6 Mixed impairments

3.1.6.1 Summary of the distribution of types and degrees of hearing / vision / manual dexterity impairments

Total number of respondents = 58

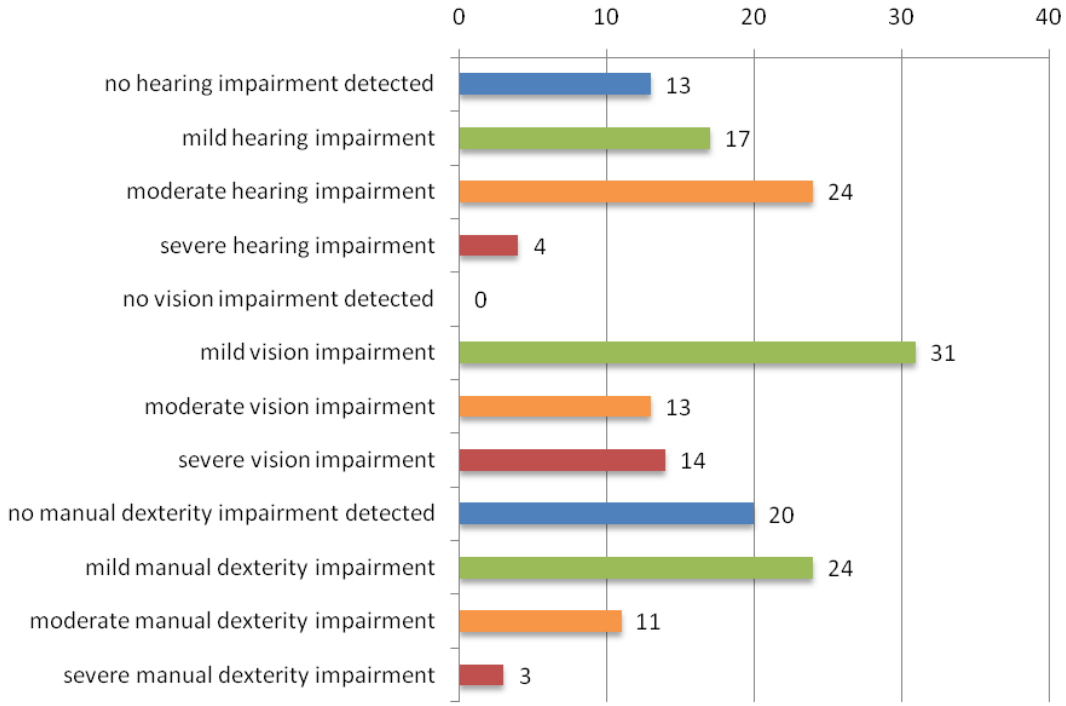


Figure 21 –Summary of the distribution of types and degrees of hearing / vision / manual dexterity impairments

3.1.6.2 Impairment categories

Total number of respondents = 58

Users were classified into four different categories based on the impairment assessments (see section 2.1.5).

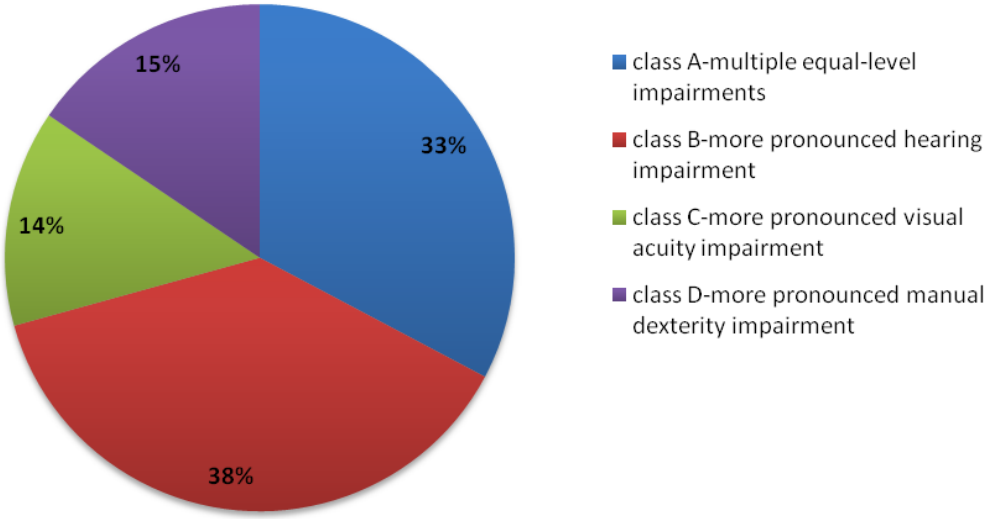


Figure 22 –Impairment categories for participants in this research

3.2 Washing machine

Specific problems and replies to questions have been attributed to the participant/s according to their user code. So R12 is participant 12 of the RNID sample, etc.

3.2.1 Opening and closing the door

Total number of respondents = 47

The majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.1.1 Problems and comments

Question	Number of problems	Details
1.1 Was it easy for you to use the door catch?	3	Small door catch, some force was needed (R10)
		Handle awkward to use, needs to be gripped and pulled at an optimal angle (F9)
		No comment given (F16)
1.2 Did you have any problems?	3	Small door catch, some force was needed (R10)
		I have a sore back, the door is too low down for me (N18)
		No comment given (F16)
1.3 Did you have any discomfort?	6	A bit of discomfort (R10)
		I have a sore back, the door is too low down for me (N18)
		Button requires some force to operate and needs to be held down for a second or two (F1)
		See 1.1 (F9)
		Door handle uncomfortable to use (F14)
		Uncomfortable to grip the door (F16)
1.4 Was it easy for you to open and close the door?	2	See 1.1 (F9)
		No comment given (F16)
		Comment: Some force needed to close the door (F10)
1.5 Did you have any problems?	3	Force needed to close door (R8)
		I have a sore back, the door is too low down for me (N18)
		Uses both hands and has to bend down. Tries to avoid slamming the door when closing it (F9)

		Comment: Door requires some force to close (F14)
1.6 Did you have any discomfort?	7	Force needed to close door (R2, F1, F16)
		I have a sore back, the door is too low down for me (N18)
		Small amount of discomfort (R8)
		Handle on door would be helpful (F3)
		See 1.1 (F9)

Table 9 – Problems and comments: Opening and closing the door

3.2.1.2 Observations recorded by researchers

Observations recorded	No. incidences
No problem	12
Force required to close the door due to poor door alignment	12
Door stiff to open and close	5
Door opens smoothly	3
Door very easy to open	2
Some force required to push 'open' button	2
Double action required to close door	1
Door button is small and has poor grip	1
Poor access	1
Took two goes	1
Two pushes to close	1
Large door catch	1
Door handle stiff	1
Easy to close door, little effort required	1

Table 10 – Observations: Opening and closing the door

3.2.2 Loading the washing machine

Total no. respondents = 47

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.2.1 Problems and comments

Question	Number of problems	Details
2.1 Was it easy for you to load the washing machine?	2	Loading was awkward due to problems with mobility, support and bending (F1, F16)
2.2 Did you have any problems?	1	See 2.1 (F16)
2.3 Did you have any discomfort?	4	My back is sore, so I feel it (N18)
		See 2.1 (F1, F16)
		Have to bend to reach into the drum (F17)
2.4 With the load in the machine, was it easy to close the door?	3	See 2.1 (F1)
		Door requires some force to close (F14)
		Door hard to close – not enough strength in hands so has to use her knee (F16)

Table 11 – Problems and comments: Loading the washing machine

3.2.2.2 Observations recorded by researchers

Observations recorded	No. incidences
No problem	25
Large aperture	5
Easy to load	4
Door opens wide	4
Door only opens to 90 degrees	1
Small aperture, but didn't cause a problem	1
Closing door when loaded required an extra push	1
Door easy to close	1

Table 12 – Observations: Loading the washing machine

3.2.3 Unloading the washing machine

Total no. respondents = 46

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.3.1 Problems and comments

Question	Number of problems	Details
3.1 Was it easy for you to unload the washing machine?	3	I get Frank (Husband?) to do it. It's too difficult to grasp the wet clothes, they're heavy (N14)
		No comment given (F1)
		See 3.3 (F16)
3.2 Did you have any problems?	4	See 3.1 (N14)
		Problems leaning into drum for small items. Rotating drum to find small items requires strength (F1)
		Water remains in door seal, so user needs to dry the seal with a cloth before removing the clothing (F15)
		See 3.3 (F16)
3.3 Did you have any discomfort?	9	See 3.1 (N14)
		Back pain (N18)
		Force to open door and discomfort from bending (F1)
		Bending and removing laundry from rear of drum (F3, F10, F17)
		Needs to support self on machine, so hard to check drum for all laundry (F9, F13)
		Hard to get tangled, wet, heavy laundry out of the drum. Then need to turn drum to make sure it is empty – requires manual strength and bending down (F16)
		Wet laundry is heavy and gets all tangled up (F17)

Table 13 – Problems and comments: Unloading the washing machine

3.2.3.2 Observations recorded by researchers

Observations recorded	No. incidences
No problem	16
Good access	3
Large aperture	2
Door opens wide	2
Reach okay	1
Bends easily	1
Poor access to rear of drum	1
Difficult to bend down and get clothes	1
Door doesn't open very wide	1
Problems retrieving items from the rear of the drum	1

Table 14 – Observations: Unloading the washing machine

3.2.4 Using the detergent dispenser

Total no. respondents = 47

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.4.1 Problems and comments

Question	Number of problems	Details
4.01 Was it easy for you to open and close the detergent dispenser?	3	Stiff to open and it sticks (R8)
		No comments given (F1, F16)
4.02 Did you have any problems?	1	See 4.1 (R8)
4.03 Did you have any discomfort?	3	No comments given (F1)
		Needs some strength to open dispenser (F13)
		Awkward to use when have crutches. Also hands are aching and shaking (F16)
		Comment: But some force is needed (R2)
4.05 Was it easy for you to add detergent?	2	Put it in the wrong place (N4)
		No comment given (N5)
		Comment: Wording in the instruction booklet is too complicated. It needs to use more simple language (N17)
Add detergent 4.07 Did you have any problems?	2	Easy to load, but labelling is unclear, hard to understand and I can't read it (R14)

		Frustrating (N4)
		Comment: Can be difficult to close dispenser (F13)
4.08 Did you have any discomfort?	1	No comment given (N4)
Add conditioner **4.09 Was it easy for you to add conditioner?**	1	Compartment is too small so conditioner often spills into other compartments (F13)
4.11 Did you have any problems?	1	See 4.9 (F13)
4.12 Did you have any discomfort?	0	NA

Table 15 – Problems and comments: Using the detergent dispenser

3.2.4.2 Questions

3.2.4.2.1 Question 4.04: What type of detergent do you normally use?

Type	No. replies
Powder	23
Tablets (including liquitabs)	11
Liquid	15
Gel	3

Table 16 – Question 4.04: What type of detergent do you normally use?

3.2.4.2.2 Question 4.04: Why do you use this type?

Reply	No. replies
Cost	7
Habit / what I've always done	7
Easier to use	7
Washes better	4
Eco-friendly	3
No reason	2
Tablets don't spill	2
Gel leaves no white marks	1
Allergies	1
Can choose how much powder I want to use in a wash	1
Kinder on my clothes	1
Heard that it (liquid) washes better	1

Table 17 – Question 4.04: Why do you use this type?

3.2.4.2.3 Question 4.06: How do you know which compartment to put the detergent into?[65]

Reply	No. replies
Habit / just know	19
Read the instructions	17
Position / location	13
Widest / largest compartment	12
Label	10
Don't know	2 (N4, N5)
Poor labelling	1

Table 18 – Question 4.06: How do you know which compartment to put the detergent into?

3.2.4.2.4 Question 4.10: How do you know which compartment to put the conditioner into?

Reply	No. replies
Clear label	9
Size (small) and shape	9
Habit / just know	7
Position / location	6
Read the instructions	6
Blue colour of compartment	3
Labelling is too small	3
Don't really know	3
Symbol	2
Special compartment and lid	1

Table 19 – Question 4.10: How do you know which compartment to put the conditioner into?

3.2.4.3 Observations recorded by researchers

3.2.4.3.1 Task 4: Please open and close the detergent dispenser a few times

Observations recorded	No. incidences
Good stop on dispenser tray	15
Good grip on tray	12
Tray opens and closes smoothly	12
No problem	9
Tray stiff to open	5

[65] This data might be unreliable as it is suspected that many participants interpreted the question as 'how did you first learn where to put the detergent', hence 17 users replied 'read the instructions'. This was especially prevalent within the NCBI sample.

Normally put detergent directly into the drum	5
Tray opens very easily	4
Tray is 'juddery' to open or close	3
Tray opens and closes easily	2
Some force needed to close the tray	2
Dual action required	1
No effort needed	1
No sharp edges	1
Good access	1

Table 20 – Observations: Please open and close the detergent dispenser a few times

3.2.4.3.2 Task 5: Please add detergent to the open dispenser

Observations recorded	No. incidences
No problem	16
Main wash detergent compartment is very large	8
Tray / compartment has good access	3
Good label	1
Normally put tablets directly into drum	2
Normally put liquid directly into drum	4
Normally put gel directly into drum	2

Table 21 – Observations: Please add detergent to the open dispenser

3.2.4.3.3 Task 6: Please add conditioner to the dispenser

Observations recorded	No. incidences
No problem	16
Don't use conditioner	16
Good access to the compartment	3
Wide compartment	1

Table 22 – Observations: Please add conditioner to the dispenser

3.2.5 Cleaning the detergent dispenser

Total no. respondents = 47

The majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

Question	Number of problems	Details
5.1 Was it easy for you to remove the detergent dispenser?	6	Difficult to remove (R1)
		Effort required, 'it was a bit of a tug' (R5)
		No comment given (N4, F1)
		Finicky (N7)
		Awkward (N9)
5.2 Was it easy for you to replace the detergent dispenser?	9	Problem with tray alignment (R1,R9 & R13) R13 took 5 attempts to replace
		Slot is too small. Grooves small (R5)
		No comment given (N4, F1)
		Very awkward (N7)
		Awkward, needs trial and error (N9)
		Tray has to be replaced at the correct angle and force is needed to replace the tray(F7)
5.3 Was it easy for you to clean the detergent dispenser?	9	Compartments are too small (R1)
		Lots of nooks and crannies (R2)
		Very difficult to clean due to dirt traps (R12)
		No comment given (N4, F1, F10)
		Picky bits to try and get at (N5)
		Awkward to clean (N15, F16)
5.4 Did you have any problems?	4	See 5.3 (R12, F10)
		No comment given (N4)
		Can't remove dispenser (F15)

5.5 Did you have any discomfort?	5	Made my hands feel sore (R12)
		No comment given (N4, F1, F10)
		Uncomfortable using cloth to clean dispenser (without removing it) (F15)

Table 23 – Problems and comments: Cleaning the detergent dispenser

3.2.5.1 Observations recorded by researchers

Observations recorded	No. incidences
Don't normally clean the dispenser	24
Many dirt traps and small spaces	9
Easy to remove the tray	8
Washed with cloth/sponge without removing it	6
Difficult to remove the tray	5
Tray too large to fit in the sink	3
No problems / easy to clean	3
Some force needed to remove and replace	3
Small button at back of tray hard to press	3
Conditioner compartment hard to re-assemble	2
Very difficult to clean	2
Tricky to re-align and replace	2
Tray fits easily in sink	1
Fiddly	1
Easy to replace	1

Table 24 – Observations: Cleaning the detergent dispenser

3.2.6 Using the main controls

Total no. respondents = 47

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.6.1 Problems & comments

Question	Number of problems	Details
6.1 Was it easy for you to set the wash programme?	4	Difficult to read the labels and use the control (R10)
		No comment given (N11)
		Hard to see if I have it set at the right spot (N15)
		Hard to grip and turn the controls for wash programme and temperature. Grip is small. Main programme controls requires some strength to turn, this hurt her hands (F16)
		Comment: N7 had to kneel down to look at the control and get it at eye level
6.2 Did you have any problems?	5	See 6.1 (R10, N15, F16)
		Poor instructions (N17)
		Confusion about using wash programmes which were new (F14)
		Comment: No, but it was quite demanding (N9)
6.3 Did you have any discomfort?	6	Gave me sore wrists and fingertips (R12)
		No comment given (N9, N11)
		Need to bend down to read labels (F11, F15)
		See 6.1 (F16)

Table 25 – Problems and comments: Using the main controls (6.1-6.3)

3.2.6.2 Observation task: How many attempts were required to set the programmes correctly?

Programme	1 attempt	2 attempts or more
Programme 1	44	3
Programme 2	38	2

Table 26 – Observation task: How many attempts were required to set the programmes correctly?

All of the problems encountered were due to setting the wrong programme on the first, or subsequent, attempt

3.2.6.3 Observations recorded by researchers

3.2.6.3.1 Tasks 8 & 9: Please set the washing machine on a wash programme

Observations recorded	No. incidences
No problems	17
Good main programme control	7
Clicks positively into settings (good feedback)	6
Problems with control alignment, had to bend & check	4
Main control is large	3
Labelling clear	3
Control requires some force to operate	2
Jerky controls	2
Problems with overshooting settings	2
Grip on main control too small	2
Dual action on control (push & turn) is awkward and demanding	1
I only ever use one programme	1
Had made own mark on the control for usual programme	1
Rotates control and counts the number of clicks	1
Large bar on control	1
East to see	1
Control and label alignment not accurate	1
Controls had a very light touch – good	1
Good tactile feedback	1
Care needed	1
Problems gripping and turning control	1
Single control for setting wash makes it easy to use	1

Table 27 – Observations: Please set the washing machine on a wash programme (8 & 9)

3.2.6.4 Questions

3.2.6.4.1 Question 6.4: Do you ever cancel a wash if you set it to the wrong programme?

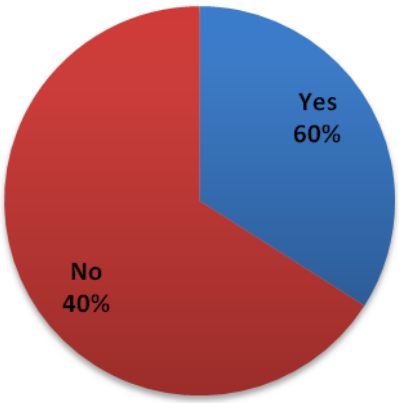


Figure 23 – Question 6.4

Twenty participants, mostly those who answered 'Yes', then answered the questions below.

3.2.6.4.2 Question 6.5 – 6.7

Question	Number of problems	Details
6.5 Was it easy for you to cancel the wash programme?	5	Complicated. Wasn't sure it was the correct thing to do (R10)
		No comment given (F1)
		Not sure what to do. Confused (F9)
		Need to read the manual (F10)
		Tries to avoid doing this (F18)
6.6 Did you have any problems?	4	It was a bit confusing (R10)
		Lack of knowledge. Not sure what to do. Confused (F1, F8, F9)
6.7 Did you have any discomfort?	1	Main control needs some strength to use and the grip is not very good. Grip on knob is too small (F9)

Table 28 – Problems and comments: Using the main controls (6.5-6.7)

3.2.6.5 Observation task: How many attempts were required to cancel the programmes correctly?

	1 attempt	2 attempts or more
Programme 1	12	1

Table 29 – Observation task: How many attempts were required to cancel the programmes correctly?

Note: In the FIT sample the data on attempts was only recorded for 3 out of 10 participants – hence missing data for 7 participants.

3.2.6.6 Observations recorded by researchers

3.2.6.6.1 Task 10: Cancel a set programme and start another

Observations recorded	No. incidences
No problems	5
'I always check the programme before starting it'	3
User needs to use the manual	3
Unsure what to do - confused	2

Table 30 – Observations: Cancel a set programme and start another

3.2.7 Using the minor controls

Total no. respondents = 46

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.7.1 Problems & comments

Question	Number of problems	Details
7.1 Was it easy for you to use these controls?	2	No comment given (N1)
		Difficult to read the labels (F1)
7.2 Did you have any problems?	6	'I'd be afraid to touch them in case it doesn't empty out' (N1)
		No comment given (F1)
		Didn't understand all of the minor controls or how to use them (F3, F9, F14, F18)
		Poor symbols and hard to tell when they are set (F9)
7.3 Did you have any discomfort?	1	No comment given (F1)
		Comment: Spin speed control was a bit

		awkward (R3)

Table 31 – Problems and comments: Using the minor controls

3.2.7.2 Observation task: How many attempts were required to set the controls correctly?

	1 attempt	2 attempts
Control type 1	39	1
Control type 2	25	0
Control type 3	18	0

Table 32 – Observation task: How many attempts were required to set the controls correctly?

The only problem was encountered by a user overshooting the correct setting on a touch sensitive pad.

3.2.7.3 Observations recorded by researchers

Observations recorded	No. incidences
No problems	19
Very easy	7
Clear indicator lights	6
Good audible and tactile feedback	5
Large controls	4
Don't normally use them	3
Spin speed control is small and fiddly	2
Difficult to read the labels	2
Spin speed control needs some force to use	1
Audible but no tactile feedback	1
Good tactile feedback	1
Confused about some of the controls	1
Good labelling	1
Dual action controls awkward and demanding	1
Touch sensitive controls were too sensitive – prone to overshooting	1

Table 33 – Observation task: Using the minor controls

3.2.8 Displays and labelling

3.2.8.1 Programme guide

Total no. respondents = 29

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.8.1.1 Problems and comments

Question	Number of problems	Details
8.1 Is the programme guide easy for you to read?	5	Have to bend to read it (R3, R7 & R10)
		Prefer to use the manual instead (R3)
		Not easy to read (R3 & N15)
		Poor position and the angle makes it hard to read (R10)
		Had to look very close and kneel down to read it (N7)
		Too small (N15)
8.2 Is the programme guide easy for you to understand?	2	No comment given (N4)
		Language not easy to understand, uses special terms (F1)
8.3 Did you have any problems with using the programme guide?	5	Problems reading the guide and translating the wash into a letter, i.e. Cotton 40 = E (R10)
		Prefer to use the manual (R10)
		No comment given (N4 & N15)
		See 8.1 (N7)
		Temperatures hard to see (N18)

Table 34 – Problems and comments: Programme guide (8.1-8.3)

3.2.8.2 Main controls

Total no. respondents = 47

Most of the participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.8.2.1 Problems and comments

Question	Number of problems	Details
8.4 Is the labelling of the main programme control easy for you to read?	9	Labels small and very difficult to see – even with glasses (R10 & N11)
		Poor marker on control (R10)
		Lower settings can be hard to read and are easier to overshoot. Have to bend to read them, so usually count the settings instead of reading them (R12)
		Labels could be larger & clearer (R13, F15)
		Labelling is wearing off! (R16)
		No comment given (N4 & N7)
		Have to bend to read label (F9)
		Negative comment: Labelling rather small (F17)
		Positive comments given: Very clear (3) Good size (2) Good contrast (2) Labels very large Excellent Front panel angled so control and labels are very easy to read
8.5 Is the labelling of the main programme control easy for you to understand?	5	Letters don't refer to (explain) the wash, you have to look at the programme guide or manual (R10, F16) Comment: Labels are numbers only so you have to look at the instructions or programme guide (N7)
		I don't understand all of the labels (R13, F14)
		No comment given (N4)
		Positive comment: Idiot proof (F17)
8.6 Did you have any problems with the labelling?	8	See 8.5 (R10)
		No comment given (N4, N7 & N11)

		Sometimes confused about settings (F1)
		Type/labels too small (F9, F17)
		Labelling at bottom of main control hard to read – have to bend to read (F15)

Table 35 – Problems and comments: Main controls (8.4-8.6)

3.2.8.3 Minor controls

Total no. respondents = 47

Most of the participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.8.3.1 Problems and comments

Question	Number of problems	Details
8.7 Is the labelling of the minor controls easy for you to read?	6	Labelling is wearing off (R16)
		No comment given (N4, N7, F1)
		Some symbols are not easy to read (F9, F16)
		Positive comments given: Very clear (2)
8.8 Is the labelling of the minor controls easy for you to understand?	6	No comment given (N4)
		Don't understand labels such as 'rinse hold' or 'high water level' or what they would do for my wash (N17)
		Don't understand all features, for example 'pre-wash' or 'soak' (F3, F15)
		Symbols not clear and not easy to understand (F9, F14)
		Positive comments given: Clear words (2) Large labelling Written English
8.9 Did you have any problems with the labelling?	5	No comment given (N4)
		Reading was okay, understanding them was the problem. Instruction booklet is mind boggling (N17)
		Lack of knowledge of these controls (F1)
		Need to use instruction manual to understand them (F9)
		See 8.8 (F15)

Table 36 – Problems and comments: Minor controls (8.7-8.9)

3.2.8.4 Displays / indicator lights

Total no. respondents = 44 (3 products didn't have any displays or lights)

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.8.4.1 Problems and comments

Question	Number of problems	Details
8.10 Are any displays / lights easy for you to read?	3	No comment given (N4)
		Very unclear, great difficulty with it. Can't see if the light is on or off (N7)
		Can't read it (N11)
8.11 Are any displays / lights easy for you to understand?	2	Confusion about the minor controls and indicators (F1, F14)
8.12 Did you have any problems with the displays / lights?	4	Problems with glare on sunny days, lights need to be brighter (R16)
		No comment given (N4)
		See 8.10 (N7 & N11)

Table 37 – Problems and comments: Displays / indicator lights (8.10-8.12)

3.2.8.4.2 Question 8.13: Do you use these displays/lights and are they useful?

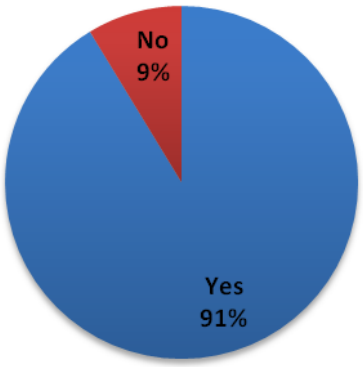


Figure 24 – Question 8.13

3.2.8.4.3 Observations recorded

Comment	No. replies
Very useful and necessary	11
Time remaining very useful	9
Wash progress / status is good	7
Never use them	3
Wash over indicator useful	3
Only use wash progress indicator	2
Lights tell me the wash has started, as I can't hear it	1
I know where it's at	1
Can't see so don't use it	1
Useful for wash temperature	1

Table 38 – Observations: Displays / indicator lights (8.10-8.12)

3.2.8.5 When the wash has finished

Total no. respondents = 47

3.2.8.5.1 Question 9.1: How do you know when a wash has finished?

Comment	No. replies
'Finished' or 'End' light	18
Very noisy just before the end / noise of spin stopped	17
It stops!	9
Dial / main control position	9
Timer at '0'	8
Makes a noise (bleep)	5
Door will open	5
I time it	4
Light goes out	3
Display says 'END'	3
Don't know	2

Table 39 – Question 9.1: How do you know when a wash has finished?

3.2.8.5.2 Question 9.2: Did you have any problem with this?

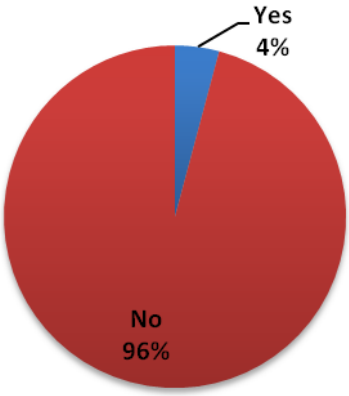


Figure 25 – Question 9.2

Problem 1: 'there is no signal to tell me it has finished'.

Problem 2: Confused by the 'crease protect / end' light (F3).

There was also a comment made that 'the light could be larger'.

3.2.9 Cleaning the filter

Total no. respondents = 47

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.2.9.1 Questions

3.2.9.1.1 Question 10.1: Do you ever clean the filter?

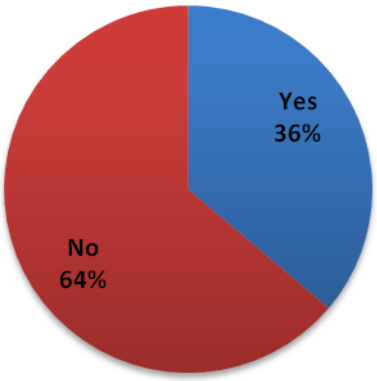


Figure 26 – Question 10.1

3.2.9.1.2 Question 10.1: Please describe how you do it and any problems you have

Comment	No. replies
Easy	6
Self-cleaning model with no filter	4
Problem to bend	4
Have to use a shallow tray	4
Very difficult	3
Fiddly	2
Do it twice a year	1
Try to get someone else to do it for me	1
Door stiff to open	1
Water spills out	1
No spill design – easy	1
Poor access for my hand	1

Table 40 – Question 10.1: Please describe how you do it and any problems you have

3.2.9.1.3 Questions 10.2-10.4

Question	Number of problems	Details
10.2 Is it easy to clean the filter?	6	Filter too close to the floor (R6, N21, F10)
		Awkward and causes spills (R6)
		No comment given (N16, F10)
		Have to get down on my hands and knees - uncomfortable (N21, F9)
		Door awkward / difficult to open. (F9, F10, F13)
		Hard to collect water and avoid spills (F9)
		Filter stiff to remove, requires strength and good dexterity required to replace (F10, F13)
		Positive comment: Very easy
10.3 Do you typically have any problems?	9	Opening flap and removing filter (R2)
		Spills, awkward, have to bend, 2 or 3 separate drains needed (R6)
		Low to the ground so access is poor and I find it awkward to bend (R17)
		Opening the cover is very difficult, then the filter is very hard to unscrew (N16)
		Difficult to find any blockages (N18)
		See 10.2 (F9, F10, F13)
		No comment given (F18)
10.4 Do you typically have any discomfort?	5	It hurts my back (N18)

		See 10.2 (F9, F10, F13)
		No comment given (F18)
		Observation: User F7 claims no discomfort but she is on her knees and struggling with the door. It appears as if she is in discomfort.

Table 41 – Questions: Cleaning the filter (10.2-10.4)

3.3 Mobile phone

Specific problems and replies to questions have been attributed to the participant/s according to their user code. So R12 is participant 12 of the RNID sample, etc.

3.3.1 Turning the phone on and off

Total no. respondents = 49

The majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.3.1.1 Questions: Turning the phone on and off (1.1-1.6)

Question	Number of problems	Details
1.1 **Was it easy for you to turn your phone on?**	9	Button had no feel, no feedback – complicated by screen lock (R3)
		Awkward (R5, N9)
		Hard to press and poor access to the control (R5)
		Difficult, had to hold button (on top of phone) down for a long time and this required force (R12, N15)
		Have to hold down for a while (R14)
		Have to use my fingernail to operate it (N16)
		Hard to switch on because control is small (N20)
		Comment: On/off can be a problem if my arthritis is bad so I usually leave the phone turned on (R8)
		See 1.2 (F1,)
1.2 Did you have any problems?	11	Small button and force required (R3, F1, F3)
		See 1.1 (R12, R14, N15, N20)
		Did not press down hard enough – took 3 attempts (N1)

		Button small, awkward to use and have to hold down for 3 seconds (N9)
		Force required (N18)
		Had to use finger nail to use (F1)
		Did not press down for long enough (F9)
1.3 Did you have any discomfort?	5	Can be uncomfortable due to force required and my arthritis (R8)
		Slight discomfort (N9)
		No comment given (N20, F1)
		Force required and key too small. Have to use nail and is uncomfortable (F13)
1.4 Was it easy for you to turn your phone off?	9	See 1.1 (R3, R5, R8, R12, R14)
		No, they should make it easier (N15)
		Quite hard (N16)
		No comment given (N20)
		See 1.2 (F1)
1.5 Did you have any problems?	7	See 1.1 (R3, R12, R14, N15)

Table 42 – Questions: Turning the phone on and off (1.1-1.6)

3.3.1.2 Observations recorded by researchers

3.3.1.2.1 Turning the phone on

Observations recorded	No. incidences
No problems	16
Had to hold down button for a second or two	16
Simply pressed on/off button	10

Button required force to operate	10
Hold down button on top	9
Problems unlocking the phone, due to dual action required	4
Button a good size	2
Button too small	2
Had to hold down button for a long time and it required force	2
I have terrible trouble with it	1
Didn't press down hard enough	1
Took a while to find the button (using magnifying glass)	1

Table 43 – Observations: Turning the phone on

3.3.1.2.2 Turning the phone off

Observations recorded	No. incidences
No problems	14
Had to hold down button for a second or two	9
Simply pressed on/off button	9
Button required force to operate	5
Button a good size	2
Button too small	1
Had to hold down button for a long time and it required force	1
Took a while to find the button (using magnifying glass)	1

Table 44 – Observations: Turning the phone off

3.3.2 Making a voice call

Total no. respondents = 46

3.3.2.1 Question 2.1-2.3

Most of the participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

Question	Number of problems	Details
2.1 Was it easy for you to make this call?	6	Often push more than 1 button at once. Keys too small so I have to concentrate (R11)
		Fiddly, have to use finger nail (R14)
		Big problems; awkward to use due to long finger nails and very, very difficult to clear/delete individual numbers if a mistake is made (R15)
		Hard to read numbers, usually only used saved numbers (N2)
		Difficult – often push wrong buttons by mistake (N15)
		See 2.2 (F1)
2.2 Did you have any problems?	8	Have to push buttons hard for them to work (obs: buttons seemed ok, problem is with user) (R3)
		See 2.1 (R11, R15, N15)
		Keys too close together (R11, N15, F1)
		Awkward (R14)
		No comment given (N1)
		Forgot to press green button after the numbers (N2)
		Can't see buttons – pressed wrong ones (N2)
		Number keys are rockers and each has two numbers. This toggling is error prone so it needed several attempts (F1)

		Comment: keys a bit small and too close together (F7)

Table 45 – Questions: 2.1-2.2

3.3.2.2 Observations recorded by researchers

Observations recorded	No. incidences
No problem	21
Inputted numbers slowly, deliberately and accurately	13
Checked the numbers onscreen as they inputted them	5
Used two hands	5
Mistake on first attempt – had to start again	5
Slow	4
Two errors made	4
Problems with keypad lock (difficult to use and very annoying)	4
Very large numbers on the display	3
Very large numbers on the display	3
Clear display	2
Had to use finger nails or a tool	2
Had to use finger nails or a tool	2
Touch screen – had to use pen/stylus	1
Inputting errors – failed twice	1
Problems caused by long fingernails	1
Normally use speed dial	1
Dislike keypad	1
Easy to push the right buttons	1
Three errors made	1
Difficult to see the numbers	1

Table 46 – Observations: Making a voice call

3.3.3 Receiving a voice call

Total no. respondents = 46

None of the participants had any problems in receiving a call.

3.3.3.1 Question 3.1 & 3.2

Question	Number of problems	Details
3.1 Was it easy for you to realise that you were receiving a call?	0	NA
3.2 Did you have any problems?	0	NA

Table 47 – Questions: 3.1-3.2

3.3.3.2 Observations recorded by researchers

Observations recorded	No. incidences
No problem	18
Loud ring	5
Strong vibration	4
Easy to know when I'm receiving a call	3
Ring too quiet	3
Screen lights up	3
Small indicator light	1
Problem with keypad lock – difficult to unlock, lock is too fast, keys too small and operation not at all obvious	1
Red light on top	1
Uses speakerphone to hear better	1

Table 48 – Observations: Receiving a call

3.3.3.3 Alert

Type of alert used	Number
Ring only	19
Vibrate only	0
Ring & vibrate	25
Ring & lights	2

Table 49 – Type of alert

3.3.3.3.1 Why use this type of alert?

Comments made	No. incidences
It's the way it was set up	10
Can feel the vibration if it's in a pocket or hand bag	6
Happy with ring only	6
All I ever use / habit	5
Don't know	3
Like ring & vibrate	3
Vibration easier to detect than ring	2
Keep phone in hand bag so vibration wouldn't help	2
Simple	1
Dislike vibration	1
Vibration handy when in noisy places	1

Table 50 – Why this type of alert?

3.3.3.3.2 Are they aware of other types?

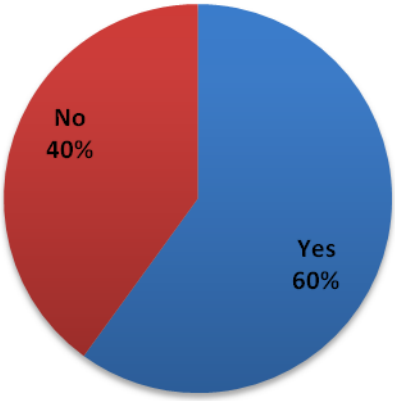


Figure 27 – Alerts: Are they aware of other types?

3.3.3.3.3 Comments

Comments made	No. incidences
Happy with current set up	8
Happy with current set up	8
It's the way it was set up	5
Like vibration	3
Have a hearing impairment so vibration is very useful	2
Like ring & vibrate	2
Keep phone in hand bag so vibration wouldn't help	1

Table 51 – Comments: Alerts

3.3.4 Performance during a voice call

Total no. respondents = 36

The majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.3.4.1 Hearing aids

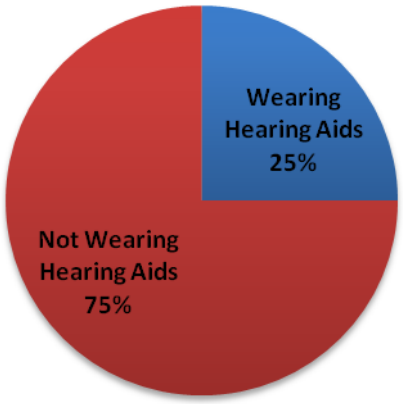


Figure 28 – Are users wearing hearing aids?

3.3.4.2 Comments given

- Usually use a speakerphone; I can then hear better (R14).
- Tend to use without hearing aids because I can hear better that way (R2, R15)).
- Use with hearing aids as I don't get any interference with this phone (R6).
- Use without hearing aids as they cause interference with my phone and it's easier (R7).
- Use without hearing aids because it is more comfortable and I can hear better (R9, R12).
- Easier without hearing aids, with aids it is fiddly to position the phone correctly over the aids (R12).

3.3.4.3 Question 4.1-4.3 and Task 6

Question	Number of problems	Details
4.1 is it easy for you to hear the speech?	6	Loud but not very clear (R7)
		Neither loud nor clear (R8)
		Can only hear the odd word (R12)
		Too quiet (R16, R17, N22)
4.2 is it easy for you to understand the speech?	9	Not very clear – can't understand it (R7,8, 9,12,14,17)
		Muffled (R8)

		Accent hard to understand (R9, R15)
		Speech too fast (R14, R15)
		See 4.1 (R16, N22)
4.3 Did you have any problems?	11	Can't understand the voice (R7,8,12,14)
		Accent hard to understand (R6,9)
		Voice not very clear (R9, 10)
		Too quiet, couldn't hear it (R16,17)
		Can just about follow it (R15)
		Speech too fast (R14)
		Initial problems but got easier once I understood the context (R10)
		See 4.1 (N22)
Adjust the volume **Is it easy for you to adjust the volume?**	10	Controls quite small (R7,8,10, 11, 13)
		Poor display (R8)
		Unclear operation (R8)
		Don't know how (R1,3,11, F11)
		Needs a lot of manual dexterity. Rocker has 2 controls on it but is small and very hard to operate (R15)
		Awkward, very difficult for my fingers (R10)
		No comment given (N1, N5, F4)
		'digging in to find where it was' (N18)
		Positive comments: like the controls on the side (R6, F1)
		Good to get 'change done' feedback afterwards (F3)
Did you have any problems?	8	Small control (R7, R8, R11)

		Hard to see what is happening (R8)
		I couldn't do it! (R15)
		Took some time to find the function in the menu (F3)
		Didn't know how to do it (F4)
		See answer above (R10, R11, R15, N18)
Did you have any discomfort?	4	Controls far too small (R8)
		Too difficult to use (R8)
		See answer above (R10)
		Awkward and caused discomfort (R10)
		Made my hands ache – painful (R15)
		Not comfortable (F1)

Table 52 – Question 4.1-4.3 and Task 6

3.3.4.4 Task 7: At the ideal setting

3.3.4.4.1 How would you describe the volume?

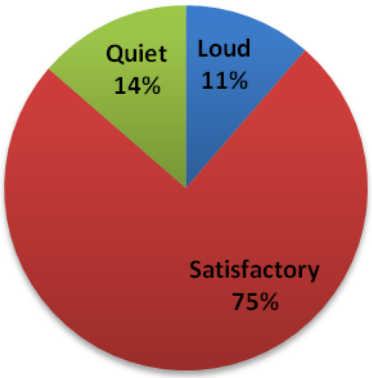


Figure 29 – How would you describe the volume?

3.3.4.4.2 How would you describe how clear the speech sounds?

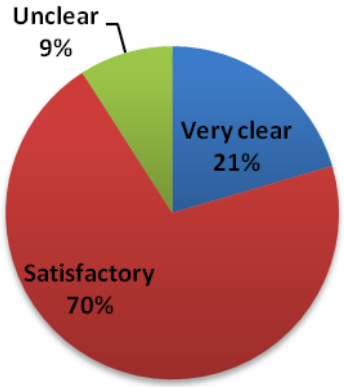


Figure 30 – How would you describe how clear the speech sounds?

3.3.4.4.3 Comments

- Just okay despite some slight muffling (R11).
- Better once volume was increased (R12).
- Better when used with aids on 'T' (R12).
- Speech too fast, had to listen very carefully (R14).

3.3.5 Sending an SMS text message

3.3.5.1 Question 5.1: Do you normally use predictive texting?

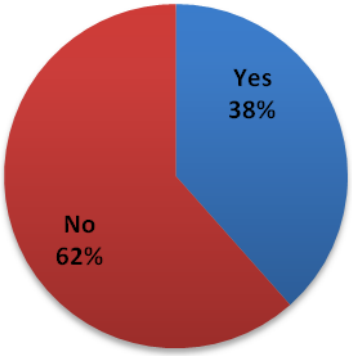


Figure 31 – Question 5.1

3.3.5.2 Question 5.2-5.4

Total no. respondents to questions about SMS texting = 26

The majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

Question	Number of problems	Details
5.2 Was it easy for you to write and send this message?	3	Forgot the process and kept forgetting where the letters are. Buttons are too small and dislike the style where adjacent letters are not in a straight line (R14)
		See 5.3 (F1)
		No comment given (F3)
		Comment: keypad small, sometimes I press the wrong button (N6)
5.3 Did you have any problems?	3	See 5.2. Prefer separate buttons and dislike this phones touch sensitive pad (R14)
		Unfamiliarity with typing. Time consuming and error prone (F1)
		Keypad lock kept causing problems – difficult to use (F3)
5.4 Did you have any discomfort?	0	NA

Table 53 – Question: 5.2-5.4

3.3.5.3 Observations recorded by researchers

Observations recorded	No. incidences
No problems / easy	9
Slow	7
Deliberate and accurate	6
Checks each letter one at a time	4
Quite fast	1
No predictive text	1
Very slow	1
No mistakes	1
Screen not very clear Used a stylus	1
Some predictive texting problems	1
Problem inputting letters	1
Problem reading the number keys	1
Overshot letters (non-predictive text) many times	1
Stored number first, lost it twice and then became confused	1

Table 54 – Observations: SMS texting

3.3.5.4 Time taken to complete the task

Min	Seconds
RNID	
2	10
3	25
1	50
3	55
6	45
2	25
NCBI	
0	30
1	14
2	03
1	18
2	20
2	12
3	35
FIT	
3	56
1	47
1	31
0	28
2	01
1	40
1	43
1	36

Table 55 – Time to SMS text

Mean time taken, RNID = 3 min 25 seconds

Mean time taken, NCBI = 1 min 52 seconds

Mean time taken, FIT = 1 min 52 seconds

Note: The differences in these results suggest that there might have been some variation in the exact methodologies employed. All partners agreed to follow the RNID designed methodology exactly, but with this task it would appear that participants used by NCBI and FIT were asked to write shorter, and possibly easier, SMS text messages. As a result this data should be used with caution.

3.3.5.5 Number of mistakes made

No. mistakes	No. incidences	Comments
0	13	
1	3	2 spelling mistakes and 1 typo
2	2	Spelling mistakes
3	3	Spelling mistakes Trying to type too fast – makes mistakes
4	1	Typos
5	1	No comment given

Table 56 – Mistakes made: SMS texting

3.3.6 Receiving an SMS text message

Total no. respondents to questions about SMS texting = 28

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.3.6.1 Alert

Type of alert used	Number
Ring / tone only	12
Vibrate only	0
Ring & vibrate	14
Ring / tone and blue, flashing LED light	1
No reply given	1

Table 57 – Alert: receiving an SMS text message

3.3.6.2 Question 6.1-6.4

Question	Number of problems	Details
6.1 Was it easy for you to know you had received a text message?	0	NA
6.2 Was it easy to open and read this text message?	1	Lack of familiarity. Confused about how to access the message and read it (F13)
6.3 Did you have any problems?	1	See 6.2 and keypad lock caused big problems (F13)
6.4 Did you have any discomfort	0	NA

Table 58 – Question: 6.1-6.4

3.3.6.3 Observations recorded by researchers

Observations recorded	No. incidences
No problems	19
Easy to read	3

Separate message alert "you have a message", shouted and repeated!	1
Slow	1
Ring volume rather low	1
User liked note in display telling him that a text message had been received	1

Table 59 – Observations: Receiving an SMS text message

3.3.7 Keys and controls

Total no. respondents = 48

3.3.7.1 Question 7.1-7.5

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

Question	Number of problems	Details
7.1 Do you think the number keys are large enough for you?	17	No. I tend to push 2 at once by mistake so i need to take care (R7, R13)
		Too small, too fiddly (R10, 11, 13, 15, N6, N9, F13)
		Keys not in straight lines – this confused her and made it awkward to use (R11)
		Large enough but don't protrude enough (R14)
		Not for me (N2)
		Impossible to use them (N15)
		Prefer it if buttons weren't depressed (N16)
		No comment given (N18, N20, F1, F7, F17, F18)
		Had to use finger nails (F13)
		Keys have a rounded surface, so fingers slips off keys and presses the next door key instead (F13)
		Comment: Touch screen so need to use a stylus (R6)
		Comment: prefer them more raised, they were too flat for me (N10)

7.2 Do you think the number controls are spaced apart enough?	18	Too close, need wider spacing (R7, 8, 10, 11, 13, 15, N2, 6, 9, 15, 16)
		I can push more than one button by mistake (R8, R13)
		They are on top of one another. I could swear I have dialled the right number, but I look at the screen and it is wrong! (N15)
		No comment given (N18, N20, F1, F7, F13, F17, F18)
7.3 Did you have any problems using the number keys?	16	See 7.1 (R7)
		I can push more than one button at once by mistake (R8, R10)
		Tricky to use and time consuming (R10)
		See 7.1 & 7.2 (R11, R13, N15)
		Would prefer to have proper raised buttons (R14)
		Too small and too close (R15)
		A little difficulty (N2)
		Sometimes I press the wrong button (N6)
		Keys are the wrong colour and backlighting makes them look very unclear (N14)
		No comment given (N20, F1)
		If I want A, B or C I tend to get L instead (N23)
		Some mistakes when user types too fast (F3)
		Keys have a rounded surface, so fingers slips off keys and presses the next door key instead (F13)
		Comment: Touch screen so need to use a stylus (R6)
7.4 Did you have any discomfort when using these controls?	4	Can be painful (R8)
		Some discomfort in my thumbs (N18)

		No comment given (F13)
		Have to use finger nail which is awkward and uncomfortable (F17)
7.5 Did you have any problems with the labelling on the controls?	15	Labels worn therefore hard to read (R14)
		Labels too small and cluttered (R15, N18, N20, F6, F7, F13)
		Letters too small when texting (R16, R18, F13)
		Can see the numbers ok, but not the letters (N1, N9)
		Cannot see them (N2)
		See 7.3 (N14)
		Have a bump sticker on 8 so know where they are, can't use the labelling (N15)
		No comment given (F1)
		Labelling hard to read (F6)
		Comment: Easy except the # and * buttons (R11)
		Comment: Dark grey on mid grey gives poor contrast but illumination helps (R13)
		Positive comments: Clear and easy (R8, R9, R10, F11)
		Labels light up in the dark (F4, F11)

Table 60 – Question: 7.1-7.5

3.3.7.2 Other controls

Most of the participants had no problems in using these controls. Here we look at any problems, or comments, which were made.

Control	Is it large enough?	Is it spaced far enough apart from others?	Did you have any problems when using?	Did you have any discomfort when using?	Did you have any problems with the labelling?
Menu control	Yes 32 No 8	Yes 30 No 10	Yes 8 No 32	Yes 2 No 38	Yes 8 No 32
Comments	Controls surrounding central menu button too shallow (R8, R10, R13, F6) Too small (R9, R14) No comment given (N18, F1)	Top ok but bottom too small, user catches A all the time (R3) Too close (R3,8,9,10, 11, 13, 14, F6) Catch fingers on other controls (R14) No comment given (N18, F1)	Catches on A (R3) Press wrong one by mistake (R8) Too small (R9, F6) Catch fingers on other buttons by mistake (R9,10, 11, 13, 14,F6) Very difficult (R10)	Painful (R8) No comment given (F6)	Can't see it easily (R7,8,9, 11, 16) Too small (R9, 16) None (R13) Sometimes you could go onto the wrong one (N18)
Controls surrounding the main menu control	Yes 33 No 3	Yes 30 No 6	Yes 6 No 30	Yes 2 No 34	Yes 7 No 29
Comments	Too small (R11, R13, R15))	Too close (R8,9,10, 11, 13)	Sometimes push 2 buttons by mistake (R7,	Painful (R8)	Can't read it (R1, R15)

		Especially too close to screen (R9, R15)	8,10, 11, 13, 15) Often push wrong one by mistake (R15)	Ache (R15)	Not sure what top one does (R3) Unsure what they do (R10, R11, R14) Too close, Sometimes push 2 buttons by mistake (R13)
Volume control on side	Yes 6 No 2	Yes 7 No 1	Yes 1 No 7	Yes 0 No 8	Yes 1 No 7
Comments	No comment given (N10, F1)	No comment given (N10)	No comment given (N10)	NA)	Very hard to see arrows – would be better if they were black or larger (N10)
Controls under the screen (that relate to functions on the display screen)	Yes 7 No 2	Yes 7 No 2	Yes 2 No 7	Yes 1 No 8	Yes 1 No 8
	Dual function control is small, very awkward and very confusing to use (R15) No comment	Dual function control is small, very awkward and very confusing to use (R15) No comment	Dual function control is small, very awkward and very confusing to use (R15) No comment	Ache (R15)	Can't read it (R15)

	given (F7)	given (F7)	given (F7)		
On/Off control **(both on top or on 'hang up' control)**	Yes 8 No 7	Yes 14 No 1	Yes 6 No 9	Yes 5 No 10	Yes 4 No 11
	Too small (N15, 16, 17, 20, F13) No comment given (F3, F4)	No comment given (N9)	No comment given (N9, N16, F3) Needs pressing very hard (N15, N18) Too small (N20)	No comment given (N9, N15, N16, N20, F3)	Red phone is not very clear (N11) None (N15, N18) No comment given (N20)

Table 61 – Review of controls

3.3.8 Display

Total no. respondents = 48

3.3.8.1 Question 8.1-8.3

The majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

Question	Number of problems	Details
8.1 Is the main display easy for you to read?	7	Display is too small and I dislike dark grey figures on orange background (R15)
		No comment given (N7)
		Calendar and messages can be quite faint (N8)

		Should be bigger (R11, N15)
		Screen darkens too quickly (F13, F18)
		Comments: Could be larger (R11, F3, F6)
		Some difficulty reading it (N2)
		Positives comments: Clear & colourful (R1)
		Easy to check numbers (R7, R10)
		Numbers a good size (R12, 13, 17)
		Excellent (R13)
		Very clear (N1)
8.2 Do you understand the icons or descriptions?	21	Don't understand the menu functions and don't use them (R3, 8, 15)
		Not sure about some of the words/icons used (R4,5,7,9,13, N18, F1, F6, F11, F13, F17, F18)
		Too complicated (R8)
		Not intuitive (N9, F1)
		Don't understand a lot of the things on the screen (N1)
		No comment given (N2,7,15,20, F3)
		Instructions and language are too complicated (N17)
		Positive comment: Clear diagrams and words (R1, R14)
8.3 Did you have any problems using the main display?	8	Tricky to read – I have to really concentrate (R15)
		No comment given (N2,7,15)

		Problems reading the display in full sunlight (N9, F17)
		Problems understanding the menu and the functions (N17, N20)
		See 8.1 (F13)
		Comment: only a problem when used outside in the sun (N6)

Table 62 – Question: 8.1-8.3

3.3.8.2 Question 8.4 In relation to the display, what are the good points and drawbacks?

Good points	No. replies	Drawbacks	No. replies
Clear	10	Locks itself all the time	2
Numbers very clear	6	Menu & function descriptions poor, not clear to me	2
Easy to use	6	Bit too small	4
Colour	4	Can't read anything	2
Numbers very large on screen	4	Don't need all these functions	1
Like the menu functions	3	Grey letters on an orange screen	1
Large screen	4	Size of numbers in the display	1
Lists in words in each menu section	1	Hard to read	1
Easy to see in the dark	1	Writing too small	1
Convenient	1	Dislike the screensaver	1
Can see menu at bottom	1	Hard to delete voicemail messages	1
When it lights up I know it is on	1	Confusion about some functions and where they are in the menu	1
Shows when battery charging	1	Need to use magnifying glass	1
Displays your mobile coverage	1	Prefer a larger screen	1
Time 7 date are good	1	Icons too small	1
Slow scrolling of name in address	1	Text is too spread out	1

book is good			
Print is brilliant	1	Problems understanding the language used	1
I can read it	1	Difficult to read in poor light	1
I wanted a better mobile than my son – I got it!	1	Longer numbers are wrapped – generally ok but with long numbers the numbers/letters become too small	1
Screen is bright	1	Screen darkens automatically too quickly	2
Symbols are good	1	Has to be recharged too often	1
Helpful information	1		
Screen automatically darkens after a while	1		
Phone is small, but opens out (slider) and is large with a big screen	1		

Table 63 – Question 8.4

3.3.9 Adding contact details to the phonebook

Total no. respondents = 48

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.3.9.1.1 Could it be completed successfully?

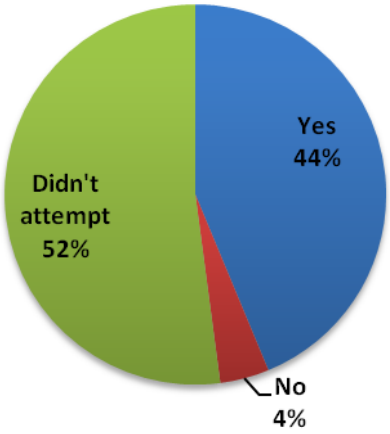


Figure 32 – Adding contact details to the phonebook: Could it be completed successfully?

3.3.9.1.2 Time taken to complete the task

Min	Seconds
RNID	
1	30
1	00
2	10
2	40
NCBI	
1	03
1	23
1	33
0	37

0	23
0	35
0	56
0	51
0	25
0	29
0	29
0	41
1	43
FIT	
0	20
0	20
0	30

Table 64 – Time taken: Adding contact detail to phonebook

Mean time taken, RNID = 1 min 50 seconds

Mean time taken, NCBI = 0 min 51 seconds

Mean time taken, FIT = 0 min 23 seconds

Note: The differences in these results suggest that there might have been some variation in the exact methodologies employed. All partners agreed to follow the RNID designed methodology exactly, but with this task it would appear that participants used by NCBI and FIT were asked to add less information to the phonebook. As a result this data should be used with caution.

3.3.9.1.3 Number of mistakes made

No. mistakes	No. incidences	Comments
0	11	
1	5	Typing error Spelling mistakes
2	2	Wrong letter + wrong digit Predictive texting problems
3	0	

4	0	
5	0	
6	1	Typing errors
Not recorded	4	

Table 65 – Mistakes made: Adding contact detail to phonebook

3.3.9.1.4 Question 9.1-9.3

Question	Number of problems	Details
9.1 Was it easy for you to do this?	4	Lack of familiarity (R4, F13)
		Had to think hard and concentrate (N17)
		No comment given (F6)
9.2 Did you have any problems?	6	Lack of familiarity (R4, F6, F13)
		Process not intuitive to me (R6, F6, F17)
		Language is difficult (N17)
		User kept making the same mistakes and wasn't able to learn from them (F13)
9.3 Did you have any discomfort?	0	NA

Table 66 – Question 9.1-9.3

3.3.9.1.5 Observations recorded by researchers

Observations recorded	No. incidences
No problem	11
Done for me by relative/friend	4
Don't do this	2
Have problems remembering how to do it	2
Accurate & methodical	2
Touch screen – used a stylus	1
Slow	1

Can't do due to arthritis	1
Hard to do	1
Numbers ok, but letters poor	1
Failed first time	1
No understanding of the process, so simply trial and error	1

Table 67 – Observations: Adding contact details to the phonebook

3.3.10 Recharging the phone

Total no. respondents = 48

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

3.3.10.1Question: 10.1-10.3

Question	Number of problems	Details
10.1 Was it easy for you to put your phone on charge?	1	Fiddly to connect. Hard to tell which way round the connection goes (R14)
10.2 Did you have any problems?	1	See 10.1 – can be really awkward (R14)
10.3 Did you have any discomfort?	0	NA

Table 68 – Question: 10.1-10.3

3.3.10.2Observations recorded by researchers

Observations recorded	No. incidences
No problems	27
Simple	3
Small tab covers the socket, it has to be removed but this is not a problem	3
Small tab covers the socket. This is a problem because you have to use a knife or long finger nail to remove it. Good manual dexterity needed.	2
Bit fiddly	2
Good display. It shows that the phone is charging	2
Needed some force to plug in	1
Easy	1

Keypad locking a problem	1
Large connector	1
Connected the wrong way round on first attempt	1
Good labelling	1
Couldn't fit it in initially – took a number of attempts	1
Mobile produces an audible alert when it needs recharging	1

Table 69 – Mistakes made: Recharging the phone

3.3.11 Doro PhoneEasy®410gsm

Total no. respondents = 52

The vast majority of participants had no problems in carrying out these tasks. Here we look at any problems, or comments, which were made.

Participants were introduced to the Doro PhoneEasy 410gsm phone and asked how it compared with their current mobile phone.

3.3.11.1Question 11.1 making a voice call

3.3.11.1.1Question 11.1.1: How does this phone compare to your normal mobile phone?

Reply	No. replies
This is far better / much better	6
Voice clearer and easier to understand	6
Easier to use	5
Easier to use	5
Easier to read	3
Easier to read	3
It is brilliant / lovely	3
Buttons easier to use	3
Clearer	2
Just as easy / about the same, for making calls	2
Screen excellent, much better	2

Used to old phone so still prefer it	1
Louder	1
Looks nice	1
Numbers better	1
Keypad better	1
Works with finger, not just nail	1
Seems ideal	1
Can even use it right handed	1
Faster to type digits	1
Seems normal, okay	1
Larger keys	1
Larger than my own phone	1

Table 70 – Question 11.1.: How does this phone compare to your normal mobile phone?

3.3.11.2Question 11.1.2: When making a voice call with the Doro PhoneEasy®410gsm

3.3.11.2.1Good points

Reply	No. replies
Large controls	25
Clear display	21
Excellent / really good / really like it / lovely / best phone I have ever seen	15
Letters / numbers very clear on screen	15
Clear labelling	15
Voice sounds clear and easy to understand	14
Clear controls	13
Volume controls on the side – easy to change volume	13
Clear controls	13
Letters / numbers very clear on keypad	11

Large display / screen	9
Easy to use	8
Colour display	5
Bright display	5
Large letters	5
Contrast of black keys on white background	4
Loud volume	3
Very clear	3
Light in weight	3
Nice phone	2
Slim	2
Nice feel	2
I like the keypad	2
Keys well-spaced apart	2
Keys very comfortable	2
Works well on 'T' setting	1
Very loud	1
Easy to hold	1
I like the case and its colour	1
Like up and down keys for scrolling	1
Attractive phone	1
Flat screen	1
Clamshell design	1
Makes life a lot easier for everyone	1
I would love to have a phone like this	1
Numbers easy to read	1
I like the soft-touch of the keys	1

Lovely clear figures on it	1
Labels on keys easy to read	1
Likes the large clock	1
Like the top keys that select operations shown on the screen	1
Very obvious indication (symbols) that a call is being made	1
Menu easy to read	1
Keys very bright	1
Likes the tone when a key pressed	1
Menu easy to use	1
Works well even in bright sunlight	1

Table 71 – Question 11.1.2: Good points

3.3.11.2.2Drawbacks

Reply	No. replies
Don't like the placement of the top 2 buttons that refer to screen options	2
Lettering isn't very big on the keys	2
Like louder volume	2
Sounds a bit 'metallic' / tinny	2
Larger than existing phone	2
Slightly heavy	1
Prefer the number keys to be more raised	1
Cost	1
Prefer to have larger buttons	1
No dot on 5 button	1
Confused about the menu and back buttons	1
Can't find the menu	1
Dislike separate menu options, prefer them all on one page	1
Dislike green colour	1

Not glamorous	1
Dislike clamshell design	1
No date on it	1
Labels in menu items not readable, but icons visible	1
A bit large to put in a trouser pocket	1
Unfamiliar with top two soft keys	1

Table 72 – Question 11.1.2: Drawbacks

3.3.11.2.3Observations recorded by researchers

Observations / comments recorded	No. incidences
No problems / Easy	17
Liked the keys and the display	8
Sounds very clear / very good	6
Nice display	5
Dialling very quick and very easy	5
Works very well on 'T'	4
Clear labels	4
Large keys	3
Easy to change volume	2
Screen is brilliant	2
Like volume control on the side	2
Very loud	1
Looks very good	1
Keypad feels a bit sticky	1
Raised buttons very easy to press	1
Large letters on the display	1
Quite fast	1
Sounds better on 'T' than on 'M'	1

Sounds very clear on 'T'	1
As good as my phone but different	1
Didn't know she had to press the green button to make a call	1
More comfortable to use	1
User astonished that this phone is so easy	1
Numbers on keys easy to read	1
Couldn't read all the icons or text	1
Like the large display	1
User looked relaxed	1
User explored the menu functions – she would not do this on her own phone!	1

Table 73 – Observations: Making a call with the Doro PhoneEasy®410gsm

3.3.11.3Sending a text message

3.3.11.3.1Question 11.2.1: How does this phone compare to your normal mobile phone?

Reply	No. replies
Easier to use	3
Just as easy / about the same	3
Easier to read	2
Unfamiliar with the controls	2
Slow at first	2
Predictive text is different to that on my phone	2
This is far better / much better	1
Clearer	1
No faster	1
Much faster	1
Unsure how to access the text	1
Slow to respond	1

Unfamiliar with use of upper and lower cases	1
Larger but very nice	1

Table 74 – Question 11.2.1: Comparison normal mobile and Doro

3.3.11.3.2Question 11.2.2: When sending a text message with the Doro PhoneEasy®410gsm

3.3.11.3.2.1Good points

Reply	No. replies
Good controls / keys	10
Easy to use	5
Screen very clear	5
Large controls	3
Good button spacing	3
Easy to read	3
Text much larger	3
Text much clearer	3
Buttons feel nice	2
Large display / screen	1
I like it	1
Clear controls	1
Very good	1
Easy to see everything	1
Buttons easy to press	1
Keys a good colour	1
Not too fast	1
Easy to handle	1
Keys comfortable	1

Table 75 – Question 11.2.1: Good Points

3.3.11.3.2.2Drawbacks

Reply	No. replies
Don't understand what SMS is / means	5
Buttons, below the screen, to select options given on the screen are confusing	1
SMS, MMS and file manager are the only options	1
Problems finding full stop	1
Hard to initially get used to it	1
Disliked predictive text on this phone	1
Seems to have a delay	1
Too many steps to get into a text message	1
Limited functionality	1

Table 76 – Question 11.2.1: Drawbacks

3.3.11.3.2.3Observations recorded by researchers

Observations / comments recorded	No. incidences
No problems	3
Struggled to learn new process	3
Slow	2
Much faster than with my phone (Motorola RAZR)	1
Easy and accurate	1
intuitive	1
Normally use 2 hands, but could use the Doro single-handed	1
Still takes time and concentration	1
Unfamiliar with menu	1

Table 77 – Observations: Sending a text with the Doro PhoneEasy®410gsm

3.3.11.4Question 11.3: Overall comments on the Doro PhoneEasy®410gsm

Note: These comments were not always collected; many participants felt they had already given their replies in sections 11.1 and 11.2.

3.3.11.4.1Good points

Reply	No. replies
Good screen / display	8
Large controls / keys	6
Easy to use	5
Like the clamshell design	3
Bright screen	2
Like the volume adjustment on the side	2
Easier to hold	2
Looks good	1
I like the loop (HAC) feature	1
Clear text	1
Very impressed	1
Wonderful	1
Very comfortable	1
If this phone was available and I was offered it, I think I would like it	1
Small size when closed, but large screen once opened up	1
Clamshell design protects keys from accidental use – so no key lock required	1
Likes intensive colour of the display	1

Table 78 – Question 11.3: Good points

3.3.11.4.2Drawbacks

Reply	No. replies
The functions are too basic for my needs	1
Dislikes patterned screen background	1

Table 79 – Question 11.3: Drawbacks

4 Discussion

4.1 Participants

The participant sample group were predominantly female and aged 65 – 74. The majority had mild to moderate impairments with few having more severe impairments.

Participants were classified according to their impairment grouping (see section 0) and problems encountered during the research were analysed with these groupings in mind. In this discussion we highlight the groups that participants belonged to, however no significant differences were found between the results for each of the user groups and no specific problems significantly relate to one group in particular.

We conclude that our sample represent a group of typical, able-bodied elderly people.

4.2 Washing machines

4.2.1 Opening and closing the door

There were a small number of problems related to using the door catch. In these cases either the catch was too small, a dual-action was required to operate the catch or a push button control required force to operate. Problems were recorded for 4 participants; 1 from impairment group A, 2 from group B and 1 from group C.

A well-designed door catch should have good access for the users hand, allow the door to be opened from a range of bending positions, be a large size to allow users with manual dexterity impairments to be able to find a suitable grip, require little force to operate and provide good grip, even with wet hands.

Opening and closing the door was generally found to be an easy task to carry out but a number of users (n=7) experienced discomfort. This discomfort was mainly due to force being required to close the door – in most cases this was due to poor alignment of the door, as a result force was required to properly secure the door catch. There were also 12 observations that force was required to close the door due to poor door alignment. Discomfort was recorded for 7 participants; 1 from impairment group A, 3 from group B, 2 from group C and 1 from group D.

A well designed door will swing open easily and then remain open whilst washing is being loaded. It should close smoothly, requiring little force and close securely without the need for a final slam or for the user to have to line up the door. A washing machine door will be subject to considerable mechanical forces during regular use, so it should be designed and manufactured with this in mind. Ideally the door alignment will not change during normal use.

4.2.2 Loading the washing machine

Generally this task was easy to carry out, with few problems recorded.

Key design solutions to ensure the easy loading of a washing machine include having a large aperture, a door which opens wide and a door seal which does not catch on either clothing or the user's hands.

4.2.3 Unloading the washing machine

There were a small number of problems (n=4) related to unloading the washing machine. Two participants (user groups A and D) found it hard to remove heavy, wet laundry from the drum. One user (group B) had problems leaning into the drum to remove clothing and some force was

required to rotate the drum to check that all of the clothing had been retrieved. Another user (group A) had problems related to water remaining in the door seal.

Key design solutions to ensure the easy unloading of a washing machine are very similar to those to ensure easy loading. They include having a large aperture, a door that opens wide and a door seal which does not catch on either clothing or the users hands. If drum capacity is not a large consideration then a manufacturer could use a drum with a large aperture (easy loading and unloading) but a shallow depth (easy retrieval of clothing). Another solution, which has occasionally been adopted by manufacturers, is to position the drum at an upward tilted angle – making loading and unloading easier.

4.2.4 Using the detergent dispenser

Participants generally found the detergent dispenser easy to use; this included opening and closing the dispenser, adding detergent and conditioner.

Three people commented that the dispenser could be stiff to open and that force was needed to open it, two of these were from group B and the other was from group C.

Observations on this task gave mainly positive comments, so generally this task was easy to carry out and the detergent dispensers appeared to be easy to use and well designed.

Three participants had problems adding detergent to the dispenser. One user (group B) found the task easy to carry out successfully but found the labelling unclear and difficult to read. The other two participants had problems associated with unfamiliarity; one (group C) normally added liquitabs directly into the drum so didn't normally use the detergent dispenser and the other (group A) was unable to use the detergent dispenser due to the installation of the washing machine. Observations of this task were all positive.

Only one user (group A) had a problem when adding fabric conditioner. The conditioner often spills into other compartments (which could affect the washing performance) as a result of the conditioner compartment being too small. The observations recorded that many people do not use fabric conditioner, but all other comments were positive.

Despite the wide variety of new types of washing detergent, 23 participants regularly used washing powder. The least used type of detergent was gel. When asked why they chose a specific type of detergent a wide range of answers were given, predictably the joint-highest were cost, habit and ease of use.

A well designed detergent dispenser should open easily and smoothly, requiring little force but should have a good stop to prevent it being pulled out by mistake. Similarly it should close smoothly and have a good, positive feel once it is closed properly. It should also have a large hand grip which is easy and comfortable to use.

The compartments should be as large as possible. Width is especially important as it will allow good access and easy filling from a range of packaging, cups or other receptacles. The labelling of the compartments is often obscured by unused/un-cleaned detergent so such labelling should be large and prominent and the compartments should be positioned and shaped to help suggest their function. Usually the pre-wash compartment is smaller than the main wash compartment and often they are separated by the conditioner compartment.

Ideally, the conditioner compartment should look very different from the other two compartments. This is usually achieved by making it a completely different size and shape. Many manufacturers also make the top of the conditioner compartment a different colour and mould a suitable symbol onto it.

4.2.5 Cleaning the detergent dispenser

Six participants had problems removing the detergent dispenser. For two users (both from group A) difficulty and effort were given as their reasons, another group A user commented that it was 'finicky' and a user from group D found it 'awkward'. No comments were recorded for two users. In the observations; 5 people had difficulties removing the tray, in 3 cases force was required to remove the tray and 3 people found the small button at the back of the tray (which has to be pressed down to remove the tray) hard to press. However, 8 people said it was easy to remove the tray.

Designing a detergent dispenser which is both easy to open and easy to remove can be difficult and often the final design solution is a compromise. Ideally it should open smoothly and come to a positive 'stop' when fully opened – the designer now has to decide whether the user should pull the tray out further to remove it, requiring force, or if the user should instead operate a small catch by hand. This small catch mechanism could be awkward to operate and is likely to become dirty as a result of excess detergent or conditioner covering it.

Nine participants had problems replacing the detergent dispenser. In 5 cases the problems can be identified as difficulties in lining the tray up correctly into its grooves, four of these users were from group A and one from group B. This task usually requires reasonably good manual dexterity and can prove awkward and time consuming to carry out. One user had 5 unsuccessful attempts before replacing the dispenser correctly. The other problems were either not recorded or explained as being awkward. Overall, 5 of the participants who had problems were from group A, 2 from group B and one each from groups C and D. In the observations; 3 people needed to use force to replace the tray and in 2 cases the tray was tricky to re-align and replace. Only one user said it was easy to replace the dispenser.

Problems in replacing the detergent dispenser are commonly due to the user having to line up the dispenser, which is often quite long, with small tracks or grooves inside the dispenser slot of the machine. We would have expected this awkward task to be more difficult for group D users (those with more pronounced manual dexterity impairment) but it appeared to affect users from all of the impairment groups. Again, this area of design requires compromises from the designer; large compartments make it easier to fill and clean the dispenser, but the larger it is the more difficult it will be to re-align and replace. Ideally there should be a good hand grip on the dispenser and the grooves and mouldings on the tray and dispenser slot should be large and visible. The tray should slide in with little effort and not be prone to jamming during closing.

Cleaning the detergent dispenser caused problems for 9 participants. Comments were recorded for 6 of these people and all suggest that cleaning the dispenser could be awkward and difficult. The comments include 'compartments are too small', 'lots of nooks and crannies', 'very difficult to clean due to dirt traps, 'picky bits to try and get at' and 'awkward to clean'. Similarly, there were 9 observations of 'many dirt traps and small spaces', 2 people found the conditioner compartment hard to re-assemble and 2 found the dispenser very difficult to clean. Another issue which might not help when cleaning the dispenser is its size, in 3 cases the tray was too large to fit into the users' sink.

Of the participants who had problems cleaning the dispenser, 5 were from group A, 2 from group B and 2 from group C. One might expect users from group D to have greater problems with this task due to the nature of the difficulties.

It is interesting to note, from the observations, that of the 47 participants interviewed 24 (51%) don't normally clean the dispenser. There are many explanations for this but difficulties in cleaning the detergent dispenser are likely to be one of the factors. It is also likely that users with manual dexterity impairment might avoid carrying out such a task.

When designing a detergent dispenser one needs to try and balance the practical requirements with those of the user. Practical requirements include storing washing detergent and conditioner, keeping these products separate and being able to add water to the compartments to wash the

product through and into the drum. User requirements include making it easy to add detergent and conditioner, making it easy to identify each compartment and designing the dispenser so it is easy to clean. Ideally the dispenser could simply be rinsed clean in a sink, and the designer should try to avoid small compartments and complicated mouldings which will act as dirt traps which will both harbour dirt and be difficult to clean.

4.2.6 Using the main controls

The majority of participants had no problems in setting wash programmes; 94% (44 out of 47) were able to set programme 1 (their most commonly used wash programme) correctly in one attempt and 95% (38 out of 40) were able to set programme 2 (a second wash programme chosen by the researcher) correctly on the first attempt.

Five users had problems when using the main control and setting a wash programme. Two had problems relating to the labelling; one (from impairment group B) found the labels difficult to read whilst the other (from group C) found it hard to see if they had it set at the right spot. One user (group A) found the control hard to grip and thought the control required strength to operate it. Another single user (group D) disliked the instructions and one (group B) was confused when setting an unfamiliar wash programme. So the number of problems was reasonably low and covered a range of different usability issues.

Six participants reported discomfort when using the main control. Two (group A) had pain in their hand, wrists or fingertips. Two (group A and B) had discomfort relating to their need to bend down to read the labelling around the control and two more (groups C and D) had discomfort but no details were recorded.

Most of the observations and comments suggest that the participants were pleased with the main programme control and found it easy to use. Problems identified here include issues with aligning the control to the correct setting (necessitating bending), the control requiring some force, the control being 'jerky' to operate, problems with the 'overshooting' of settings and the main control having too small a grip. Positive observations included positive clicks on settings (an effective combination of audible and tactile feedback), large control, good labelling and a large bar on the control (improving ease of turning and providing a clearer indication as to where the control is set).

Some users had obviously adapted their behaviour to make their particular washing machine easier for them to use. There were observations of users adding their own marks to the control, counting the number of clicks to identify a certain programme or they might only use a single wash programme. This way, users were able to successfully compensate for their impairments, deficiencies in the design of their washing machine or both of these factors.

On most modern washing machines the main wash controls are solid state, electronic controls using push buttons, soft keys or rotary controls. The most common type are rotary controls and these can be rotated in either a clockwise or anti-clockwise direction, having positive stops at each setting. They are generally easy to use and require little force to operate. In comparison many older models of washing machine used rotary, electro-mechanical programme controls which could only rotate in one direction, often required force to operate, could feel jerky in use and were prone to overshooting the desired setting.

A well-designed, modern programme control should ideally be of solid state design. In addition it needs to have a large grip so users with manual dexterity impairments can use it easily – a bar-type control is often preferred as it is easy to grip and also allows the user to quickly and easily identify the programme set. The control should be designed so that it looks different from the other, more minor, controls and is positioned in a logical position on the front of the product. Another important consideration is good hand access to the control – ideally the control will stand proud from the main fascia of the washing machine making it easy to operate and easy to line up with the labelling. Also it should be visibly distinguishable from the surround and have a clear (visible and tactile) marking to indicate what setting it is pointing to - these features should make

making it easy to operate and easy to line-up with the labelling.

To assist users with manual dexterity impairment the main programme control should be spaced apart from any other controls to help avoid the users hand from catching on other controls or operating them by accident.

When labelling a rotary control, a manufacturer needs to consider how a user will accurately set programmes when the labelling is in the bottom half of the control. They can do this by angling the control upwards, printing the labelling in large type or by using a separate (for example, LCD) display to indicate which programme has been selected.

Users were asked to set a wash programme and then cancel it and start another programme, as if the first programme was selected by mistake. 31 participants (66% of the total) said that they would never do this and 3 stated that they always check the programme carefully before starting it. Only twenty users attempted this task and of these 6 (30%) had problems when doing it, so this is obviously quite a difficult task for most users to attempt. The main problems with carrying out this task appear to be related to not knowing what to do and confusion about which procedure to follow. Problems were found by 4 people from group B and one each from groups A and D. However, confusion over such a complicated and seldom carried out task is unlikely to be directly related to any of these specific impairments.

One user found this programme cancelling task caused discomfort; this was due to the design of the main control not the actual procedure itself.

The main design challenge with this task is to come up with a procedure which is intuitive for the user. Most users would make use of such a feature, but probably only on rare occasions so any specific controls, procedures or labelling would have to be extremely clear and easy to follow. All washing machines will have information on how to carry out this task in their instructions, but ideally the user should not have to consult their instruction booklet to carry out this task. Some washing machines have a cancel button or a pause feature built into a main 'start' control – these are suitable design solutions as long as the controls are clearly labelled and fully understood by the user.

4.2.7 Using the minor controls

Users were asked to operate the different types of minor control. Of the 46 washing machines included in this research; 40 had at least one type of minor control, 25 had two and 18 had three. Although most of the products had a wide range of features and minor controls, in most cases the design of these minor controls was identical - presumably for aesthetic reasons. It is common for a washing machine to have a row of between 3 and 6 identical minor controls between the main programme control and the start or on/off control – these minor controls only differing in their labelling.

With only 1 exception, the participants were able to operate the minor controls on the first attempt. This one exception was when a user had a touch sensitive pad control which proved slightly too sensitive, the desired setting was overshot on the first attempt but was easily rectified.

When using the minor controls, 6 participants reported having problems. 4 users (two from group B and one each from groups A and D) didn't understand the controls or how to use them and another (from group D) was afraid to use them in case it stopped her washing machine emptying out. One user (group B) found the labels difficult to read and another (group B) thought the symbols were poor and it was hard to tell when the minor control functions were set. These comments suggest that the problem is not with the design of the controls themselves but with either the labelling, the instructions or the users knowledge of the product and requirement for these features. It is common for manufacturers to use simple terms to describe features, but in some cases these may not be sufficiently descriptive. The function of a 'rinse hold' feature may be clear to a washing machine manufacturer or retailer, but many users might not understand this term nor realise that another manufacturer might call it 'crease guard' or 'reduced ironing'. One

user's washing machine had a minor control labelled 'gentle action' and the control next to it was labelled 'delicates', with no obvious difference between the two. So such labelling needs to be as clear and intuitive as possible and be backed up by clear, easy to understand explanations in the instruction booklet or on the programme guide.

Only one user reported feeling any discomfort when using the minor controls and no comment was recorded for this.

Observations made when the minor controls were being operated were mainly very positive, with 41% saying they had no problems at all. Negative observations recorded more than once were small spin speed controls and labels difficult to read. Positive observations included; clear indicator lights, good feedback to the user and large controls. 3 participants said they don't use the minor controls but (from the experiences of the RNID researcher) many others only appeared to use a limited number of the minor controls and features available on their washing machine.

4.2.8 Displays and labelling

Eight participants had problems when using the programme guide; 4 (two from user group A and two from B) had to bend or kneel down to read it, 3 (one each from groups A, B and C) said it wasn't easy to read and single users commented that they would prefer to use the manual instead (group A), the guide was too small (group C) and the language was not easy to understand (group B).

Although programme guides, as opposed to clear programme labelling around the main control, appear to be less common on current washing machines, these results do suggest key design guidelines which could be followed. Such guides have to communicate a lot of information in a very concise and visually appealing way (they are often very prominent on the front of a washing machine), however they do need to be easy for a user to read, understand and be able to relate to the main wash programme control. Ideally a user should be able to read such a guide without the need to bend or kneel down – this could be achieved by angling the guide, printing it in larger type or making it available as a removable card instead of printing it on the fascia. With the current use of solid state electronic controls, most models now have the information which was previously contained in the programme guide printed around the main control itself – if well designed; this could be a better solution.

Many of the participants had problems when reading or understanding the labelling on the main programme control. When asked if the labelling was easy to read or if they had problems with the labelling 10 people reported problems. 6 users said the labels were either too small and difficult to see or that they could be larger and clearer. 3 people complained that they had to bend to read the labelling, 2 users commented that settings in the lower half of the control were hard to read, one said that the marker on the main control was poor and another was confused about the settings. However, there were also a number of positive comments made about the labelling, so although labelling proved to be problematic for some people it was not necessarily an issue for everyone. Of the people who had problems reading the labelling 4 were from group A, 4 from group B and 2 from group C.

Less people (n=5) had problems in understanding the labelling on the main control and one user thought that they could not be improved, describing them as 'idiot proof'. One of the problems encountered by 2 people was that their washing machines had programme guides and so the main control was simply labelled as programme A, B, C, etc instead of describing each programme around the control as Cotton 40c, Cotton 60c, etc. This meant that the user had to read the programme guide, ascertain the correct letter for the wash programme and then find this on the main control. These 2 users (from groups A and B) disliked this. Another user commented on this but did not report it as a problem. 2 users (from groups A and B) did not understand all of the labels.

A well designed main programme control should have a clear marker on it, either moulded or

printed, so that a user can easily line it up with the labelling. The labelling itself needs to be large, have strong colour contrast and be easy for a typical user to understand. In the past, products commonly used codes or letters around the main control which related to wash programmes on the programme guide, however most modern washing machines now print the wash programme information clearly around the control itself. The only problem with this solution is that settings on the lower half of the control can be hard to read – this can be overcome by angling the control or adding a display explaining exactly which programme has been chosen.

Participants also had problems when using the labelling of the minor controls. 6 people found the labels were not easy to read and comments included; symbols not being easy to read and problems due to a general lack of knowledge of the controls. Of these users, 2 were from group A, 3 from B and 1 from group C. However 2 users commented that the labels were very clear. The negative comments here do not mention the specific size or legibility of the labels, so the researchers would suggest that the main issues here are more related to the understanding of the controls themselves and the associated labelling or terminologies employed.

Seven participants found the labelling of the minor controls difficult to understand. Everyone who gave a comment (n=6) seemed to have problems in understanding the terms used for the labelling and what the feature controls actually do. For example there was confusion about 'rinse hold', 'high water level', 'pre-wash' and 'soak' features. 2 of the users thought the symbols were unclear and 2 needed to use the instruction booklet – unfortunately one of these then found the booklet 'mind boggling'. Of the users who had problems 1 was from group A, 3 from B, 1 from C and 2 were from group D. A few positive comments were made, but these were less than the problems encountered.

Designers are faced with a number of compromises when labelling the minor controls. The first is related to the size of the labelling; it needs to be legible and easy to read yet usually no larger than the width/diameter of the control itself. However, our research suggests that for our specific sample this might not have been a big problem. Another problem for the designer is how to explain what might be quite a complicated feature in just a single term or couple of words. Our research suggests that many older users do not understand the terminology that is being used so greater effort must be made to make such features easier to understand, relate to and use.

Forty four of the washing machines tested had either visual displays or indicator lights and few problems were found with these. 3 participants said the display/lights were not easy to read; one commented that it is hard to see if the light is on or off and another said they could not read it. However with 93% of the washing machines there were no problems.

When asked whether the display/lights were easy to understand, 2 users had some confusion about the lights related to the minor controls. This is likely to be more related to the minor controls themselves than the indicator lights.

Generally, clear visual displays or bright indicator lights are liked by users and are far preferable to printed labelling, or the position of a control, when indicating whether or not a function has been set or the status of a wash programme.

93% of participants said that they find displays and indicator lights useful, coincidentally the same number that had no problems with them. When asked why they are useful the most common replies were for indication of the time remaining, wash progress/status or to show that the wash had finished.

4.2.9 When the wash has finished

We wanted to see if people had any problems in identifying when their wash had ended, but only two users had problems with this. One complained that there was no signal to alert the user and the other was confused by an indicator light indicating 'crease protect / end'.

Observations were either positive or simply described how the user became aware that their wash had finished. Many participants (n=18) washing machines had a light indicating 'finished' or 'end'

and almost as many (n=17) relied on the fact that the final spin is very noisy and they simply wait for this to end. Similarly 9 users commented "it stops" which probably also relates to the loud final spin coming to an end. Other users relied upon the position of the main (electro-mechanical) programme control, the timer being at '0', an audible bleep or the display reading 'end'. Interestingly, 4 users actually timed their wash so they already had a good idea when it will have ended.

Due to the lack of problems recorded with this task it would appear that most current washing machines perform this task well. It appears that many users rely on hearing the loud, final spin coming to an end, but many others find an indicator light, display or the position of the main programme control (electro-mechanical) very helpful. Results from section 5.1.8 also indicate that many users like having a time remaining display – this allows them to see how much longer the wash will last, how far through the programme they are and if the wash has actually finished yet.

4.2.10 Cleaning the filter

Only 36% of the participants ever clean the filter on their washing machine. When asked to describe how they do it 6 said it was easy to do and 4 users had self-cleaning models without a filter. Other users reported problems with having to bend, having to use a shallow tray to collect any water spillages and the fact that it could be a difficult and fiddly task to carry out. So, the reasons why most of the users don't clean the filter could be due to these difficulties or maybe even because they aren't aware that it needs to be cleaned regularly.

This task had the most problems of any of those carried out on washing machines during this research, not only did 10 separate users have problems with cleaning the filter but this number was out of only 17 who ever carry out this task. So this suggests that about 59% of people who clean the filter on their washing machines have problems doing it.

Of the 10 users who had problems with this task; 5 found the filter door difficult to open and 4 found the filter was hard to remove, requiring good manual dexterity. 4 users said the filter was too close to the floor and 2 complained that they had to get down on their hands and knees. Single users commented that this task is awkward and causes spills and that it can be difficult to find blockages. Most of the users who had difficulties with this task (n=6) were from user group B though there is no obvious connection between this task and having a hearing impairment. 3 people from group A and one from group C also had problems. No one from user group D (more pronounced manual dexterity impairments) reported having problems with this task, which leads to the assumption that people with manual dexterity impairment probably avoid carrying out this difficult task.

Five participants (2 from group A, 2 from group B and 1 from group C) reported feeling some discomfort during this task, this was not surprising considering the number of problems which were reported.

This research suggests that every stage of the process of cleaning the filter causes problems for the user. They have to bend down, collect water spills in a shallow tray, the filter door can be difficult to open and the filter itself is often stiff and difficult to both remove and replace. An ideal design would be one where there is no filter. Otherwise you could use a system where the filter is higher up on the machine (as found on some Zanussi models) – this would reduce the need to bend and, because it would not cause any spills, you would not have to struggle to collect spilled water.

4.3 Mobile telephones

4.3.1 Turning the phone on and off

Many users (n = 15) reported having difficulties using the On/Off control, their problems can be divided into a number of separate issues.

The first issue was related to the force required to press the button. Many users (n = 10) had difficulty with this task either as a result of having to use too much force or because they experienced pain or discomfort. One user reported leaving the phone on continuously, to avoid the difficulty of turning it on and off, as she had arthritis. In the observations 12 people reported that the button required force to operate, so this was obviously a significant problem.

Another problem, related to the force required to operate the control, was the need to hold the on/off button down for a second or two in order to activate the On/Off function on particular models of phone. 4 users complained about this and there is likely to be a strong relationship between the force required and the amount of time the control has to be held down. Additionally, users did not always understand this functionality and some mistakenly believed that they were not pressing the button with sufficient force. This could result in unnecessarily excessive force being applied to the button. Other users understood the functionality of this feature, but found it physically difficult to depress and hold down the small control. In the observations, 18 people commented that they had to hold down the control.

Some users (n = 5) reported that the button was either too small or too flush against the surrounding body of the phone, making it awkward to operate the control and gain access to it. As a result it was considered 'awkward' to successfully operate it. In the observations only 2 people commented that the control was too small. Perhaps related to problems with the size of the control, one user reported that there was no obvious tactile feedback from the button alerting the user that it had been pressed successfully or sufficiently.

Four users, in both the questions and observation, experienced difficulty with the On/Off function as a result of the keypad lock system being activated. This feature proved to be a problem for a number of users during this observational research; if they were carrying out a task slowly the keypad lock would operate and they would then have to unlock the keypad before being able to proceed. Some users did not fully understand how to unlock the keypad and many found it time consuming and awkward.

Of the users who reported a problem while turning the phone on or off, 5 were from category A, 3 from B, 4 from C and 3 from D. so this task caused problems for participants from all impairment groups.

The researchers noted that the visibility of the On/Off controls on some models was poor and that the labelling was often difficult to see. In many cases there was no colour contrast against the main body of the phone and any labelling was small, indistinct or difficult to understand.

Although 15 people reported having problems when turning the phone On or Off, in the observations 16 people were recorded as having no problems in turning the phone on and 14 had no problems turning it off. Other positive comments included; simply pressed the button, and button a good size.

There are many ways in which a mobile phone might be turned on and off, but the researchers observed that particular problems were encountered when the phone had a small, separate on/off control which was often positioned on the top surface of the phone. Other on/off controls which were built into main keys, such as the end call / cancel button, were much easier to use, larger and required less force. Although the small, separate controls were much more difficult to operate it would appear that they had been designed specifically to reduce the chances of inadvertent operation - this probably being given priority over ease of use during the design process.

When designing an On/Off control it is important to consider access to the control, force required to operate, reducing accidental operation, intuitive functionality and simple operation. Ideally the control would be a good size, be easy to operate and would not require holding down for a prolonged period. Little force should be required to operate it and the control should be obvious to the user. Preferable additional features would also include the control being a contrasting colour to the surrounding body of the phone and good tactile and possibly audible, feedback on successful operation.

4.3.2 Making a voice call

Eight participants had problems when making a voice call and all of these problems were related to the operation of the number keys and other controls (see section 4.3.7). 3 users had problems due to the number keys being too close together, so they often pushed more than one button at the same time. Other individual problems included buttons being too small and fiddly, buttons being difficult to operate if the user has long finger nails, problems deleting incorrect numbers, the numbers on the keys being hard to read and force being required to operate the keys. One user had a phone where the number keys were rocker controls – each one functioning as two separate numbers, i.e. an upward press = 1, downward press =2, etc. This functionality was prone to errors and proved very difficult to use.

One user did not realise that the green button should be pressed once the phone number has been entered in order to activate the call. This particular user only ever makes calls to phone numbers that are already saved in their contacts list and had never made a call from the mobile by dialling in the number before.

Only 3 users reported feeling any discomfort when making a voice call; one was due to force being required, one had discomfort due to having arthritis in the hands and the third person said the task caused aching and pain.

Of the 8 users who reported a problem while making a voice call; 1 was from group A, 4 were from B, 1 from C and 2 from D.

The researchers observed 13 users inputting the numbers very slowly and deliberately. This is not necessarily a negative observation but indicates how people of this age, and who only use their mobile phones occasionally, use these products and take care not to dial an incorrect number. Five users were observed to check the numbers on the screen individually as they inputted them, this was a slow process but they were confident that they would not make any mistakes. Five users had to use their phone with two hands and another five made a mistake on their first attempt and had to start again.

As mentioned in 4.3.1, researchers observed 4 users having problems due to the keypad lock. In most cases they were slowly carrying out this task but due to their slow pace the keypad lock operated during the task – this made the task difficult to carry out and very annoying for the user. Other negative observations included; errors being made, small controls making them use their finger nails or a tool to operate them, and many individual complaints about the keypad.

In the observations, 'no problems' was reported for 21 users and other common positive comments included; very large numbers on the display, and clear display.

One user did not realise that the green button should be pressed once the phone number has been entered in order to activate the call. The user had never made a call from the mobile by dialling in the number, they had only ever made calls to phone numbers that were already saved in their contacts list. Inputting a new, unsaved, number was a novel task.

The main problems identified in this section relate to using the controls and the display, both of these factors and potential design solutions to them will be discussed in greater detail in sections 4.3.7 and 4.3.8.

4.3.3 Receiving a voice call

No users reported having problems when receiving a voice call. Observations recorded few negatives but in 3 cases the ring was too quiet and 1 user had problems with the keypad lock. There were many positive observations made including; loud ring, strong vibration, easy to know when I am receiving a call and screen lights up.

Over half (n =25) of the users used the Ring and Vibrate setting to alert them to incoming calls, but almost as many (n=19) used ring only. 2 users were alerted to calls by ring and light but none chose to be alerted by vibration alone.

When asked why they chose a particular alert, 10 users said that that was the way the phone was set up for them - the phone was either already on this setting, or a family member had selected it for them. Other replies generally explained and justified most users chosen method of being alerted to a call.

When asked if they were aware of other types of alert, 65% (n=30) said they were but the remaining 35% (n=16) were not. The comments generally explained their current choice of alert, however 2 users said they were unable to change the settings.

When designing a communication product such as a mobile phone it is important to include a range of alerting technologies to suit users with differing sensory abilities and who might be using the product in different use scenarios. As a result, an ideal mobile phone would have:

- An audible alert which could be adjusted from quiet to very loud
- A wide range of ringtones, including melodies and simple tones in both high and low frequencies
- A strong, vibrating alert which could be either continuous or pulsing
- Visual indication of a call by using a continuous or flashing light or by the screen or number pad lighting up.

Importantly, the user should be able to easily, and intuitively, change these settings and be able to adapt them for specific use scenarios.

4.3.4 Performance during a voice call

4.3.4.1 Clarity of speech received during a voice call

When asked if it was easy to hear the speech during a call, 6 users reported having problems. For 4 participants (2 each from groups B and C) their phone was too quiet, 2 users (1 each from groups B and C) said the speech didn't sound clear and one user (group A) could only hear the odd word.

When asked if it was easy to understand the speech during the call, 9 users reported having problems. 6 participants (2 each from groups B and C) couldn't understand the recorded message and said it wasn't clear. Two users (one each from groups A and B) found the accent of the voice difficult to understand, 2 others (both from group B) found the speech too fast and 2 (one each from groups B and C) found that the low volume made it hard to understand the speech.

Eleven participants said they had problems with the performance of their phone during a voice call. 6 people could not understand the voice and thought it was not clear, 3 found the volume too quiet and 2 found the accent hard to understand. Single-users comments were that the speech was too fast, they could just about follow it and after initial problems it became easier to understand once the user understood the context of the recorded message.

Five users, who normally wear hearing aids, reported that they prefer to use their phone without

their aids. All five of these said that this was because they can hear better without the hearing aids and it makes phone conversations easier and more comfortable. One user explained that there is interference between their hearing aid and their mobile phone. However, another user used hearing aids with their phone because it sounded better and there was no interference.

One user reported that their mobile phone must be positioned carefully over their hearing aid in order for the incoming speech to be audible. This is a common problem with hearing aids as the microphone for the hearing aid is usually at the top front of the aid and therefore the top front of the ear – not in the middle of the ear. So the user must get used to holding their phone differently and experimenting with holding the phone against the ear in different positions.

So the main problems encountered here were poor sound clarity and low volume.

When designing mobile phones, especially for users with a hearing impairment, many manufacturers focus upon amplification and aim to provide a high listening volume. This can be helpful but in RNID product evaluation research it has been found that the most important factors are sound quality and clarity. A phone that sounds clearer and has better sound quality will usually be rated as easier to hear and understand than one with greater volume. One reason for this is that as volume increases, distortion may also increase – RNID have evaluated phones with an extremely high volume but due to distortion it is almost impossible to understand what is being said. So an initial trade-off for a manufacturer is volume against sound clarity. A potential problem for a manufacturer is that in order to achieve good sound quality the phone itself will need very good build quality and be subject to rigorous production quality control. Poor build quality will lead to distortion, vibrations and other issued which will directly affect sound quality and clarity.

Hearing aid compatibility is another important issue, and one that more manufacturers are now starting to address. Most modern mobile phones will cause interference when used with a hearing aid – the resulting buzzing or screeching noises making the two devices incompatible or very difficult to use together. Manufacturers should design mobile phones so that they can work with hearing aids when set to their 'T' setting.

Some users will use their mobile phone in speakerphone mode – this gives increased volume but in most cases the sound quality is further reduced.

When asked about the performance of their phone; 75% rated the volume satisfactory and 70% rated the speech clarity as satisfactory. This indicates that most phones are performing adequately for older users or that they are at least meeting their expectations.

4.3.4.2 Volume change option

In order to achieve a good match between your hearing ability and your mobile phone it is a good idea to experiment with different earpiece volumes. Being able to change the volume easily also helps when you enter environments which are noticeably quieter or noisier. It is an advantage if the volume is easy to adjust and in RNID product evaluations it has been found that users like , and prefer, phones which have volume controls on the side of the phone; these controls are usually dedicated to this functionality, easy to use and one can alter the volume during a call without having to move the phone away from the ear (allowing a conversation to continue during volume adjustment).

Participants were asked to alter the volume of the recorded speech message during a call and 10 people had problems carrying out this task. 6 users (3 each from groups A and B) didn't know how to alter the volume, but the researchers suspect that many others were unsure about what to do and were only vaguely aware that the volume could actually be changed.

Six users (1 from group A, 4 from B and 1 from C) found the controls too small. Other user comments included criticisms of the display and the need for good manual dexterity. 4 users experienced discomfort during this task, complaints covered the small and awkward controls and the operation of the controls causing pain, aching and discomfort.

The volume change function varied quite considerably between mobile phone models. In some cases, the user had to find the appropriate function through the main menu, under 'Settings'. On some models the volume up/down controls operated on a general up/down menu control during a voice call whereas on other models, specific 'Volume up' and 'Volume down' buttons were located on the side of the phone. Furthermore, in some models, the actual function of the 'Volume up' and 'Volume down' buttons on the side of the phone changes depending on how the phone is being used. For example, if pressed while the phone is ringing, the buttons change the volume of the incoming call alert (i.e. the ringtone).. Whereas, if pressed while the user is on a voice call, the buttons change the volume of the speaker.

The lack of consistency between phone models, and lack of awareness of the feature, is of concern. From previous product evaluation research by RNID, the preferred option is to have a dedicated volume control on the side of the phone. This can be quite a large size and is usually a rocker-style control. Ideally it should not control any other functions and should be positioned such that one can easily operate it with a thumb or index finger whilst making a call. It is also important to have a clear visual display of the volume to help people find their ideal setting or return to it after any temporary adjustments have been made.

4.3.5 Sending an SMS text message

Of the 49 participants who took part in this research, only 26 (59%) send SMS text messages and answered questions on these tasks. This indicates that although many elderly people now have mobile phones, their primary use is likely to be for occasional voice calls instead of text messaging.

When asked about predictive texting it appeared that 10 users normally use predictive texting and 26 do not. These numbers do not agree with those who then proceeded to answer further questions about SMS texting, so it is likely that all of the 10 participants who use predictive text are included in our 26 text users whereas many of the 26 people who do not use predictive text also do not use text messaging.

Four participants had problems when sending a simple text message. One user (group B) found the buttons too small and had problems with the phone where adjacent buttons were not arranged in a straight line. This user would have preferred more separated controls and disliked the phone's touch-sensitive pad. Another user (group B) did not text very often and was quite unfamiliar with the keys, finding this task error prone and time consuming. Another user (group D) had problems related to the keypad lock, it kept locking the keypad and so made this task difficult to complete.

Observations recorded during this task included that the process was slow, that users were deliberate and accurate in their texting and that at least 4 users checked each letter one at a time – ensuring accuracy but proving to be time consuming.

No users experienced discomfort whilst sending a text message.

A large degree of variation was observed in the time taken to send a text message, from 28 sec to 6 min 45 sec, but most took between 2 and 4 minutes. 13 participants were able to send a text message with no mistakes at all. With those users who made mistakes, most were spelling errors which were easily corrected by the user.

There are many ways that an SMS message can be composed, the characters inputted and the functionality designed. However, this research suggests that in the majority of cases this task is reasonably easy to carry out. Although only 26 participants attempted to send a text message, of these the majority were quite confident and successful. It would appear that with this task, if a user is able to carry it out then they can do so with a high degree of success. As a result the wide range of current design solutions would appear to be reasonably successful.

Obvious potential problems with this task will be related to the keypad and display design which shall be discussed in later sections. However designers must strive to make the whole processes as streamlined and intuitive as possible.

4.3.6 Receiving an SMS text message

Twenty eight participants attempted this task. Similar to the results for receiving a voice call, 50% (n =14) used the Ring and Vibrate setting to alert them to an incoming message and 43% (n=12) used Ring/Tone only.

Only one user reported having any problems during this task. This user (group B) suffered from a lack of familiarity with receiving a text message. He/she was not sure how to access and read the message and also had problems caused by the keypad lock.

In the observations; 19 users reported having no problems and 3 said it was easy to read the message.

A well-designed phone will have functionality allowing a received message to be quickly and easily accessed. The message should be clear and easy to read and ideally the user will have some control over the size and style of the text – allowing them to make the message easy to read and tailor the display to their sight or current environment.

4.3.7 Keys and controls

4.3.7.1 Main number controls

Using the main number controls was the mobile phone task which produced the second most problems and negative responses from the participants.

Many users (n=17) had problems when they were asked if the number keys were large enough for them. 10 users specified that the keys were too small; 7 said that they found the keys too small and fiddly, 2 stated that they tended to push two keys at once and 2 obviously found the keys too small. Other problems recorded include the number keys not being arranged in a straight line, the buttons not protruding enough, having to use fingernails to operate the small controls and a rounded button shape making it too easy for the finger to slip off and press the neighbouring button by mistake.

A similar number of users (n = 18) did not think that the number controls were spaced far enough apart. 11 participants said the controls were too close together and needed wider spacing and 2 stated that they push more than one button at a time by mistake.

Of the users who reported a problem with the size of the buttons, 5 were from category A, 9 from B, 3 from C and 3 from D. Of the users who reported a problem with the spacing between the buttons, 4 were from category A, 7 from B, 4 from C and 3 from D. So problems with using the main number controls are evident amongst all of the user groups.

When asked about other problems they had, many comments were similar to those discussed above. Different comments included (the task was) time consuming, keys are the wrong colour, backlighting makes the keys look unclear and problems getting the correct desired character.

Four participants reported feeling discomfort when using the main number controls; 1 from group A, 1 from group B and 2 from group C.

Participants were then asked about the labelling on the main number control and many (n=15) reported having problems. 9 users specifically mentioned that the letters or labels were too small, 2 commented that they could see the numbers but not the letters on the controls and one user simply could not see them. One user from group C, so with a more pronounced vision impairment, used a 'bump' sticker on the '8' button, he/she was not able to use the labelling. Due to the small size of mobile phones the controls are often limited in size and this will have a direct influence on the size of any labelling. So it is to be expected that some users will have problems in reading the labelling on these controls. In most cases the numeral label will be considerably larger than any

letters so we would expect comments on the small size of letters on the keypad. Of the users who reported a problem with the labelling of the buttons, 3 were from category A, 11 from B, 4 from C and 4 from D.

Negative comments made by people who did not report having a problem with the labels were poor contrast and problems with the labelling of the hash (#) and star (*) buttons. Positive comments included 4 users thinking the labels were clear and easy to use, and 2 users liked the labels being illuminated in the dark.

It was not possible to distinguish between issues caused by size, font type, colour contrast or proximity of adjacent letters and numerals. It is possible that any combination of these factors could have played a part in the poor legibility of the labelling. However, when shown the DORO 410 GSM mobile phone, see section 4.3.12, many users made positive comments on the clarity and legibility of the numerals and lettering. This shows that solutions are possible and can be practical.

One user had a keypad, on which the numeric keys were located in pairs on a single button. For example 1 and 4, 2 and 5, 3 and 6, 7 and *, etc. In order to dial 1 or 4, the user must toggle up for 1 or down for 4. This feature was troublesome both with regard to pressing the correct button and legibility of the labelling.

In conclusion, when using the main number controls most elderly people (approximately 66%) had no problems, however around a third (approximately 35%) did encounter difficulties with either the controls or their associated labelling. They key issues were that many of the mobile phones had buttons which were too small, too close together and their labelling was too small and difficult to read. Users responded far more positively to the controls and labelling of the Doro 410 GSM phone (see section 4.3.12) and this indicates that suitable design solutions do exist, are practical and commercially viable.

When designing the main number controls on a mobile phone a designer is likely to be constrained by the overall size of the phone and therefore the space available for the keys. Good inclusive design practice, this research and previous evaluation studies by RNID and other organisations suggest that ideally the main number controls should be:

- As large as possible
- All number buttons the same size and shape
- Spaced apart from each other to reduce inadvertent operation
- Ideally concave in profile, certainly not convex
- Raised dot on the '5' button
- Arranged logically and in straight lines
- Each control only controlling one number
- Should give the user good tactile feedback
- Should not require force to operate
- Should have good colour contrast against the main body of the phone

Labelling should be:

- As large as possible
- Use clear font types
- Illuminated from behind, with the option to turn this function on/off
- It should have strong colour contrast against the button itself
- Any symbols or labels should be intuitive, clear and easy to understand

4.3.7.2 Other controls

When asked specific questions about the other controls on their mobile phones (menu controls, volume controls, controls beneath the screen relating to functions on the display, etc) a number of problems were recorded and these were similar to the problems reported for the main number controls. However, most participants did not report having problems.

In summary, for additional controls on mobile phones when being used by elderly people with mixed, moderate impairments:

- Many of the controls were too small and close together
- Often there are controls surrounding a central menu control – invariable these are too narrow, shallow and close to other controls – making them difficult to operate accurately or easily
- Few of these controls cause discomfort but many are awkward or fiddly to operate and demand concentration from the operator
- Labelling is often too small
- Labelling often uses symbols which users might not clearly understand and which might not be intuitive
- Users' liked having volume controls on the side of the phone and preferred these to volume control functions built into the controls surrounding the menu control

When using the On/Off control, results agreed with those discussed in section 4.3.7.1. Users found the controls too small, they often required force to operate and labelling could be clearer and easier to understand.

Design guidelines for additional controls should follow those already suggested for the main number controls (section 4.3.12) and take note of the comments made above. In addition, volume controls should ideally be placed on the side of the phone, be a large size and give good tactile feedback.

4.3.8 Main display

4.3.8.1 Ease of reading the display

Some users (n = 10) reported not finding the display easy to read or having problems with it. Three users (2 from group B and 1 from C) found the displays on their phones too small and one of these also disliked having dark grey figures on an orange background. Two users (from group A and B) found that their phone had an energy saving function which darkened the screen, this happened too quickly for them making the display difficult to read. A single user (group A) commented that the calendar and menu functions looked quite faint.

Two users (from group A and D) had problems reading the display when in full sunlight. This is a valid comment but any small, mobile device is likely to suffer problems when used in full sunlight.

Some users reported issues with the display, but did not consider these real problems. Negative comments were that the display could be larger and it was difficult to read. Positive comments were that the numbers were a large size, numbers were easy to check, the display was clear and colourful, the display was excellent and very clear.

When asked about general good points and drawbacks of the display, the main good points were:

- Clear
- Numbers very clear
- Easy to use
- Liked the use of colour
- Numbers very large on screen
- Large screen

And the main drawbacks:

- Display too small
- Phone/keypad locks itself too frequently
- Hard to read
- Small numbers and icons on the screen

4.3.8.2 Ease of understanding the icons, descriptions and menu functions

For mobile phones, this was the usability issue which had the most problems associated with it. 21 participants reported having problems when they were asked 'do you understand the icons or descriptions'. 12 users said they were not sure about some of the words or icons used and 3 people did not understand the menu functions and so don't use them. 2 users thought the descriptions were not intuitive and another 2 thought the instructions and language were too complicated.

Two users commented that they liked the clear diagrams (icons) and words.

So, around 44% of our user group reported having problems understanding the menu descriptions or icons. Also, at least 25% of older people, 12 people out of 48, might be able to use some of the menu functions but are not sure about the descriptions of others which might potentially be useful to them. This is a very unsatisfactory situation and something which product designers need to address.

When asked about general good points and drawbacks when understanding the display, 3 users liked the menu functions and 1 liked the options in each menu section being described in clear words. 2 participants disliked the poor descriptions of the menu and functions and others were

confused about some functions and the language used.

The icons used on the main display (for example Bluetooth, network coverage, status icons, etc.) were not always understood. However it could be argued that understanding of these icons is unlikely to be critical to the successful every-day operation of the phone.

Another difficulty identified through the field trials included usability issues relating to differences in common terminology in different countries. Anecdotally, in certain European countries the term 'SMS' is more familiar among the general public compared to Ireland, where the term 'Text' or 'Text Message' is used. Five users specifically asked what the menu name "SMS" meant when using the Doro 410 GSM phone. In the UK the term SMS is more readily recognised and is commonly used to avoid confusion with MMS messaging or text messaging using a textphone or PC-based solution such as instant messaging, RNID TalkByText or email.

Making the many functions and features of a modern mobile phone easy to understand and navigate is a huge challenge for the designer. Some products, for example the Doro 410, may achieve this through a reduction in features and clearer function descriptions, but others must adopt more rigorous user testing regimes in order to achieve more intuitive and clearer terms and descriptions.

4.3.9 Adding contact details to the phonebook

Less than half of the users (n=23) attempted to add contact details to the phonebook. The remainder either had friends or family members carry out the task for them, did not use the phonebook and did not have any numbers stored in the list of contacts (simply dialling numbers), or only used the phone for incoming calls.

The time taken to add a contact varied from 20 sec to 2 min 40 sec. So despite the potentially complex nature of this task most users who attempted it were able to carry it out reasonably swiftly. Many (N=11) made no mistakes at all and the problems encountered were either spelling or typing errors.

Six users had problems with this task. Three had problems related to a lack of familiarity with the task and 3 found the process was not intuitive for them. One user said they had to concentrate on this task and that they found the language difficult. Another user kept making the same mistake, but because it wasn't intuitive to them they were not able to learn from their mistakes. Of the users who encountered a problem when adding contact details to the phonebook, 2 were from category A, 3 from B and 1 from D.

In the observations 11 users (48%) had no problems with this task, but 3 had problems remembering how and others found it slow or difficult to carry out.

Making this task easier for a user to carry out will require considerable thought and user-evaluation. Importantly the procedure needs to be simple and intuitive so that it can be carried out easily and the user will gain confidence in using it, use it more frequently and then, through familiarity, soon find the whole operation straightforward. As much as possible the process should be simplified and involve as few separate steps as possible. During the process any descriptions, functions or prompts need to be clear, easily understood and relate to both the user and this specific function.

4.3.10 Recharging the phone

Before the observational research was carried out it had been assumed by the research team that users would have problems recharging their phones due to the small connectors used with modern phones and the potentially fiddly and awkward nature of this task. However, in reality only one user (out of 48) had any problems carrying out this task. This user (group B) found it fiddly to connect the charger - the phone Motorola RAZR) had a mini USB connector and this user found it

hard to tell which way round the connector went, therefore considering it awkward.

During the observations; most users (n=27) had no problems with this task, and 3 described it as simple. Five users had phones with a small tab which covered the charger socket on the mobile phone, which has to be opened in order to connect the charger to the phone. Two of these users found the tab feature difficult to use, as they needed a long fingernail or a knife to open the tab and this obviously required good manual dexterity. The other 3 users had no problems when removing/moving this small tab. A small number of users (n = 2) described the recharging process as fiddly but another 2 commented on how they liked the display which clearly showed them that the phone was charging.

Some other single issues included the charger requiring force to be connected to the phone, difficulty finding the correct location on the phone to connect the charger and attempting to connect the charger the wrong way round.

The researchers all recorded the fact that many of the participants had identified recharging as a possibly troublesome procedure and so had put some effort into solving these potential problems. Many of the users left the charger in the same place and whenever their phone needed recharging simply plugged it in, knowing exactly where the charger was. A number of users also had a routine where they would always recharge their phone on a specific day – a regular habit which they found easy to remember and meant they could easily charge their phone and never run out of charge.

In the near future all mobile phones will have the same charger connection, the micro USB. This standardisation will help reduce the number of chargers which people accumulate in their homes and allow for great economies of scale in the production processes. Mobile phone designers will need to ensure that users can easily identify which way round the connector should go – most probably by labelling or designs on the connector itself. They will also need to make sure that if the small tab, covering the socket, is actually required then it must be easy for users to open and close it without requiring manual dexterity or the use of tools.

4.3.11 Keypad lock

During this research many users had problems with their mobile phones which were directly related to the keypad lock. This function has been designed to help prevent accidental use of the phone and the keypad and so locks the phone after a short period of time. On clamshell phones this keypad lock can simply be unlocked by opening up the phone, but on conventional 'candybar' style phones the user normally has to press 2 buttons in close succession – a task which can prove awkward and fiddly to carry out, especially if the user has vision or manual dexterity impairments.

Participants reported problems caused by the keypad lock when turning the phone on, making a call, receiving a call, sending an SMS text message, receiving an SMS text message and reading the display.

The keypad lock can be a useful function but a designer should endeavour to come up with a design solution which allows the user to easily tailor the feature to his/her needs. They should be able to intuitively adapt the lock so that they have control over the amount of time which needs to elapse before the lock operates. Additionally any unlocking process should be simple, clear and very intuitive. Some smart-phones have sliding controls clearly marked with a key symbol - these are an improvement over the standard 'push two controls in close succession' solution. However even this improved solution could be better designed and better take account of the needs of a far wider target audience.

4.3.12 Doro PhoneEasy®410gsm

The majority of participants owned mobile phones which had not been designed with the needs of older users in mind. Because of this, the research team decided to introduce the users to the Doro 410GSM mobile phone, which was specifically designed to be easier for older people, and those with auditory, visual and manual dexterity impairments, to operate and use. Users were shown the phone and its key features were explained to them, they were then asked to make a voice call and send a text message.

4.3.12.1Making a voice call

The Doro 410 was very popular with almost every participant in this research. Of the 52 users; one was used to their existing phone and therefore preferred it, another thought their own phone was as good as the Doro model but the remaining 50 preferred the new Doro phone.

When asked to compare phones the most common comments about the Doro phone were that; speech is clearer and easier to understand, it is easier to use, it is easier to read, the buttons are easier to use and the screen is better.

When users were asked to make a voice call a very large number of positive comments were made. 25 users (48%) liked the large controls, 21 thought the display was clear and many others commented on the clear letters/numbers on the screen, good labelling, clear sound of speech and the volume controls on the side.

There were far fewer drawbacks recorded, the most common being that 2 users disliked the two controls directly beneath the screen, 2 people thought that the letter labels on the main keys were too small and 2 said it was larger than their existing phone.

The majority of participants thought that the Doro phone was far superior to their own phone when making voice calls - having greater volume, sound quality and clarity of speech. However 2 users would have liked more volume from the Doro phone and another 2 users thought it sounded a bit 'tinny'.

Researchers observing participants making voice calls with this phone recorded that 17 users had no problems at all, which is impressive when you consider that almost everyone was using this phone for the first time. Other comments were similar to those already recorded except that 6 users found the Doro phone worked very well when used with their hearing aid set to its 'T' setting.

4.3.12.2Sending an SMS text message

Fewer participants used the Doro 410 phone to compose and send a text message, because fewer of them actually use mobile phones for this purpose. However those that did send an SMS text message were impressed with this phone and found it easy to use and understand.

When asked to compare phones 4 users said the Doro was easier, or far better, to use than their existing phone and 3 said that it was about the same. Considering the complexity of this task and the fact that this was the user's first experience of using this phone, these comments are very positive and indicate that the phone must be very intuitive and easy to use for sending text messages. Negative comments focussed upon the facts that the phone was unfamiliar and that the process was slower, presumably because it was new to them.

When users were asked to send a text message, similar to making a voice call there were many more positive comments than negative ones. 10 users liked the controls, 5 found the phone easy to use and another 5 said the screen was very clear. Other positive comments included liking the large controls, good button spacing and the ease of reading the large, clear text on the screen.

The main drawback recorded, by 5 users, was that they were not familiar with the term 'SMS' - all

of these users were in the NCBI sample from Eire. Obviously this is not a fault of the phone itself but is an issue which the manufacturer might seek to address in this market through other means including clearer wording in the instruction manual or packaging. The few other negative comments were mainly attributable to unfamiliarity with this model and the processes involved with sending an SMS text message.

Researchers observing participants send text messages with this phone recorded that 3 users had no problems at all, however 3 people struggled to learn the new process and 2 were slow. However this is to be expected on one's first experiences of using a new mobile phone.

4.3.12.3Conclusions drawn from using the Doro PhoneEasy®410gsm

Overall comments on the Doro 410 were very similar to the positive comments which have already been discussed and only 2 drawbacks were mentioned at all.

The results for the Doro 410GSM phone clearly demonstrate that most of the problems which users reported on their mobile phones can be solved by following inclusive design principles and by focussing ones efforts upon the needs of people who might have mild to moderate impairments. The Doro 410 is not perfect but shows significant improvements over the user's own phone in all areas of use and user interaction. What's more it proves that these improvements are practical, relevant to user needs and commercially viable.

APPENDIX A Internal design processes – Confidential

This part of the deliverable provides an overview of the internal design process of the VICON industrial partners DORO and ARCELIK. Due to company-policy reasons, this information is considered confidential and is not publicly available.

Annex A ARCELIK's Design Process Activities

The design process at Arcelik as seen in Figure 33 defines the activities for planning, tracking and controlling of Arcelik's new product development projects.

The Capability Maturity Model Level 3 (CMMI L3) based development process and Brand guidelines are used in the design process. In addition style-guides or brand-standards are used, Arcelik's best-practices – knowledge base are included to process schedule and also validation and quality assurance is needed by respective groups and end users.

ProEngineer is used as a design tool. In addition to that Compiler, Debugger and Code editors are used in software development. CVS and Starteam Borland are used for configuration management. Starteam Caliber RM is used for the requirements management. User Interface design is being done by platform based UI tools and self-development.

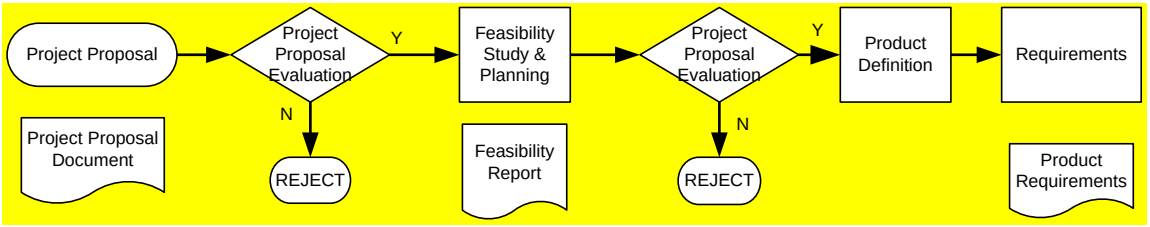


Figure 33: Project Proposal Flow

The basic process activities are summarized below in the following sub-sections.

Proposal Phase

Arcelik Product Management Department and/or other departments prepare Project Proposal Document for their new product requests.

The Product Management Department is responsible to organize PPR (Project Proposal Review) meetings to review the Project Proposals. During the PPR meetings, the Project Proposals are evaluated along with market, cost, timeline and forecast sections of the Project Proposals considering company objectives and strategies and an ACCEPT/REJECT decision for each proposal is given which is recorded in the related folders on the Arcelik Intranet.

PMO Manager assigns a Project Manager to each accepted Project Proposal to initiate project planning activities.

Establishing the Core Team

The PM (Project Manager) coordinates with the Department Managers to select the individuals with skills and experience appropriate to the individual roles as well as to the project requirements to establish the core team of the project.

Feasibility Study

Project Scope Definition

The core team defines the project scope by working with the Product Management Department and Benchmarking Office. The PM is responsible to organize the working sessions.

During the project scope study, the core team defines high level requirements and architecture of the product. The following issues are investigated:

- Functionality
- Out of scope features
- Interfaces
- Similarities and/or differences with other products; benchmarking

The core team documents its findings in the form of Feasibility Report.

Concept Analysis

Based on the Project Proposal and information gathered during product scope studies the core team defines the priorities for the items on Concept Evaluation Form which is part of feasibility report and used to evaluate product concept alternatives.

The core team, based on the priorities, selects among the product concept alternatives and records the rationale for decision.

Preliminary Project Management Plan

The PM, with feedback from the core team, prepares a high level project plan including high level work packages, major milestones, effort and budget estimates.

The PM records the high level plan into the Feasibility Report.

ROI Analysis

Based on the estimated schedule and the estimated amount of work a preliminary ROI (Return On Investment) analysis is done. After completing the ROI analysis which is documented in Feasibility report, PM ensures that the report is ready for the review.

The PMO organizes a Concept Review Meeting (CRM). Concept Review Meeting results can be acceptance, rework or reject. The core team updates the Feasibility Report to reflect the decisions and suggestions made during the Concept Review Meeting.

Project Planning

The PM performs the following project planning activities in cooperation with the core team members and prepares the Project Management Plan (PMP).

The PM also utilizes organizational assets entities during planning activities such as

- Project Management Plan(s) of similar projects (size, application domain, etc)
- Project closure reports of similar projects
- Measurement Repository

The PM also plans the planning tasks defined in this procedure and assigns appropriate personnel to these tasks. The PM is the responsible body to monitor the planning activities and take corrective action when needed.

The PM coordinates with the Department Managers to identify the appropriate staff (those with the required skills) to allocate to the project.

Based on the Feasibility Report, the PM prepares WBS for the project.

The WBS covers the tasks for

- Planning and monitoring activities
- Development activities (e.g. software, hardware)
- Supporting activities (e.g. training, configuration management, risk management, quality assurance, maintenance)
- Integration and management of non-developmental activities (e.g. integrating reusable components)
- Acquisition and reuse

The PM establishes project schedule in the form of a Gantt chart considering the following:

- Time phasing of activities
- Dependencies between the activities
- Milestones identified
- Duration of activities
- Frequency of the progress/milestone meetings
- Assumptions and constraints related to the scheduling
- Return Of Investment Analysis

The PM establishes the project budget based on resource cost estimates and estimates for other expenses related to the project (infrastructure, training, travel etc.) and documents the project budget.

Software Development Management

The PM and The Department Manager establish a Project Management Team involving at least a Software Leader (SL), Software Quality Assurance Representative (SQAR) and Software Configuration Manager (SCM). The PM and Department Manager select individuals for the Project Management Team with skills and experience appropriate to the individual roles.

The PM asks the Software Leader (SL) to plan for the software development activities based on the Preliminary Project Management Plan. The SL needs information from Requirement Development Process to have the details of the Project to complete the plan for software development.

The SL establishes the software development process using the standard procedures and other defined assets (e.g. guidelines, templates). Based on the product requirements, Arcelik Process Tailoring Guidelines, and Software Life Cycle Definitions (e.g. waterfall, iterative, agile), the SL decides on the project life cycle and the activities that will be executed within the context of software development (e.g. software development process). The WBS reflects the decisions regarding to the software development process:

- Requirements development
- Requirements management
- Design, and coding
- Product integration
- Software testing
- Software configuration management
- Software quality assurance

Depending on the project's specific requirements, the SL might need to adapt a process/method/tool that is not defined in the Arcelik Process Asset Library (PAL). In this case, the SL documents the rationale for each deviation from the standard processes.

The SQAR reviews the project's defined process and ensures that it is aligned with Arcelik Process Tailoring Guidelines and process management infrastructure. The review of the project's defined process is performed in accordance to the Software Quality Assurance Process. The SL resolves the issues identified in the review.

If there are deviations from the standard processes, the PMO approves the project's defined process.

The SL documents the project's defined process by extending and organizing the WBS in the Project Planning Tool. The SL establishes estimates for software work products using Arcelik Estimation Guidelines. The SL may form an estimation team in case of need.

The Hardware Development, Mechanical Development and Industrial Design management and planning is similar to software development management process defined above.

The PM, together with the team leaders e.g. SL reviews all project plans (Project Management Plan, Software Development Plan, Hardware Development Plan, Mechanical Development Plan, Industrial Design Plan, Test Plan, Procurement Plan, Production Plan, Contractor Plan, Configuration Management Plan and Risk Management Plan) for alignment.

- Identify and analyse product and project interface risks such as incomplete interface specifications, availability of commercially available components, inadequate team interfaces etc.
- Schedule the tasks in a sequence that accounts for critical development factors and project risks

- Objective entry and exit criteria for major project tasks to authorize the initiation and completion
- Compatibility of the plans with the plans of relevant stakeholders.

Review Project Management Plan

PM organizes a plan review meeting to discuss the details of all the project plans and assignments and obtain commitments of the project stakeholders. Representatives from all related departments attend to the review meeting.

PM is responsible for updating the Project Management Plan (PMP) to reflect the review results. The PM also ensures that all related development plans are updated.

Project Kick-off meeting

The PM arranges a project kick-off meeting involving all the project team and reviews the scope and objectives in the meeting.

Project Execution

Monitor and Control the Project

During the execution of the project, the PM monitors the project progress, resolve issues by taking corrective actions and coordinate the stakeholders in accordance to the Project Management Plan.

Project monitoring and control is achieved by:

- Progress review meetings,
- Progress reporting,

Conduct Progress Review Meetings

The PM organizes progress meetings after the completion of each project milestone. All stakeholders of the project attend to the milestone progress meetings. The PM prepares Project Progress Report before the meeting and distributes the report to the stakeholders of the project.

The PM ensures that the following issues are discussed during the Milestone Progress Meetings:

- Status of the project from the following perspectives: schedule, effort, quality
- Status of the project risks
- Issues related to coordination and communication and/or involvement of stakeholders
- Subcontract management issues (if applicable)
- Other issues raised
- The PM ensures that project status information is communicated regularly to the following stakeholders through reports or meetings:
- All the team leaders
- End users,
- Customers,
- Suppliers

Prepare Progress Reports

The PM is responsible to prepare project progress reports at the intervals defined in the PMP. The project progress report is distributed to all project stakeholders.

Project Change Management

Any change to the project is communicated to the PM through Change Request form. All changes are recorded in Change_Request_Log_Template.

The PM will evaluate the change request and may perform one of the following activities. The PM records the decision and/or the rationale on the change request form.

- REJECT the change – if it is a major out-of-scope request. In this case the department requesting the change can initiate a project cycle using Project Proposal Form.

- ACCEPT and execute the change – if is a minor change that does not affect the project schedule. In this case the PM also assigns one or more members of the project team to implement the change.

- FORWARD FOR EVALUATION – if the PM cannot decide the scope and impact of the change then s/he will forward the change request to project team members for evaluation.

If the change request is forwarded to the project team for evaluation; the team performs an impact analysis and makes a decision based on the following rules. The project team records the results of the impact analysis and/or the decision and/or the rationale on the change request form.

- If the change request can be implemented within the project schedule with additional effort then it is the project team's decision whether to implement or not. In this case the PM and/or team leaders assign appropriate team members to implement the change. The PM may also need to change the project plan to reflect the implementation activities.
- If the change request has an impact on the budget and/or on the schedule of the project more than 10% then it is forwarded to the Change Control Board for a decision.
- If the project team cannot make a decision on the implementation of the change request, then it is forwarded to the Change Control Board.

The Change Control Board makes the final decisions regarding to the incoming change requests. The PM records the decisions and/or the rationale on the change request form and is responsible for the execution of the change.

After the implementation of the change request, the PM closes the change request and informs the initiator.

Project Closure

- The PM closes the project when the closure conditions defined in the PMP are satisfied and production approval document defined by Quality Department is approved by related departments.
- The PM prepares a Project Closure Report that includes information from individual team closure reports, the results of Project Closure Meeting, as well as project measurements.

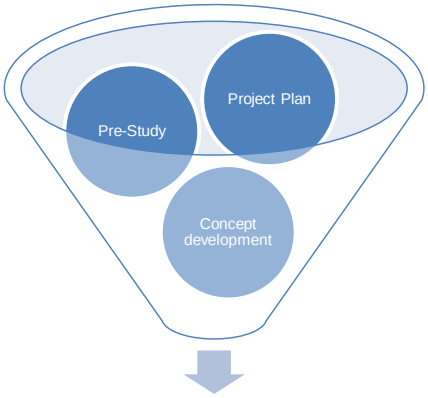
Annex B DORO's Design Process Activities

The following section provides an overview of the product development process as performed at DORO.

Doro Design
Development process

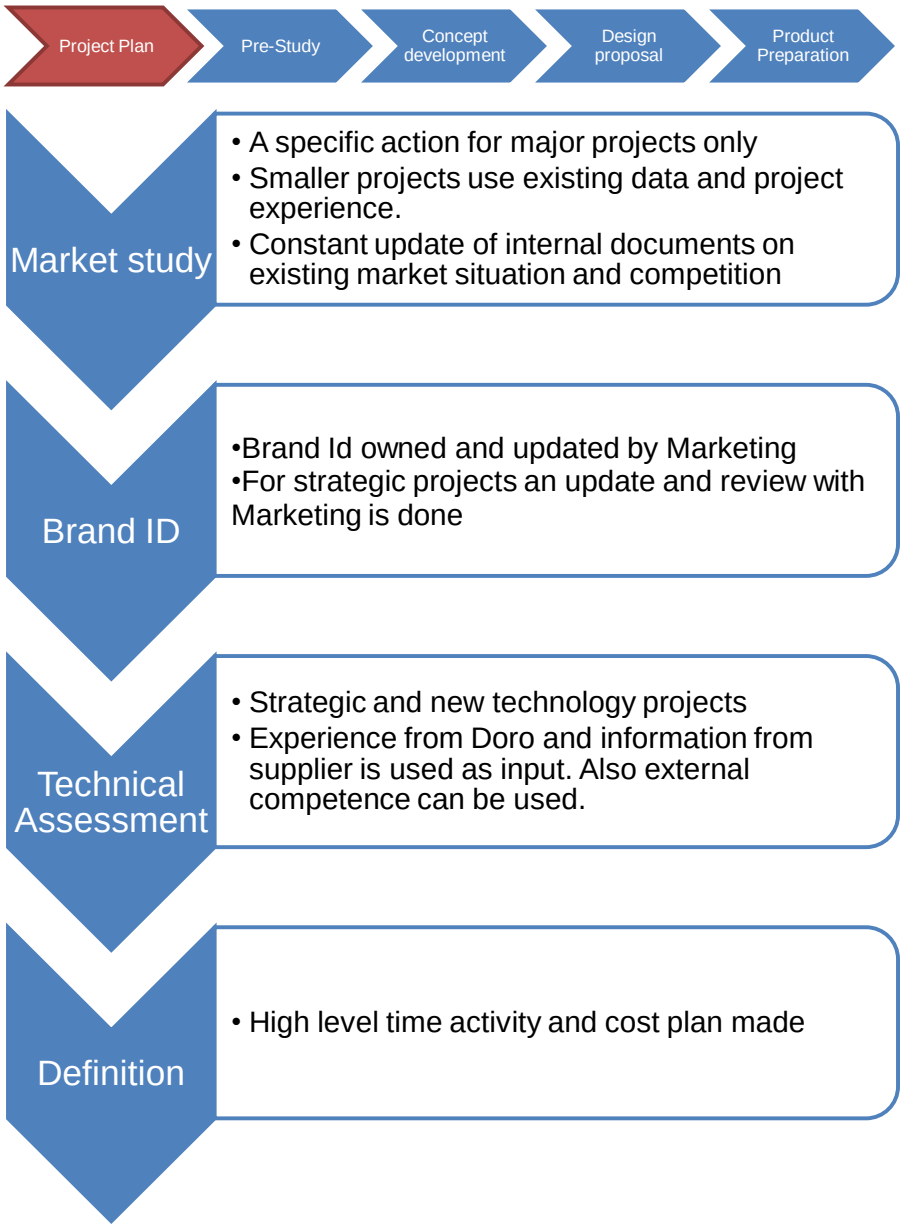
Document name:	Design process
Version:	4
Approval date:	2010-08-10
Approved by:	TBL
Replace version:	3
Issued date:	2010-08-09
Total number of pages:	8

Doro Design process



Design proposal

Production preparation



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Doro Design process v4-
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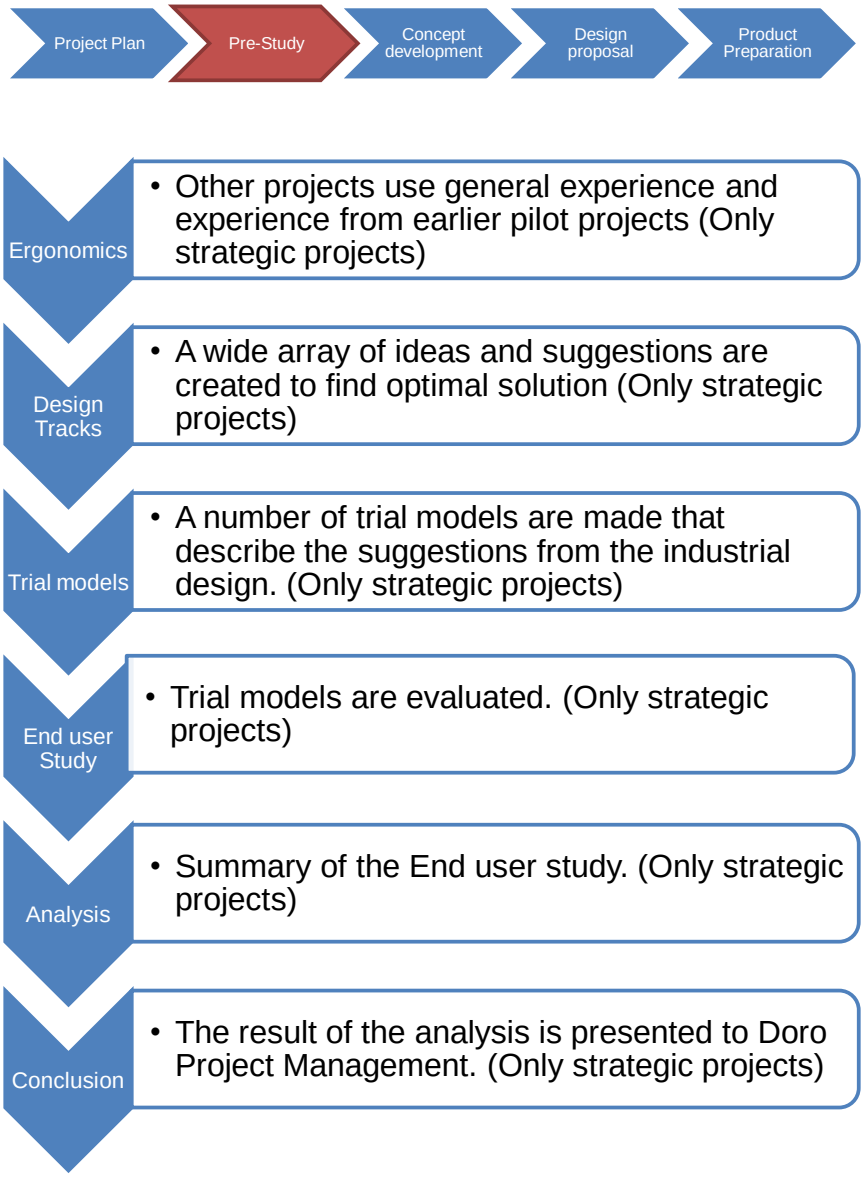

Project Plan
Pre-Study
Concept development
Design proposal
Product Preparation
Ergonomics
• Other projects use general experience and experience from earlier pilot projects (Only strategic projects)
Design Tracks
• A wide array of ideas and suggestions are created to find optimal solution (Only strategic projects)
Trial models
• A number of trial models are made that describe the suggestions from the industrial design. (Only strategic projects)
End user Study
• Trial models are evaluated. (Only strategic projects)
Analysis
• Summary of the End user study. (Only strategic projects)
Conclusion
• The result of the analysis is presented to Doro Project Management. (Only strategic projects)
2010-08-10
Doro Design process v4-
Confidential

Project Planning
- Time and cost plans are detailed

Creative stage
- Different concepts and solutions are brainstormed to identify detailed direction

Workshop
- Choices are made based on creative stage phase. (Only in medium size or major projects)

Concept for design
- Details in the identity and mechanical design are studied to secure feasibility.
- The design is coordinated with corporate identity.
- Colour suggestions, graphics and materials are suggested

Harmonisation
- Evaluation of the selected concepts regarding design, functionality, industrialisation potential, ergonomic quality.

Illustration
- Scale models in 3D and correct scale for user tests. (Only strategic projects)
- Description of appearance and finish. (Only strategic projects)

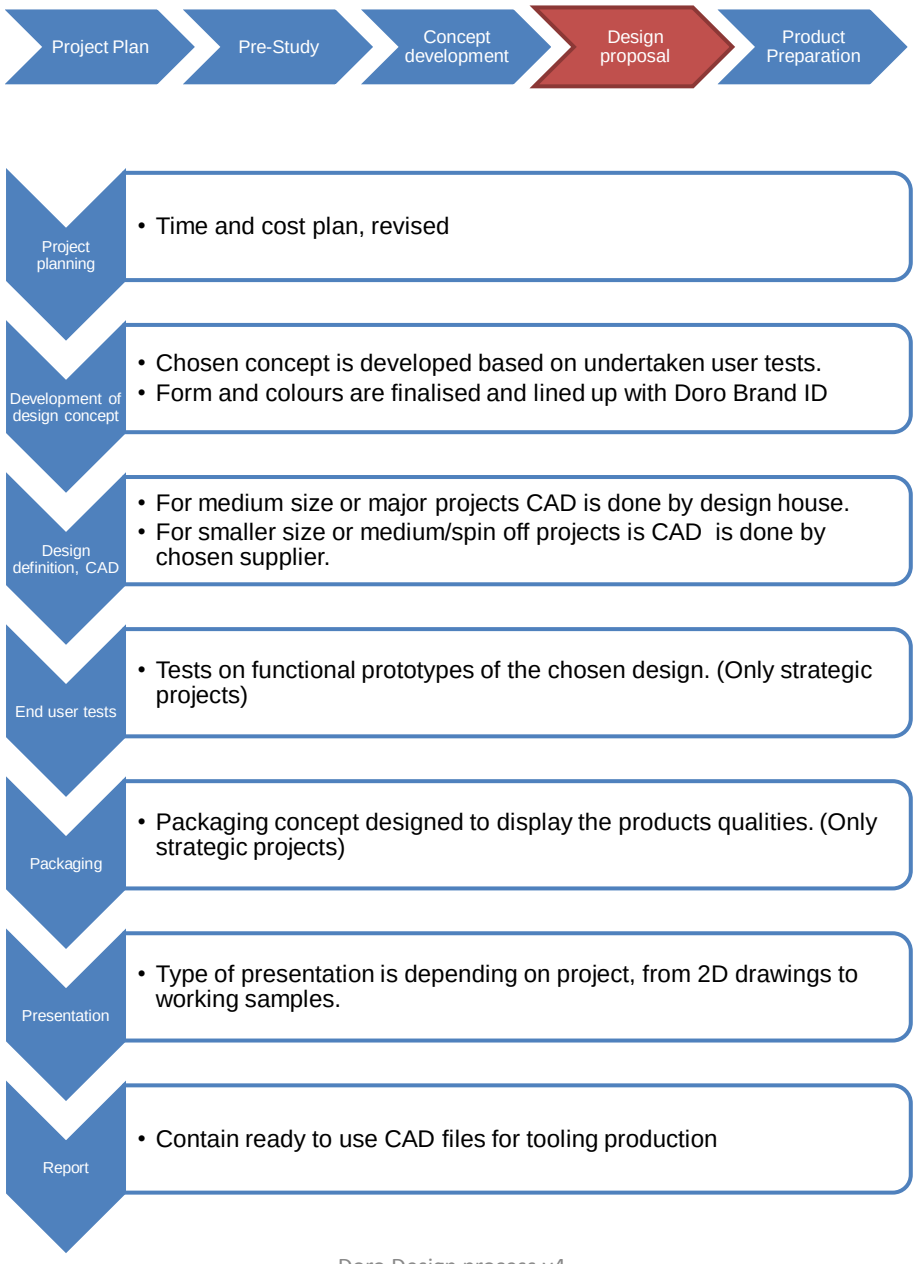
User tests
- Scale models are used. (Only strategic projects)

Analysis & Evaluation
- Result from User tests are analysed and evaluated. (Only strategic projects)

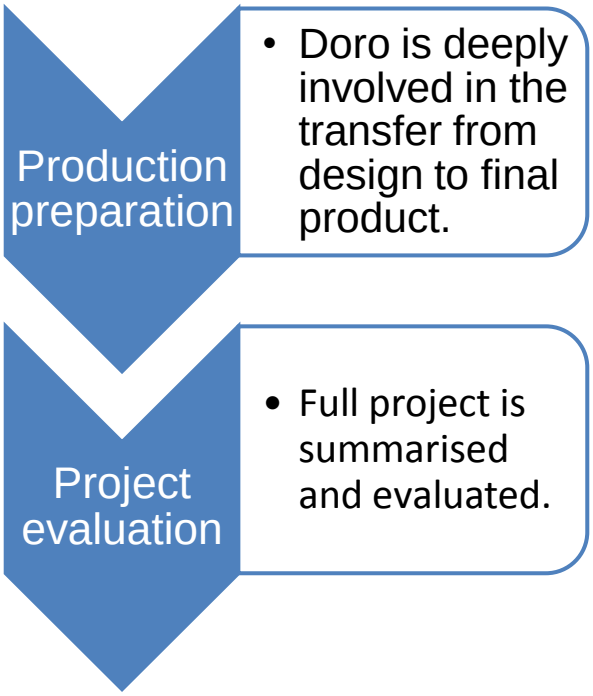
Conclusion
- Result are presented for Doro Project Management.

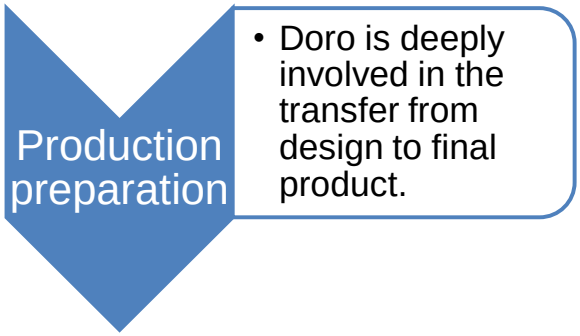
2010-08-10

Doro Design process v4-
Confidential


Project Plan
Pre-Study
Concept development
Design proposal
Product Preparation
Project planning
• Time and cost plan, revised
Development of design concept
• Chosen concept is developed based on undertaken user tests.
• Form and colours are finalised and lined up with Doro Brand ID
Design definition, CAD
• For medium size or major projects CAD is done by design house.
• For smaller size or medium/spin off projects is CAD is done by chosen supplier.
End user tests
• Tests on functional prototypes of the chosen design. (Only strategic projects)
Packaging
• Packaging concept designed to display the products qualities. (Only strategic projects)
Presentation
• Type of presentation is depending on project, from 2D drawings to working samples.
Report
• Contain ready to use CAD files for tooling production
2010-08-10
Doro Design process v4-
Confidential


Project Plan
Pre-Study
Concept development
Design proposal
Product Preparation


Production preparation
• Doro is deeply involved in the transfer from design to final product.
Project evaluation
• Full project is summarised and evaluated.



Doro Design process v4-
Confidential

2010-08-10

APPENDIX BUser Questionnaire – Personal details

VICON WP1.3 User field research – Personal details

Name: ……..User number: ……

Age:…….Date :..... / …… / 2010

How often do you use your washing machine?Every day

At least once a week

At least once a month

Seldom

Never

How often do you use your mobile phone? Every day

At least once a week

At least once a month

Seldom

Never

What do you use your mobile phone for?

(Ask them to describe their typical use)

Annex A.Hearing

1. Do you use hearing aids? Yes / No

2. If Yes, what are they, when and how often do you wear them?

3. How would you describe your hearing **when not using hearing aids**?

- ☐ I have no difficulties hearing what is being said, even in noisy situations
- ☐ I have some difficulty hearing what is being said, mainly in noisy situations
- ☐ I have some difficulty hearing what is being said, even in quiet situations
- ☐ I cannot hear what is being said, but I can hear some sounds
- ☐ I am profoundly deaf

4. How would you describe your hearing **when using hearing aids**?

- ☐ I have no difficulties hearing what is being said, even in noisy situations
- ☐ I have some difficulty hearing what is being said, mainly in noisy situations
- ☐ I have some difficulty hearing what is being said, even in quiet situations
- ☐ I cannot hear what is being said, but I can hear some sounds

Task 1: Using the laptop and headphones please ask the participant to carry out the hearing check when not wearing hearing aids

Result : …….

Annex B.**Vision**

5. Do you wear spectacles? Yes / No

6. If Yes, what are they, when and how often do you wear them?

Please select the descriptions below that best describe your normal vision, for each description please also indicate the degree that you are affected.

Without spectacles

7. Things appear to be indistinct/blurry.

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

With spectacles, if applicable

8. It is difficult to change focus when looking at something near and then far away

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

9. I have a reduced field of vision, I find it hard to see things to the side, top, bottom of what I am looking at.

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

10. I can't distinguish colours

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

11. It can be hard to judge distance

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

12. It is hard to adjust to changes in light levels

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

13. I am more sensitive to light and glare than I used to be

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

Task 2: Not wearing spectacles - ask the participant to read the passage of text

How far could they read?Did they encounter/report any problems?

Task 3: Wearing spectacles - ask the participant to read the passage of text

How far could they read?Not applicable

Did they encounter/report any problems?

Annex C.Manual dexterity

Please select the descriptions below that best describe your manual dexterity, for each description please also indicate the degree that you are affected.

14. Do you have difficulties in gripping small items, for example a pen or the handle of a cup?

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

15. Do you have difficulties when using controls such as knobs or sliders?

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

16. Do you have difficulties when using buttons or keys, for example when using the number keys on a phone?

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

17. Do you have any discomfort in your hands when gripping small objects or operating controls?

☐ No ☐ Slightly ☐ Moderately ☐ Strongly

18. Comments on user's manual dexterity

APPENDIX CUser Questionnaire – Washing machine

VICON user field research User no. : ……..

Washing machine

Make……

Model……

Approximate age…….. years

Condition:As new

Good

Fair

Poor

Old and worn

Comments

Environment

Please describe

Consider:

- *What type of room*
- *Size of room*
- *Access to washing machine*
- *Heat*
- *Light*
- *Other things in the room*

Participant

WearingSpectacles / hearing aids / Other ……..

VICON user field research – Using the washing machine

1. Opening and closing the door

Task 1: Please open and close the door a few times

Observation

Consider:

- *Comfort /discomfort of using door catch*
- *Single/dual actions*
- *Grip on handles/surfaces*
- *Access to catch / door*
- *Force required to use catch or open door*
- *Catch alignment*

1.1 Was it easy for you to use the door catch?Yes / No

Comments

1.2 Did you have any problems?Yes / No

Comments

1.3 Did you have any discomfort?Yes / No

Comments

1.4 Was it easy for you to open and close the door?Yes / No

Comments

1.5 Did you have any problems?Yes / No

Comments

1.6 Did you have any discomfort?Yes / No

Comments

2. Loading the washing machine

Check that the standard washing load isn't larger than is typical for this user, if it is then reduce it.

Task 2: Please load the clothing into the washing machine.

Observation

Consider:

- *Ease of access*
- *How far door opens*
- *Size & height of aperture*
- *Hands/clothing catching on seal*

2.1 Was it easy for you to load the washing machine?Yes / No

Comments

2.2 Did you have any problems?Yes / No

Comments

2.3 Did you have any discomfort?Yes / No

Comments

2.4 With the load in the machine, was it easy to close the door?Yes / No

Comments

3. Unloading the washing machine

Task 3: Please remove the clothing from the washing machine.

Observation

Consider:

- *Ease of access*
- *How far door opens*
- *Size & height of aperture*
- *Hands/clothing catching on seal*

3.1 Was it easy for you to unload the washing machine?Yes / No

Comments

3.2 Did you have any problems?Yes / No

Comments

3.3 Did you have any discomfort?Yes / No

Comments

4. Using the detergent dispenser

Check that the participant normally uses the detergent dispenser, instead of adding detergent and conditioner directly into the drum

Task 4: Please open and close the detergent dispenser a few times

Observation

Consider:

- *How they grip the tray*
- *How easily, and far, the dispenser opens*
- *Comfort*
- *Force required*
- *Does it open smoothly*

4.1 Was it easy for you to open and close the detergent dispenser?Yes / No

Comments

4.2 Did you have any problems?Yes / No

Comments

4.3 Did you have any discomfort?Yes / No

Comments

4.4 What type of detergent do you normally use?Powder / tablet / liquid / gel / other

Why do you use this type?

Ensure that you have detergent & conditioner of a similar type to that used by the participant

Task 5: Please add detergent to the open dispenser

Observation

Consider:

- *Did they put detergent in the correct place?*
- *How did they recognise where to put detergent*
- *Ease of access*
- *Is the compartment a suitable size*

4.5 Was it easy for you to add detergent?Yes / No

Comments

4.6 How do you know which compartment to put the detergent into?

Comments

4.7 Did you have any problems?Yes / No

Comments

4.8 Did you have any discomfort?Yes / No

Comments

Task 6: Please add conditioner to the dispenser

Observation

Consider:

- *Did they put conditioner in the correct place?*
- *How did they recognise where to put it*
- *Ease of access*
- *Ease of pouring*
- *Is the compartment a suitable size*

4.9 Was it easy for you to add conditioner?Yes / No

Comments

4.10 How do you know which compartment to put the conditioner into?

Comments

4.11 Did you have any problems?Yes / No

Comments

4.12 Did you have any discomfort?Yes / No

Comments

5. Cleaning the detergent dispenser

Only carry out this task if they use the detergent dispenser and if they regularly clean it

Task 7: Please remove the dispenser, clean it and then replace it

Observation

Consider: • *How they grip the tray* • *How easily it is to remove & replace* • *Comfort* • *Force required* • *Does it open smoothly*

5.1 Was it easy for you to remove the detergent dispenser?Yes / No

Comments

5.2 Was it easy for you to replace the detergent dispenser?Yes / No

Comments

5.3 Was it easy for you to clean the detergent dispenser?Yes / No

Comments

5.4 Did you have any problems?Yes / No

Comments

5.5 Did you have any discomfort?Yes / No

Comments

6. Using the main controls

Ask which programme they most frequently use; ask them to set this (programme 1) and then another wash programme of your choice (programme 2), typically a 60oC Cotton or 40oC Synthetic wash

Task 8: Please set the washing machine on wash programme 1 (……..)

Task 9: Please set the washing machine on wash programme 2 (……..)

Observation

Consider:

- *Size/shape of controls*
- *Are controls in a logical order*
- *Force required*
- *Ease of reading labelling*
- *Comfort*
- *Do controls move smoothly*
- *Ease of access*
- *Feedback to the user*

How many attempts were required to set the programmes correctly? Prog 1

Prog 2

Comments

6.1 Was it easy for you to set the wash programme?Yes / No

Comments

6.2 Did you have any problems?Yes / No

Comments

6.3 Did you have any discomfort?Yes / No

Comments

6.4 Do you ever cancel a wash if you set it to the wrong programme?Yes / No

If Yes, go to task 10

If No, go to section 7

Task 10: Please set the washing machine on wash programme 1, again.

"You have changed your mind about this programme, cancel it and start another programme instead"

Observation

Consider:

- *Size/shape of controls*
- *Are controls in a logical order*
- *Force required*
- *Ease of reading labelling*
- *Comfort*
- *Do controls move smoothly*
- *Ease of access*
- *Feedback to the user*

How many attempts were required to cancel the programmes correctly? ……..

Comments

6.5 Was it easy for you to cancel the wash programme?Yes / No

Comments

6.6 Did you have any problems?Yes / No

Comments

6.7 Did you have any discomfort?Yes / No

Comments

7. Using the minor controls

Inspect the washing machine and identify any differing types of minor controls (these might be rotary, slider or push button, and in different sizes/shapes). Make sure that at least one of every minor control-type is operated.

Task 11: Please set the washing machine to a half load / rinse hold / economy / spin speed, etc

Observation

Consider:

- *Size/shape of controls*
- *Are controls in a logical order*
- *Force required*
- *Ease of reading labelling*
- *Comfort*
- *Do controls move smoothly*
- *Ease of access*
- *Feedback to the user*

How many attempts were required to set the controls correctly? *Control 1*

Control 2

Control 3

Comments

7.1 Was it easy for you to use these controls?Yes / No

Comments

7.2 Did you have any problems?Yes / No

Comments

7.3 Did you have any discomfort?Yes / No

Comments

8. Displays and labelling

Programme guide

8.1 Is the programme guide easy for you to read? Yes / No

Comments

8.2 Is the programme guide easy for you to understand? Yes / No

Comments

8.3 Did you have any problems with using the programme guide?Yes / No

Comments

Main control

8.4 Is the labelling of the main programme control easy for you to read? Yes / No

Comments

8.5 Is the labelling of the main programme control easy for you to understand? Yes / No

Comments

8.6 Did you have any problems with the labelling?Yes / No

Comments

Minor controls

8.7 Is the labelling of the minor controls easy for you to read? Yes / No

Comments

8.8 Is the labelling of the minor controls easy for you to understand? yes / No

Comments

8.9 Did you have any problems with the labelling?Yes / No

Comments

Displays / indicator lights

Any display which is in addition to the labelling or marks on specific controls. For example a time remaining LED, digital display panel or lights indicating wash progress

8.10 Are any displays/lights easy for you to read? Yes / No

Comments

8.11 Are any displays/lights easy for you to understand? Yes / No

Comments

8.12 Did you have any problems with the displays/lights?Yes / No

Comments

8.13 Do you use these displays/lights and are they useful to you?Yes / No

Comments

9. When the wash has finished

9.1 How do you know when a wash has finished?

Comments

9.2 Did you have any problems with this?Yes / No

Comments

10. Cleaning the filter

10.1 Do you ever clean the filter?Yes / No

If Yes,

Please describe how you do it and any problems you have

10.2 Is it easy to clean the filter?Yes / No

Comments

10.3 Do you typically have any problems?Yes / No

Comments

10.4 Did you typically have any discomfort?Yes / No

Comments

APPENDIX DUser Questionnaire – Mobile Phone

VICON user field research User no. : ……..

Mobile phone

Make……

Model……

Approximate age…….. years

Condition:As new

Good

Fair

Poor

Old and worn

Comments on model or condition

Environment

Please describe

Consider:

- *What type of room*
- *Size of room*
- *Heat*
- *Light*
- *Other things in the room*

Participant

WearingSpectacles / hearing aids / Other ……..

VICON user field research – Using the mobile phone

Go to a normally lit room. The user may stand or sit for these tasks – let them choose which is the most common situation for them when using their mobile phone.

1. Turning the phone on and off

Task 1: Please turn your mobile phone on

Observation

Consider:

- *Ease of access to control*
- *Button size*
- *Force required*
- *How they hold and operate the phone*

1.1 Was it easy for you to turn your phone on? Yes / No

Comments

1.2 Did you have any problems?Yes / No

Comments

1.3 Did you have any discomfort?Yes / No

Comments

Task 2: Please turn your mobile phone off

Observation

Consider:

- *Ease of access to control*
- *Button size*
- *Force required*
- *How they hold and operate the phone*

1.4 Was it easy for you to turn your phone off?Yes / No

Comments

1.5 Did you have any problems?Yes / No

Comments

1.6 Did you have any discomfort?Yes / No

Comments

2. Making a voice call

Task 3: Ask them to turn their phone on again

Please call this number 01256 378314

Observation

Consider:

- *Keys*
- *Displays*
- *How they hold and operate the phone*

2.1 Was it easy for you to make this call?Yes / No

Comments

2.2 Did you have any problems?Yes / No

Comments

2.3 Did you have any discomfort?Yes / No

Comments

3. Receiving a voice call

Task 4: Go into another room, call their mobile phone and have a short conversation.

"I shall call your phone, please accept the call and we shall have a short chat"

Observation

Consider:

- *Ease of receiving the call*
- *Keys*
- *Displays*
- *How they hold and operate the phone*

Alert

What type of alert do they use? *Ring only / Vibrate only / Ring and vibrate / other : ……..*

Ask why they use this type?

Are they aware of other types? *Yes / No*

Comments

3.1 Was it easy for you to realise that you were receiving a call?Yes / No

Comments

3.2 Did you have any problems?Yes / No

Comments

4. Performance during a voice call

Is the user: wearing hearing aids / not wearing hearing aids

Comments

Task 5: Please call this number again 01256 378314 and listen to it

4.1 Is it easy for you to hear the speech?Yes / No

Comments

4.2 Is it easy for you to understand the speech?Yes / No

Comments

4.3 Did you have any problems?Yes / No

Comments

Task 6: Please adjust the volume until you have the best loudness and clarity for this call

Is it easy for you to adjust the volume?Yes / No

Comments

Did you have any problems?Yes / No

Comments

Did you have any discomfort?Yes / No

Comments

Task 7: Now, please listen a little longer at this ideal setting

How would you describe the volume?

☐ Loud ☐ Satisfactory ☐ Quiet

Comments

How would you describe how clear the speech sounds?

☐ Very clear ☐ Satisfactory ☐ Unclear, it sounds muffled or distorted

Comments

5. Sending an SMS text message

Make sure that the user regularly send and receives SMS text messages – if not go to section 6

5.1 Do you normally use predictive texting?Yes / No

Carry out the following tasks with/without predictive text in accordance with their normal use.

Task 8: Please send this message:

'Are we still going to the Chelsea flower show?'

To: xxxxxxxxxx (your mobile phone number)

Observation

Consider:

- *Number of errors*
- *When/how corrections are made*
- *Keys*
- *Display*
- *How they hold and operate the phone*

Time taken to complete this task ……. *Min* …… *Sec*

Number of mistakes made …… *Describe*

5.2 Was it easy for you to write and send this text message?Yes / No

Comments

5.3 Did you have any problems?Yes / No

Comments

5.4 Did you have any discomfort?Yes / No

Comments

6. Receiving an SMS text message

Task 9: Send the participant this message:

'Yes that's a great idea. Shall we drive or go on a coach?

Ask them to please accept and read the message

Observation

Consider: • *Number of errors*

- *When/how corrections are made*
- *Keys*
- *Display*
- *How they hold and operate the phone*

Alert

What type of alert do they use? Ring only / Vibrate only / Ring and vibrate / other : ……..

6.1 Was it easy for you to know that you had received a text message?Yes / No

Comments

6.2 Was it easy to open and read this text message?Yes / No

Comments

6.3 Did you have any problems?Yes / No

Comments

6.4 Did you have any discomfort?Yes / No

Comments

7. Keys and controls

Main number controls

7.1 Do you think the number keys are large enough for you? Yes / No

Comments

7.2 Do you think the number controls are spaced apart enough? Yes / No

Comments

7.3 Did you have any problems using the number keys?Yes / No

Comments

7.4 Did you have any discomfort when using these controls?Yes / No

Comments

7.5 Did you have any problems with the labelling on the controls?Yes / No

Comments

Other controls

Consider all other types of control, i.e. volume controls on side, function and menu controls

Control	Is it large enough?	Is it spaced far enough apart from others?	Did you have any problems when using?	Did you have any discomfort when using?	Did you have any problems with the labelling?

	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No

	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No

8. Main display

Carry out this task in both the normal room and either outside or in a brightly lit room with the user standing up

Task 10: Please look at the menu items on your main display, read the previously sent text message and start dialling a telephone number

8.1 Is the main display easy for you to read?Yes / No

Comments

8.2 Do you understand the icons or descriptions?Yes / No

Comments

8.3 Did you have problems using the main display?Yes / No

Comments

8.4 In relation to the display, what are the good points and drawbacks?

Good points	Drawbacks

9. Adding contact details to the phonebook

Ask if they use their phonebook, if not go to section 10

Task 11: Please add these details to your phonebook

Paul Jones 01234 132479

Observation

Consider:

- *Understanding of process*
- *Use of menu system*
- *Number of errors*
- *When/how corrections are made*
- *Keys*
- *Display*
- *How they hold and operate the phone*

Could it be completed successfully?	*Yes / No*
Time taken to complete this task	*……. Min …… Sec*

Number of errors made	……

9.1 Was it easy for you to do this?Yes / No

Comments

9.2 Did you have any problems?Yes / No

Comments

9.3 Did you have any discomfort?Yes / No

Comments

10. Recharging the phone

Task 12: Please put your phone on charge

Observation

Consider:

- *Ease of connecting*
- *Grip issues*
- *Force*
- *Dexterity issues*

10.1 Was it easy for you to put your phone on charge?Yes / No

Comments

10.2 Did you have any problems?Yes / No

Comments

10.3 Did you have any discomfort?Yes / No

Comments

11. Doro PhoneEasy®410gsm

Intro: This phone has been designed specifically for older people. It has large buttons, a clear display and loud volume.

11.1 Making a voice call

Task 13: Please call this number 01256 378314 (recorded message)

Observation

Consider:

- *Ease of dialling*
- *Keys*
- *Displays*
- *How they hold and operate the phone*

11.1.1 How does this phone compare to your normal mobile?

11.1.2 When making a voice call with the Doro PhoneEasy®410gsm:

Good points	Drawbacks

11.2 Sending a text message

Make sure that predictive text is on/off in accordance with user preference

Task:Please send this message:

'Are we still going to the Chelsea flower show?'

To: xxxxxxxxxx (your mobile phone number)

Observation

Consider:

- *Number of errors*
- *When/how corrections are made*
- *Keys*
- *Display*
- *How they hold and operate the phone*

11.2.1 How does this phone compare to your normal mobile?

11.2.2 When sending a text message with the Doro PhoneEasy®410gsm:

Good points	Drawbacks

11.3 Overall comments on the Doro PhoneEasy®410gsm

Good points	Drawbacks

APPENDIX EGeneral info on each user

No	M/F	Age	Mobile Phone	Washing Machine
N1	F	78	Motorola W377	Zanussi Aquacycle 1000
N2	F	72	Nokia 1.3 megapixel, 4.5 1:3:2 (could not access battery)	Zanussi Aquacycle 1000
N3	F	91	N/A	Hotpoint Aquarius 800
N4	F	82	(Siemens portable telephone used)	Zanussi Electrolux Essential 1000 Aquacycle
N5	F	69	Nokia E65	Bosch Classix 1200 Express
N6	F	67	Nokia 5130	Hotpoint Aquarius 1100
N7	F	78	Nokia 2330c-2	Zanussi Aquacycle 1000
N8	F	83	Nokia (could not access battery)	Whirlpool AWM 1200
N9	F	69	Nokia 6610	Powerpoint 1200 IWD
N10	F	65	Samsung SGH-J700	Bosch Classix 1200
N11	F	81	DORO HandlePlus 326i gsm	Zanussi Aquacycle 1000
N12	F	67	Nokia 6303c	Zanussi Aquacycle 1000
N13	M	74	Nokia 2630	N/A
N14	F	71	Nokia 2760	Zanussi Jetsystem iz10
N15	F	79	Nokia 3120	Zanussi Aquacycle 1050
N16	F	69	Nokia 6303c	Whirlpool 1000 Spin
N17	F	79	Nokia 3120	Siemens SIWAMAT 2105
N18	F	65	Nokia 6410	Zanussi Aquacycle 1000
N19	M	70	Nokia 3110c	N/A
N20	F	67	Nokia 6030	Neff (model no. could not be found)
N21	F	67	Nokia 2760	Miele Hydromatic W698
N22	M	68	Nokia 2760	N/A
N23	M	85	Nokia 1600	N/A

F1	F	70	Sony Ericsson w890i	Miele Monotronic W527
F3	M	65	Nokia 5110 NSE-1NX	Miele Softtronic W3245
F4	M	65	Nokia 6300	N/A
F5	M	90	N/A	Matura Oekomat 1005 duo
F6	M	71	Samsung SGH-C260	N/A
F7	F	74	Siemens A55	Bosch Sportline WFL 284 S
F8	F	86	N/A	Bosch MaXX
F9	F	80	Siemens (model info not visible)	Siemens Siewamat Plus 3371
F10	F	89	N/A	Miele Novotronic W830
F11	M	80	Samsung SGH E250V	Bosch WFK 5510
F12	F	89	N/A	Privileg (Quelle) 220 S
F13	F	72	Siemens A50	Miele Softtronic W437
F14	M	96	N/A	Bauknecht W 3573
F15	F	72	N/A	Bauknecht WAK 5750
F16	F	84	N/A	Blomberg
F17	F	69	Nokia (no model recorded)	Privileg 3142
F18	F	74	Motorola C123	Miele Prisma
R1	F	68	Samsung SGH D600	Bosch FD8706
R2	F	70	Nokia 3310	Miele W844
R3	F	82	Samsung E1100	Hotpoint Aquarius WMA32
R4	M	70	Nokia 1100	NA
R5	F	65	Nokia 3410	John Lewis JLWM1407
R6	M	70	Samsung GT-S5230	Bosch Classix 1000
R7	M	78	Nokia 1110	Tricity Bendix AW1401W
R8	M	65	Nokia 2610	Hotpoint Ultima WMA62
R9	M	67	Nokia 2610	Zanussi ZWD1272W
R10	F	69	Samsung E1120	Hotpoint Aquarius WM62

R11	F	84	Nokia 1650	Bosch Toploader WOP2407GB
R12	F	77	Nokia 2760	Indesit WG1130T
R13	F	69	Samsung C140	Zanussi ZWF1621W
R14	M	74	Motorola RAZR	Siemens E14.16
R15	F	61	Siemens A50	NA
R16	F	78	Nokia 1600	Zanussi Aquacycle FLE1216W
R17	M	80	Binatone Big Button	Bosch FD8506
R18	F	79	Binatone Big Button	Bosch FD8506