Designing a kettle to be inclusive of the elderly

Contents

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Abstract

Many of the elderly have issues with strength, dexterity, joints, cognitive function and perceptual abilities, and the kettles available on the market do not sufficiently account for these needs. The aim of this project is to design a kettle to solve as many of these as possible, informed by data from available relevant literature, a questionnaire sent to elderly kettle users, and experiential testing of a prototype. Testing substantiated the claim that our product was an improvement over a typical existing product in the reduction of strength, dexterity, visual acuity and contrast sensitivity needed for use, and articular pain caused. Literature suggested that it would be more usable for the cognitively impaired and would minimise the errors completed for any user.

Introduction

The majority of the British population own kettles: 78.8% in 2012 according to one market research study (Reuters UK, 2013). With an ageing population - currently one sixth of which is over 65, to increase to a projected quarter of the population by 2050 (Cracknell, 2010) - there are a large number of kettle users who are elderly. There is a large quantity of research on the changes that occur as people age and the difficulties in function that can arise as a result, much of which has direct implications for the potential challenges in using kettles (e.g. Carmeli, Patish and Coleman, 2003; Goodpaster *et al.*, 2006; Haigh, 1993; Keys and White, 2000; Landers *et al.*, 2001; Petersson, 1983; Pinto *et al*., 1997; Vanderplas and Vanderplas,1980). When considering many capacities related to kettle use, the elderly are often the limiting user, meaning that design with them in mind will also include all those users who are more capable. This report aims to first demonstrate the potential problems with kettle use for the less capable based on empirical, peer-reviewed research; to evaluate some of the existing kettles on the market with respect to how well they mitigate these problems; and to suggest how the proposed project can fill the gaps left by existing products. A description of the design process, the final concept, the potential impact on society and an evaluation will follow.

Problems

The personal challenges faced by the elderly with regard to kettles can be split broadly into 4 interrelated categories: strength and dexterity, articular (pertaining to joints), cognitive function and perceptual ability. Most kettles looked at during this project fell short for the majority of the following problems.

As people age, muscle mass and strength tend to decrease (Goodpaster *et al.*, 2006; Landers *et al*., 2001). Kettles, filled with varying quantities of water, can become very heavy (often ≤2kg), making them difficult to operate for many (Maguire *et al*., 2011). The recruitment of large muscle groups in order to lift a kettle is key to the main aspects of its use - filling, carrying, and pouring (Uy *et al.*, 2013) - and so this problem alone is a source of great difficulty. Lack of strength also affects the hand, often resulting in

lowered dexterity and a lessened ability to grip (Carmeli, Patish and Coleman, 2003), creating potential adversity in holding a kettle in the air, varying in difficulty based on handle design.

Another key issue with grip comes from articular problems. Osteoarthritis (OA) - “the leading cause of disability in later life” (March and Bachmeier, 1997) - creates particular issues, as hand OA not only correlates with weakened grip strength, but also appears to cause pain in the use of the joints affected (Dominick *et al*., 2005; Jones, Cooley and Bellamy, 2001). The combination of a high proportion of grip strength needed and pain levels correlating with effort leads to high pain levels in the use of kettles, both in lifting kettles and opening the often stiff lid, something which should be avoided if at all possible. Articular degeneration is also common in the acromioclavicular joint (Petersson, 1983), typically a key movement point in kettle pouring, adding more potential pain to the list of difficulties faced by many of the elderly.

As well as from specific diseases such as dementia, age is associated with cognitive decline even among ‘healthy’ people (Deary *et al.*, 2009), and it has been found that executive function decreases with age at an extent that cannot be accounted for by psychomotor slowing (Keys and White, 2000). As a result, it is likely that any design issues that cause cognitive errors in product use among the general population (such as those expounded upon by Norman (2002)) will have an exacerbated effect on the elderly, and so elements of the design such as feedback about the state of the system are particularly important. Kettle designs vary in effectiveness at mitigating these errors, as will be demonstrated later.

The perceptual abilities pertinent to kettles are primarily vision and, to a lesser extent, sound. The research in this area shows that older adults typically have lessened visual acuity, contrast sensitivity and colour vision (Haigh, 1993; Pinto *et al.*, 1997). This is the cause of a common problem as the writing on kettles giving information on volume etc tends to be both very small and contrasts very little with the material on which it is printed, sometimes even being simply the same material and colour, just raised very slightly. Research by Maguire *et al.* (2011) showed that a number of the elderly have

hearing difficulties including the noise of the kettle obscuring the sound of the doorbell. The also found a lack of faith in hearing abilities such that some people would not leave anything (including kettles) unattended, and some would ensure the doors between the kitchen and living room were open so that they could monitor the sounds of the kitchen.

Existing products in relation to problems

As alluded to earlier, most kettle designs currently on the market do little to alleviate most of the problems mentioned, indeed some seem to exacerbate them. There are some kettles and related solutions that appear to have been designed to help the elderly, these typically alleviate one or two of the problems at the exclusion of the others, and/or create new problems of their own, as will be established.

Almost all of the kettles available appear to have been designed for one-handed use, with handles too small for two hands, and the outside too hot for prolonged holding when the water is boiled. Some kettles found did appear to be usable with two hands, such as the Morphy Richards Traditional Kettle and the Breville VKJ775 Traditional Kettle, although not ideally so, as the hands would have to bunch up. Sarina Fiero's Creativi*tea Kettle (Yanko Design, 2009) has the best handle for two-handed holding found by the group, although this appears to be only a concept, with no existing product. All three of these examples fall short in other areas, particularly in providing feedback about the level of water in the kettle. By nature of only having space for one hand, the kettles forced the hand into a particular orientation and position in relation to itself. As Uy *et al*. (2013) found, hand position and angle during kettle pouring appears to be a tradeoff in muscle activation between the shoulder and the forearm, thus a forced handle position will make pouring particularly difficult for those not favoured by its position.

All of the kettles looked at provided an inadequate solution to one, if not both of the two key issues with vision - decreased visual acuity and contrast sensitivity. The majority had text that was too small and too low in contrast to the background, partly due to low luminance around the text. The Breville VKJ595 Kettle was among the best, with an illuminated background that was high contrast to the text, but for which the writing and lines were still too small.

The Breville VKJ595 Kettle was also most likely the best for providing feedback about the state of the system. The majority of the body is translucent, so a rough level of water volume can be approximated, and the body also lights up from blue to red when boiling, showing clearly that both the kettle is on, and its progress through the boiling process. The large lever switch allows for easy operation with little dexterity, although there is still a lid that requires some dexterity to open. The handle allows for just one hand, there is no aid for pouring, and the kettle would likely have to be held tilted sideways while filling as most taps are closer to the sink base than the height of this kettle.

Kettles alone do not appear to solve many of the problems associated with ageing, but there are some accessories and alternatives that make some progress, although these are not without their shortcomings. One solution to the issue of the strength required to pour the kettle is the existence of kettle tippers, which can have most kettles mounted on them and use a large lever to tilt the kettle when pouring. These ease this problem, but tend to be ugly and space consuming, and as Maguire *et al.*, (2011) found, most of the elderly do not have enough kitchen space already. Depending on the size and style of kettle, the strength may still be an issue when filling the kettle, as if it is taller than the gap between the sink floor and the tap, the kettle will need to be held at an angle. People with shorter kettles or taller taps may not have this problem. The other hardships of this ‘solution’ are that it may be considered patronising, and that the reinforcement of age stereotypes may serve to make the user respond to stereotype threat, and behave in a stereotypically less capable way, similar to the participants in the studies by Desrichard and Köpetz (2005) and Levy et al. (2006). The one tipper found that is not ugly and/or patronising is part of The Lazy Teapot (Yanko Design, 2007), however this falls short on lifting at all other times due to the angle, position and small size of the handle, and complete lack of feedback regarding water volume. The design also seems to only be a concept, so is not helpful for actual users.

A solution providing an alternative to kettles is the instant boiling water tap, installed in the sink. This bypasses many of the issues of kettles, but has some issues of

its own. There is no problem with lifting strength or filling, and the status of the system is almost self-explanatory (“is there water currently coming out of the tap?”). Taps could vary in quality with respect to dexterity and hand strength, although this is an issue that would already be faced with a regular kettle, and solved in the same way - having taps with levers that can be moved easily without gripping. The downsides to this approach include the potential for mistaking it for a normal tap and scalding oneself, and the fact that it is unfamiliar as a process for boiling water for tea or similar, which goes against the suggestion by Jönsson (2003) to “change as little as possible”. it also changes the process of boiling water for a hot drink, the activity and procedure of which some people enjoy. The installation of an instant boiling water tap is intrusive and expensive. Kettles, by comparison, tend to be relatively cheap: >£800 vs <£80 respectively at the time of writing.

Our project

With the use of literature in the area and some of our own research (a questionnaire and experiential testing of a prototype) we intended to design a kettle that feels familiar to the elderly, but which would also mitigate as many problems as possible. With our project, we focussed our attention primarily on the typical changes that occur from ageing, rather than on specific diseases such as dementia, which we thought would require a design change too drastic to be used by the majority of people, resulting in an exclusive design. This would be an appropriate design choice, but was not the direction in which we wanted to go. In our project to make an inclusive design, we acted under the assumption that the typical less well functioning elderly would be the limiting users, and so if they can use it, younger/more capable people can as well.

As none of the key problems mentioned above are sufficiently accounted for by existing kettles or accessories on the market, the objective for our project was to create a kettle that improves on the experience for people with any or all of these problems. We aimed to minimise the strength and dexterity requirement, aid the use by those with perceptual difficulties and reduce the cognitive demand of use, all while minimising errors and avoiding creating a patronising design.

Design activities

Literature and Existing products

After the initial decision on the general direction of the project (a kettle design with a focus on the needs of the elderly), we brainstormed for ideas on issues we might expect and potential solutions to those, to give us a base from which to iterate and improve. We very soon started to study the literature pertaining to the elderly and to kettle design, and looked at existing products to see how, and how well they solved the problems we found. The main findings of this are detailed in the introduction above. A standard detailing design considerations for the elderly was found (PD EN ISO/TR 22411:2011), which we used both for early ideas, and for checking against to evaluate our implementations.

Ideation/sketches

With an understanding of the issues faced (and the lack of a near-complete solution on the market), we thought up and sketched all the solutions we could think of, to later be filtered down by priority of problems solved. Many of the ideas thought of here ended up in the final concept after being modified to suit our better-developed understanding. The main ideas discussed, loosely grouped, include:

- Cleaning
    - Built-in filter to prevent limescale etc
    - Rounded corners at the inside of the base
    - Flat surface of base on the inside
- Help with strength difficulties
    - Two handles
    - Two-handed handles of different varieties
    - Weight minimisation
    - Cradle alternatives
    - Base shape to allow tilting without extra cradle
- Lid design

    - Slide
    - Easy-twist (prominent handle/lever)
    - No lid
        - Groove from spout to channel water
- Clear communication
    - Large text contrasting with background
    - Colour-temperature associations
        - LEDs
    - Time until finished
    - Finished notification
    - Clear body to see liquid level
- Safety
    - Leaking steam
        - Spout lid
    - Shatterproof material (if dropped etc)
    - Hot sides
- Control
    - Large on/off lever switch
    - Easy-push button
    - Variable temperature for tea connoisseurs

Task Analysis

We looked at existing task analyses of the main uses of a kettle and carried out our own (see *Appendix A*) with a regular kettle to see if all the steps were complete. Confident with our own, we tried to see if any of our proposed improvements could simplify the task by eliminating any steps, leading to our first major refinement.

Refinement 1

The task analysis of the cleaning process for kettles showed that it is not a hands-on process - if liquid can enter the kettle and be boiled, the kettle can be cleaned. As a result, the need for a filter is reduced, and outweighed by the long time taken for water to pass through a filter. The need for the kettle to be opened is also minimised, correspondingly reducing the need for a lid. We decided to replace the lid with a water inlet to simplify the task structure and reduce the demand on the user's dexterity.

This design choice has two initial barriers: the potential for steam to escape from the top and scald the user, and the potential for small objects to be lost inside. The former can be solved by having the inlet end in a one-way valve, allowing water in, and preventing steam from exiting via that route. The second by having a (removable) mesh cover the inlet and spout and additionally a hinged lid on the spout to further discourage the attempt or error.

Accounting for errors

We considered any error possible, and tried to mitigate as many as possible through good design. To this end, Norman (2002) provided many useful concepts and frameworks. The idea of forcing functions was particularly insightful, and although we had used a form of *lockout* already by preventing water being poured in the spout, we considered the idea of *interlock* - a function that forces proper sequencing of actions - and included the feature that the kettle would not turn on before water was present inside. This would prevent a disappointed user coming back to their kettle to find out that they had not boiled anything and would also prevent the damage to the element and risk of fire that dry boiling a kettle can cause.

As Norman explains, the error-correction process in humans tends to progress from the detailed to the big picture, so when encountering the switch not turning the kettle on, their first thought is likely to be that the switch is not working, before they later consider whether there is water in the kettle. To curtail this, the LEDs already in place to show the temperature change can flash red once. This should have two effects: demonstrating that the switch use has been registered, so the user is aware that it is

likely something else that is the issue; bringing the user's visual attention to the water chamber of the kettle, as this is both where the LEDs are and where the problem lies - with the lack of water.

The slip known as the *loss-of activation error* was another error we sought to counter. The slip occurs when the stimulus for a course of action decays, and one forgets what one intended to do (Norman, 2002). This was considered possible if a user was brought into the kitchen by the sound of the kettle boiling, which stopped before they entered, whereupon they would see their normal kitchen with no particular focus, and forget that they came in for the boiled water. The standard for designing for the elderly (PD EN ISO/TR 22411:2011) indicated that flashing lights are useful for attracting attention. With these two pieces of information, we decided that the LEDs would flash to attract the attention of the user. A frequency of 1Hz was decided upon, as it is fast enough to be difficult to miss, but slow enough to not be visually uncomfortable (tested with a simple LED and coin cell setup) or be in a dangerous range for those who suffer from photosensitive epileptic seizures (PD EN ISO/TR 22411:2011). Additionally, this would provide a much-needed notification for the deaf and hard of hearing.

Initial Testing Planning

It was at this point that we decided that some user-based or experiential testing comparing our design to a pre-existing one would be useful, and after coming across an article in *The Ergonomist* on old-age simulation (Goodman-Deane, Walker and Clarkson, 2013), we contacted Sharon Cook (with the help of Thomas Jun), who would later provide us with osteoarthritis simulation gloves, and various vision impairment glasses for use in our testing.

Questionnaire

We had made some initial presumptions from the literature review and our personal experiences about the design, and wanted to test those by asking some questions of the potential user base. We devised a questionnaire (see *Appendix B*) that was distributed to a convenience-sampled group of people, a large number of whom were over 65, but younger people were also included. The results (see *Appendix C*) largely corroborated our presumptions, but also served to focus our attention on what

potential users found the most difficult with their current product, namely the weight and the handle design making the kettle hard to lift; the lid being difficult to open, and the markings on the kettle being difficult to see. There was no definitive response to the preferred method to turn on the kettle, but it was considered afterwards that this may be because the question asked was potentially ambiguous. Some people may have considered the “switch” option to be a rocker style switch, when we had intended to refer to a lever style switch. Greater precision in phrasing and appropriate images may have yielded different answers.

Refinement 2

Based on the questionnaire and continued discussions on the literature, there were a few more changes before the prototyping was finished: the spout would be vertical, so that no water can be poured in unless the kettle is tilted. The hinged lid, already providing a similar function, would now include a small hole from which the steam could escape, also creating the traditional whistling sound to notify users that the water is boiled. To ensure safety and maximise grip in wet environments, the base and handle would be coated in a non-slip rubber. To prevent the kettle from pouring over too far, stoppers would be made at the top of the tipping track. Research into fonts suggested that 44pt Arial would include >95% of all people if used from a distance of 1m indoors at night (Loughborough University, 2013). Although this may not be a large concern due to minimal text, Arial appears to be an acceptable font for dyslexic people (Rella and Baeza-Yates, 2013). The most important piece of anthropometric data we found was the 97.5th percentile male minimum square access for a hand (Peebles and Norris, 1998), as it provides an estimate for space under the handle that can be used for inserting a full fist for extra support. The 97.5th percentile was used as with the largest hands, they are the limiting user for this dimension.

Final Testing Planning

Before prototyping was finished, we decided on the parameters to test, which we would do by directly comparing the prototype with a kettle currently on the market. We gathered subjective but quantitative data on the following parameters:

- Weight/strength
- Grip
- Filling
- Pouring
- Lever Switch
- Lid
- Overall

These would be determined by simulating the tasks normally performed with a kettle, with the prototype containing 1kg of rice, to compare with an actual kettle with 1kg of water, where each participant would rate both kettles on a 0-10 scale for each parameter, where 0 meant unusable and 10 meant seemingly unimprovable. We also aimed to compare the different readabilities of the text on the existing kettle, and a number of different font sizes for comparison, including our expected acceptable value of 44pt (in Arial).

Prototyping

The prototype was created primarily for the purposes of testing (and so excluded features that would complicate production but not add value to the testing), but was also useful in that the production ensured that all of the team fully understood what was quite a complex 3D shape (see *Figures 2, 3 and 5)*. The budget for making the prototype was relatively small, requiring us to make it by hand with basic materials. The materials used were:

- foam board for the base, tipping track and stand
- acetate for the clear body
- duct tape to hold pieces together and cover gaps
- newspaper (rolled up and papier-mâché) and pva glue for the handle
- tennis racquet grip wrapped around the handle

The prototype as a whole was made at an enlarged size to try to exaggerate any existing issues.

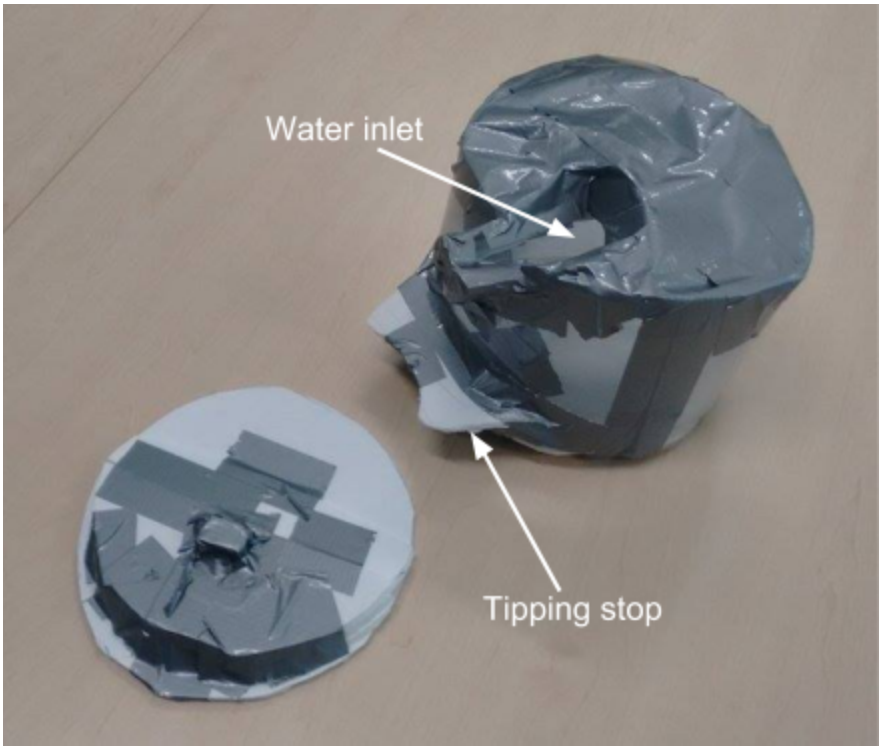

Figure 1: Photo showing key features of the design on a partially finished prototype

Figure 2: Photo showing the prototype kettle shortly before testing

Testing

Figure 3: Testing the prototype and existing kettle with osteoarthritis simulation gloves

Back-to-back testing of the prototype with the existing kettle was performed using simulation spectacles provided by VINE (Visual Impairment North East) and OA simulation gloves by LUSKInS. It was overseen by Sharon Cook.

Osteoarthritis gloves

The OA gloves could not give us the full experience of being elderly, due to physical and ethical limitations, and had particularly little effect on our strength, which one would expect to be a lot higher in active 21 year olds than in the elderly. Despite this, our time with the OA gloves gave us considerable insight into some of the potential effects of age. Along with the quantitative results (see *Figure 4* and *Appendix D*) we felt better able to empathise with our potential users, both on a physical and a psychological level - even though our strength was unaffected, what had been a simple elbow flexion to pick up the exiting kettle became a whole body movement, including a pronounced

lateral flexion. This emphasized to us the importance of what we were doing and the improvement that our product could have.

Regardless of an unavoidable amount of bias that was certainly the result of having designers compare their product with another, the amount of improvement over the existing kettle suggests that the prototype is in fact superior in all the parameters that we compared On the existing kettle, we were particularly impressed by the lever-style switch, which required no hand or finger dexterity - if the hand hit it while moving in the right direction, it would easily switch the kettle on or off. The lid, on the other hand was the most disliked parameter during the testing, reaffirming our choice to use an alternative to the lid. It is accepted that the kettle tested was unlikely to have had the best design of lid that exists on the market, but no lid was certainly an improvement in this case.

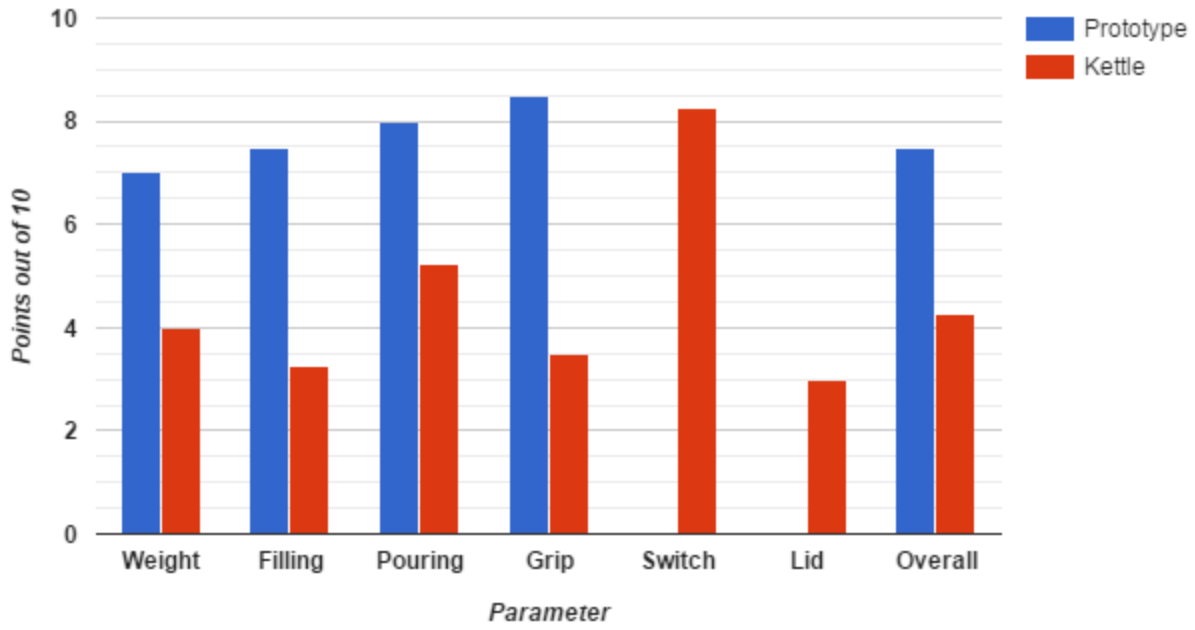

Figure 4: Chart comparing our prototype to an existing kettle in multiple parameters

Visual impairment spectacles

Two different spectacles were used to simulate visual impairment. One simulating reduced visual acuity, leaving approximately 6/18 vision (just below the driving

standard), and the other simulated hazy vision with light scatter and glare. All of the team found the existing kettle's text unreadable with both spectacles when read at any angle other than straight-on and very close-up, due to the small size and low contrast. Looking at the Arial font size alternatives, all of the team found everything tested fully readable from standing normally, although half of the team saw the size below 44pt - 36pt - as slightly blurry (but with no difficulty in making it out). As those simulated were not the worst visual impairments possible, 44pt seemed like a good solution for most people, and fit with the suggested size for including >95% of the population (Loughborough University, 2013). The text on the existing kettle was quite dark, and so it was expected to perform better than it did. We realised that due to the transparent nature of the material it was on, in an unlit kettle the background would similarly be dark, creating a low contrast.

Final refinement

From the testing we reinforced a number of our design decisions and made further minor changes to others. Our comments were as follows:

- Text
    - 44pt
    - black
    - sans-serif (Arial)
    - white translucent background
    - horizontal arrows from text to clear plastic for water level
- Handle
    - Keep general shape
    - Ensure section over centre of mass
    - Rubber grip excelled
- Switch
    - Large lever
- Tipping mechanism

    - Worked as intended
- Inlet
    - Filling process is improved
    - Ensure steam-proof valve

Final design concept

Accounting for all our revisions, and translating our user/interaction focussed concepts into the criteria for the product resulted in the following:

Customer

The kettle will be suitable for everyday use by anyone, including people that are 65+. The main focus is on allowing use for people with the most common impairments that occur with age - strength and dexterity issues, cognitive decline and perceptual difficulties.

Environment

The kettle will be made for use in the kitchen in any home. The product should be suitable for a smaller than average kitchen.

Materials

The materials that are to be used are, clear plastic for the main body, handle and spout, opaque plastic for the base as to hide the electronic components, rubber for the non-slip areas of the kettle, a temperature controlled LED system, steam-proof valve in the inlet and mesh over both inlet and outlet to prevent anything from being dropped into the kettle.

Size

The size of the kettle will be quite compact and smaller than the prototype. The handle will be a greater distance than the 97.5th percentile male minimum square access measurement from the kettle as knuckles commonly swell with articular

problems such as rheumatoid arthritis and this space also allows for pouring/lifting strategies including a fist supporting the handle. It will be roughly in the shape of a quarter of a circle and long enough to easily be used with both hands. It will have similar dimensions to the prototype. The volume measurements on the side of the kettle will be 44pt sans serif (Arial) text in black on a white translucent background to increase the contrast. The switch will be a long, large lever similar to the one present on the kettle used for testing.

Function

The kettle is to be tilted to pour out the water, the front of the kettle will have a curved bottom to act as a tilting area between itself and the worktop, and will have a rubber non-slip covering as well as a mechanism to prevent the kettle tipping too far. The handle will allow two hands to hold it, which will allow easy movement from heating base to sink. Our design will have no lid to the kettle, the water will be poured into an opening, and this will eliminate the need for a handle or button that opens the kettle to allow water in. LEDs will be inserted into the bottom of the kettle that shine through the clear body to show the temperature of the water inside. The clear plastic that the kettle is made from will allow the user to see into the kettle and view the water level more clearly.

Aesthetics

The product will look as much like a kettle as possible while still being quite modern, this is because the kettle should to appeal to everyone not just people 65+. The kettle will look modern to attract users that are under the age of 65 and to prevent the elderly from feeling old. The LEDs will add aesthetic appeal to the product as well as having a functional use. The clear plastic adds to the modern aesthetic of the product as well as being functional.

Safety/Errors

The product will be as safe as possible; the steam-proof valve and mesh will protect user from danger and error at the inlet. The LED lights will be colour changing; while the water is cold the LEDs will be blue and as the water heats up the colour will

gradually change to red indicating the temperature of the water. The kettle will also flash and make a noise to indicate the end of the boiling cycle, with an aim to reducing the incidence of loss-of-activation errors. The non-slip rubber covering on the handle and curved base of the kettle will prevent the kettle from slipping and the mechanism on the front of the kettle will prevent it from tipping too far.

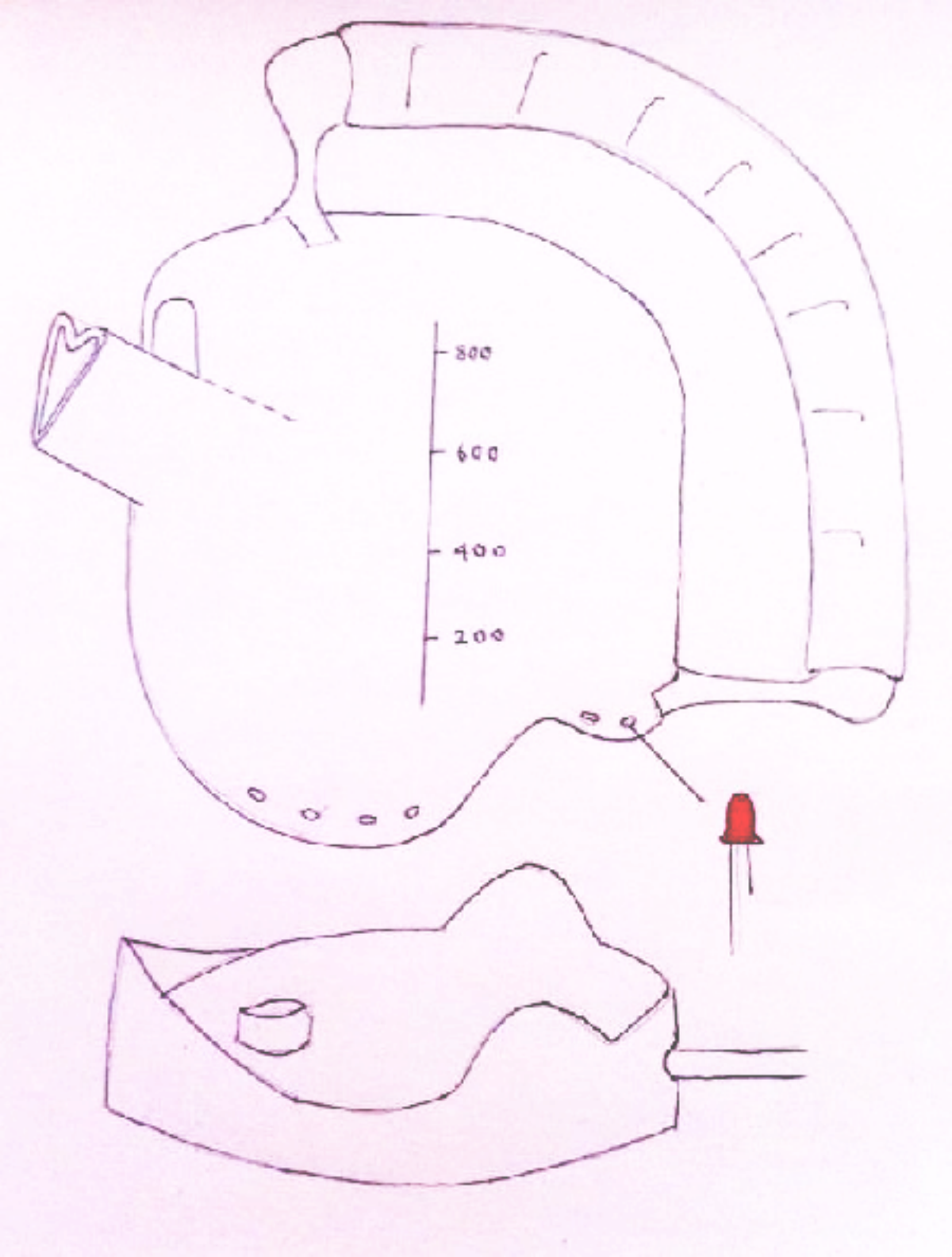

Figure 5: Final design

Impact statement

The final design, compared to most of the products on the market will be easier to use for the physically weaker, allowing people to use it to their strengths; less painful on osteoarthritic joints; require less dexterity to use; cater to those with diminished visual acuity and contrast sensitivity; and require at most the same cognitive load as the better options, while still being an interesting enough design for more capable people to want to use it. It would be expected that as a non-patronising, desirable, more easily usable product, for those who owned this kettle there would be one fewer contributing factor reinforcing negative self-schema related to age. This could have a small positive impact on an older owner's mood, which may lead to knock-on effects.

Conclusions

Overall, the team achieved its primary objectives in creating a kettle that would allow for the elderly and less capable to use it with less difficulty and pain than the products currently on the market. While further progress may still be made in this area, empirical evaluation has demonstrated that our design improves upon the areas that both existing literature and our questionnaire suggested that the elderly would find difficult.

The first major improvement is a reduction in strength required due to a number of factors: the two handed handle, which allows for hand positioning to suit the individual's shoulder and forearm strength as well as providing space for a fist to fit under the handle, giving the user the option of different weight compensation and pouring strategies; the tipping mechanism, which almost eliminates the difficulty of the typically most challenging aspect of kettle use - the pouring; the water inlet, which obviates the need to hold the kettle at an awkward angle when filling. The second major improvement was the lowered dexterity requirement, due to the replacement of a lid that requires no opening and a handle and switch that can operate the kettle with anything up to hands closed into fists. The third major improvement is the ability to read the volume markings with impaired vision. These are all demonstrated by the quantitative

and qualitative testing carried out with the prototype. The more complete error mitigation from the inclusion of interlock and lockout in the design, the partial solution for the loss-of-activation error as well as the colour-based system feedback on boiling progress are predicted to be large improvements, which, although not empirically tested for this particular product, are backed up by the existing literature.

Recommendations

More time spent having elderly users test the product and provide their feedback would have a particularly beneficial effect on the improvement of our product. Looking at the effect of activating negative self-schema about age from our product compared to the current alternatives and empirically testing the effectiveness of our error-correction mechanisms would make useful evaluations. While our choice of font (Arial) would include most people, dyslexics among them (Rello and Baeza-Yates, 2013) there is some suggestion (PD EN ISO/TR 22411:2011) that better fonts for dyslexic people are available, more research into this may elucidate an answer.

Our research focussed primarily on the common effects of aging in mostly healthy people. To extend the scope of this work, it would be valuable to look at those people with greater disability or impairment, particularly dementia sufferers and the physically handicapped. It may be that to fully cater for their needs separate products would have to be made, but it is likely that further improvement could be made for people somewhere along these spectra. It would also be worthwhile to see the appeal of the design to people of all ages (as there is not necessarily a limiting user in design taste). The hope is that the design did not make people feel old or patronised in any way, and that it would be something that anyone would be comfortable using.

Project review

The quality of teamwork displayed during this project was mixed. When all the team members knew what they were doing, they tended to work together well. When immediate actions were less clear, however, some of the group members would often get distracted by talking or other activities, rather than think of something useful to do, asking what else had to be done, or helping the people who were actually working with what they were doing.

The team mostly communicated very well, as a facebook group specific to this purpose was set up. Differences in opinions were discussed rationally and all came to a reasoned consensus or were voted on when no universal agreement could be reached. People did not end up sulking when their ideas were not those chosen. It felt as though decisions were made by the group as a whole. Google Drive was to used to provide a master copy of all shared documents that could be edited by anyone on the team.

Our prototyping was effective in that we focussed on the key aspects that we wanted to test. Enlarging it allowed for an expected factor counting against our kettle, which it overcame, but a life size prototype would have given a more representative experience. The testing demonstrated what we wanted to, and the typical kettle was an acceptable comparator, but market leaders in each of the aspects tested would have been preferable. The questionnaire provided valuable data, but some of the questions could have been clearer or phrased better, particularly relating to the switches, as it was ambiguous what was meant. Asking the participants to compare photos of switches for which they would prefer would likely have yielded better results.

The design process and inclusion of academic ergonomics throughout was well done for this project, almost all our assumptions were either researched or tested ourselves. Experiential testing for the majority of our functions allowed us to see what the product would be like to use, although it would have been an improvement to have a broader range of people test the product, particularly older people, to give an even better indication of how it would fare.

Word count: 6293

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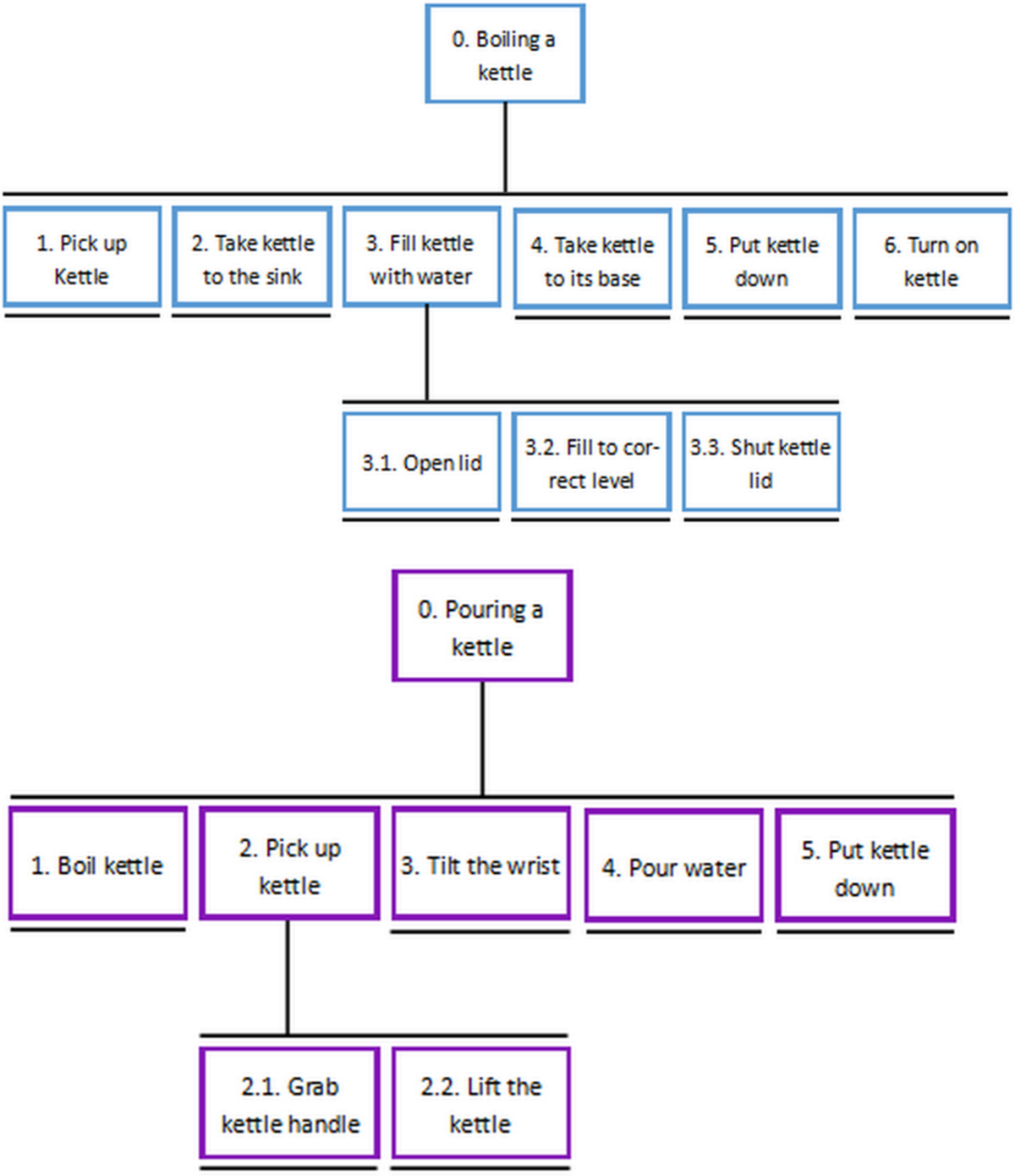
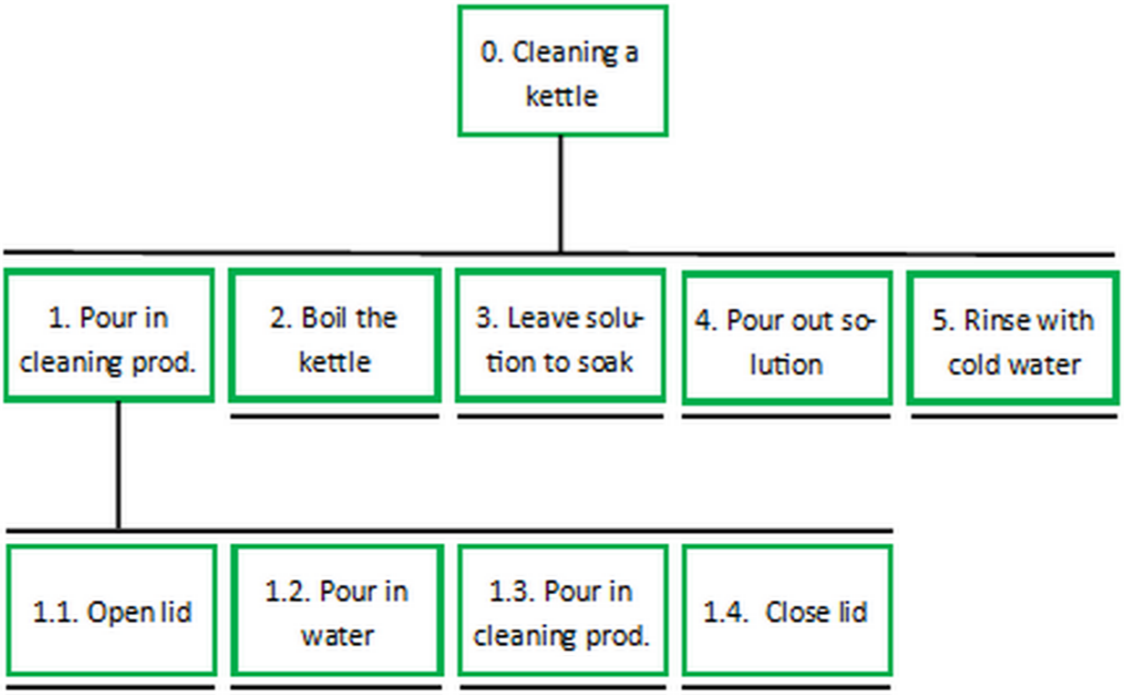
Appendix A: Task Analysis




0. Cleaning a kettle
1. Pour in cleaning prod.
2. Boil the kettle
3. Leave solution to soak
4. Pour out solution
5. Rinse with cold water
1.1. Open lid
1.2. Pour in water
1.3. Pour in cleaning prod.
1.4. Close lid

Appendix B: Questionnaire

Questionnaire

This is a short questionnaire about kettles and what aspects you would change about the kettle you have currently. All questionnaires are anonymous and if there is any information you are not comfortable sharing please leave the answer blank.

1. How old are you? (Please circle appropriate age)

40-50 51-60 61-64 65-69 70-74 75-79 80-84 85+

2. How much Countertop space do you have in your kitchen? (Circle appropriate)

Very little Small amount Average Quite a lot More than I need

3. On a scale of 1-10 (10 being the hardest) how hard do you find your kettle to lift? (Circle appropriate)

1 2 3 4 5 6 7 8 9 10

*3a. If **2-10** then why is it difficult? (Circle as many answers as you wish)*

Very heavy Handle difficult to hold Other (please elaborate)

.....

4. On a scale of 1-10 (10 being the most difficult/awkward) how difficult/awkward is it to open the lid of your kettle (Circle appropriate)

1 2 3 4 5 6 7 8 9 10

*4a. If **2-10**, then why is it difficult? (Circle as many answers as you wish)*

Hard to press button Hard to hold lid handle Stiff lid Other

5. How would you prefer to turn on your kettle? (Circle appropriate)

Button Switch Other (please elaborate)

.....

6. On a scale of 1-10 (10 being the hardest) How hard to you find the markings on your kettle to read? (Circle appropriate)

1 2 3 4 5 6 7 8 9 10

*6a. If **2-10**, then why do you think this is? (Circle as many answers as you wish)*

Very small Same colour as kettle Other (please elaborate)

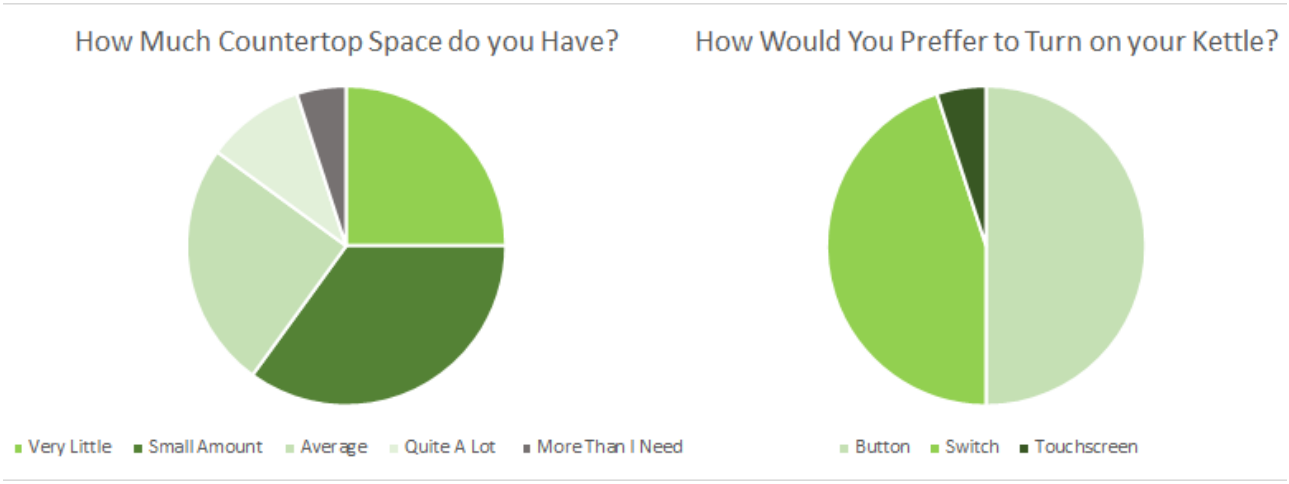
.....

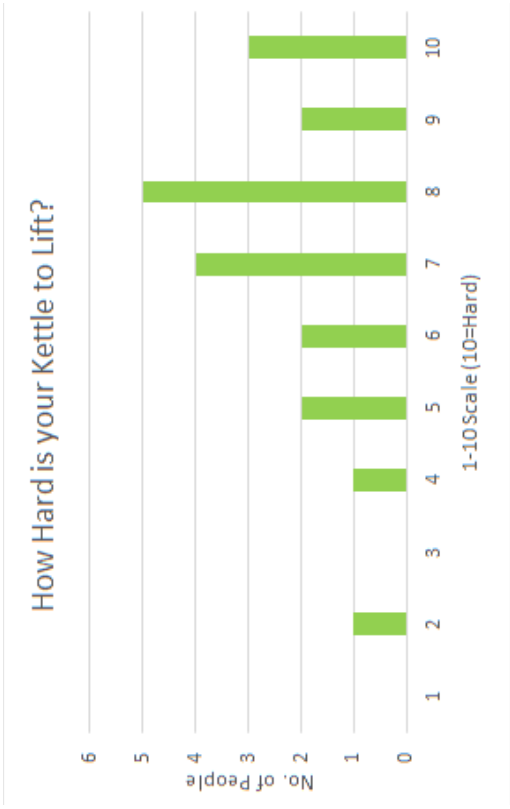
7. Are there any other issues you have with your kettle?

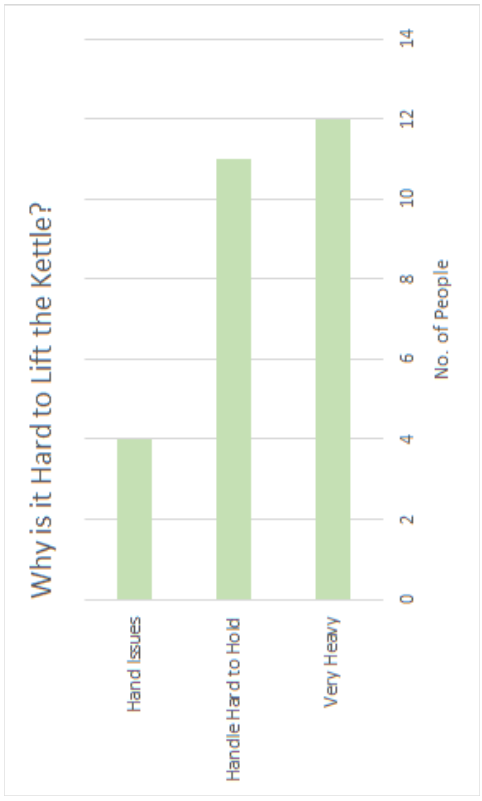
Appendix C: Questionnaire results

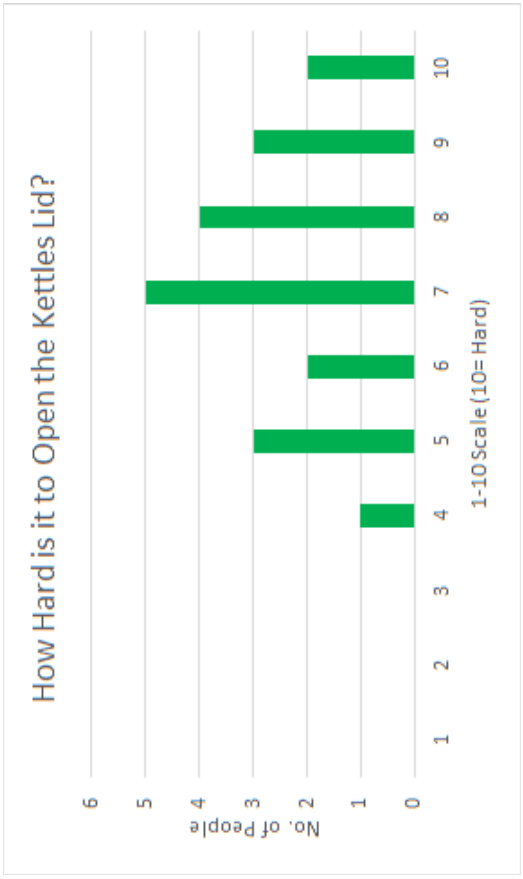
Participants

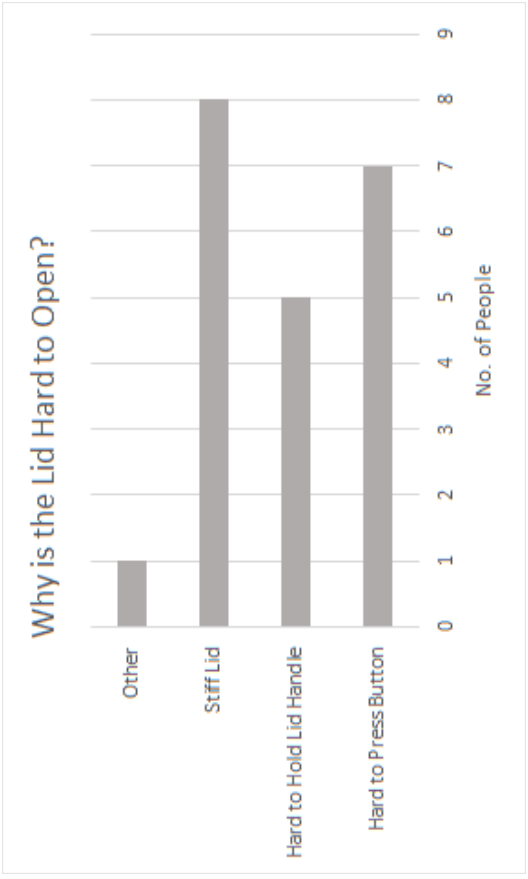
Age	No. of People
51-60	1
61-64	2
65-69	3
70-74	4
75-79	5
80-84	3
85+	2

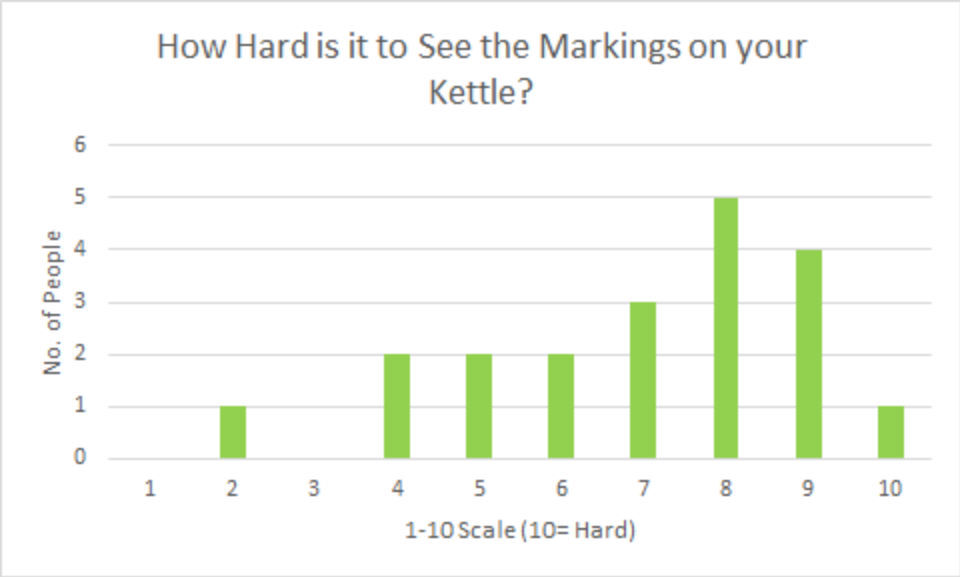


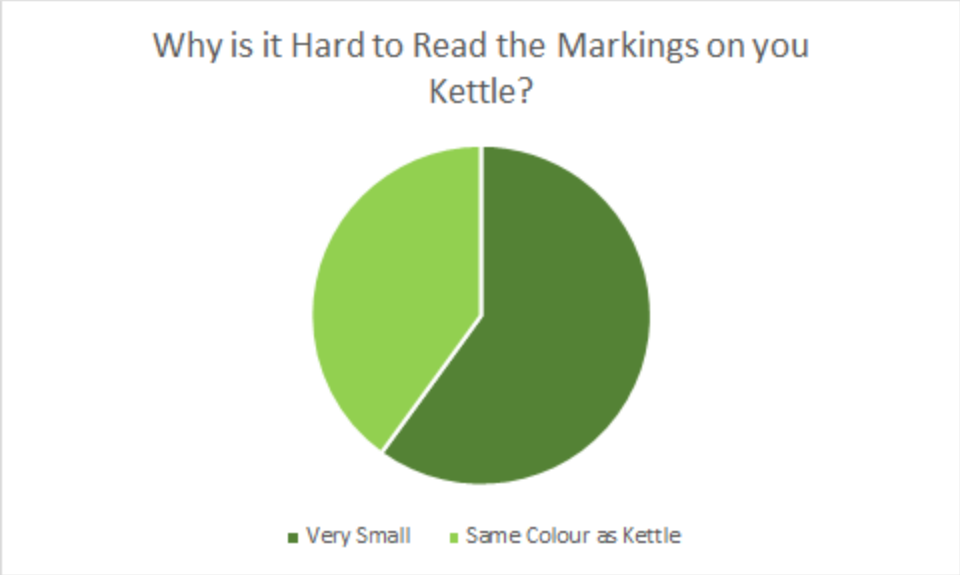

How Hard is your Kettle to Lift?
No. of People
1-10 Scale (10=Hard)


Why is it Hard to Lift the Kettle?
Hand Issues
Handle Hard to Hold
Very Heavy
No. of People


How Hard is it to Open the Kettles Lid?
No. of People
1-10 Scale (10= Hard)


Why is the Lid Hard to Open?
Other
Stiff Lid
Hard to Hold Lid Handle
Hard to Press Button
No. of People


How Hard is it to See the Markings on your Kettle?
No. of People
0
1
2
3
4
5
6
1
2
3
4
5
6
7
8
9
10
1-10 Scale (10= Hard)


Why is it Hard to Read the Markings on you Kettle?
Very Small
Same Colour as Kettle

Appendix D: Testing results

Osteoarthritis gloves

Table of results

Difficulty of use of our prototype against an existing kettle; numbers on a 0-10 scale, where 0 is unusable and 10 is seemingly unimprovable.

	Participant 1		Participant 2		Participant 3		Participant 4	
	Prototype	Kettle	Prototype	Kettle	Prototype	Kettle	Prototype	Kettle
Weight	6	4	7	4	7	4	8	4
Filling	8	2	8	3	7	5	7	3
Pouring	8	6	8	4	8	5	8	6
Grip	8	3	9	4	9	3	8	4
Switch		7		8		8		10
Lid		2		3		3		4
Overall	8	5	7	4	8	3	7	5

Key Comments

Participant 1 - Hard to grip the kettle, difficult to hold with gloves on.

Participant 2 - Awkward to hold kettle, have to move whole body/arm to pour etc.

Participant 3 - Prototype handle easier to use, can hold it in different ways e.g.. two hand to bear more weight.

Participant 4 - Prototype is much easier to use.

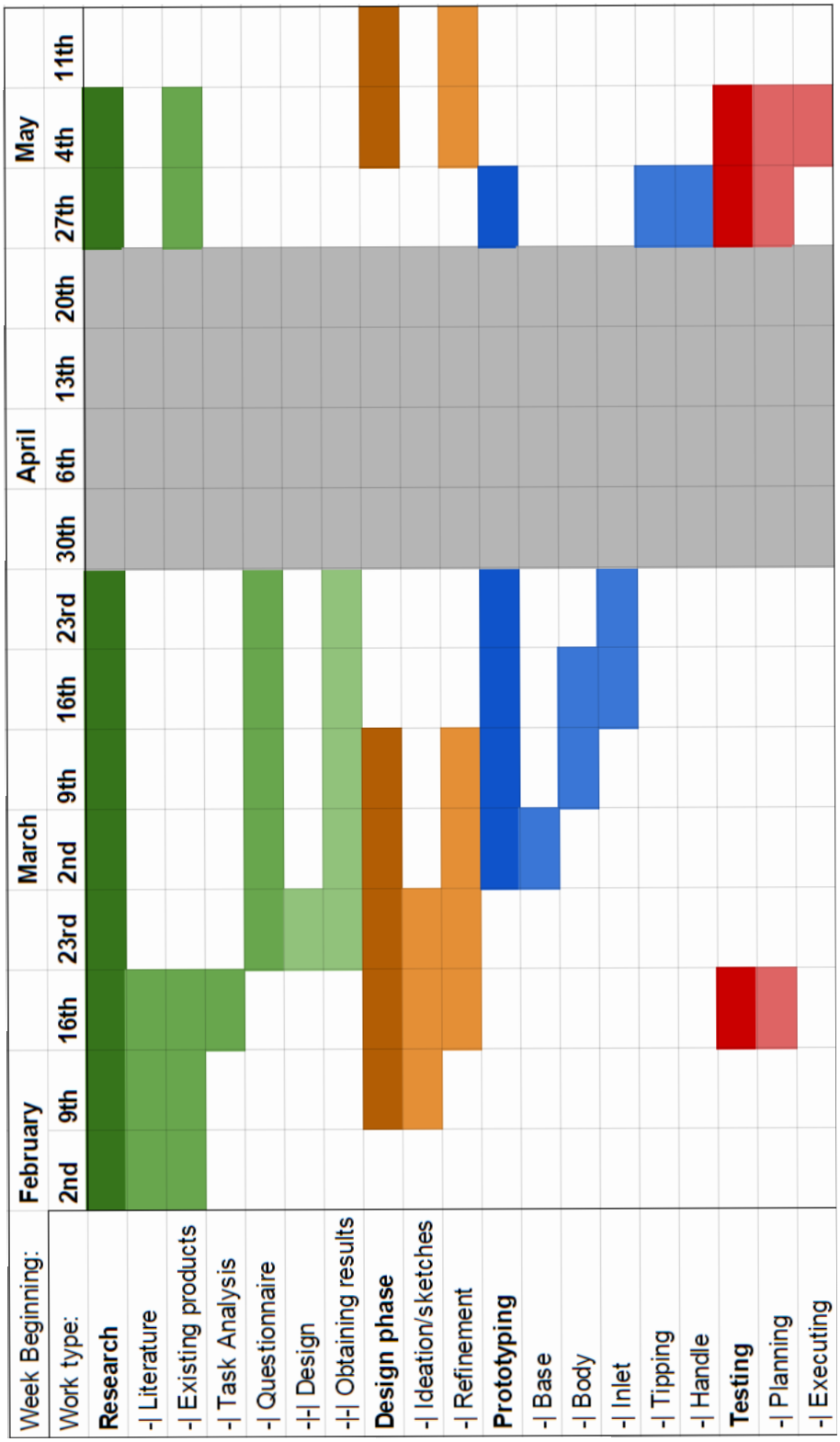
Visual impairment

	Glasses No. 4	Glasses No. 6
Participant 1	Kettle - Just about visible at eye level Sheet - Smallest letter is visible (slightly blurred)	Kettle - Extremely difficult to see anything Sheet - Smallest Letter is visible
Participant 2	Kettle - Just about visible straight on Sheet - Smallest letter is visible (slightly blurred)	Kettle - Can only make out one word Sheet - Can see everything
Participant 3	Kettle - Blurred totally Sheet - Smallest letter is visible	Kettle - Nothing is visible Sheet - Can see everything
Participant 4	Kettle - Only slightly visible above water level Sheet - Smallest Letter is visible	Kettle - Nothing is visible Sheet - Smallest letter is visible (Slightly blurred)

4 - Reduced visual acuity leaving approx 6/18 vision (Just below the driving standard)

6 - Hazy vision with light scatter and glare, variable visual acuity

Appendix E: Gantt Chart


Week Beginning:
February
March
April
May
2nd
9th
16th
23rd
2nd
9th
16th
23rd
30th
6th
13th
20th
27th
4th
11th
Work type:
Research
-| Literature
-| Existing products
-| Task Analysis
-| Questionnaire
-|-| Design
-|-| Obtaining results
Design phase
-| Ideation/sketches
-| Refinement
Prototyping
-| Base
-| Body
-| Inlet
-| Tipping
-| Handle
Testing
-| Planning
-| Executing

Appendix F: Meeting minutes

Date of Meeting: 3/2/2015
Group: 5
Minutes Prepared by: Andrew Reece

1. **Attendance:** Andrew, Jamie, Holly, James

2. **Apologies for Absence:** Hitarth - partially torn lateral collateral ligament - unable to walk

3. **Issues Discussed:**
   Choice of project - multiple alternatives
   Communication methods

4. **Decisions Made:**
   Main project to be a kettle
   Inclusive design - focus on elderly
   Google drive for shared files
   Facebook group for ideas and organization

Action Items

Action	*Assigned to*	*Due Date*	*Status**
Literature Review	Holly, Andrew	10/2/2015	In Progress
Existing Products	James, Jamie, Hitarth	10/2/2015	In Progress

Status*: in progress, open or completed

Next Meeting Date: 10/2/2015

Date of Meeting: 10/2/2015
Group: 5
Minutes Prepared by: Andrew Reece

1. **Attendance:** Andrew, Jamie, Holly, James, Hitarth

2. **Apologies for Absence:**

3. **Issues Discussed:**
   Focus of things to improve
   Suggestions for solutions

4. **Decisions Made:**
   Minimisation of weight/strength needed
   Allow for visual acuity loss
   More research before idea finalisation

Action Items

Action	*Assigned to*	*Due Date*	*Status**
Continue Literature Review	Holly, Andrew	17/2/2015	In Progress
Continue Existing Products Eval	James, Jamie, Hitarth	17/2/2015	In Progress

Status*: in progress, open or completed

Next Meeting Date: 15/2/2015

Date of Meeting: 15/2/2015
Group: 5
Minutes Prepared by: Andrew Reece

1. **Attendance:** Andrew, Jamie, Holly, James, Hitarth

2. **Apologies for Absence:**

3. **Issues Discussed:**
   Progress check-in

4. **Decisions Made:**
   Additional focus on grip

Action Items

Action	*Assigned to*	*Due Date*	*Status**
Continue Literature Review	Holly, Andrew	17/2/2015	In Progress
Continue Existing Products	James, Jamie, Hitarth	17/2/2015	In Progress

Status*: in progress, open or completed

Next Meeting Date: 17/2/2015

Date of Meeting: 17/2/2015
Group: 5
Minutes Prepared by: Andrew Reece

1. **Attendance:** Andrew, Jamie, Holly, James, Hitarth

2. **Apologies for Absence:**

3. **Issues Discussed:**
   Incorporate ideas from existing products and literature
   Problems/solutions re: visual acuity loss & handles
   Filter?
4. **Decisions Made:**
   Include lighting of water depending on temperature
   Font guidelines following ISO 22411:2011
   Large handle to allow for two-handed use/choice of hand position
   Clear body

Action Items

Action	*Assigned to*	*Due Date*	*Status**
Continue Literature Review	Holly, Andrew	17/2/2015	Complete
Continue Existing Products	James, Jamie, Hitarth	17/2/2015	Complete
Task analysis	Holly	24/2/2015	In progress
Potential for filters	Andrew	24/2/2015	

Status*: in progress, open or completed

Next Meeting Date: 24/2/2015

Date of Meeting: 24/2/2015
Group: 5
Minutes Prepared by: Andrew Reece

1. **Attendance:** Andrew, Jamie, Holly, James, Hitarth

2. **Apologies for Absence:**

3. **Issues Discussed:**
   Questionnaire layout & questions
   Lid difficulties
   Tilting
4. **Decisions Made:**
   Questions for questionnaire
   Provisional lidless design - heart shaped spout
   Tilting - rounded base, not tipping cradle

Action Items

Action	*Assigned to*	*Due Date*	*Status**
Distribute >3 questionnaires	everyone	24/3/2015	In Progress

Status*: in progress, open or completed

Next Meeting Date: 3/3/2015

Date of Meeting: 3/3/2015
Group: 5
Minutes Prepared by: Andrew Reece

1. **Attendance:** Andrew, Jamie, Holly, James, Hitarth

2. **Apologies for Absence:**

3. **Issues Discussed:**
   Prototyping
   Initial questionnaire results

4. **Decisions Made:**
   Foam-board base,
   acetate body,
   rolled up newspaper/papier-mâché handle - tennis racquet grip

Action Items

Action	*Assigned to*	*Due Date*	*Status**
Distribute >3 questionnaires	everyone	24/3/2015	In Progress

Status*: in progress, open or completed

Next Meeting Date: 10/3/2015

Date of Meeting: 10/3/2015
Group: 5
Minutes Prepared by: Andrew Reece

1. **Attendance:** Andrew, Jamie, Holly, James, Hitarth

2. **Apologies for Absence:**

3. **Issues Discussed:**
   Prototyping
   Incoming questionnaire results

4. **Decisions Made:**

Action Items

Action	*Assigned to*	*Due Date*	*Status**
Distribute >3 questionnaires	everyone	24/3/2015	In Progress

Status*: in progress, open or completed

Next Meeting Date: 17/3/2015

Date of Meeting: 17/3/2015
Group: 5
Minutes Prepared by: Andrew Reece

1. **Attendance:** Andrew, Jamie, Holly, James, Hitarth

2. **Apologies for Absence:**

3. **Issues Discussed:**
   Prototyping
   Incoming questionnaire results

4. **Decisions Made:**

Action Items

Action	*Assigned to*	*Due Date*	*Status**
Distribute >3 questionnaires	everyone	24/3/2015	In Progress

Status*: in progress, open or completed

Next Meeting Date: 24/3/2015

Date of Meeting: 24/3/2015
Group: 5
Minutes Prepared by: Andrew Reece

1. **Attendance:** Andrew, Jamie, Holly, James, Hitarth

2. **Apologies for Absence:**

3. **Issues Discussed:**
   Prototyping
   Complete questionnaire results

4. **Decisions Made:**
   Questionnaire confirmed hypotheses based on literature

Action Items

Action	*Assigned to*	*Due Date*	*Status**
Distribute >3 questionnaires	everyone	24/3/2015	Complete

Status*: in progress, open or completed

Next Meeting Date: 28/4/2015

Beyond this point, all of our communication was carried out on the Facebook group as a continuous conversation with no official meetings.