Keep in touch with a mobile phone

Technology for seniors

Master thesis in program

Design for all

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by

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Preface

This work is a Master thesis project carried out at Mid Sweden University in a collaboration with Doro AB in scope of investigate “Technology for elderly people” - easy handle touchscreen mobile phones for seniors by the use of haptics.

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Summary
This project follows a design process of finding a haptic solution of how elderly users (65+ with age-related declines) can deal in a smooth way with touchscreen mobile phones. Users behaviour is observed and analysed. It is investigated how vibrations can help and improve the interaction and connection between the technology and user. Problematic areas are selected and examined. Possible solutions are discussed and tested with persons. Final solutions supplying easier navigation and understanding on a touchscreen mobiles for seniors. Haptic transmitter to support the link between phone and living is presented as well.

Illustrations and pictures: Ivelina Gadzheva
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Introduction

Technology nowadays is an area that develops very fast, and for some users, even extreme. There is a massively-growing older population (UN Population Aging Development 2009) that express specific needs to handle new technology, such as touch screen devices, computers, etc. Seniors should be able to manage up-to-date solutions in a smooth and simple way, the products should be easy to learn, easy to handle and therefore useful and enjoyable.

Touch screens are advanced technology that is replacing traditional user interfaces. Interacting on a flat surface causes loss of tactile or haptic feedback. There is no feel of touch sense feedback. There is no sense of confirming pressing or performing a task on a touch screen. Within this project it will be investigated and presented a solution of how a haptic feedback can improve the interaction between a user and a touch screen phone.

Doro AB

This project is ran in a collaboration with Doro AB
Doro is a Swedish telecom brand, leader in developing products set to the needs of elderly. Doro is focused on creating user-adapted technology.
Products for elderly in this field should “help people who face the challenges of ageing to live an easier, safer and more fulfilling everyday life.” (Doro AB)

Aim

The aim of this project is to investigate how to apply vibrations in order to develop solution that can simplify the use of nowadays technology for seniors. The product should provide an easy way, for elderly, to understand how to work with a cell phone and its features. The goal is to improve the whole interaction process for seniors using touch screen phone. The aim is to use vibrations in the design to make it possible for the users to manage new technology in a smooth and convenient way.

Method

User Tests
Individual user tests are made in order different phases to be evaluated. Users’ feedback is collected through questions, discussions and models testing.

Usability test with think aloud protocol
Participants think aloud and make comments while performing tasks.

Group discussions
Group meetings are organized to discuss problems and possible solutions on the topic.
What is haptic

Definition
adjective
technical
relating to the sense of touch, in particular relating to the perception and manipulation of objects using the senses of touch and proprioception: haptic feedback devices create the illusion of substance and force within the virtual world

Origin:
late 19th century: from Greek haptikos ‘able to touch or grasp’, from haptein ‘fasten’
(Anon., u.d.)

Types of haptic feedback
Kinaesthetic - Kinaesthetic feedback describes the knowledge people have of the position of their body, and the movements they have just performed, based on feedback from their nerve endings into the central nervous system. Kinaesthetic feedback is sometimes called proprioception.
Tactile - Provide a user with the sensations of heat, pressure, and texture.
(Almajed, 2012)

In this work haptic and vibration are used as synonyms as they both refer to the sense of touch; spot awareness.

Haptic technology has a longer history in fields of entertainment – computer games, as well as in medicine – specific robot assisted surgeries, and recently reaches touch screen devices and tablets. (Kwon, 2007)

Haptic can be applied into:

- Mobiles
- Sport
- White goods
- Art
- Gaming
- Science
- Medicine
- Industry
- Education
- Commerce

There are different applications of haptic used in market. The focus of this project is on how it is developed in a touchscreen phones and tablets.
Current market situation

BlackBerry SurePress Touch Screen
It can be felt the screen click underneath finger to help prevent applications from opening accidentally and phone calls being placed unintentionally. Technology was designed to provide a dynamic mobile gaming and viewing experience. (Bjoern., 2010)

Samsung Anycall
It uses a vocabulary of 22 different vibrations to simulate actual feels and actions. (ROTHMAN, u.d.)

Nokia haptic tattoo
Made of ferromagnetic (containing metal particles) ink, which can be wirelesses controlled by phone. When a notification is received from the phone, the ink would start vibrating on the skin. While tattoos are a lasting decoration on a skin, the concept would also work with removable stickers treated with the same ferromagnetic ink. (Filip, 2012)

Tactus
Tactus Technology has developed a new tactile user interface for touch screen devices. Tactus provides a new dimension to touch screens by enabling real, physical buttons that rise up from the surface on demand, and then recede back into the screen, leaving a perfectly flat, transparent surface when gone. (Tactus website)

Immersion MOTIV™ SDK 1.0 for Android Developers
MOTIV SDK gives Android developers access to hundreds of pre-designed haptic effects, code samples and resources to easily incorporate tactile feedback into their applications. (developer.immersion website)

Toshiba
“Toshiba have picked up Finnish firm Senseg’s haptic feedback system (http://www.senseg.com/) and plan to release commercial products using the technology next year. Senseg’s system, unlike mechanical haptic feedback which use vibration to help users identify touch screen taps, uses an electrical field to stimulate the receptors in the fingertip that would normally feel vibration”. (Chris Davies 2010)

* no information found about a released product based on Senseg’s system

Apple
There is lot of information, but nothing proved. The company is willing to include a haptic feedback by using a vibration or something like Tactus technology . (Anon, 2012)
Conclusions

Haptic systems are technologies which provide a sense of touch within a virtual interface. By using electromechanically elements (e.g. solenoids to create magnetic field) or electopolymer the system can give a user sensual feedback.

Haptic technology has a longer history in the fields on gaming and medicine and recently it is included in the development of touch screen phones, tablets and computers. Flat screen solutions have no physical or mechanical feedback when a task is performed (f.e. typing). Application of it can provide more realistic experience there is why haptics are topic of interest.

Main taken directions in applying haptics into touch screen technology are

- Vibration
- Dynamic touch interface (pop up buttons, electrical or magnet stimulation)

No combination found during the research

Haptic technology is extreme developed. It can provide realistic sense of touch on any screen surface. Companies have access to this technology; can choose the best option for their products and order.

If sensing buttons is an issue for elderly to handle touchscreen mobiles in an easy way, companies that work on haptic technology can already offer best solutions. Other problematic areas should be investigated.

Target group

Inclusive criteria - Elderly people (65+) with common age related physical and sensorial impairments – visual, hearing, mobility, dementia and dexterity.

Exclusive criteria - severe cases - deaf, blind, deaf blind, extreme mental loss, etc.

Test persons in this study are chosen by age; with abilities decline related or not to the age.

Who are elderly people?

This work refer to elderly people with age-related ability decline. Older computer users and not quite familiar with touch screen technology adult persons.

When it is used words “elderly” or “seniors” these refer to people after the age of 60.

It is considered age related differences: (Phiriypakonan, 2011)

- Cognitive decline
  - Eye vision
  - Colour
  - Sound
  - Memory

- Motor decline
  - functionality and usability with aging
  - Dexterity
User test 1
Participants
Individual user tests are made during the first phase of the project. In the research part general information is gathered and observation is made.

Participants – 3 people (2 female and 1 male)
Age – 42, 60 and 69
Test persons have different health conditions
- Wheelchair user, cognitive problems
- Very low eyesight (lost one eye and has 40% vision on the other), arthrosis, age related degrading
- Nerve damage in right hand, arthritis, whiplash in neck, colour blind
1st User test

Test performance
1. Questionnaire – questions for gathering general information about user experience
2. Task performance – write a message- observing process typing on different keyboards (comparing performance on Doro phone and two other types of smart phones with different sizes of keyboard buttons (not physical))

- The task is made in order to be observed users behaviour and general information to be gathered on seniors and cell phones

Questionnaire

- All persons use cell phone everyday
- Main use is for calls and messages (only one person use almost everything that phone offers)
- For two most important is that by having a cell phone they feel connected to others and gives them a sense of security
- For all users having too many apps causes confusion, multitasking jobs are not good
- Two test persons want to buy a new phone, but they didn’t decide what yet (the reason to buy a new one is that they want to be modern, not to feel left behind, they are curious about their children and grandchildren phones)
- One person use his phone all the time as a reminder
- To all users happens to forget to charge the phone
- To all happens to forget where they put it or left it To two persons happens not to hear (it was in another room, in the bag, even in the jacket’s pocket, because the fabric is thick)
- For all (but especially for those who have grandchildren) important feature is camera. This is one of the main reasons they want to buy a new phone, so they can make good pictures and send them to family and friends
User comment “you may have a photo camera but when you are on vacation and it is not always with you, have to make pictures with phone”
- Big enough display
User comment “I have to go now to computer to see the picture my grandchildren send me because the display of the phone is too small for me”
- For one user the weight matters
- One person don’t want to be connected with computer or internet by phone because she doesn’t feel secured about her personal information
Task performance

The way users trying to press a letter on the screen shows it is difficult to type on the right one

Comments

• Due to limited time users start directly from message menu
• The focus is on touchscreen keyboard, no physical keyboard is tested
• None of the test persons succeeded in correctly typing on the 3 touchscreen devices (Doro PhoneEasy 740, HTC Wildfire and iPhone 4). Two persons said that the letters are so small so they need a pen.
• “The letters are too close to each other, it’s difficult to type the correct one”
• “Usually you are typing with the thumb and by doing this...no... I can’t”
• The letters on Doro phone were the smallest and it was hardest to type on.
• One person couldn’t finish the task (on HTC Wildfire) because the contrast is not good.
• Two of users type the text on the place where it is supposed to be written number of the receiver. They didn’t understand the mistake till they were done with the message.
• On all mobiles used in the test the vibration while typing was a good feedback, but it doesn’t give any information if the right task is performed. It feels that something is done, but it is not clear what.
1st User study conclusions

Conclusion
• Main feature used in cell phones is ‘to be connected’ and ‘to share’

Comments
Having a mobile gives security in a sense that they can be reached; they can inform and being informed. It becomes a necessity when users want share moments - to use a good camera so they can send a proper picture to family and friends or just to play games with their grandchildren.

‘I want to buy a new phone because I need one with a good camera so I can make a better pictures to show or to send to my friends’ (test person)

Other features of a mobiles (mail,internet,watching videos etc.) are not in the focus of interest because users are using a computer or tablet due to the relatively small screen size of the phone.

Conclusion
• Very important is the feeling not to be “left behind”

Comments
Psychological aspect is very important. Seniors would buy new technology because of self esteem; to show to their grandchildren that they are ‘not living in the past’. Since nowadays kids spend a great amount of time using technology “we lived for a computer, now my grandchildren live in a computer” (test person), elderly adults have to learn how to use it so they can share same interest and spend time together - “I am playing minecrafts with my son and my grandchildren” (test person)

“I want to buy a new phone because I don’t want my grandchildren to think that I am old and boring and I don’t understand anything” (test person)

Conclusion
• Vibration haptic feedback - It provides equal feedback because there is no difference in a strength or length of the vibration while operating with menus and features
  It is not clear why the feedback is only on some tasks. It causes confusion when there is no feedback.

• It is not about the mobile phone as a devise nor the realistic feeling of pushing buttons, it is about a process how to understand
Observations

Observation of everyday activities is being made in order to highlight important cases where the use/need of a mobile phone occurs.

Twenty people from ages 65-75 were asked how would they spend their time?

What seniors would like to spend time for:
- take a walk, doing sport, being active
- spend time with family, friends, being social
- spend time/play with grandchildren
- relax

Mobile might be needed in all of these activities - to make a call, to receive a call, to shoot a photo, to send message. In all of the occasions people should be able to take a call, to hear an alarm, to see a message. Sometimes the ability to send and receive information via mobile phone can be important, even life saving.

Closer look into above activities shows that there are many occasions where people can not use the mobile by purpose.

- under the shower,
- swimming pool/sea,
- sport, vacation, relax

- dirty hands -
  - painting, having fun with grandchildren
  - cooking
  - taking care of plants

- forget where it is

- use a lot of accessories (need of extra tools in different situations, could make the use of touchscreen mobile annoying)
  - repair, hobby (like to spend a lot of time in a garage under the car)
  - not able to hear it
Conclusions and development
The focus of the project is how users can ‘keep in touch’ with the phone

The main use of a mobile is to “keep in touch” people, family, relatives, friends despite the distance. Another highly appreciated use of a mobile phone is to help “keep in touch” with everyday activities like

- wake up call
- reminder - take a medicine
  - water the plants
  - appointment with a doctor; friend; meeting

Observation of different activities showed numbers of occasions where there is no connection with the mobile; where people can missed all that the mobile phone is used for.

“I forgot to take my pills because I missed the reminder, I was in another room”
“I always have my phone in the inner pocket of my jacket, but when I put it on the hanger I forgot it there. I remember later when I need it where it is and then I saw that I have missed calls or messages”

The mobile is very useful but there are many situations when it is not there, on the table, in the right pocket, next to us when it is needed.

Development

Focus on haptic feedback, sense of touch and vibrations
To feel the difference

- Vibration haptic feedback - It provides equal feedback because there is no difference in a strength or length of the vibration while operating with menus and features
  It is not clear why the feedback is only on some tasks. It causes confusion when there is no feedback. Thats why there should be vibration feedback on every task performed on the phone.
  There should be different patterns of vibration for different tasks for example incoming call, receive message, receive e-mail, confirm notification, battery low.
  Not so many in number so the users can set the pattern by themselves therefore can easily remember and distinguish them.
  Introducing to users the idea of haptic transmitter with the following functions:
    Having a number of vibration patterns set by users on the phone and having the same vibrations on a devise that can be always with the user. Thus the person can understand by feeling and distinguish if receiving a call or a reminder signal whenever the phone is not around.
Possible to call the mobile in case of not being able to find it.
Possible to reject a call.
Waterproofed and nonchargeable material.
Vibrate approximately 10 seconds before the phone starts ringing in order to give time to prepare (if cooking for example).

Not possible to answer a call.
Not possible to read a message.

Sense of touch on the mobile (touchscreen)
Apply actual touch on every task selecting or performing by suggesting press-screen. On the screen is attached transparent layer that pop up when the mobile is unlocked and goes back to form a smooth flat surface in lock mode. To perform an action user should press the layer and thus to touch the selection beneath. Where it is pressed with a finger have to match with the selected item under the screen. The model provides possibility to feel actual press/touch when an action is performed.

Haptic keyboard
Inspired by Tactus technology but instead popping buttons a grid around to distinguish by touch- feeling the parameters of buttons and using the grid as a dead area in order to help accurate writing.
Haptic ring

Placed under a finger, by relatively small area of the head (smaller than a finger tip closer to screen sized items) helps to point/select more accurate on the screen. Provides possibility to feel actual press/touch because of the soft head.

2nd User test

Participants

Individual user tests are made at Mid Sweden University. Information gained through discussion and models testing.

Participants – 3 people (1 female and 2 male)
Age – 42, 69 and 65

Test persons have different health conditions (written by following the age order)
- Wheelchair user, cognitive problems
- Very low eyesight (lost one eye and has 40% vision on the other), arthrosis, age related degrading
- Rheumatoid arthritis, and replacement in joints, colour blind

Models testing

Vibration as a haptic connection

Vibrational small sized tool is tested on different placements of the body in order to be investigated best places to feel and whether this vibration can be felt at all. Different materials in a combination with the tool are tried. The level of comfort is discussed.
Models testing

Flat wrist
soft material inside and plastic on the other side
one size
open

Flat wrist
soft rubber material on both sides
visible mechanism
one size
open

Flat wrist
plastic material on both sides
sensible different parts
one size, elastic
closed

different lengths
chest sensation

ring attached to strings
different placements

round wrist
soft, elastic
one size

round wrist
rubber, adjustable
different length

flat wrist
rubber, slightly elastic
2nd User test  Models testing
On the mobile phone

Haptic ring

doesn’t work properly
not comfortable

preferable grip
(not under the finger but rather holding it as a pen)
don’t like to have something extra
prefer to use fingers

Haptic keyboard

doesn’t improve the task performance

Haptic screen

it depends on how hard have to push

Vibration as a haptic connection

not possible

not comfortable
might lose it
2nd User test  Models testing

Feels good
Easy to put

Easy to put
Feels comfortable

Easy to put

Best among tested

Conclusions

• not clear whether the haptic ring helps
• haptic keyboard improve the feeling but not helping performing task
• vibrations can be felt
• best place on the wrist
• best way to put on a wrist - elastic material
• flat models are preferred to round
• the idea of developing vibrational transmitter is welcomed very positive
• users believe that they can learn the patterns and would use/wear such transmitter
Meeting with 7 people from a senior club in Sundsvall. Discussing problems and possible solutions on the topic.

All the people in the group

- use a mobile phone everyday
- experience problems with finding it
- experience problems writing, because of the small letters
  (they believe that parameters of the keyboard can be optimised and items on the screen re-organized in order to offer bigger letters)
- no one read the manual description book (if experience any troubles they call or ask family members)
- no one buy a mobile phone because of the features that are offered (don’t know what to look for)
- want to buy or already have the same brand what their children or grandchildren has so they can count on them (to explain how to use it, to ask how to fix something etc.)
Conclusions and comments

Adapting technology is a process:

- Understand
- Learn
- Use
- Enjoy
- Thrust
- Attract

For every person that process is different. Technology nowadays offers myriad ways to choose from and find what fits best ones’ needs. The only guide is the manual description but people don’t use it. There should be another type of guidance through the depths of these choices therefore to discover the best option that corresponds to needs.

“'No, I don’t use fast dial because I don’t know if I have it’’
“'I like my phone the best because it has the right contrast for me (has bad eyesight). No, I don’t know how to change it. My son did it for me’’
“'I had no idea that I have to close applications to save battery’’
“'I don’t want to change my phone because I am used to type like that and I can’t do it on a touchscreen’’ - phone is with buttons where have to press 1,2 or 3 times on a it to get the correct letter

note: there is option to change the keyboard mode like this on Android but in Menu/Settings/language and keyboard/Touc h input/keyboard types

Further development

Hypothesis

If there is supporting program on the mobile phone to help exploring the device will thus make it easy to use and understand without external help.
Further development  Models

Three different ways of delivering support on the phone - read, audio and video.
Novice users can choose most appropriate for their needs to navigate and learn how to use different features of new technology.
Another option is to use these options if help is needed at certain point.

_for example_
I want to delete all my messages but I don’t know how. I prefer to watch a video how to perform this task.
1. Press the button with picture of an old videocamera and a search area to write will appear (like searching in Google).
2. Write in this space “delete all messages”.
3. Suggestion of videos will appear
4. Choose
5. Play on the phone
6. See how to do

Buttons supporting understanding and navigation will be always on the screen thus there will be no need to enter in different menus if help is needed.

It is represented how it will look the screen and where it will be the position of the support.
It is suggested one step on a page.
Comparison of colour inverted keyboard.

**NOTE**
_In this test no button representative look is on focus. Suggested are examples._
Another tool for novice users is presented. It is a navigator for every task. Once it is learned it can be deleted or there is a possibility to choose where to keep it.

For example

I learned how to use my phone. but it is sometimes confusing how to send video clip because I don’t often use this feature. That is why I decided to keep the support program there to navigate me.

Fig1 to fig 5 Shows how the support may work
Press on the hand in fig1 and fig 2 appears. Press on the picture of hand again and it is followed by fig3 -press ok and after is back on that part in the menu where have to perform an action and then new instructions appeared fig5 and fig6

NOTE
In this test no button representative look is on focus. Suggested are examples.
3rd user test

Participants

Individual user tests are made at Mid Sweden University. Information gained through discussion and models testing.

The test is made to evaluate two directions:
- support on the phone
- haptic wrist models (components and sizes)

Participants – 3 people (1 female and 2 male)
Age – 42, 52 and 65

Test persons have different health conditions (written by following the age order)
- Wheelchair user, cognitive problems - short memory troubles
- Rheumatoid arthritis, pain from finger to elbow; lack of liquid in joints; difficulties to grip due to the pain; difficulties with precision movements. Sometimes because of anxious she experience lack of breath and this block her mind; can’t concentrate
- Rheumatoid arthritis, and replacement in joints, colourblind

Model testing

All participants prefer to use reading as a support compared to video and audio.

“ At my age I am used to read when I want any information, because there were no other options before ”

“ If listen it might be too fast for me to follow ”

“ Video might be hard to manage, may not see what they are doing ”

In general no support in order to explain how a technology can be used is appreciated. Users prefer the technology to serve them in way that they would be able to understand by themselves, using their own abilities.
3rd user test  Model testing

Too stiff
Not nice to wear in for a long time

Hard bending material. Adapting size. No display. Different vibrations, light indicators on top.

Too small
Too much strings
Not comfortable

Not very good having a strong magnet on the hand
Not comfortable
Not good without display

Hard transmitter attached on double elastic strings. No display. Different vibrations

Soft elastic material. Magnet snap.
No display, no light indicator only

Not very good combination of the sizes of the elastic wrist band and big display; “Might stuck a lot on clothes”

Hard transmitter on double elastic strings.

Elastic material, separate vibration transmitters, no display

Elastic material, one vibration transmitter in a combination with display

Too small
“For girls may be”

Not good combination of the sizes of the elastic wrist band and big display; “Might stuck a lot on clothes”

Elastic material, separate vibration transmitters, no display

Elastic material, one vibration transmitter in a combination with display

Hard wrist is difficult to attach
Not comfortable on the hand
Feels like it will drop off

Wrist from hard material. No display.
Different vibrations, light indicators on top. One size
3rd user test  Model testing

Feels light
nice material
not good size of the wrist radius

Rubber material combined with elastic part. Display positioned on the rubber.
Two sized models - wider and thin; same wrist radius

Flat wide elastic wrist band with a screen the same wideness
Display turned on only when a notification is received, light + text information

Feels good
better wider and flat
better to have text
good size
better one display
wider gives more stable feeling

If larger would be better feels steadier compared to other suggestion
Nice idea

Not feel really stable

It was suggested the idea of having attachable headset part of the wrist in order to accept calls

wide and elastic is good feels nice on the hand

elastic, wide, flat wrist band combined with separate vibration transmitters
Display text + light available on each
Conclusions

Test was made in two directions- hypothesis evaluation and haptic wrist size and components development.

Hypothesis examine:
Navigating program is not appreciated. It does not give confidence or improve user experience.
Interface should be designed in a way to support users’ understanding and satisfaction.
Help function might be needed sometimes when a task is not performed before (for example change time, change background etc.)

Haptic wrist:
Wide flat parts are preferable
Display text + light + vibration would give best information and awareness according to test results

Further development

Define main problems that users experience, using a mobile phone, in close relation with specific age-related declines.
Making possible solutions of how difficulties could be solved on a touchscreen phone.
**Lock/unlock the phone**

It is not clear when a touchscreen phone is in locked mode. When the screen is black users are not sure if it is not turned off at all or the backlight time is too short. People experience uncertainty how to lock and unlock and they are afraid of doing something by mistake. This is the reason why clamshell type is preferred. Black screen seem confusing.

“Before this one (clamshell) I had another phone and when it was in my bag somehow I was calling my friends”

“I feel more secure with this one (clamshell). I know that when I open it is unlocked”

“It is clear what to do”

**Possible solutions**

- + Special sound
- + specific vibration
- to turn button
to shake
to slide
to drag
- to press
to hold
to push
to switch
- Button that pops up and goes back when lock
- All + phone says “locked”
  “unlocked”
- cover
- Change pattern on the screen
- Different colour Picture
  Clock
Hear
Most interviewed persons has problems hearing mobile ringing. Some expressed embarrassing when they are in public and their phone start ring really loud, their complained that they accidentally turned the volume down while holding their mobile.

Possible solutions

Set the right volume
- easy to find in the menu
- easy to set/confirm
- not possible to change accidentally

feel/recognisable vibration

see that it is flashing

To have something that alerts you when the phone ring

Recognisable tone

Replacing the buttons from aside
See/locate
Problems are experienced trying to find/locate the phone among other objects (at home, in the bag) due to size and dark or monochrome coloring. To be able to see on the screen is another issue; depending on size, font, layout, contrast.
Morrell (1996) reviewed a wide range of researches on text characteristic of older users. He suggested that the elders may gain benefits from sans-serif fonts in size between 12-14 point in normal display (72dpi), short line lengths and left justified text. In his research, he also suggested that older users may gain benefits from static text and black text in white background. Kosnik (1988) also recommended avoiding moving text.

Possible solutions
Remember

Using the mobile as a helping tool of doing everyday activities should be possible to navigate easily through menus to set reminders and alarms. There is no effectiveness of usability when it comes to memory help.

Possible solutions

- Different colours
- Light Patterns
- Recognisable sound
- Recognisable vibration
- Easy to set alarm to find in menu to set/confirm to turn on/off
- Call to phone
- Put something on it that beeps when needed
- Ask the phone (voice recognition)
Models

Shape/size

Model No6 has smooth flat backside thicker upper part and where it is stored a T shaped holder. Pull out and put between fingers. No need griping the phone. It is possible to turn the mobile on 360°.

All other models have different in size and distance snicks to provide no slippery surface.

There are two suggested sizes of a screen and models are doubled.

Size 1st

Size 2nd

There is small arc aside this model. It offers better grip - for fingers if held in left hand and for the thumb if positioned in right hand.

This model has a wider upper or lower side, depends on user needs to hold.

Note: No buttons are placed on all models in order user to be guided by intuition how to hold the devise.
Models

Lock/unlock understanding

Different previews of a screen when is locked are made to test
- blackscreen
- clock + key image
- patterns
Dark or light background combination is suggested to test different contrast

Screen vision

Different visions of main screen view are suggested in order to investigate the how many and what are the most important/mostly used features of a mobile.

Presented are examples and after user choose vision she/he has to name the features wanted/needed/used the most.
Models

Buttons

Buttons are given separately to users. They can choose the size and placement on the screen and explain why.

Buttons for general functions are suggested: locking, take and reject a call and home/main menu button

Developing the search function from previous test only in a read/print form.
Support function button is presented with different symbols in order to be chosen the most suitable and understandable one.

Font size

Placed always (like the battery image is situated) in the right upper corner of the screen, these buttons allows to change the size of the letters on the screen at the very moment it is needed.

Two ways of presenting the button function are suggested.

Keyboard

Users experienced difficulties using a keyboard on a touchscreen mobile due to small size of the letters. No existing example of changing the size of a keyboard is found.

“You can change the size of the letters when you flip the phone, but I never do it. I prefer to have a way to get the size I need without changing the position of the phone”

The suggested keyboard has biggest size of the letters 16p sans serif.
Button size:
Optimized space for the keyboard on the screen. Sequence of the letters is changed a bit due to the larger size.
**Ergonomic**

The measurements are taken from this picture.

![Diagram of hand dimensions](image)

**Source:** Henry Dreyfuss 2002 *The measure of man and woman. Human factors in design*

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**4th User Test Participants**

Individual user tests are made at Mid Sweden University. Information gained through discussion and models testing.

Participants – 5 people (2 female and 3 male)

Age – 42, 69, 65, 48, 32

Test persons have different health conditions (written by following the age order):

- Wheelchair user, cognitive problems - short memory troubles
- Very low eyesight (lost one eye and has 40% vision on the other), arthrosis, age related degrading
- Rheumatoid arthritis, and replacement in joints, colour blind
- Suffers from herniate discs, has a pain in entire body
- Spina bifida, uses wheelchair
Model testing

Shape/size

The flat backside seems slippery to all TP “smooth is not good”

The wider size is good, but too big for the pocket

The wider part provides such a grip that gives pressure in the hand

The T-holder was possible only for one person

Model №5
- more comfortable than the others to hold
- good size
- easy to hold
- easy to take (from table)

Model №2
- fits in my hands
- can’t drop it
- good grip
- feels very stable

Three people can’t decide between №2 and №5
4th User test  Model testing

Lock/unlock

1TP choose black screen in combination Clock+ key view - can see it better
Light background in combination Clock + key view
4 people out of 5 prefer this solution
- best to see
- best to give information
“I can see it much clearly”

Unlock

Only one person prefer to shake the mobile in order to unlock it.
4 out of 5 users want to press and hold it is suggest to have 2 buttons on the top - one to lock and another to unlock.
No buttons aside the phone are wanted because users pushing them by mistake while holding the phone.
Sliding is not good solution
- one test person has coordination problems and this move is bad for him
- afraid that may unlock it by mistake (“while putting in the pocket for example”)

Comments and observations
No one choose black screen as an indication of locked mode. Patterns gives information but it was not clear what. Interpretation may varies.
It was difficult for users to imagine other ways of unlocking from the one used on their own mobile.
Model testing

Buttons placement

4 out of 5 people prefer rectangular shape of buttons

Locate

Part length colour line
All the colours are only examples

Different colour combinations are expressed

Whole length colour line
5 out of 5 users prefer to have a colour line all around the phone in order to easily locate it

It is good to have some different colour at the backside as well
4th user test Model testing

Keyboard

Keyboard view has been discussed with 8 people
+2 female 50 and 73 years old with age-related decline

One person choose round buttons
- letters look more independently
  since there is more space between
- probably it will be easier to write

6 out of 7 prefer the rectangular
- can distinguish better the letters
- more clear
- better for the finger to write
- more familiar “Is there any phone with phone on the market with round buttons?” (asked TP)

Vision

5 TP prefer the three rectangles vision as a main page
- easy (not too much not too little, enough for my needs)
- easy to read
- can understand the most
- most standing out

1 TP liked this option
- more orderly clear to me
- can see the best

1 TP choose this view
- visually like it the most
- it is clear, don’t confuses me
Model testing

Support button

Two TP associate the support function with loop and called it search button “like on a computer”

No one choose it

Five people prefer this one and name for this button ‘Help’

The position of the support button is always on top, (next to operator name for example) to provide opportunity to be used whenever is needed.

Font size view

6 out of 7 TP prefer a single letter image for better understanding of the function

The one that has both letters causes confusion and users thought that by pressing on it can write with capitals or small letters.

Suggestion from a test person: “Don’t use three close sizes make two distinguishing”

Vibrations

Use vibrations as a haptic feedback. If there is a certain vibration pattern the task is performed correctly. When there is no, users are aware.

An application with a list of different vibration modes is downloaded on Android platform.

Users chose a pattern for main tasks.

Confirm (task completed vibration)

Message receive

E-mail receive

Incoming call

Reminder
Model testing

Vibrational tool is attached to users’ wrist. The device has 10 modes of different vibrations and it is controlled by a remote control. Jamming headphones are used in order to be clear whether the vibrations can be distinguished by feeling rather than hearing.

All participants can feel different modes.
The feeling is described as “good”, “ok”, “nice”, “no problem”.

Zenit group meeting

Zenit group members are mostly retired people with IT background. On the meeting at MIUN four people participated. Age of group members - 67, 70, 69, 64 (1 female and 3 males) The initial idea to discuss problems around structure logic on touchscreen mobiles did not succeed due to the high experience of the participants. All have touchscreen mobile phones.
Main use of the touch mobiles and age ability was discussed. All experienced troubles writing due to the small size of the letters. To all happens to forget where they left the phone. To all happened not to hear it. All have no troubles using the phone. Everyone is using all the features that the phone offers. They know what to use the mobile for, but have much lower awareness what they can do or change on the phone. The idea of having a support button for help/search is highly appreciated. The idea of vibrational transmitter and its functions was also presented and had very positive review.
“I would definitely use it”
“Where I can find it to buy”
Spatial test

Test for spatial orientation was made with 6 participants. The test is available on Internet and the results are sent by mail. Link to the test:
http://lapdp.umd.edu:81/vz2/
The number of correct answers is collected where 20 means no mistake.

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Collected result shows a rather big decline in spatial abilities.

Conclusions and further development

Hypothesis for further development

Users want to be able to understand and manage new technology by themselves. The elders feel lack of confidence in their skills to operate computer devices. Elderly users mostly found that they are sensible for failures and inconsistencies situation, but younger shows less effect in the experiments (Czaja SJ L. C., 2007), (IJsselsteijn W, 2007). More recent research from Reddy (2009) reported that the seniors took more time to recover from their failure and get more anxious when the tasks are getting more complex. Elderly experienced problems with touchscreen technology not because the lack of sense of touch but because there is lack of presented information. Buttons provide visual information that is static and predictable.

In button based mobiles the process of learning is supported by the knowledge that there is nothing hidden. The buttons are needed, not because they are physical, but because they exist. When seniors see fig1. they don’t have the intuitive interaction to try to scroll or to slide. None of the users saw the small arrow on the screen, everyone used the
buttons to navigate because there is information on. They perceive the information and can predict what will happen when press. On a touchscreen there are hidden menus, if hold more, another menu comes, don’t know what will change on the screen and where is back button or red button or close button. This causes fear of mistake and lack of confidence in personal skills. There is no clear indication on the screen where to press/touch since buttons have fixed localization and thus gives mental support. The focus of attention is too much in motion therefore is difficult for seniors to build up an appropriate mental model what will happen, while younger users can compensate this and handle shortcuts and pop up interaction.

If the navigation is visible and clear on the screen there will be no need of extra program or alternative tools to help understanding fig 3 and fig 4.
Final model

Touchscreen mobile

Volume regulation buttons placed on top in order to avoid accidental change (when placed aside holding could cause change).

Distinguishing colored lines helping to locate (in bag, on shelf, etc.).

Lock/Unlock button

Green headphone physical button

Red headphone physical button

Screen

Grip supporting arc
Final model

Development and inspiration

Developing the arc shape aside the phone on the wrist in order to create a visual feeling of belonging.

Inspiration

Form and meaning

During observations and discussions with users and participants in the project the shape and size of mobiles occurred on focus. Answering the question “How it should look like your dream phone?” no different answer was given but “rectangular and small so I can put it in my shirt pockets”.

Giving a certain shape of everyday objects influence mind and imagination.

Living in rectangular rooms, sleeping in rectangular beds, looking trough rectangular windows changed view into such prism so to want edged product to fit edged pockets.

Mobile phones are used for sharing (information, emotions, etc.).

Looking on a bigger perspective all people share planet Earth.

Planets, sun, trees, molecules none of these is rectangular.

Moon shape is chosen for this product to remind that the world human beings share is not edged shape, to look out of the personal world. It also represent the process of developing in a way that not everything perceived at a certain moment is total truth. There is visible truth and such that is in the shadow. It exist and when the right time arise it will be lightened too.
Haptic wrist

Models of the transmitter are printed and put on hands in order to be gained better visual picture. Different straps are attached to the main body of transmitter.
Clip at the backside of the main transmitter body allows to be removed from the wrist and attached to different places - pockets, clothes, necklace, glasses and others.

On the main body is applied display so to be possible to read the received notification very general

- call
- sms
- e-mail
- other

There is button placed aside. Pressed once reject a call or confirm that the notification is received so to stop vibrate. Hold or pressed twice connect to mobile phone and it starts ringing. Thus help find the location of the mobile when could not remember.

The surface around the display is slightly lightened when it is vibrating to provoke awareness.
Interface
Add new contact

Buttons for changing the size of letters

Help button always on the screen, no need to go in menu to use it

Navigating buttons
When there is no sign means no option available

(on the example it represents that here are no other information up but there is down the screen)

When an area is selected it changes colour to give visual information of what action was done. Should be touched again to perform an action.

One step per page is suggested.

Navigation is placed down on the screen. No hidden or double functions and menus.
Interface

Add new contact
Interface

Send message

Send new SMS
Delete SMS
All SMS

Write message

The book is on the table.

The book is on the table.

Send to: Linda Falang

Send
Final user test

Participants

Individual user tests are made at Mid Sweden University. Information gained through models testing. Scale for Design for all is used for evaluation.

Participants – 6 people (2 female and 4 male)
Age – 42, 69, 65, 48, 32, 52, 69

Test persons have different health conditions (written by following the age order):
- Wheelchair user, cognitive problems - short memory troubles
- Very low eyesight (lost one eye and has 40% vision on the other), arthrosis, age related degrading
- Rheumatoid arthritis, and replacement in joints, colour blind
- Suffers from herniate discs, has a pain in entire body
- Spina bifida, uses wheelchair
- Rheumatoid arthritis, pain from finger to elbow; lack of liquid in joints; difficulties to grip due to the pain; difficulties with precision movements. Sometimes because of anxious she experience lack of breath and this block her mind; can’t concentrate
- Blind person

Test Performing

Physical model of the haptic wrist and touchscreen mobile phone is evaluated. Users are testing comfort and visual impression of the objects.

No function is tested

Three tasks are performed to be examined developed hypothesis:
- Unlock the phone
- Add new contact
- Send message

Colours are discussed.

feels good on hand

can be placed on a scarf

no problem to feel and press the button

test person liked the image
Evaluation

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<td>Very difficult/uncomfortable</td>
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<td>Neither nor</td>
<td>Easy/Comfortable</td>
<td>Very easy/comfortable</td>
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</table>

- **Rheumatoid arthritis, and replacement in joints, colour blind**
- **Suffers from herniate discs, has a pain in entire body**
- **Spina bifida, uses wheelchair**
- **Rheumatoid arthritis, pain from finger to elbow; lack of liquid in joints**
- **Very low eyesight, arthrosis, age related degrading**

Overall results
The idea was introduced to a blind test person. The solution was discussed but no real function was tested. He is blind by birth and he did not feel the need of having a haptic wrist in his everyday life due to his habits. He learned where to put things and all his clothes has pockets, so his phone is always with him. He build his routine for many years, but he suggested that it might be useful for others that do not have his life style. He said that probably he would like to have a vibration wrist when he is in a hotel or totally new area so to connect navigation for “Restaurant“, “Reception“ etc. on it and thus to know his way. He does not use touch screen phones.

Colours

Colours of the products are discussed. Figure in the picture bellow was shown on the screen of the computer. The colours are modified with the help of a colour blind person in a sense to be found best contrast combination. It was later shown to other participants to be valuated.

Grey
R: 48  H: 0
G: 48  S: 0
B: 48  V: 18

Yellow
R: 255  H: 49
G: 233  S: 50
B: 127  V: 100
Sustainability

Considering environmental impact of products, materials usage should be examine. Electronic paper display is applied on the wrist. E-paper display can be read in direct sunlight with no disturbing reflection. It look like a normal paper, it is portable reusable storage and by thus can safe a great amount of battery life. Wrist band is made from material that charges from the heat of the body. There will be no electricity consumption and therefore no need to be taken away.(There are already wrists on the market which work as a portable charger of a mobile phone).

Another option is body heat transform material to be applied on the backside of the main body transmitter (moonshaped part). Therefore the wrist band could be personalized and other materials can be used - leather, fabric, ribber etc.

Wearing a haptic wrist connected to a mobile can save battery life of the phone because of not checking so often.

Touchscreen mobile body is made from material - graphene- called “new plastic”.

It is discovered on 2004 in Russia and recently becomes more and more popular. It won Nobel Prize in Physics in 2010. It is a single layer of graphite.

Properties of the material:

• 2D
• the thinnest ever known
• the lightest
• strongest
• harder than diamond
• conducts electricity
• transparent
• bendable/flexible

This allows to be used in great number of applications. Flexible, extremely durable technology with almost no need of charging because the material has the potential of super capacitor.

In general Doro acting in a very responsible way. Company is looking for materials with the least possible impact on the environment. Taking into consideration materials, production, products, transportation and recycling, therefore the materials are used for Doro’s products could be applied in this project too.

Materials are not yet decided that is why no LCA calculation is made.
Communication connects people. Technology nowadays support the need of sharing - information, emotions. It can have different sizes, shapes, features, names but all is made to serve this need. Products should contribute freedom and confidence. Trust the tool and trust in own abilities.

Design toward abilities corresponds to the needs of belonging and esteem and thus raising the feeling of independency. Products in this project are developed in a way to be understand and used by elderly. Presented solutions adapted new technology for seniors and thus create a feeling of belonging to the contemporary world, sharing same devises as other family members or friends.

Possibility to handle touchscreen mobiles reduce the feeling of “left behind” and stimulate their self-confidence. Helps to enjoy everyday life in an “no barrier” manner. Haptic wrist could reduce the tense of too much awareness - to hear the phone, not to miss a call or reminder or something important. Could reduce embarrassing moments too - forgot to turn the loud sound in the cinema, forgot to turn down the reminder volume of taking medicine at restaurant, etc.

Recently more and more wrist-wear products are introduced to the market - wrist phone, wrist charger, wrist sport runner, wrist remote that control all technical devices by reading the muscle movements of the hand. If the haptic wrist is used now then later when technology changes where all be on the wrist it could be easier adopted.

Maslow’s Hierarchy of needs

Discussion

Results Final test

Symbol was not very clear to all users; **Help** was suggested
“ I am not sure but I will press on it and see”
“ I can try what it is”

The arrow symbol was suggested to be replaced with
Not clear if the arrows are misunderstood or just this particular example

It was preferred by all test persons first to choose menu/task and touch/press on it => it changes colour to indicate selection => press/touch again to access
“ It is better like this, because it might be a mistake what you choose and the it’s annoying to go back”

Big size (10.632mm/7.895mm) of the letters in a keyboard mode was highly appreciated and changed order did not matter, size was more important.

No user has problems navigating or understanding tasks.

Overall process

Project was made to investigate how elderly can understand and easy handle touchscreen technology in general. Initial hypothesis and starting point was that the main problem is lack of the sense of touch. There is why the solution is based on vibrations as a sensual feedback. Market research showed that haptic is developed technology that could be applied on any touchscreen product in order to supply real feeling of touch. Another problematic area should be studied where vibration can be solution or improvement. First user study indicate difficulties in two fields - phone connection (cannot hear,forget etc.) and main issue on the phone - visual troubles (too small letters, caused incorrect typing and the screen size was not big enough). It was clear that physical parameters of the mobiles nowadays do not allow to be always around when needed. This technology is made for establishing connection between people. Sometimes this link is very necessary and important. If cannot be heard, if cannot be found, if the environment is not suitable (in the pool for example) then there are many occasions to miss this connection. Then the purpose of this devise become meaningless. Vibrational transmitter can resolve this problems by creating a sensual relationship between the phone and the owner. Developing of the idea started. Sizing and accurate typing was an issue but do not solve in general how elderly can understand easily touchscreen mobiles. Further study is made and additional meeting with a group of seniors is organized. No clear problems was found. Persons who already have a smart phone has no fundamental troubles using it, except the sizing (therefore typing too) and others, who owned still a phone with buttons, experienced uncertainty of what troubles they have or might have. All wished additional applications (GPS or route map for example) or making comparements of their present phone with a new touchscreen mobiles in a sense of habit (“I do not want to change my phone with a new one because I am used with this type of writing, not like keyboard. It’s the easiest for me’’). All users wanted the same brand as their family relatives, so to count on them for explaining how to use the device. Closer look of persons wishes showed that almost every smart phone include many differ-
ent ways of operating with it. There is a way to change keyboard mode, and to choose best way for personal needs. Problem was that people express less interest in technology in general and did not explored their phones to check what they can change according to individual needs -how and where. Navigational support is suggested on the following user test. Leading system is developed due to less curiosity from users and no reading of manual description.

The solution failed. Persons want the system to be designed in such a way so they can use own abilities of navigating and understanding. Deeper analyze and another approach is made. In the forest, on the road no matter where people are, if want to take a certain direction they use signs to navigate. When feeling lost person look for a sign. Buttons on the phones are signs for navigation. People perceive the symbol or text on it and this leads his/her action. On smart phones there is lack of such navigation. There are no signs to help them predict an action (should drag to see or slide to move or touch at certain place to pop up options). Since elderly from this generation are used with mechanical tools and less electronic, static information is better rather interactive guessing.

Buttons (visual, not physical) are placed on the screen containing navigating information. If there is visual options to lead a task, there is no need of additional programs to help orientating and understanding.

**No user have problems performing the tasks on last test.**

**Achievements**

**General use of touchscreen mobile phone**
- easier to see letters
- bigger buttons
- easier to use
- easier to navigate
- better grip

**Haptic wrist**
- helpful for remembering
- improving connection (information-recipient)
- reduce number of missed calls

**Further development**

**Touchscreen mobile phone**
No wording, symbols or visual parameters (screen colour, screen contrast) are tested due to limited time. Symbol recognition and language can influence understanding and navigating. No working prototype of haptic wrist or touchscreen mobile is tested. Technology should be applied in the products by experts in this field.

**Haptic wrist**
Developing the wrist band. In a sense of sustainability what is the best One size solution;is it possible and what are the alternatives.
User-safety. There is an assistance button at the back of Doro’s phones. When it is pressed it sends automatically signal to close or important people (added in advance on a phone list). Future option is to have such button on the haptic transmitter as well to improve user security.

Research for alternative connections (not only bluetooth) between haptic transmitter and phone in order to be established long distance link.

Look to combine materials and functions to create optimal solution. There are too many useful gadgets and supporting devices that can be unite.

Developing unique patterns of vibrations as a haptic feedback on the phone and applying the same into the transmitter.

It should be tested further with blind people due to insufficient condition and limit number of tests.

Vibration on the phone:
- Confirm (task completed vibration)
- Message receive
- E-mail receive
- Incoming call
- Reminder
- Other notification

Vibration on the wrist:
- Message receive
- E-mail receive
- Incoming call (starts vibrating before phone starts ringing)
- Reminder
- Other notification

The haptic wrist could be used not only for seniors. It could be wear from all ages:
- doing sport and have no place phone
- listening music with a headphones
- at concerts or noisy environment where it is difficult to hear (and it’s uncomfortable to hold the phone all the time)
- when forgot phone on a silent mode
- when there are people around who need silence (babies, small children, in hospitals, etc)

**Limitations of thesis**

Language.
To none of participants in this project English is a native language. This could lead to some misunderstanding or limitation of expressing and therefore to affect the process of collecting information and feedback.
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