

CHALMERS



Tomorrow's rugged PDAs

Industrial Design with focus on Semantics and Brand Identity

Master of Science Thesis in the Master Degree Program, Industrial Design Engineering

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Master of Science Thesis PPUX05

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Abstract

Handheld Group AB is one of the world's leading suppliers of rugged PDAs, computers, tablets and mobile phones. The head office is located in Lidköping, Sweden. They deliver solutions to industries such as forestry, construction, maintenance, security, public transport and logistics. The production is outsourced to Asian companies.

This project has been aimed at developing two products for Handheld. One is the successor to one of their PDAs called Nautiz X7. The other one is a rebranded version of the X7 called Nautiz X6. The X7 and X6 shares the fundamental hardware components but the X6 has an additional GNSS antenna.

The focus has been on Handhelds own product, the Nautiz X7. However information found about the X7 has been applicable on the X6, as they are similar products. The given technical specifications have been taken into account, but the focus areas have been ergonomics and communication of Product characteristics and Brand Identity since that is what Handheld want to improve.

The development of the products has been divided into two phases; Prestudy and a Conceptualization and detailing phase. In the Prestudy requirements were gathered with e.g. user studies. Within the Conceptualization and detailing phase an extensive idea generation was held, with both free sketching and a methodical approach. The final result is one concept each for the Nautiz X7 and X6. The X7 has a bigger screen than the current one but is still slimmer. It has better ergonomics through a better grip. The usability is better with rearranged buttons on the keypad. The product characteristics have been fulfilled with the design features. The X6 suites its brand's identity.

In the Brand Identity study the focus was not only on the new Nautiz X7 but on the whole Handheld product family. A broad study will ensure that the products lead the development of the Brand Identity in the, by Handheld, desired direction. The result of the Handheld Brand Identity study is documented and will be beneficial when developing other products as well.

Terminology

In the report the following terms have been used.

Geographic Information Systems (GIS)

Geographic Information Systems (GIS) gathers, stores and analyzes geographical reference information. The gathering of GIS data and creation of maps with GIS data typically means that users are out in the field, often in remote locations. GIS data is also increasingly used by companies and authorities to track position, properties and quality of their assets. (Handheld, 2012a)

Global Navigation Satellite System (GNSS)

Global Navigation Satellite System (GNSS) is a satellite system that is used to pinpoint the geographic location of a user's receiver anywhere in the world. Two GNSS systems are currently in use; The United States' Global Positioning System (GPS) and the Russian Federation's Global Orbiting Navigation Satellite System (GLONASS).

Global Positioning System (GPS)

The Global Positioning System (GPS) is a satellite-based navigation system, and one of the GNSS systems.

IP67

IP stands for Ingress Protection. An IP number is used to specify the environmental protection of enclosures around electronic equipment. The ratings are determined by specific tests and the IP number is composed of two numbers. The first number refers to the protection of solid objects and the second against liquids. The higher the number the better the protection. "6" as the first number means that a product is totally protected against dust and "7" as the second number means that the product is water immersion protected. (SP, 2013)

ODM

An Original Design Manufacturer (ODM) is a manufacturer which designs and produces a product for another brand.

PDA

PDA is short for Personal Digital Assistant and is a handheld device that combines computing, telephone, internet and networking features. Other names for PDAs are handheld computers and pocket computers.

PRD

Product Requirements Document. Document defining the product.

RFP

Request For Proposal. A specifications document, often sent to potential suppliers in a bidding process.

Stimuli

Input to the senses.

Tablet

A tablet computer is a general-purpose computer that consists of a single panel. Its distinguishing characteristic is the use of a touch screen as the input device. Tablets are operated by fingers but stylus is an option.

Total station

A total station is an electronic measuring instrument. The instrument is used for measurement, particularly in construction projects and surveying. A total station measures vertical angle, horizontal angle and sloping length against a reflecting prism. With the information the prism's three-dimensional position in a cartesian coordinate system can be calculated.

Touchscreen, resistive

Resistive touchscreens require more pressure to be activated compared to capacitive touchscreens.

Touchscreen, capacitive

Capacitive displays can be controlled with light touches of a finger. A conductive stylus is needed, or a stylus powered with a battery if it will be used with gloves. Some can fail to sense with water on the screen.

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1. Introduction

1.1. Background

Handheld Group AB, based in the Swedish city Lidköping, is one of the world's leading suppliers of rugged PDAs and computers. They deliver solutions to high demanding industries such as forestry, construction, maintenance, security, public transport and logistics.

Their product range has adapted to the market demand, and is today including a Windows laptop computer, Windows tablets, different kinds of PDAs and an Android smartphone, see figure 1.1. Every product has an high IP classification and withstand heat, cold, fall, vibrations, wet and other outer strains that can occur in field.

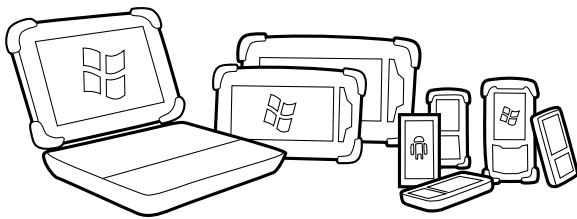


Figure 1.1 Handheld's product family

To remain flexible and shorten the lead times Handheld have outsourced all production and development, mostly to Asian companies. With this strategy Handheld have successfully competed with larger companies like Casio, Trimble, Panasonic and Motorola.

1.2. Purpose and goal

The intention of this thesis has been to contribute to consolidate Handheld's position on the market. Factors such as usability, physical ergonomics and aesthetic appearance grow in significance when the worldwide competition intensifies. Handheld wants the project to give some new perspectives and ideas regarding their products. Compared to a normal process at Handheld this thesis had the time to investigate everything deeper, and the fact that the work will be carried out in close collaboration with Handheld makes it easier to share ideas between the design team and Handheld.

The primary task of the thesis project has been to develop two new products. One of them is a successor to an existing rugged PDA called Nautiz X7. The other product is a rebranded version of the Nautiz X7, called Nautiz X6, with some additional features. The thesis goal was to come up with three concepts for each product, with different form and design solutions. One of the concepts for each product were chosen and further developed in collaboration with an external hardware developer. These two products will go into production after the thesis project.

Parallel to the development of these two products there has been a secondary task – to document Handheld's Brand Identity, and to point out possible improvements. Since new types of products are being developed the need of a consistent Brand Identity is growing. The design of the Nautiz X7 should

to a high extent be applicable on other products in Handheld's product portfolio.

1.3. Limitations

Since the hardware of the two products are developed and manufactured by another company, a so called Original Design Manufacturer (ODM), the technical development was not addressed. Instead the work of this project has been focused on Ergonomics and communication of Product characteristics and Brand Identity. These are the things Handheld want to improve. The technical specifications were set before the project started.

This thesis project had a limited time span of approximately 20 weeks. External factors, like the ODM's development, affected the possibilities of doing a finalized product within these weeks. The project group therefore limited the deliverables to be three concepts mainly presented with images.

1.4. Project process

This project has followed the structure of a generic development process. Our process is presented in figure 1.2.

In the first phase of this project, the area of the two PDA models was investigated. First of all the given technical specifications were studied. Then the users and possible use situations were studied and a benchmarking was made with competitive products. In parallel a study was conducted about the expression of the products. They should express their brand's identity, but also product-specific expressions depending on the intended market.

Out of this first phase came a list of requirements, documentation on the users and a documentation of the products' intended expressions.

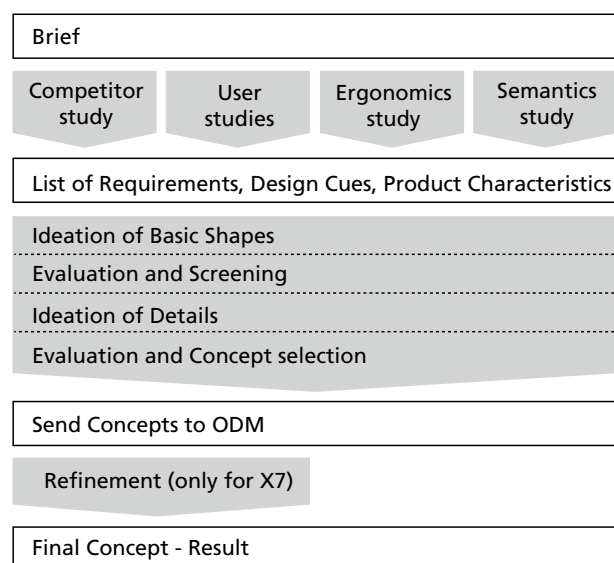


Figure 1.2 The product development process of this project.

The result of the ideation was analyzed, evaluated and combined into concepts. The concepts were then evaluated and the most promising ones were chosen in collaboration with Handheld. After some fine-tuning of the concept for each of the two products, they were presented to the manufacturer (ODM). In the end of the project the proposals from the ODM on the Nautiz X7 were received and reworked into a final concept.

The ODM will do the final implementation of the design concepts and prepare production blueprints etc, but that is beyond this thesis project.

1.5. Report outline

This report will essentially follow the order of the project process. Development of the two PDAs has been carried out in parallel, and their processes are described together as far as possible. When there have been distinct differences in the process or result they are however separated into two subsections.

2. Handheld

2.1. Handheld's development process

All the production is outsourced to suppliers, mainly in Asia. The normal design process at Handheld is that they specify the components and briefly sketch how they want the product to look. The sketches are then sent to the ODM in Asia who does the final design. It is also the ODM's task to package the hardware in the best way to suite the exterior design.

2.2. The product family

Every product has a high IP classification and withstand heat, cold, fall, vibrations, wet and other outer strains that can occur in field.

Example of use areas are the forest industry, construction, transportation, military, waste disposal, public security, energy and water supply, stock work, road and railway maintenance, service and maintenance, the mining industry, GIS/mapping and adventure. (Handheld, 2012b)

The product portfolio consists of PDA's, tablets, a laptop and a smartphone, see figure 2.2.

2.3. Current Nautiz X7

The current Nautiz X7 is Handheld's most advanced PDA. It is equipped to a high extent regarding performance, functions and ruggedness. Among the functions are GPS, Bluetooth, WLAN, 3G capacity and a 3 megapixel camera. It also has a g-sensor/accelerometer and can be equipped with a barcode

reader or RFID reader. Regarding ruggedness it is IP67 classified which means dust and waterproof, meets the military classification MIL-STD-810G and withstand repetitive drops. See table 2.1 for specifications and figure 2.1 for pictures.

Table 2.1 Present Nautiz X7 specifications

Size	179 mm x 97 mm x 37 mm
Weight	490 g
Operating temperature	-30 °C to 60 °C
Operative system	Microsoft Windows Mobile 6.1
Display	3.5-inch, VGA (480 x 640 pixels)

2.4. Competitors

Handheld have some competitors whose products have been studied in the project. The biggest competitors according to Handheld is Trimble, Datalogic, Getac and Topcon, see figure 2.3-7 for examples of their products.

Most rugged products do not look that modern. The plastic surfaces are big to enhance the tough appearance. Some companies have inconsistent product portfolios regarding the brand identity. It is common that products are developed in cooperation between companies and rebranded. That can lead to products not that thought-through, made with many compromises.

The current Nautiz X7 and the new Nautiz X6 have one specific main competitive product each. The competitive product for the Nautiz X7 is the Trimble Nomad, see figure 2.2. The main competitor for the Nautiz X6 is the Trimble GeoExplorer 6000, see figure 2.6. A study of these can be seen in chapter '4.1.5 Competitor study'.



Figure 2.1 The current Nautiz X7



Figure 2.2 Some of Handheld's products



Figure 2.3 Trimble Nomad (Trimble, 2013a)



Figure 2.4 Datalogic Falcon X3 (Datalogic, 2013)



Figure 2.5 Getac PS336 (Getac, 2013)



Figure 2.6 Topcon GRS-1 (Topcon, 2013)



Figure 2.7 Trimble GeoExplorer 6000 (Trimble, 2013b)

3. Theory

3.1. Introduction

When developing a product several different aspects affect the process and the final product. There are technical performance, safety, ergonomics, production cost, environmental impact etc. The Swedish design theorist Rune Monö (1997) has categorized these aspects into three terms: communicative, ergonomics, and technical.

3.2. The communicative aspect

3.2.1. Introduction

The theory of the communicative aspect of a product is called semantics (Monö, 1997). Every shape, color, material etc. communicates things to the users of the product. It is not within the designer's ability to decide whether or not a product communicates, only what it says (Coates, 2003). Some things, like a sharp dangerous edge, are interpreted almost in the same way by everyone. Other things, like colors, are interpreted different depending on the culture and the user's previous experiences of products in that color. If a product's semantics is not considered there is a risk for the product to be misinterpreted.

Products are multimodal and "address various senses simultaneously" (Hekkert, 2006). The different human senses play an important role in people's understanding and experiences of products (Dagman, et al., 2010). Vision has often been described as the most important dominant sense. However it depends on the product (Schifferstein, 2006). One sense especially important when dealing with handheld devices is touch. Haptic product experiences are related to the experience of shape, weight, material, structure, temperature and balance, most often with interplay between those properties (Dagman, et al., 2010). The information from one sense creates expectations for information from the other senses. Information from the second sense is used to confirm, explain or modify the first experience. This congruence or incongruence between senses may result in an overall positive or negative product experience.

All features on a product communicate, alone and together. These units of expressions are in the theory of semantics called 'signs'. Due to Charles Peirce (Bergman & Paavola, 2003) a sign is "something which stands to somebody for something". Peircean semiotics says that there are three different kinds of signs: icon, index and symbol (Monö, 1997). An Icon is connected to what it designates through likeness; like a toy car is interpreted as a car because of the likeness to a normal car. An Index has a causal relation or physical connection to what it designates. An example of an index is footsteps that indicate that someone has walked there. Symbols are built upon cultural agreements and are e.g. letters. (Warell, 2006; Monö, 1997)

Monö (1997) highlights four things that he names semantic functions: to describe facts, to express properties, to exhort to reactions and to identify e.g. origin. Crilly et.al. add some areas to Monö's theories. Due to them (Crilly et.al., 2004)

the communicative aspect of a product could be divided into three subcategories: Aesthetic impression, Semantic interpretation and Symbolic association. Crilly et.al. place Monö's four semantic functions into the area of Semantic interpretation (Figure 3.1).

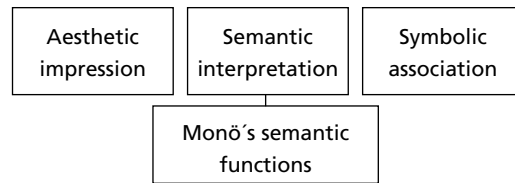


Figure 3.1 Where Crilly et al places Monö's semantic functions

3.2.2. Aesthetic impression

The aesthetic impression of a product means whether it is seen as visually attractive and beautiful, or not. It is difficult to deal with the aesthetic impression theoretically. One theorist, Hekkert (2006), says that "we like to look at things that support navigation and identification". The Gestalt laws are one attempt to find out what's giving order and easing navigation to a product. There are over one hundred different Gestalt laws (Bloch, 1995), and most of them focus on "symmetry, proximity, similarity, continuance, repetition and closure" (Crilly et.al., 2004). The Gestalt laws are however not enough to ensure a visually attractive product. There are big differences between people's impression of products due to subjective things like situational factors (motivation, financial constraints etc.), cultural factors (cultural agreements, general trends etc.) and personal factors (age, gender, experience and personality etc). Therefore designers usually design products intuitively, and forget that they as designers usually are not representative of the users but have another experience, background and taste.

Balance is probably the most applicable principle when designing for aesthetic impression. Crilly et al. (2004) highlights that a product's stimuli must be in balance with the level of interesting information that the stimuli presents. Another balance is presented by Gombrich (1984), who writes: "delight lies somewhere between boredom and confusion". Hekkert (2006) has similar thoughts in his theories on that a product should be "most advanced, yet acceptable", a principle from Raymond Loewy. Loewy explains the principle as "It is a sort of tug of war between attraction to the new and fear of the unfamiliar" (Loewy, 1951).

Balance is also a good example of how the ideas of Hekkert can be extended to other senses than just the vision. A weight balance that is haptically sensed is also important for an attractive impression.

One thing that is important to know is that the aesthetics can give a negative impression of the product (Bloch, 1995). Professional users might not need or want a beautiful product; a neutral one works for them. However they don't want to have an unattractive one.

3.2.3. Semantic interpretation

The semantic interpretation is what message the product tells the user about the product itself (Crilly et al., 2004). Crilly et al. consider Monö's four semantic functions as part of the semantic interpretation. Monö's semantic functions are to:

- Describe the purpose, function or mode of operation.
- Express properties, such as stability, sustainability or friendliness.
- Exhort reaction.
- Identify origin, category, brand etc.

If the expression within these four functions is not in harmony with the technical and ergonomic aspects, then the product could be seen as cosmetic, seductive and dishonest. (Monö, 1997)

3.2.4. Symbolic association

The last of Crilly's et al. categories is Symbolic association. It is defined as "what the product is seen to symbolize about its user", in contrast to Semantic interpretation which means "what the product says about itself" (Crilly et al., 2004). Crilly et al. says that e.g. a product made out of metal can be interpreted as precise (semantic interpretation), but the user of the product can be seen as a skilled and precise person, (symbolic association) due to his or her product choice.

Behind the Symbolic associations, and sometimes behind the other two aspects as well, is a culturally agreed meaning of that object. Peoples' associations do not just depend on the products themselves but also on marketing programs and prior experiences. (Crilly et al., 2004)

3.2.5. Core values

Companies should develop products with designs that appear attractive, describe their purposes, way of use etc. but also carrying references to the brand. This area has become increasingly important (Warell & Näbo, 2001). One common way of describing the desired brand character is through Core values, also called Kernel values (Kapferer, 2012). Stompff (2003) made a study about the dutch copying machine company Océ. In the study it became clear that their customers did not request "stylish" products but products that expressed reliability and professionalism. Descriptions that might not suite consumer products, like: "looks like a tank, build like a tank" or "very plain-looking; simple interface" were here positive. The relevance of the Core values is usually uncertain at the beginning and is confirmed by the company's commercial success (Kapferer, 2012).

In this project Core values have been applied to the design in form of Product characteristics that the products should express.

3.2.6. Design cues

Design features that creates brand recognition is called Design cues and they can be features such as shape, form, color, material, surface, texture, graphical elements and logos. The Design cues can either be linked to the brand's Core Values, so called Value-based Design Cues, or not be linked to any specific

values (Karjalainen, 2007). Volvo, for example, uses a strong shoulder line as a Value-based Design cue to express safety, see figure 3.2. Value-based design features involve both explicit and implicit cues and they can be consistently or flexibly used over the product portfolio.

Explicit visual references are used in design features that designers use with the intention of being immediately perceived and recognized. In order for product design to contribute to desired identification, visual references employed in the form must be appropriate, consistent, and clear (Warell & Näbo, 2001). Volvo has explicit Design Cues in the V-shaped hood, diagonal Volvo grille, distinctly carved taillights and the flowing line from roof to boot-lid, see figure 3.3. Implicit references are features that are not immediately distinguished but used with the intention of being perceived and recognized without the customer being aware of it (Karjalainen, 2007). Implicit cues are always value-based and make sense when the product is used. Volvo could for example use different design features to transmit their Scandinavian design heritage. These design features refer to Volvo's Core Values but can change in form between the products. If the same shapes are used repeatedly in the brands products they become explicit cues.



Figure 3.2 Volvo value based design cue (mad4wheels, 2013)



Figure 3.3 Volvo explicit design cues (Motor-Palast, 2011)

Styling references from earlier models are often used when companies design new products. In that way the design can develop according to current styles and trends with references to the brand heritage. The new product will then be perceived as new and recognizable, which means a coherence in time and a recognition of the brand. It is important to balance the the degree of novelty against established and familiar forms. Too much novelty may not be accepted by the customers, while a

model that differs too little from the previous one will not be perceived as a new product. (Warell & Nåbo, 2001)

3.2.7. Product portfolio

Consistency is needed to create an identity because it helps to show visual difference from competitors (Karjalainen, 2010). “Family resemblance” is preferred above the distinctive appearance of individual products. That is, you buy “an Océ copying machine,” not “a 3165,” just as you might buy “a BMW” (Stomppf, 2003). Warell and Nåbo (2001) says that companies designing and producing a range of products, e.g. a product family, have to consider the design of the products and the product family together in order to maintain a clear and unambiguous identity on the market. Consistency becomes hard to use with many models in the portfolio, when having products in many market segments for example (Karjalainen, 2010). A more flexible application of the design philosophy is then needed. When a brand portfolio contains only a few models the importance of a single product becomes greater. Every model then have a great impact on brand recognition and the design will have high significance for the Brand Identity.

If the brand operates in a mature product category, with established technical solutions and a stable brand image, consistency over the portfolio is preferred according to Karjalainen (2010). It is also beneficial with consistency when the renewal cycle of products is long. Consistent use of explicit design features is also appropriate for niche brands and new brands that focus on a limited number of market segments. If the brand has a strong heritage there might be a greater need of consistency in the portfolio, and a greater potential to achieve it by referring to iconic designs from the brand’s past. Repetition can create boredom and reduced attention of the brand values expressed by design. Balance between renewal and consistency is therefore important to sustain the visual recognition of the brand. (Karjalainen, 2010)

3.3. The ergonomic aspect

3.3.1. Introduction

Ergonomics, or Human Factors as it is sometimes called, is defined by International Organization for Standardization as: “The application of scientific information concerning humans, such as behavioral and biological information, to the design of objects, systems and environment to ensure their safe, efficient and convenient use by people.” (ISO, n.d.)

In order to get successful products they must be designed to suite the users.

3.3.2. Anthropometry

Anthropometry is the branch of human science that concerns body measurements, in particular measurements of body size, shape, strength and working capacity. To know which dimensions that suite a population the best and to see where adjustments are necessary, anthropometric data is available. It is common to aim on letting the product fit 90% of the population. Then the product should fit persons with measures between the measure for the 5:th percentile and the 95:th

percentile. To decide on design limits and criteria the population and its characteristics must first be defined. (Pheasant, 2003)

Two anthropometric measures are especially important for the products being developed in this project. These are the hand length and breadth in order to provide an ergonomic grip of the products, see figure 3.4. Of the affected markets the biggest hands found in the book *Bodyspace* (Pheasant, 2003) are British 95:th percentile men 19-65 years. The hand length for them is 205 mm and the hand width is 95 mm. The smallest hands are US women 5:th percentile 19-65 years. The hand length for them is 160 mm and the hand width is 65 mm.

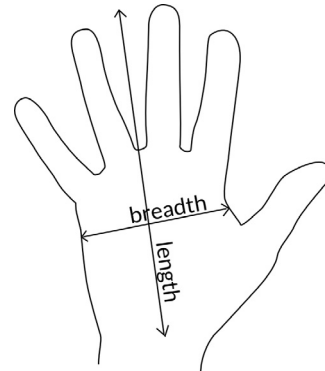


Figure 3.4 Hand measures

3.3.3. Guidelines

There are some guidelines applicable on PDA's.

Sharp edges and other surface features which can cause pressure hot spots when gripped should be eliminated. Finger shaping is one of those and should not be used. It is also important that the users are not cutting themselves on sharp edges, like parting lines without radii. (Pheasant, 2003)

Surface quality should not be so smooth that it is slippery nor be so rough that it is abrasive. The frictional properties are complex because they change when the hand gets wet or lubricated or when gloves are used. (Pheasant, 2003)

3.4. The technical aspect

Within the technical aspect there are areas like the product's technical function, construction, production and environmental impact. This project has not covered this area more than briefly.

3.4.1. Plastics and injection molding

Injection molding of plastics is a common manufacturing method for housings. A melted plastic is injected into a mold, taking the shape of the mold. When designing for injection molding there are some guidelines available that are useful when dealing with the external design of the housing.

A texture can hide manufacturing defects as knit-lines, blemishes and scratches during use. It can also give a better grip. (Kazmer, 2007)

Sharp corners should be avoided since they will result in stress concentration and less torsional stiffness. They also produce an uneven heat flow when the plastic solidifies, which may cause shrinkage and warpage. The guideline is that the inner radii shall be $>50\%$ of the wall thickness, see figure 3.5. (Kazmer, 2007)

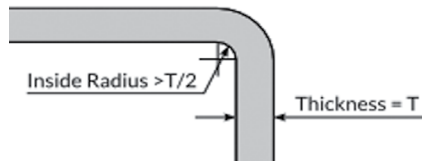


Figure 3.5 Minimum radius

Minimum draft angle is $\sim 1^\circ$ (Kazmer, 2007). With textures the needed draft angles increases. A simple rule for determining the draft is to count $1.5^\circ - 2^\circ$ per $25\mu\text{m}$ in texture depth (Mold-Tech, n.d.). A smooth sand texture can have a depth of $\sim 50\mu\text{m}$, while a more distinct structure like leather often has a depth of $\sim 125\mu\text{m}$ (Kazmer, 2007).

An Undercut is a feature that will not allow the mold to slide away. When they are needed because of the design it requires more advanced molds with side-cores or internal core lifters. (CustomPartNet, n.d).

3.5. Chapter discussion

As stated in '1.3 Limitations' the work in this project have been focused on Ergonomics and communication of Product characteristics and Brand Identity. The specifications for the products were already set from the beginning, but some technical aspects such as the limitations of injection molding have

been taken into account.

Besides the technical specifications the first user studies highlighted ergonomics as the most critical aspect. The products being developed are professional tools and do not have the same need of cosmetic styling as a consumer product. The products must suit the users' anthropometrical measures, be efficient and not create any kind of discomfort for the users. Tests were later carried out to evaluate the ergonomics of the products.

The theory about communication states that it is important to think about each communicative aspect of a product. Therefore not only the aesthetic impression of the products will be taken into consideration but also semantic interpretation and symbolic association. All these three areas are important in order to let the product fit into its area of use and suite its specific users.

Handheld is a leading manufacturer of rugged PDAs and computers, however their product portfolio lacks of consistency. This is because Handheld have not designed all products by themselves; some are rebranded products from other companies and some of Handhelds own products have been designed to be able to easily rebrand them. According to the theory a consistency is needed to create a strong identity.

Focus will therefore be on developing Handhelds brand identity by identifying the most important design cues, modernize but still create minimalistic designs to avoid cluttered products. How a product is perceived and experienced depends a lot on the human senses. Properties of a product that is experienced by senses should be taken into consideration when designing. That is important in order to create congruence in the information perceived by the senses to get the desired product experience.

4. Prestudy

There is much information that has to be gathered in order to be able to design a product that fulfills its purpose and satisfies the users' demands. In the prestudy phase all necessary information were gathered and analyzed. The information gathered was then structured. The primary outcome was a list of requirements for each of the products, Nautiz X7 and X6. In addition to the list of requirements the prestudy resulted in documentation of the users with personas and scenarios and Product characteristics describing the desired expressions of the products.

4.1. Process

4.1.1. Information from Handheld

Regular meetings have been held with Handheld since the startup of the project. Handheld has provided information on the intended market for the Nautiz X7 and X6 as well as on their customers within these markets. Further Handheld has described some typical use cases, needs and possible improvements of the present Nautiz X7. Each meeting has been documented with notes about Handheld's feedback.

The RFP's sent to the ODM has also been available for the project team. The documents described the products' technical requirements. The most important things described by the RFP's and added to the list of requirements were which functions and components the products should have, maximum size and size of the display.

4.1.2. Handheld's Product characteristics

During the meetings with Handheld several words describing the expressions of the new Nautiz X7, so-called Product characteristics, were mentioned as important. Product characteristics is a common tool to verbalize and simplify what the products should express. To make a systematic study of the desired Product characteristics Handheld's managers were shown a list of possible words, from which they had to choose the ones that best described the product's intended values. The chosen words were then discussed, combined and developed into three Product characteristics. These three words were confirmed by Handheld and later on confirmed as important by the users in the User studies.

The Product characteristics for the Nautiz X7 were chosen to be Tough, Professional and Premium. Tough were obvious since the main priority regarding Handheld's products is that they must withstand outer strains. Professional means that their products are not toys but tools used by professionals. Premium stands for Handheld as the world leading company providing high-tech products with high quality, attention to details and everything packed in a sophisticated way.

For the Nautiz X6, made for another company, Product characteristics have not been specifically studied, but the three words Tough, Professional and Premium are applicable to that product too since it partly shares use areas with the X7.

4.1.3. Moodboards and Sample box

Moodboards are good when trying to explain or visualize a design idea or feelings that are hard to communicate (Creative

Bloq, 2013). They consist of a collection of images related to a design theme. Two Moodboards were created; one with focus on the products' contexts and one with focus on the products' expressions. In the Context Moodboard several pictures of the contexts and their strains were placed, see figure 4.1. This helped to get an understanding of the strains that the products have to deal with. The Expression Moodboard was constructed using the Product characteristics. This helped to create inspiration about the visual features that express the Product characteristics. Examples shown in the Expression Moodboard, see figure 4.2, are attention to details from the car industry, slim/compact products, tools for a professional look, several products expressing robustness with protections on them and shapes or surface textures.



Figure 4.1 Context Moodboard

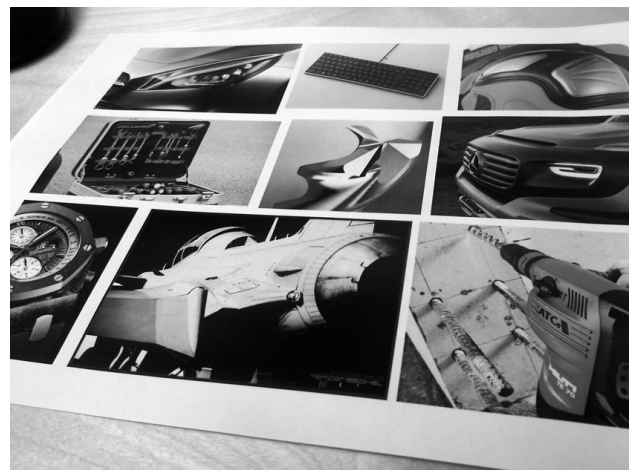


Figure 4.2 Expression Moodboard

In addition to the Moodboards all kinds of inspirational images were collected in a Sample Box, see figure 4.3. Most of the images in the Sample Box were products used in the same context as the Nautiz X7 and X6. They might have characteristics or details that can give inspiration for the products being developed.

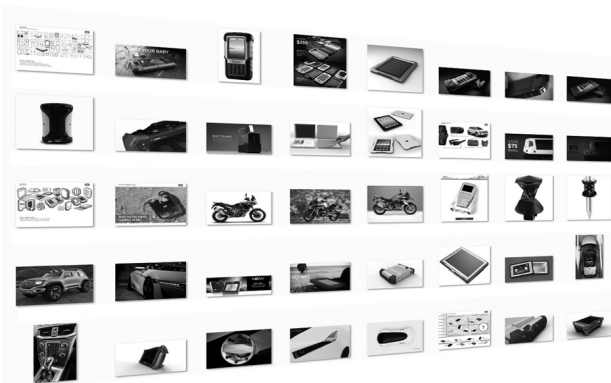


Figure 4.3 Sample box

4.1.4. User trip

A User trip was carried out on the current Nautiz X7 to get to know the product. Things studied were ergonomics, visual appearance, functions and usability. In a user trip a product is used in an aware and critical state of mind to identify improvements that could be made (Cross, 2008). User trips can generate many ideas for improvements but suffer from some shortcomings. For example a product can have many different users and it is difficult to take the viewpoint of a user who has a different role than the team members. Mistakes can be made that an experienced user would not have done which means obtaining the wrong impression of the product.

At first the product looked big and clumsy, like a brick. This feeling was confirmed when holding it. As it is quite wide it is hard to get a good grip. The buttons were hard and stiff and gave little feedback. As the display is immersed it is hard to reach its corners. The product looked robust but there were big plastic areas which made it look cheap. A requirement added exclusively from the user trip was to make more ergonomic buttons with better feedback.

4.1.5. Competitor study

Handheld provided a list of products competing with the Nautiz X7 and the future Nautiz X6, see section '2.4 Competitors'. A study was made on these products, mainly concerning aesthetic impression and semantic interpretation. One of the main competitors of the Nautiz X7 was available for testing; the other models were evaluated through pictures, videos and data sheets. With this method positive and interesting details were identified, but also things that should be avoided.

The physical testing was made on the main competitor to the current Nautiz X7 called Trimble Nomad, see figure 4.4. It was noticed that the function button is easier to find since it is clearly marked with a yellow field that connects to the yellow icons on the buttons. It has a black frame around the display which removes the impression of a small screen thanks to less yellow casing at the sides. Another interesting thing noticed was that the smaller buttons compared to the Nautiz X7 actually worked good when testing. Doubtful concerns were raised about the green and yellow colors on the keypad. One point of view was that it does not look that modern. Regarding the basic shape the hourglass shape with thick ends and a straight

top and bottom makes the product look heavy in the ends. It leads to an unpractical and unbalanced expression as a lot of the weight seems to be at the ends.

The Nautiz X6 has its main competitor in the Trimble GeoExplorer 6000, see figure 4.4. It has consistent colors and a rubber protector all around the sides. The black rubber makes the antenna part look integrated and more well designed than on some other models who loss this integration. The tapered shape of the antenna makes it look lighter. A big disadvantage is that the product is thick: 56 mm. An interesting thing is that it does not have any navigation buttons, maybe the intention is that the screen should be used to a high extent. The camera button is placed in the middle which must mean that it is an important feature that is used often. The status LED's have labels which might be good to have if the space is available.



Figure 4.4 Trimble Nomad (Trimble, 2013a) and Trimble GeoExplorer 6000 (Trimble, 2013b)

4.1.6. User studies

User studies were carried out to find out the use of the existing Nautiz X7; what the users think about it as well as what they want to improve. At large the other model, Nautiz X6, is used in the same way and by the same kind of users as the Nautiz X7, and the user studies are therefore applicable on both models.

The Nautiz X7 is one of Handheld's flagship models and is used in most of the more tough use areas in outside environments, see section '2.2 The product family'. While the Nautiz X7 is a product with many use areas the Nautiz X6 is specifically made for GIS/mapping. Nautiz X6 is mainly used by municipalities, utility companies and construction management who need decimeter accuracy. For both models the users are professionals who use the products as tools in their everyday work. Another important user category is the purchasers, who decide which product to buy.

The data has been collected with a combination of interviews, questionnaires and field studies. Mostly qualitative methods were used since there are a limited number of users available in the region. The information gathered in the User studies was later on translated into Personas, Scenarios and parts of the Lists of Requirements.

To investigate the requirements both from users in extreme environment as well as from users in an environment with less strain the interviews were held with two different user categories. Those were GIS users who works in tough outside conditions, and service technicians who mostly use the product indoor and more occasionally. GIS workers have certain needs, while the ones using the device mainly indoors have other needs. These two focuses provided a broad area of requirements that reflects the X7:s wide area of use. The X6 is specifically made for mapping, however most of the requirements were applicable on both products.

Six users participated in the user studies. Two were service technicians using the PDA when documenting and managing their job. One was an expert in GNSS/GPS systems using the PDA when collecting data from a total station. His job was to test PDAs for Svensk Byggnadsgeodesi (SBG) who provides solutions for measuring in field. Two GIS workers who worked on construction sites were also interviewed and observed while performing real measuring in field. Finally a manager was interviewed. He recently had to choose between the Nautiz X7 and the main competitor product, Trimble Nomad.

The interviews were structured around ergonomics, aesthetic impression, semantic interpretation and usability. A semi-structured approach (Lantz, 2007) was used which means that the questions were used to proceed with the discussion and not forget anything. The interview questions are available in Appendix I. Details and different functions like the camera, handstrap and buttons were discussed but were involved in the main questions.

In combination with the interviews a questionnaire was used to get feedback on the aesthetic impression and semantic interpretation since that was a hard subject to discuss without aid. In the questionnaire the product was graded on how well it related to the Product characteristics and if the design enhanced, weakened, or did not at all affect the expression related to each Product characteristic. After this grading it was possible to discuss why the users thought as they did and identify which specific details on the product that affected it. The questionnaire can be seen in Appendix II.

The interviewed users were observed when they used the product. The interaction was documented with photos in order to remember the context, environment, how the product was hold, the use of the stylus and other details, see figure 4.5.

Nautiz X7

Most of the users said that the current Nautiz X7 is good enough for their job. However the GIS workers sometimes had a hard time to use it since they now and then need to hold and use the PDA with one hand. The present X7 is too large for using with one hand, and a responsive display is hard to use with fingers. Its display brightness was bad and the display and display protector got scratches. The most important aspects, according to the users, are the function and ergonomics of the product. It does not have to be nice looking, just be easy and comfortable to use and withstand strains.

Nautiz X6

The use situation of the X6 model is limited in a higher degree than the use of the X7. There were no product similar to the X6 in use, but the two users interviewed were both construction site supervisors and within the range of possible users.

4.1.7. Ergonomic studies

Clay models were made to let different persons test the physical ergonomics of different sizes and shapes. This was done in house with Handheld personnel. The main thing tested was how the product felt in the hand when holding it. Important aspects when studying this was how convex the product should be on the sides and the backside and also which shape the section view of it should have, see figure 4.6.

The width on the clay models differed which made it possible to compare and evaluate which was the best. Also the concavity, roundness and thickness differed slightly. A range of people tested the clay models. The range was from people with big hands representing the 95:th percentile to people with small hands representing the 5:th percentile, according to measures presented in chapter '3.3 The ergonomic aspect' The current X7 was also compared to the competitor product Trimble Nomad. Trimble Nomad is more rounded and has more concave sides which was preferred, see figure 4.6.



Figure 4.5 Examples of documented interaction with the products and their context

The study showed that the products should not be too wide and the sides should be more concave than on the current X7. The absolute minimum width, due to technical limitations, was 70mm at the waist of the products. That was the most pleasant width of the ones tested. 75 mm was also feasible, but when the model was 80 mm it felt too wide. The most comfortable section shape found in the ergonomic studies can be seen in figure 4.6.

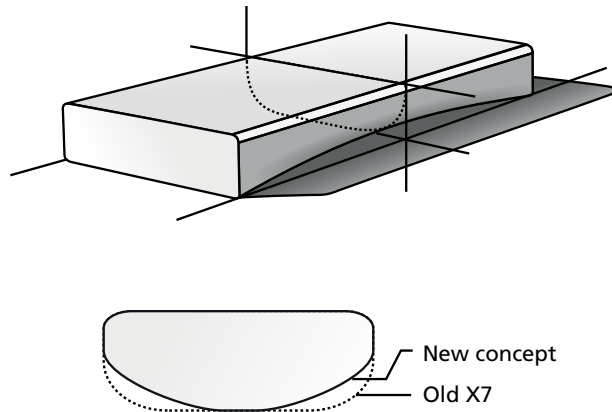


Figure 4.6 Concave shape like Trimble Nomad, and the most comfortable section shape

4.1.8. Design Format Analysis

When evaluating the explicit Design Cues of a brand the method Design Format Analysis (DFA) can be used. The method explores the occurrence of different design features among a brand's product portfolio. Features that are considered to be most important for visual recognition are selected by studying the products. The company might also have defined Design Cues for the brand. Selected products are then examined to see if they have these features or not. The features

and products are then ranked to see their importance for visual recognition, the most typical product and most typical feature. The result is qualitative and potentially biased which means that a DFA has its strongest contribution in boosting discussions about a brand's visual recognition. (Karjalainen, 2007)

Nautiz X7

Handhelds products were studied and analyzed with the method Design Format Analysis to find out how they connect to the product family. Several explicit Design Cues were found, see table 4.1. The DFA is attached in Appendix III.

Most of the Design Cues were value-based which meant that they were used to express some important Product characteristics. Nearly all of these design cues contributed to the expression of the Product characteristics (Tough, Professional and Premium). Those Core values were chosen when developing the X7 and applied for the entire Handheld product portfolio. However different products have to express the Product characteristics to different degrees. It depends on which context a product is used in. If a product is used outside for example it must express and fulfill the tough core value to a higher degree compared to a product used indoors.

The DFA showed the products with most Handheld characteristics and the design cues that was used the most, see Appendix III. The products with most Handheld design cues were the tablet Algiz 10X, the mobile phone Nautiz X1 and two of the PDAs, the Nautiz X3 and X7, see figure 4.7. One thing noticed was that the newer products, the tablet Algiz 10X and the mobile phone Nautiz X1, have a new design cue which is a black backside. Otherwise there were not any big differences between the products. The PDAs and the mobile phone have extra black rubber at the top which is not that suitable for a tablet because of its size. The other difference is that the tablet lacks triangular embossed lines.

Table 4.1 Handheld design cues

	Design cues	Output
1	Front in light gray	Distinguish
2	Back in black	Slim look, less dirty
3	Black rubber details	Robust
4	Black keypad	Usability
5	Black buttons	Robust
6	White icons	Good usability
7	Convex/concave basic shape	Ergonomic
8	Rubber bumpers on 4 corners	Robust
9	Extra rubber at the top	Robust
10	Embossed lines on bumpers	Robust
11	Logo on face of product	Distinguish
12	Model name on face	Distinguish
13	Triangular embossed lines	Robust
14	Structure on surface	Robust



Figure 4.7 Algiz 10X, Nautiz X7, Nautiz X3 and Nautiz X1

However as most methods the DFA was an additional tool to explore the products and their design cues. When just looking at the products the result in the DFA did not completely conform. Handheld's laptop did for example highly express a Handheld look, while the mobile phone Nautiz X1 did not. It does not matter how many design cues a product has but which design cues that express Handheld the most. A conclusion is that all design cues does not have to be used, but the ones who are used should be used clearly. Additionally nothing should go against the design cues.

Many of the design cues were used in most of the products. The Handheld logo is red-orange and placed inside a rectangle with round edges on most products. The model name is placed on the face of all products. Other strong characteristics are the black rubber details with embossed lines, black keypad, black buttons with white icons, light grey upper casing, black lower casing and angled lines.

When looking at the product portfolio in the DFA it was seen that Handheld have a good consistency to create recognition. However some products are old and some are developed together with other companies or rebranded, which means that

these products are not that strongly connected to Handheld's design language.

Nautiz X6

In the same way as for Handheld a DFA was made on the product family where Nautiz X6 will be included. The Design Cues found are presented in Table 4.2 and the DFA is attached in Appendix IV.

4.1.9. Personas and scenarios

Scenarios were created, describing how a product might be used by different users. It means constructing storylines of the user's lifestyle and requirements (Cross, 2008). First the potential user personas were identified. This was made with help of the user studies and also with help of Handheld that provided information about the users. A user persona is a hypothetical but well-defined particular user and act as imaginary examples of real users (Cross, 2008).

Two personas and scenarios were created for the Nautiz X7 and one for the Nautiz X6. However some information gathered about the X7 can be applied on the X6 as the use areas intersects. Below is a summary of the personas and scenarios.

Table 4.2 X6 design cues

Design cues	
1	Convex/concave basic shape
2	Curve line
3	Green color
4	Black rubber details
5	Smooth rubber details
6	Red navigation, windows and on/off buttons
7	Logo on face of product
8	Black button icons
9	Grey button area
10	Grey buttons



Figure 4.8 Jörgen (Sänerland, 2007)

Jörgen

42 years old, Swedish

Service technician

Jörgen (figure 4.8) is single and lives in a small town in his parents' old house. He likes ice fishing, has a boat and gamble on horses with his friends. He is a bit technical interested and likes Biltema.

Scenario 1

It is Monday and Jörgen drives the service car from his home to Dafgårds, Källby, for his first job for the day. A 7 ton forklift needs service. Jörgen brings his bag with his computer, special tools and his Nautiz X7.

He types the trucks ID number into the software. Everything seems ok with earlier service checks on the forklift. When he troubleshoots with the help of the computer he identifies a problem in one of the electrical components which needs to be replaced. Jörgen again uses his Nautiz X7 and the service company's software to order the component. Jörgen cannot do much without the part so he sits down at the coffee table and writes the hours he has spent on this work into his X7. After this he checks the schedule and goes to the next client.



Figure 4.9 Mick (Punch, 2008)

Mick

62 years old, Australian

Surveyor

Mick (figure 4.9) lives with his wife in a house just outside Melbourne and he has two grown up children and even a grandson. Every year he and his wife go on a long travel to enjoy the sun and relax. He owns a Ford F-150 pickup which he uses to get to his work.

Scenario 2

Mick's job is to measure if the floors and walls are positioned in line with the blueprints. He uses his PDA, the total station and a small reflective prism. In one hand Mick holds the prism, and in the other hand the PDA. In this way he can control the total station from the PDA, and also see all the saved measurement data. Sometimes the sunlight shines directly on the screen and makes it hard to see, since the screen has bad brightness and is quite scratchy. He does not use the touch screen since he often has dirt, dust or concrete slurry on his hands. He also has a hard time to trust new technology and wants good feedback when he presses something.



Figure 4.10 Jenny (Nikolov, 2010)

Jenny

26 years old

Provincial government inspector

Jenny (figure 4.10) is a happy and environmentally conscious environmental inspector, living in an apartment in Gothenburg with her boyfriend. She likes physical training and to hang out with friends.

Scenario 3

It is Friday and Jenny is longing for the weekend. She mostly works in an office but today she is going to do one of her frequent mapping inspections. Today's task is to mark out protected trees in a nature reserve area. Unfortunately it is raining outside. Jenny has small hands and the PDA is large which makes it uncomfortable to use. A map is shown in the scratchy display and it updates as Jenny goes around marking out the trees. The points are found although trees sometimes disturb the connection and the brightness of the display is bad in the light outside.

4.1.10. List of Requirements

The List of Requirements for the two products consists of all found requirements. Most of them come from Handheld or the User studies.

Nautiz X7

A short version of the requirements list for the Nautiz X7 can be seen in table 4.3. For the whole list see Appendix V. The requirements were divided into Form and Appearance, Technical and Ergonomics.

Nautiz X6

The list of requirements for the X6 was divided in the same way as the one for the X7 into Form and Appearance, Technical, and Ergonomics. A short version of it can be seen in table 4.4. For the whole list see Appendix VI. The requirements were basically the same as for the X7. A difference was that the X6 was more specified in the brief; e.g. each specific button on the keypad was set.

4.2. Chapter discussion

All the data collection and data analysis methods in the Prestudy have both advantages and disadvantages. Because of the disadvantages it is important to combine results from different methods. In this Prestudy may e.g. the information from Handheld about user needs be supplemented by data from the User Study.

The risk of misinterpretation and misuse of the result is reduced when it is used with a critical mindset. This chapter discussion will highlight which result that is reliable and which has to be carefully used.

4.2.1. Discussion of the different methods

It is important to remember that the Product characteristics and the interpretation of the products' expression are something personal and depends on the user's background and experience. Another important thing to know is that the method of using Product characteristics is focusing on just a limited set of words. Other Product characteristics may have some importance too.

There is a risk that the features and expressions showed in the Expression Moodboard are not interpreted in the same way by every person. One way of controlling the reliability would have been to do a User study. That was not of high priority due to time constraints, but might have changed the Expression Moodboard slightly.

User trip is difficult to use as a source to requirements since there is no possibility of covering all the users' viewpoints. Fortunately there is just one requirement from the User trip: the requirement of flat buttons. The doubtful method is one reason for categorizing the requirement as "wish" instead of "demand".

A big focus in this project has been the aesthetic appearance of the products. That is something that users have a hard time to verbalize. The questionnaire that was used in the User study

Table 4.3 Short List of Requirements for Nautiz X7

ID Requirement		Metric
Form and appearance		
1	Maximum size	179x97x37
2	Maximum width	<75 mm
3	Preferred width	<70 mm
4	Match Handheld's brand identity	
5	Reflect the Core values/Product characteristics	
6	Consider functional surfaces	
Technical		
7	Preferred display size	4.7 inch
8	Avoid water and dirt collection on the screen	
9	Provide stylus	
10	Designed for double injection molding	
11	Expected lifetime	3-5 years
Ergonomics		
12	Feedback both for where the button is and when it is pressed	
13	Suit both left and right handed, eg Enter button	
14	Rounded backside	
15	Larger stylus than for present X7	min 11.2mm x ø4mm

Table 4.4 Short List of Requirements for Nautiz X6

ID Requirement		Metric
Form and appearance		
1	Maximum size	200x90x35
2	Maximum width	<75 mm
3	Preferred width	<70 mm
4	Consider functional surfaces	
5	Smallest possible size that includes all features desirable	
Technical		
6	Preferred display size	4.7 inch
7	Avoid water and dirt collection on the screen	
8	Provide stylus	
9	Front camera	
10	Possibility to attach a handstrap	
11	Expected lifetime	5 years
Ergonomics		
12	Feedback both for where the button is and when it is pressed	
13	Suit both left and right handed, eg Enter button	
14	Rounded backside	
15	Larger stylus than for present X7	min 11.2mm x ø4mm

was a good way of aiding the discussion. Not only direct users of the product were interviewed. One manager, responsible for purchasing, was interviewed. He might have had other demands, but it is important to consider that kind of users too since they are the ones buying the product.

Usually 15±10 persons needs to be interviewed in order for the result in a study to be reliable (Kvale, 1997), but the number depends on the product. The Nautiz X7 is a product used in a variety of ways, and 6 persons interviewed is in danger of unreliability. A possible effect may be missed demands or an excessive focus on service technicians' demands. However most of the demands were general in its nature, and not restricted to a specific type of user. The most important demands have probably been found since that is what users usually mention when questioned about demands (Bergman & Klefsjö, 2010). At the same time some not that obvious demands might have been missed.

In the clay model ergonomic study the test persons could immediately communicate what they felt. Therefore this study might have worked well with more details included. There are no immediate risks that the result is incorrect since it was easy for the test persons to communicate their thoughts. One possible source of error could be the weight of the clay models. The real products' weight might not have been represented and the weight might also have differed between the clay models.

It is doubtful if the right design cues have been chosen to be studied in the DFA. However the DFA method has its weaknesses and the risk of incorrect choices of design cues is one of them. That is why a DFA is preferred to have as a base for discussion. The design cue study could have been developed to

investigate how Handheld distinguish from competitors, but that was realized too late.

The breakdown of demands and wishes in the Lists of requirements was done by feel, as a hint. That is something to be aware of. How important the requirements are is something that has to be discussed later if they have to be weighed against each other.

4.2.2. Summary and Implication

Overall the result from primarily the user studies is statically quite weak. Some things might have been missed. However the Lists of Requirements is rigid as most of the requirements have been confirmed in several studies or by several sources. The fact that these products have many use areas means that compromises might have to be made regarding some demands. Probably the most important demands have been found, and made it possible to make a broad product good for many things but not perfect in every specific situation.

The X6 is not as broad in its area of use as the X7. However the focus has not been the X6, which is why more studies about it have not been carried out.

The result of the exploration phase is compilations of all the studies and methods used that will serve as something to rely on during the whole project. Gathered information about users was compiled into personas and scenarios and each demand and improvement that could be made on the products were gathered in a Lists of requirements. Moodboards and a Sample Box were created to provide inspiration in the next phase of the project - idea generation.

5. Conceptualization

5.1. Introduction

The idea generation process started wide and got narrower towards the end where one concept of each product, Nautiz X7 and X6, were created. Tools from the Prestudy, such as Moodboards and a Sample Box, were used in the beginning of the conceptualization phase. Both free sketching and a methodical process were done in parallel. Ideas and concepts were presented to Handheld and evaluated. Concept selection was made with help of Handhelds feedback, the Product characteristics, the Lists of Requirements and a concept selection matrix. Clay models were used to test the different concepts regarding size and ergonomics. In the end the concepts were refined to the final concepts presented in Chapter 6.

5.2. Idea generation

Free sketching and structured idea generation methods were done in parallel in order to cover wild and crazy ideas as well as small variants of the simplest basic shapes. The result from the free sketching was used in the methods. In the same way was the result from the methods used as inspiration for the unstructured sketching.

The Moodboards were used to get inspiration about how the products could look to express the desired Product characteristics. To get more inspiration a Sample Box was used. The Sample Box consisted of pictures with different interesting aspects, solutions and details that inspired in the idea generation process. The Design Format Analysis was also used for inspiration.

A subset of the Sample Box was created with products within the same product family as the Nautiz X6. This gave information about the brand's visual identity. The Design Format Analysis for this brand was also important for getting familiar with the design language later on applied in the idea generation.

5.2.1. Methodical procedure

Nautiz X7

The methodical approach started with an analyze of the

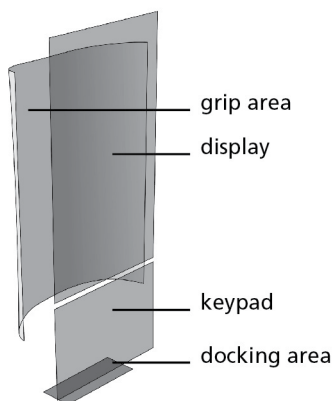


Figure 5.1 Basic functional surfaces for Nautiz X7

product's basic functional surfaces. They were found being the display, keypad, grip area and the dock area with the connections, see figure 5.1. Those areas have to be in specific places and have their specific measures, but everything between them could be designed. The main opportunity for a change in the functional surfaces is to either have a straight keypad or make it angled, see figure 5.1.

Different basic shapes of the front view of the product were sketched and then further developed in a vector application, see figure 5.2. The different shapes went from slightly bend curves to more extreme ones. In addition to the basic shape of the whole body the shape of the bumpers were systematically varied. The ideas were then evaluated in the aspects of ergonomics, aesthetic impression, semantic expression, and the relation to Handhelds current design language.

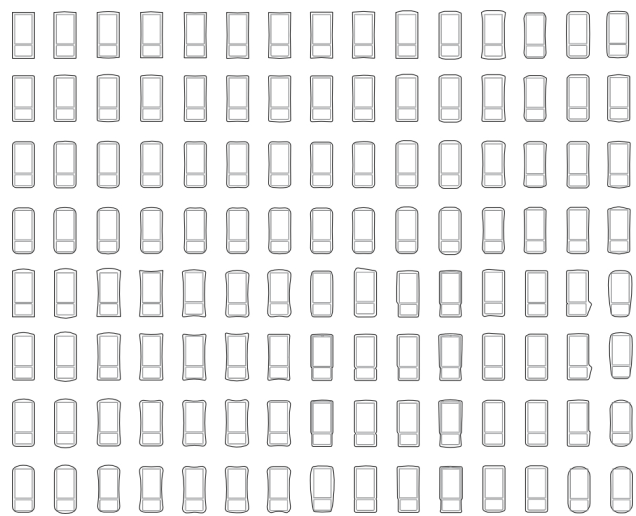


Figure 5.2 Basic shapes for Nautiz X7

Nautiz X6

A difference with the X6 compared to the X7 is that it has one more feature and functional surface: the antenna, see figure 5.3. Therefore the basic shape differed compared to the X7.

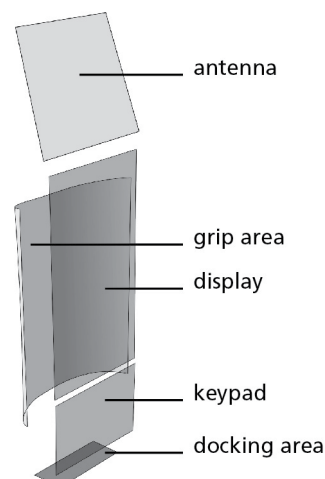


Figure 5.3 Basic functional surfaces for Nautiz X6

To vary the functional surfaces the keypad can be straight or angled like on the X7. The antenna can be placed either vertical or horizontal inside the casing.

Different basic shapes were generated for the X6 model, in the same way as for the X7. It was further studied how to connect to the X6 brand's identity. The bumpers and other details like the keypad and antenna area were systematically varied. As with the X7 the ideas were then evaluated against ergonomics, aesthetic impression, semantic expression, and the relation to its brand's current design language.

5.2.2. Free sketching

The free sketches were developed in sessions where all different kinds of ideas were sketched down without criticizing. Those sketches could be inspired by other tough products. Most of them were more detailed than the simple shapes created in the methodical approach. The sketches had annotations on key features if there were interesting details that could be considered. See figure 5.4 for examples.

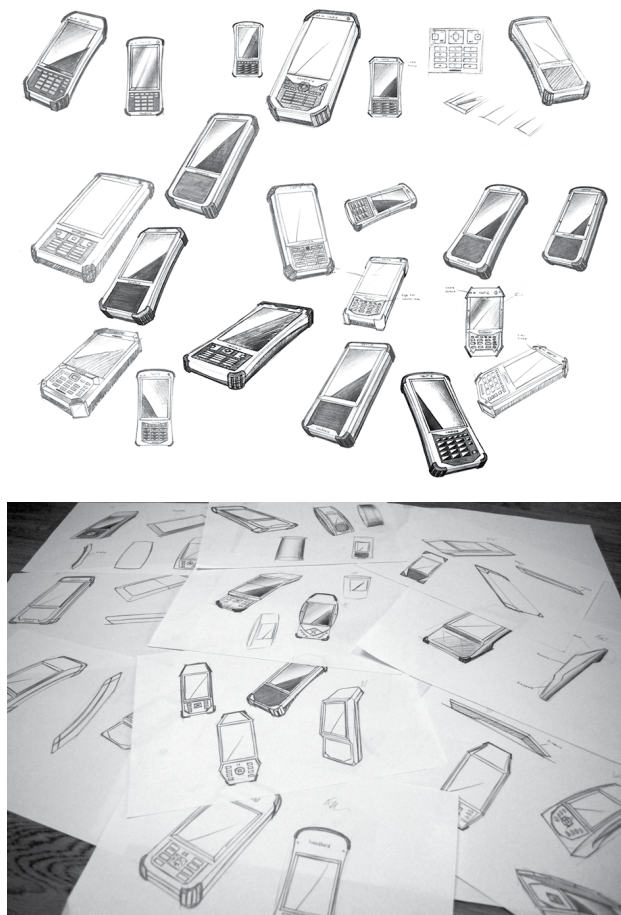


Figure 5.4 Free sketching

5.2.3. CAD-supported sketching

With simple CAD models the basic shapes could easily be visualized in 3D and discussed. The CAD models also acted as a base when sketching. The models' wireframe views were printed out and sketched over with marker pens, see figure 5.5. This sped up the sketching time and made sure that the proportions were right.



Figure 5.5 CAD-supported sketching

5.2.4. Combination

The ideas from the free sketching, the methodical sketching and the CAD-supported sketching were combined to create several basic concepts. The details like the button layout on the keypad and exact shape of the rubber bumpers had not been taken into consideration into those basic form concepts. There was a review with the Lists of Requirements to see if the ideas were reasonable.

5.2.5. Ideas

Nautiz X7

The first ideas of the X7 were a lot connected to Handhelds design language, and the basic shapes were similar to the ones that the current X7 has, see idea 1 and 2 in figure 5.6. The sides are concave while the top can be either convex or flat. All corners are rounded and there are bumpers in all four corners, on top of the product the bumper goes all the way, following one of Handheld's explicit Design Cues.

Some variants of this first basic shape idea was developed, see idea 3 and 4 in figure 5.6. One variant has chamfered corners instead of round, as an index to express ruggedness. A lot of products in the Sample Box had angled edges for a robust look. Another variant of this first basic shape idea is a cut on each side between the display and keypad. This was made to explore if it would make the product look more compact or shorter.

Another idea was to further enhance the tough and edgy look by chamfering all edges, see idea 5 in figure 5.6. This idea also has visible screws to improve the high-tech look by showing the hardware.

The next idea has an oval shape inspired by Apple's iPod Nano 4th generation, see idea 6 in figure 5.6. The whole product is oval, seen from the top view.

The last two ideas have slanted top and bottoms, see idea 7 and 8 in figure 5.6. This was made to give a more dynamic and slim look.



idea 1



idea 2



idea 3



idea 4



idea 5



idea 6



idea 7



idea 8

Figure 5.6 Nautiz X7 concepts



idea 1



idea 2



idea 3



idea 4



idea 5



idea 6



idea 7



idea 8



idea 9



idea 10

Figure 5.7 Nautiz X6 concepts

Nautiz X6

The first ideas of the X6 have some relations to some of the ideas of the X7. This was made to see how it looked as the products are similar. The first ideas are the simplest ones with Handheld's design language in mind, see idea 1 - 4 in figure 5.7. They have a bigger area on top of the screen where the antenna is placed.

Next up are ideas that are inspired by the design language of the company that the X6 is specifically made for. They basically use a lot of curved shapes. One idea is a simple convex shape with bumpers at the top, see idea 5 in figure 5.7. The curved shape, found in the DFA, has inspired to the curve on the antenna and also to the area around the display and the buttons.

An idea that has more straight lines, no bumpers and no sweeping line around the display and buttons were also developed, see idea 6 in figure 5.7.

Another idea is similar but has the sweeping line around the display that goes through the buttons, see idea 7 in figure 5.7. It is also chamfered in the corners and do not have the sweeping line on the antenna.

Next idea has bumpers both on the top and the bottom and the curved line is only used around the display and buttons, see idea 8 in figure 5.7.

Concave sides were also tested, see idea 9 in figure 5.7. This idea was made to explore the balance of the product with these round shapes.

Finally a concept where the casing around the antenna and button areas are slimmer, see idea 10 in figure 5.7.

5.3. Idea evaluation

5.3.1. Handheld's feedback

The ideas were presented to Handheld in form of a presentation with a following discussion. It was explained that the presentation mainly considered basic shapes and did not went deep into details. The strengths and weaknesses of the ideas were also discussed; like how well they fit into the product families. The presentation gave a lot of feedback about which ideas that were the most interesting for Handheld.

Nautiz X7

Since the Nautiz X7 is not a new product, and is one of Handhelds most important ones, far too pioneering ideas were considered not suitable. The shapes that connected the most to Handheld's current design language were preferred to be applied on a new Nautiz X7. The iPod-shaped idea, as well as the ones with chamfered or too straight shapes differed from Handheld's design identity. The requirement "#6 - Match Handheld's brand identity" got a more precise meaning after this first presentation.

The cut on the waist that was a variant of the most conventional idea was interesting, see idea 4 in figure 5.6. It was

decided that it should be further analyzed to see if the product looked shorter or longer with that feature, how it looks in 3D and how it affects the ergonomics.

The rounded/convex top shape of the product looked better than a flat top which gave the product a squeezed expression. Also the round bottom edges of the keypad were considered to fit Handheld's design language better than the edgy variant. Regarding the shape of the bumpers an empty spot/"forehead" above the display should be avoided, see idea 1 in figure 5.6.

The idea of having the keypad and the display in the middle and transfer the logo to the bottom of the product was considered good. Doing that way the most important features, the keypad and display, are located in the middle. It makes it easier to reach the buttons when using the PDA with one hand, and in addition it adds to the expression of professional, user friendly, premium and high-tech.

Nautiz X6

Regarding the X6 the product should not look like a product from Handheld. The sweeping lines that suite the other company's design language were appreciated. It was stated that it would be preferred to have rubber bumpers both at the top and at the bottom. Idea 8 in figure 5.7 had a bottom bumper that Handheld liked. They suggested that this bottom bumper should be integrated into idea 9 in figure 5.7. A curved outer shape was best as it fits into the product family. The round curve on the antenna area made the antenna look smaller, see idea 6 in figure 5.7. The brand logo was going to be placed on the antenna area. That was decided because it fits the design language and it was also proposed doing that way in the RFP document.

5.3.2. Idea screening with Kesselring matrix

After the presentation for Handheld a screening process began. To evaluate the ideas a Kesselring matrix (Johannesson et.al.,2004) was used. In the matrix six different weighted criteria was used, see table 5.1, all taken from the Lists of Requirements.

Table 5.1 Weighted criteria for Nautiz X7

Match Handheld's design language	5
Reflect Tough	1
Reflect Professional	1
Reflect Premium	1
Ergonomic grip	5
Smallest possible size	1

The criteria "Match Handheld's design language" got its high weight out of the discussion with Handheld after the first idea presentation. The three Product characteristics criteria are together of a weight of 3, proportional to the first criteria. The ergonomics is very important for this product, hence a 5. The last criteria is to do a product of smallest possible size. That is not that high weighted since the two criteria on an ergonomic grip and the premium expression already reward a compact size. The Kesselring matrices can be found in table 5.2 and 5.3.

Table 5.2 Kesselring matrix X7

Criteria description	W	ideal	1	2	3	4	5	6	7	8
Match Handheld design language	5	25	25	25	20	25	10	5	10	10
Reflect Tough	1	5	5	5	4	5	4	4	4	4
Reflect Professional	1	5	5	5	4	5	5	2	3	3
Reflect Premium	1	5	4	4	3	4	4	2	3	3
Ergonomic grip	5	25	25	25	25	25	20	25	10	10
Smallest possible size	1	5	4	5	3	4	5	1	3	3
total		70	68	69	59	68	48	39	33	33
Ranking			2	1	4	2	5	6	7	7

Table 5.3 Kesselring matrix X6

Criteria description	W	ideal	1	2	3	4	5	6	7	8	9	10
Match Handheld design language	5	25	0	0	5	10	25	20	25	25	25	20
Reflect Tough	1	5	4	3	3	3	3	3	2	3	4	3
Reflect Professional	1	5	4	3	4	4	4	4	3	4	4	4
Reflect Premium	1	5	4	3	3	4	5	4	3	3	5	5
Ergonomic grip	5	25	25	15	15	15	15	15	15	15	25	10
Smallest possible size	1	5	5	4	5	5	5	5	4	5	5	3
total		70	42	28	35	41	57	51	52	55	68	45
Ranking			7	10	9	8	2	5	4	3	1	6

As a result of the matrix and Handhelds feedback it was decided to further develop the two X7 ideas with basic shapes that were similar to the current X7 and the idea with cuts on the waist. They have clearly higher ranking in the matrix than the other ideas. The four highest rated X6 ideas were the same as the ones highlighted by Handheld as promising. Idea number 7 had been given an even higher value if it would have had bumpers which would have increased the tough expression. Therefore the four X6 ideas will be combined in order to find the best concepts.

5.4. Concept generation

The most promising concepts of the Nautiz X6 and X7 were further developed into three concepts for each product. Differences between these three concepts were just slight changes in the basic form, the bumpers, the keypad on the X7 and the antenna line on the X6.

Nautiz X7

A large amount of different shapes of the bumpers were tried out on the three concepts, see figure 5.8. They should provide a nice transition from the concave side to the perpendicular top and bottom. The bumper ideas were evaluated, and the most promising ones were applied to the concepts. The three Nautiz X7 concepts can be seen in figure 5.10.

The first concept is the most conventional one with rounded

edges both in the corners of the outer shape and the lower corners on the keypad. The only change on the next concept is the cuts on the waist; on the side between the display and keypad. This design was chosen because it was interesting in the way it makes the product look; possibly shorter. The last concept does not have the cuts. The difference from the conventional concept is the sharper lines on the lower corners of the outside shape and the lower corners on the keypad. This was made to improve the robust look with more sharp edges.

Nautiz X6

From the concept selection it was decided to combine four of the ten ideas into three concepts. As with the Nautiz X7 several bumper ideas were tested on these concepts, see figure 5.9. The result was the concepts shown in figure 5.11. As with the X7 the development of these three concepts consisted of another idea generation phase with focus on the design of the details. Different ideas for bumpers, button layouts and the grey area around the display were tried out.

The first concept is the most unconventional one by having a quite distinguished outer shape. The lower corners and the top antenna area are chamfered. The lower rubber bumpers do not go all the way around the product, just around the corners. Next concept is more towards a simple basic shape. The chamfers are not as extreme as in the first concept. The lower bumper goes all around the product and the antenna area has a curved line to enhance that Design Cue. This line was as well a way to make the antenna area look more compact

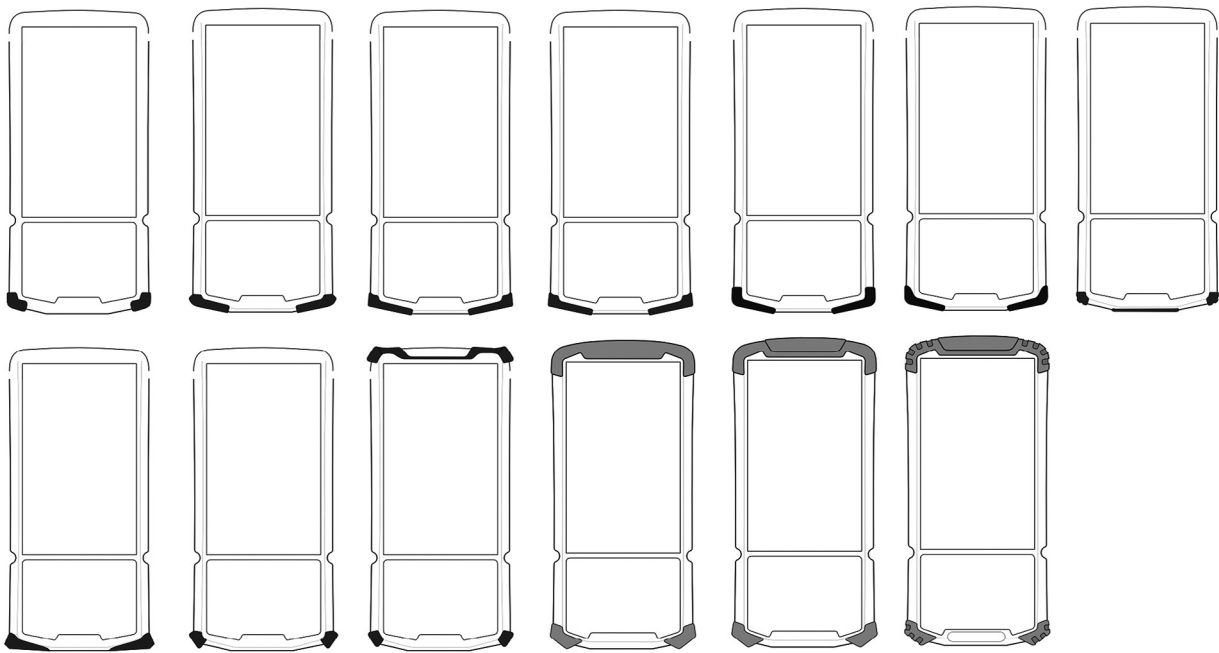


Figure 5.8 Examples on bumpers tested on the Nautiz X7 concepts

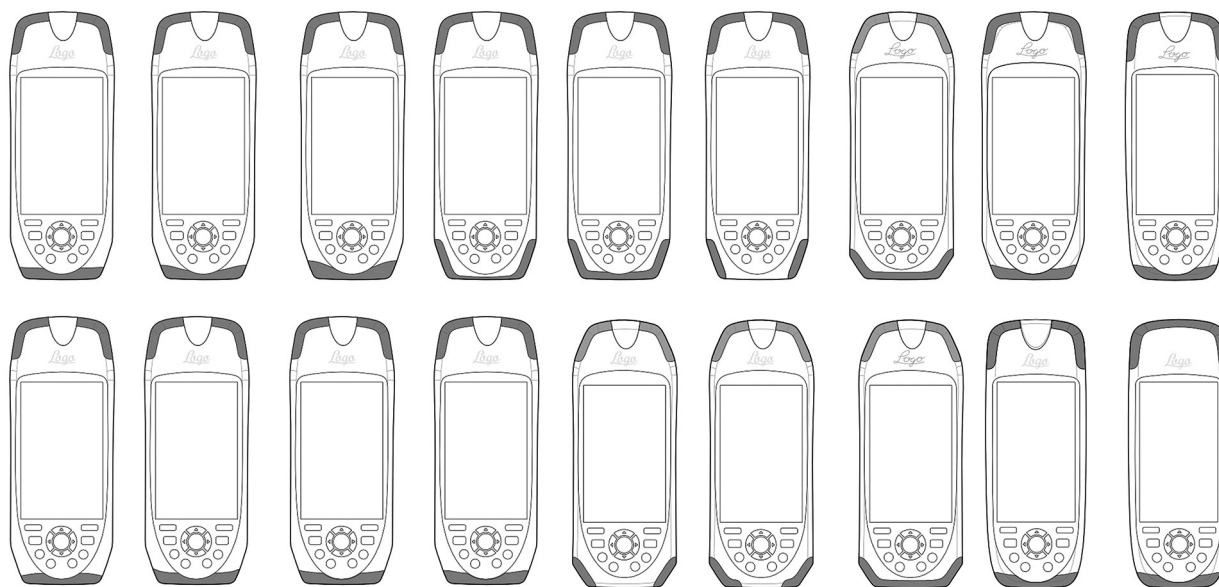


Figure 5.9 Examples on bumpers tested on the Nautiz X6 concepts

since a compact look enhances the premium expression. The last concept has an even more simple basic shape, it is slightly convex all around.

5.5. Concept evaluation

In order to create one final concept of each product the concepts had to be evaluated and compared against each other.

5.5.1. Clay model testing

Clay models were created to get a better feeling of the shapes and the 3D look, see figure 5.12. The clay models were also used to test the ergonomics when holding and using the products. The display, keypad and bumpers were marked out to see

some variants in 3D and to see if everything would fit.

Three clay models for each product were created to test different designs of the grip area. Those clay models were evaluated both by the group members and the people at Handheld, see figure 5.13. Different basic shapes and details were also evaluated. The X6 models were more varied in their basic shapes and details than the X7 since the X7 was strictly limited to fit into Handheld's design tradition. A round antenna line was made on one of the X6 models. After evaluation it was decided not to keep that line as it made the product look cluttered and unprofessional. One X6 model had convex sides and it was excluded as it did not provide as good ergonomics as concave sides. A concave side is in addition a semantic index indicating where to grip the product. The clay models were adjusted



Figure 5.10 The further developed concepts of the Nautiz X7



Figure 5.11 The further developed concepts of the Nautiz X6

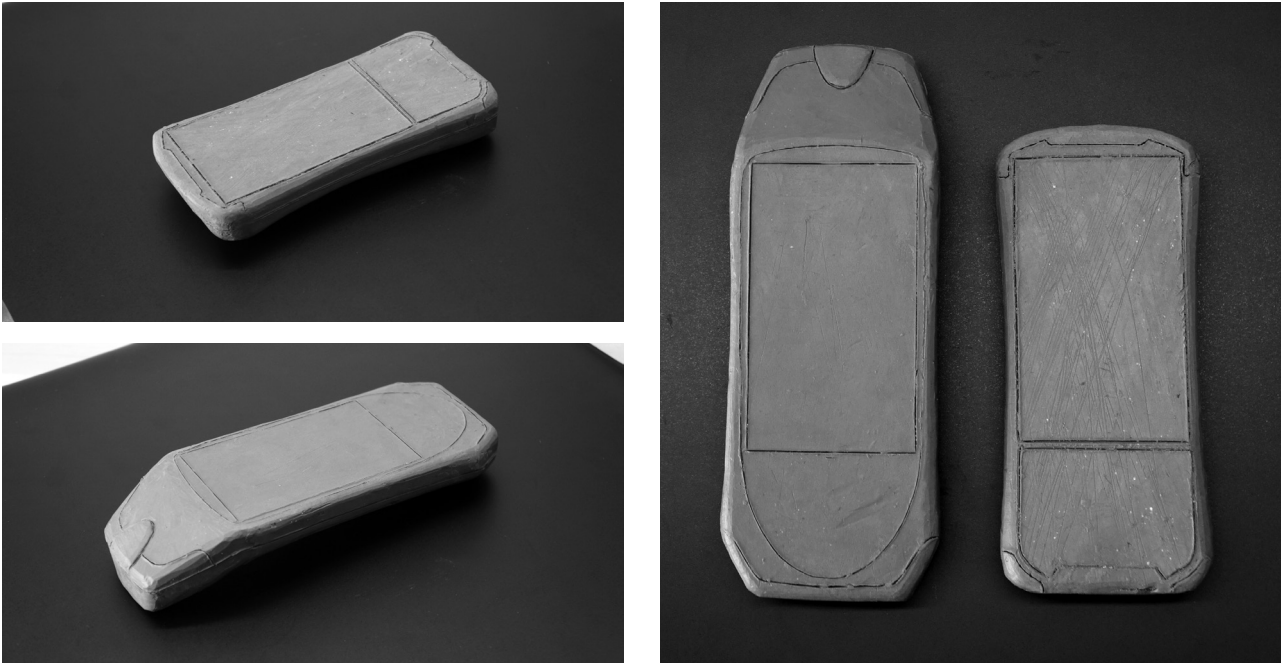


Figure 5.12 Examples on clay models for ergonomic studies

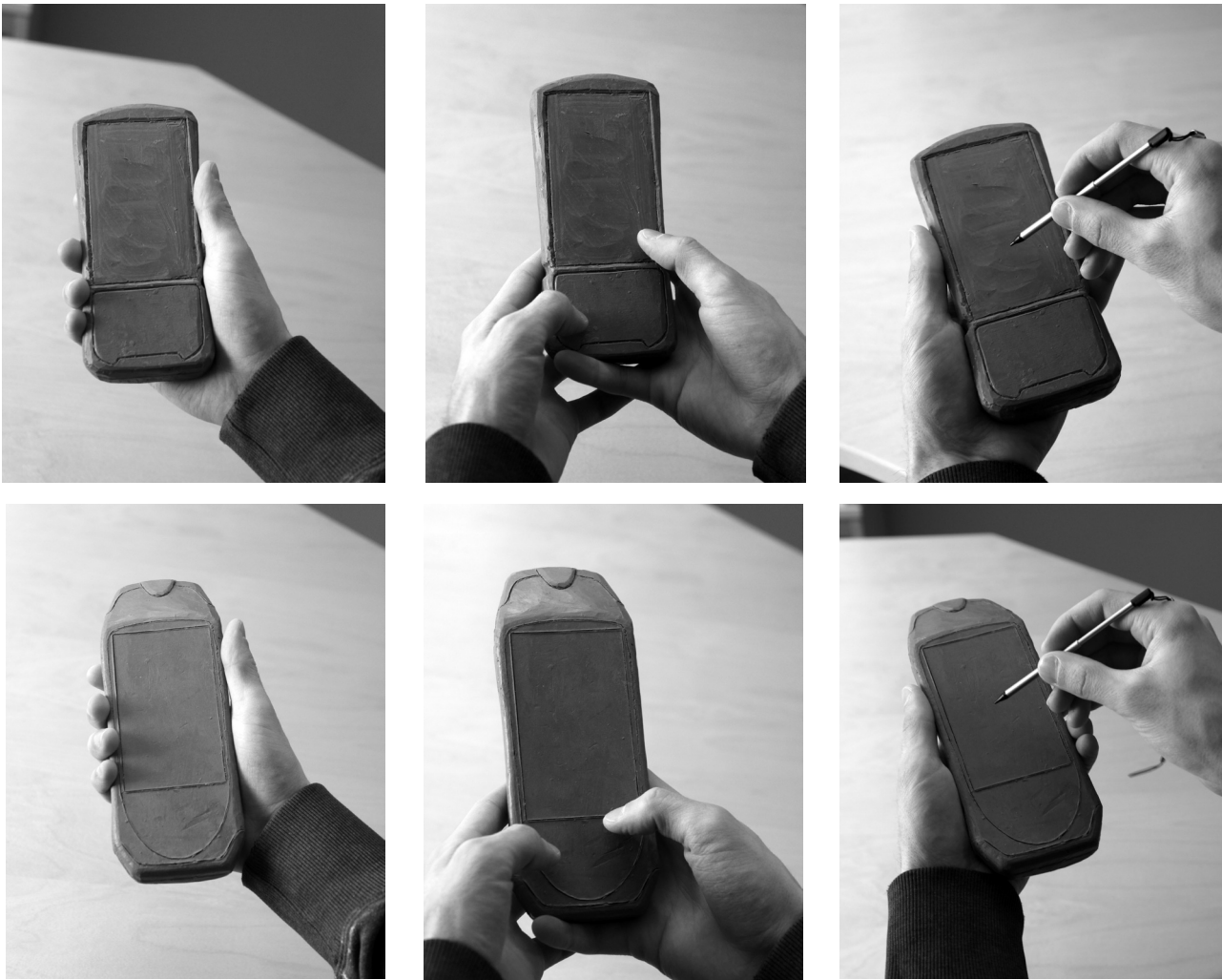


Figure 5.13 Ergonomic studies of the clay models

during the evaluation with the consequence that in the end more than just three models for each product were tested.

During the Prestudy user studies it was found that the present X7 was often held in one hand, using the stylus and the buttons with the other hand. Then a concave backside is preferred, since it gives a good and balanced one-hand-grip. However because of the new bigger capacitive display the product might be used as an ordinary smartphone; with the same hand gripping and typing on both the screen and on the keypad. To reach all the way from the bottom of the keypad to the top of the screen there is a need of flexibility in where to grip the unit. Then an excessively concave side would make it difficult to grip it on other positions than in the middle.

5.5.2. Concept scoring

To help with the concept selection the method Concept scoring was used (Ulrich & Eppinger, 2008). The method consisted of a matrix in which the three concepts were weighed against different criteria. As criteria the Product characteristics and some additional words, like ease of use and ease of manufacture, were used. Since the concepts were very similar to each other both regarding the X7 and the X6 the method gave no evident winner.

However some interesting thoughts were raised. The main thing that reduces the X7's tough look is the big screen. An immersion of it would probably enhance the tough expression. The big display and small amount of plastic areas around it makes the product look slim, efficient and less like a toy. The ergonomics were not good on the X6 with convex sides.

5.5.3. Conclusion

Nautiz X7

In collaboration with Handheld the concept to the left in



Figure 5.14 The current X7 in front view

figure 5.10 was chosen as the final Nautiz X7 concept. This concept connects the most to Handheld's brand heritage. It provides a good balance between renewal and consistency to sustain Handheld's visual recognition. The basic shapes were set with this concept. Things to further refine were the keypad, buttons and the exact location and visual appearance of all features.

Nautiz X6

The Nautiz X6 concept chosen was the middle one in figure 5.11. The connection to the brands identity was good with the simple bumpers. Slightly concave sides give a more slim visual appearance and are also preferred for an ergonomic grip. As with the X7 the basic shapes is set but the keypad and the location and visual appearance of all the details have to be further developed.

5.6. Concept refinement

Nautiz X7

A fundamental thing that has a lot to do with the usability and the function of the product is the keypad. On the current X7 the buttons have a rounded slightly convex shape, see figure 5.14. The buttons' surface was convex which made it protrude into the fingertips. To avoid discomfort and create congruence between the visual and haptic sense the touch surface on the buttons was changed to be matte and flat. The button layout was also reworked, see figure 5.15. Because of user demands the enter button was placed in the middle of the top row. The camera button in the top row was removed to get a slimmer keypad and to be able to have the enter button in the middle. There are other ways of accessing the camera function than using that specific button. The Fn button was placed at the side instead of in the top row. A protruding dot was added on the



Figure 5.15 The new concept in front view

#5 button for better haptic recognition. The on/off button icon was changed to be red as that is a new design cue Handheld wants and it also have protruding lines on each side for a robust expression. All buttons kept their icons in order to not confuse old X7 users.

To let the big display look and be more protected it was immersed 1 mm and got chamfered edges to show the immersion in the front view, see figure 5.15.

Despite that the backside is not the product's main surface for interacting it was important to design it thoroughly. It contributes a lot to the impression of a professional product. Basically it followed similar design as the current X7, although everything had to be changed to fit into the new design, see figure 5.16. The locking of the battery compartment was changed because the current X7's solution looked old and needed two movements to unlock it. It consisted of a metal ring that was needed to be flipped up and then turned. The new lock is a slide lock that needs just one movement to lock/unlock. It is immersed so it is not used by accident. Handstrap mounts were placed at the top and the bottom of the backside to provide enough space for the considered user group described in chapter '3.3 The ergonomic aspect'. The size of the flash and camera were determined and they were placed beside the upper handstrap mount. For a more premium expression they were connected with a smooth surface around them. The bumpers were designed to connect to the placement of the components and Handheld's Brand Identity.

This design with measures and descriptions was sent to the ODM in order for them to create a production ready product as similar as possible to the design.

Nautiz X6

Upcoming of new detailed information about the Nautiz X6 antenna meant that the design had to be reworked to make the antenna fit. Different solutions were tested by placing the antenna board either vertical or horizontal, see figure 5.17. The solution chosen meant that the product became longer and a bit thicker, see "b) vertical" in figure 5.17. The thickness results in a protrusion on the backside which gave support for the hand when gripping the product. The sweeping line on the antenna part was removed to create a more professional look. At the bottom the bumpers were decided to be simply horizontal to create an aesthetic balance. Both the antenna area and the bottom of the product got small chamfers on the side for a slim and balanced expression. The shape of the top three buttons on each side were changed to further connect to the X6 brand's identity, see figure 5.18.

The backside needed to have the features in the same place as the X7, since it shares the same hardware. However the new brief told that the X6 needed a bigger battery which meant that

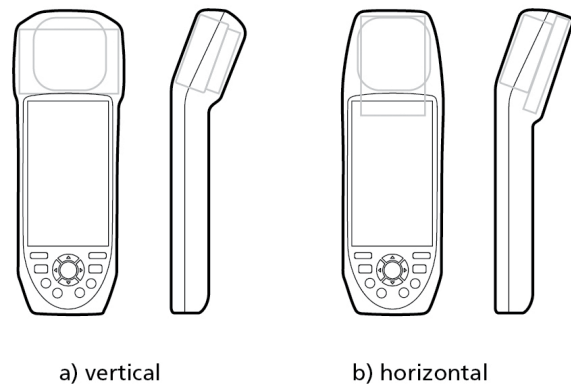


Figure 5.17 Variations of the placement of the antenna board

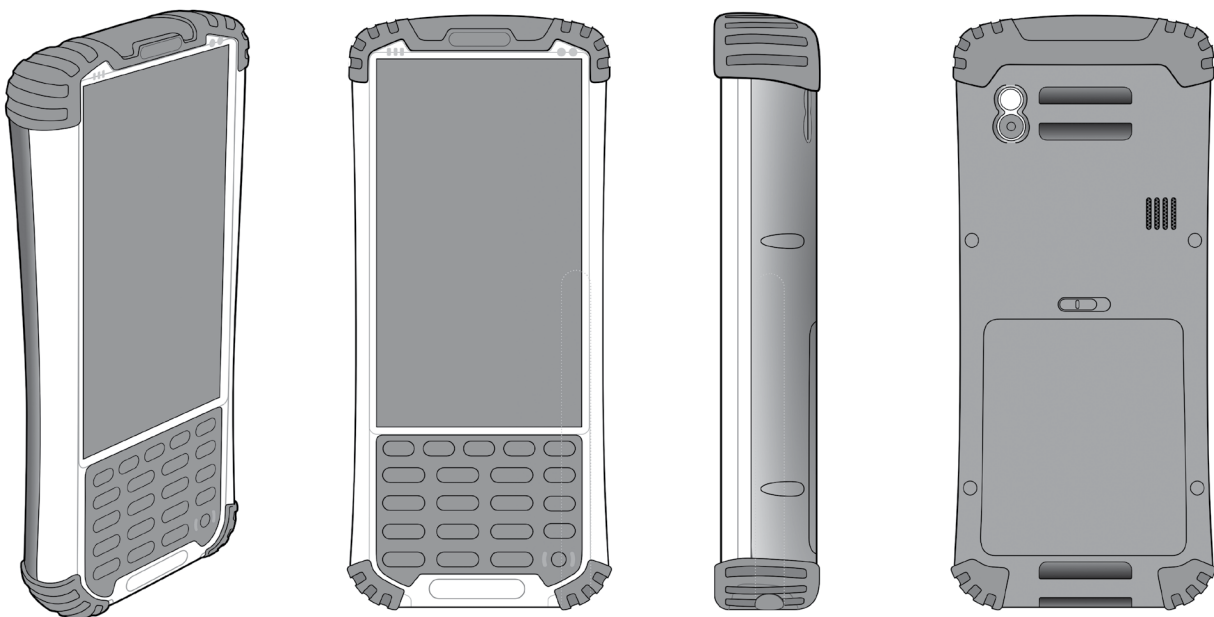


Figure 5.16 All views of the Nautiz X7

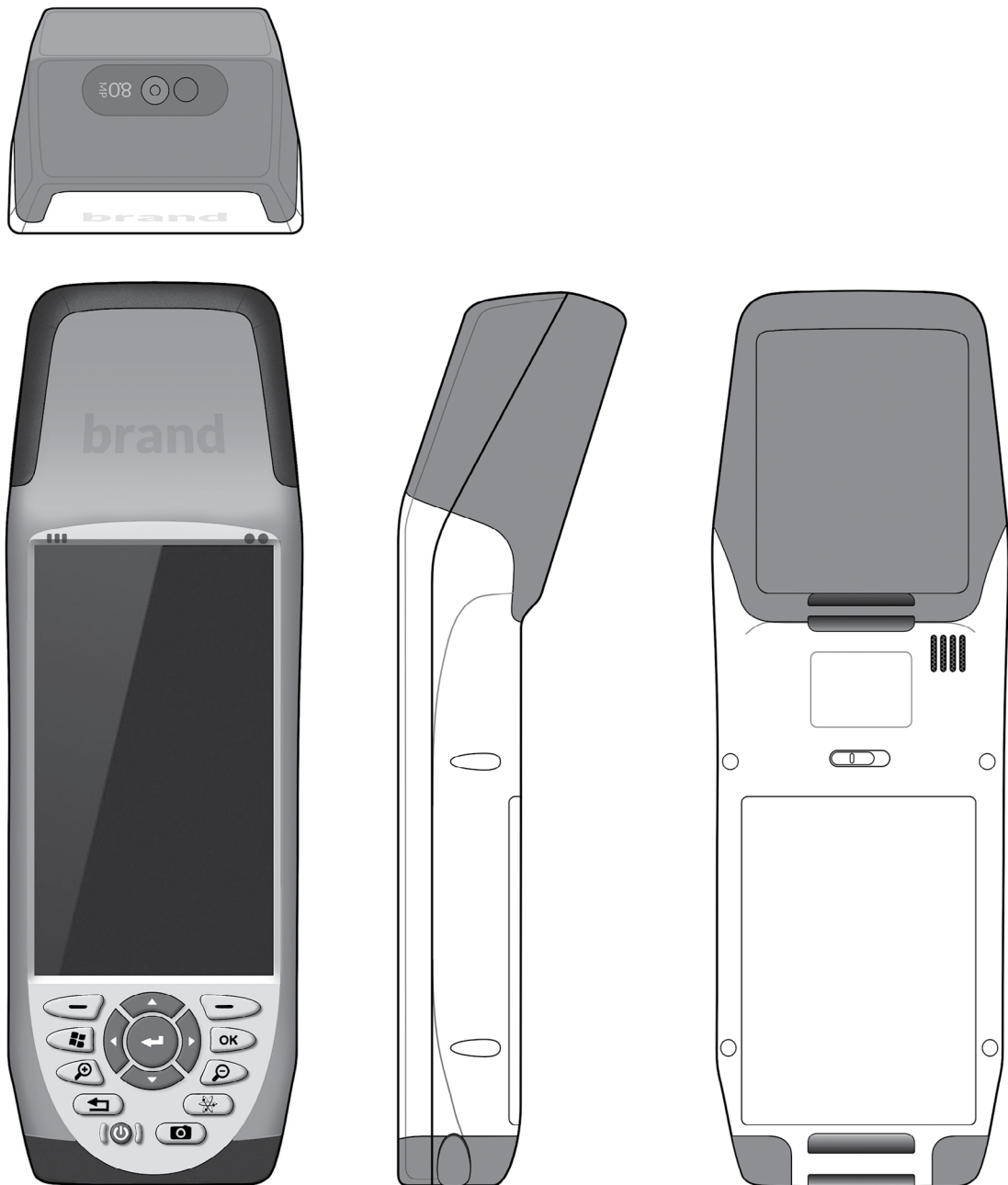


Figure 5.18 All views of the Nautiz X6

it had to be a bit thicker and have a larger battery compartment. The camera was also going to be placed on top of the unit. The bumpers were designed to match the locations of the features. For the backside view see figure 5.18.

As with the X7 this design was sent to the ODM to get ready for production.

5.6.1. Process with ODM

The design solutions had been sent to Handheld's Engineering Project Manager and Chief Technical Officer for review. These were the people who now sent the design to the ODM. The contact with the ODM was an iterative process. The events with the highest importance for the project are here described. It only concerns the Nautiz X7 as the Nautiz X6 had a later deadline.

As a reply on the product concept the ODM sent three similar design proposals. The biggest difference between the ODM's design proposals were the section profile which on two concepts were slimmer and wrapped as tight as it could around the hardware components, see figure 5.19. One proposal was considered to be the best since it had the normal section profile and layout of the backside. However there were a huge amount of things that did not match the design sent to them at first, and therefore these concepts did not suite Handheld's Brand Identity and the expression of the product.

The ODM's proposals were therefore reworked to conform with the first design sent to them. The result can be seen in figure 5.20. The basic shape was changed to round at the top and flat at the bottom. The section profile of the backside was changed to get better ergonomics with an as soft rounding/



Figure 5.19 First Nautiz X7 design proposal



Figure 5.20 Reworked Nautiz X7 design proposal

edge as possible. Glass was added around the display in the ODM’s proposals and that was one of the things that were added as the project went further. This was now a solution that was decided to be used with the logos placed on it. The shape of it was changed to be straight horizontal at the top. The buttons was changed to matte flat ones with a tactile dot on the #5 button. A huge amount of small changes were made to conform with the final design first sent to the ODM, the shape of the bumpers and keypad for example. The ODM was told to make the whole product smaller than in their first design proposals. For the measures in the ODM’s design proposals see table 5.4.

Table 5.4 Measures of ODM’s first proposal (mm)

	type A+B	type C
Min width	80	81
Max width	84,7	80
Width including bumpers	87,3	82,5
Thickness	30	30
Thickness including bumpers	32,6	32,6
Height	187,5	183
Height including bumpers	190	185,6
Display	4.46 inch	

After sending the updated design to the ODM the interaction was high. Contact was held almost every day in order for the ODM to get every detail right. Many things were further developed so they could be set. It was found out that Handheld wanted to get away from the orange color on the function features on the buttons. This was because that color was used

in collaboration with Getac; see chapter ‘2.4 Competitors’, when developing the current X7 and Handheld now wanted to step away from that. The most suitable color was decided to be blue, it is for example often used for function buttons on computers. The whole layout of the keypad was also changed to make place for general function buttons on top that could be used for both OSs; Android and Windows Mobile. The Enter button could then no longer be placed in the middle. It was an important demand to make it easier to reach. It was therefore placed as high up as possible and was made bigger as a Windows button was no longer needed. It was decided to have a green and a red phone icon instead of the text “send” and “end” on the top corner buttons. This describes the function better and shows the phone function. Two buttons on the side of the product was added, the left side in front view. Those two buttons could be used for volume up and down or zooming in and out. As with the camera it was decided to have a smooth surface surrounding these buttons for an enhanced premium expression. The stylus was a problematic thing and it was determined that the product cannot be designed to hold a stylus inside as that leads to too many compromises. A solution was to have the stylus on the handstrap. The final solution of the stylus was however not set at the deadline of this project. For ODM’s updated designs see figure 5.21.

Now there were two proposals, with the shape of the section profile as the only difference. The height, width and depth of the product were improved to be 183 mm, 73.6 mm and 30.4 mm respectively. The width measure is for the waist of product which has the smallest width. It is very close to the best evaluated width measure in chapter ‘4.1.7 Ergonomic studies’, were the best measure was said to be around 70 mm. Prototypes of these two proposals were received and evaluated, see figure 5.22. It was decided to move on with the different section profile to the right in figure 5.22. The ergonomics was about the same as the area where the material is removed is not touched when gripping the other prototype either. The



Figure 5.21 Second Nautiz X7 design proposal



Figure 5.22 Nautiz X7 prototypes

advantage with the chosen proposal was that it looks and feels more neat and compact.

5.7. Final evaluation

A final evaluation was made in order to verify the final concepts of the two products, Nautiz X7 and X6. The evaluation was divided into two aspects: semantic interpretation and ergonomics. The new Nautiz X7 and X6 was evaluated together with the current Nautiz X7 and then compared. Front views of the devices were shown for users to evaluate the semantic interpretation and clay models were used to evaluate the ergonomics. Five persons outside the project did the evaluations. This was made in order to confirm the expected improvements over the current X7 and to see if the new products were perceived as they were expected.

5.7.1. Semantic interpretation

When evaluating the semantic interpretation a questionnaire similar to the one used in the Prestudy was used. The different semantic aspects studied were primary the three Product characteristics (Tough, Professional and Premium), and then three more aspects (Quality, High-tech and Attention-to-details) complementing the Product characteristics and investigating whether or not other values than just the Product characteristics were expressed. Each aspect was rated on a scale from "do not agree" to "totally agree".

The products rated were the current X7, the new X7 concept and the new X6 concept. The test persons were shown a cut out front view picture on each of the products. The picture was in true scale to show the differences in size. All three products were rated on the same scale. Doing that way the products were scored relative to each other.

A discussion about the result was held where the reasons behind the rankings for the different aspects and devices were investigated. Notices was taken during the evaluations on why the test persons ranked the devices as they did, which was part of the explanations behind the result. For the complete result see Appendix VII. The possible explanations behind the rankings towards the Product characteristics are as follows:

Tough: All devices were ranked high in being perceived as tough. The current Nautiz X7 was however perceived to be the toughest. The probable explanation of this is that the current X7 is bigger than the other two devices. It has large plastic areas which improve the tough expression, and the display is smaller. The new devices' bigger displays are real weaknesses regarding the toughness but the display size was specified as big while the products were demanded to be small. An important thing is to not express more toughness than the products physically can withstand.

Professional: The new X7 concept was ranked as least professional but still high on the scale. This might be because it looks more like a mobile phone than the other two devices which means that it is not perceived completely as a specialized tool. However Handheld do not want to make products that connects too much to the consumer market. The product was

still ranked as quite professional, and its size will definitely make sure that it still will be seen as a professional product.

Premium: The new X7 concept was ranked high while the X6 concept and the current X7 was ranked lower. The new X7 has smaller plastic areas and is slimmer than the current one which enhances a premium look since it highlights the technical features and makes the product look more thought out. The result for the X6 concept might not be fair as it here is compared to products that do not have the same functions. Therefore it is bigger and the premium expression is reduced.

5.7.2. Ergonomics

The ergonomics were evaluated towards width, height, thickness, shape of the grip area and reachability of the display and keypad. Here follows a summary of the result, for the complete result see Appendix VII.

Both the X7 and X6 was ranked better regarding the ergonomics than the current X7. The main reason behind this is that the current X7 is bigger in every dimension except height compared to the new one. The X6 is longer because of the antenna and thicker because of the larger battery which might have affected the result. The width is the same for the X7 and X6 concepts, but the X6 was ranked a bit lower. A reason for that might be the bigger dimensions and added weight, but it can also be a pure semantic issue.

5.8. Chapter discussion

This phase has been a bit special in this project because of the development of not just one, but two products. Because of that the two products are related to each other with the same hardware the methods have been carried out in parallel. The focus have been on the Nautiz X7 which means that the Nautiz X6 have not been as thoroughly studied.

5.8.1. Requirements changed since the Prestudy

The close collaboration with Handheld meant a lot in this phase where clear directives could be given. Some of the requirements from the Prestudy were changed or further developed. The most important new insights were probably that Handheld wanted the new X7 model to be closely connected to the present one in its style and that the X6 should not look like a product from Handheld.

The project were limited by the fact that all the technical specifications and components were not set. When the specification came for the X6 antenna some of the concepts had to be drastically changed since they otherwise got strange proportions. Unfortunately it was difficult to avoid these problems since they could not be controlled.

5.8.2. Idea generation

It was positive with both structured methods and free idea generation. They complemented each other and have contributed to a reliable result. Clay models were a good way to explore ideas in 3D. Working in clay would have been beneficial even in the first idea iteration.

5.8.3. Concept choices

One question that has appeared several times during the project is: why was often the least bold alternative chosen? Especially regarding the X7 Handheld favoured the simplest and safest ideas. It is possible that another form of presenting the concepts might have given a different result. It is however more likely that Handheld did not see any gain in choosing a more exciting concept. It was also important for Handheld to sustain the visual recognition by balancing between renewal and consistency. The X7 is a professional product that does not have to be interesting and good looking. Maybe it is better if it is not noticed at all and just does its job efficiently like a tool.

Another concept choice issue was the difficulties to evaluate the semantics since it is a subjective judgement. The result of the evaluation attempts was mostly qualitative and was difficult to use in concept selection matrices. The matrices were especially difficult to use when the concepts were too similar.

The conceptualization and refinement phase was an iterative process that consisted of several rounds. At some point the important decision of when to end the iterations and starting to present the result in this report had to be taken.

6. Result - Concepts

6.1. Nautiz X7

6.1.1. Basic shape

The outer shape of the product is important in order for the product to fit into Handheld's brand identity. The flat bottom is where most connections are placed and where the product can be docked. Concave sides makes the product look slim, more interesting and dynamic, connects to the old X7 model and also provides good ergonomics when gripping the product. A convex top connects to Handheld's design heritage and simply looks the best together with the shape of the other sides. The shape is seen in figure 6.3.

6.1.2. Front

The front or upper casing of the product is colored in Handheld's light grey, see figure 6.1. The surface has a fine structure to get a matte finish for a tough expression and good dust and dirt resistance. The display has a glass area over and around it to be able to touch it everywhere. It also enhances the premium expression and the logotypes are placed on it to develop the Brand Identity and connect to Handheld's new mobile phone, Nautiz X1.

The most important things on the product are the display and the keypad. Those features are therefore highlighted in the middle of the product.

A slight revision had to be made to the keypad because of user demands and the more compact product. The buttons are now not as round as before. This gives a more professional and ergonomic expression and the buttons are gentler to the fingers. The enter button is placed to the right because of function buttons in the top row, but it is bigger than on the current Nautiz X7 and therefore easier to reach. A feature kept is the

protrusions on each side of the on/off button which protect it from being clicked by accident and enhances the tough expression. A protrusion has been added to the number 5 button in the middle of the numerical buttons so it is easier to determine the locations of the buttons haptically. The shape of the keypad is triangular at the bottom to connect to Handheld's brand identity. White icons are most suitable on a black keypad and the blue function icons are a development of Handheld's brand identity to distinguish from competitors.

6.1.3. Back

The backside is more rounded than the current X7 for better ergonomics and there are no protruding parts, see figure 6.1. The backside is black which contributes to a slimmer look and is part of Handheld's desired brand identity.

The camera is placed at the top of the backside of the product. The design of the camera and flash is considered instead of having just two holes for the camera and the flash as on the current X7. The handstrap is designed in the same way as on the current X7 and fits the user group.

6.1.4. Details

The bumpers do not protrude as much as the bumpers on the current X7 to get better attention to details, but they will still protect the display when the product is placed with it down on a flat surface. The shapes of the bumpers are used to connect to Handheld's brand identity. Some lowered ribs are placed repeatedly on the bumpers to further enhance the tough impression.

The stylus is placed on the handstrap, see figure 6.1, since it would lead to too many compromises to have it inside the product. It is a capacitive stylus that is equipped with a battery to be able to be used with gloves.



Figure 6.1 All views of the Nautiz X7

6.2. Nautiz X6

6.2.1. Basic shape

The X6 had to connect to another brand's visual identity, but share the hardware with the X7 and have an antenna as an extra feature. The sides are concave for an ergonomic grip and slim appearance. The bottom is flat just like on the X7 for placement of connections and easy docking. To get a compact looking device the antenna area at the top have sloping sides towards the top and to get balance the lower sides are sloping in the other way. The shape is seen in figure 6.4.

6.2.2. Front

On front the product have typical design features from the X6 product family, see figure 6.2. There are two colors, light green and light grey, which almost all of their products have. The separation between them is another Design Cue, a round line which here goes around the display and buttons. Just like on the X7 the surface has a fine structure for a matte tough expression. The display has the exact same location as on the X7 to be able to share the same hardware. It will have the same glass design as the X7 but renderings with this feature were not received before the deadline of this project.

The keypad has the buttons demanded in the product brief and they are placed in typical places for good usability, see figure 6.2. The three top buttons on each side have a sweeping look which is a feature from the other brand's products. Around

the on/off button protrusions are put to protect it and connect more to the shape of the other buttons. The red color used on the navigation buttons and the on/off button was specified in the PRD document.

6.2.3. Back

As with the X7 the backside is rounded for good ergonomics and do not have any protruding parts, see figure 6.2. The camera is placed on top of the antenna, which was preferred according to the PRD

6.2.4. Details

To suite the other brand's visual identity the bumpers are flush with the surface. On the X6 the bottom area is not as wide as on the X7. However the connections still fit because the bumpers on the X6 makes it possible to have an as big connection area as on the X7.

A main difference between the X6 and the X7 is the antenna area. It has sloping sides for a compact look and slip angles. The antenna area is slightly angled downwards in order for it to be horizontal when the product is held in the hand. The angle is needed in order for the antenna to have the right direction towards the satellites when it is used. Another advantage of the angle is that it makes the product look smaller than it actually is.

The stylus is the same as for the X7 and it is placed on the handstrap on the X6 too.



Figure 6.2 All views of the Nautiz X6



Figure 6.3 The Nautiz X7 in perspective view

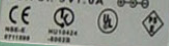




Figure 6.4 The Nautiz X6 in perspective view



MODEL NO. WT-AD18W050010K
INPUT: 100-240V 50-60Hz
OUTPUT: 5V 1.0A



7. General discussion

7.1. The Process

Compared to an ordinary development process at Handheld this project has enabled a closer collaboration between Handheld and the design team. This has given Handheld bigger opportunities to affect the result, which is both positive and negative. It is positive as a close collaboration increases both parties understanding. However it is negative if the collaboration inhibit the development of challenging ideas. Maybe the close collaboration is a reason that the Nautiz X7 concept is quite similar to the current X7.

Another result of the process has been a not that close collaboration with the manufacturer. Some technical specifications have been added late in the project and some things are not set yet. For example the size of the antenna on the Nautiz X6 affected the design a lot. It would have been beneficial to have known this at an earlier stage. The parallel work of the X7 and X6 worked good. It was even an advantage to work with two products at the same time as ideas that did not suite one of the products sometimes could be used on the other.

7.2. Final result

The result is one concept each for two rugged PDAs, Nautiz X7 and Nautiz X6. The concepts are sent to the manufacturer for review and are refined, even though small changes may have to be done on the concepts before they are ready to be manufactured.

The final evaluation indicates that the ergonomics of the two concepts are quite good. It is rated far better than the present X7. That is a result of the thorough clay model studies that was made on both models.

Besides the ergonomics the focus has been on semantics and the communication of Product characteristics and Brand Identity. There is a trend among other PDA producers of doing more and more consumer-market-inspired products. Generally Handheld do not want to leave the rugged and professional aspect, but since the new X7 concept has a larger display than the predecessor, and is significantly smaller, it was expected that it would look less rugged. In return the expression of premium is getting stronger. The result from the final

evaluation verifies these assumptions for both the X7 and X6.

A question that has been relevant to this project is how to make the products sustainable. The aspect of sustainability that has been the most applicable to this thesis is the ergonomics. Since the development has focused on ergonomics this area is closely studied. Other factors covered by this project that have affected the sustainability are the optimization of the products' life time through quality and timeless design and some material choices.

7.3. Achievement of Goals

As discussed in '7.2 Final result' the goal of developing the Nautiz X7 and X6 have been fulfilled. They are getting refined and ready for production. The result itself is products with strong brand identities and in the case of the X7 a developed and more well defined form language. The brand identity have been deeply investigated. The new X7 has the proposed developments of the form language. This means that the brand identity study and suggestions on how to develop it is in the right direction.

7.4. Conclusion

The new Nautiz X7 fit into Handheld's current product portfolio but takes the form language one step further. Compared to previous Handheld products every aspect of the product have been considered. Because of the close collaboration with Handheld the product could be seen in a more complete perspective which means a more thoroughly investigated and developed product. The X6 differs completely from the X7 and suites its brand identity. Much of the information gathered in the more thoroughly X7 studies could be applied also on the X6. The close connection between the two products means that they both fulfills each aspect almost as good, seen in the final evaluation. Because of that each aspect of the products have been investigated every sense is considered. It means that the visual information is congruent with the haptic information. The products both look ergonomic and are ergonomic. The premium visual expression are matched with high attention to details and good weight balance in the products. This has resulted in products that are strong in every aspect which means satisfied users for a long time.

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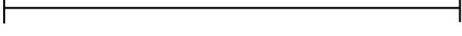
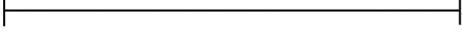
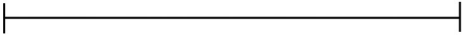
Appendix

Appendix I – Interview questions

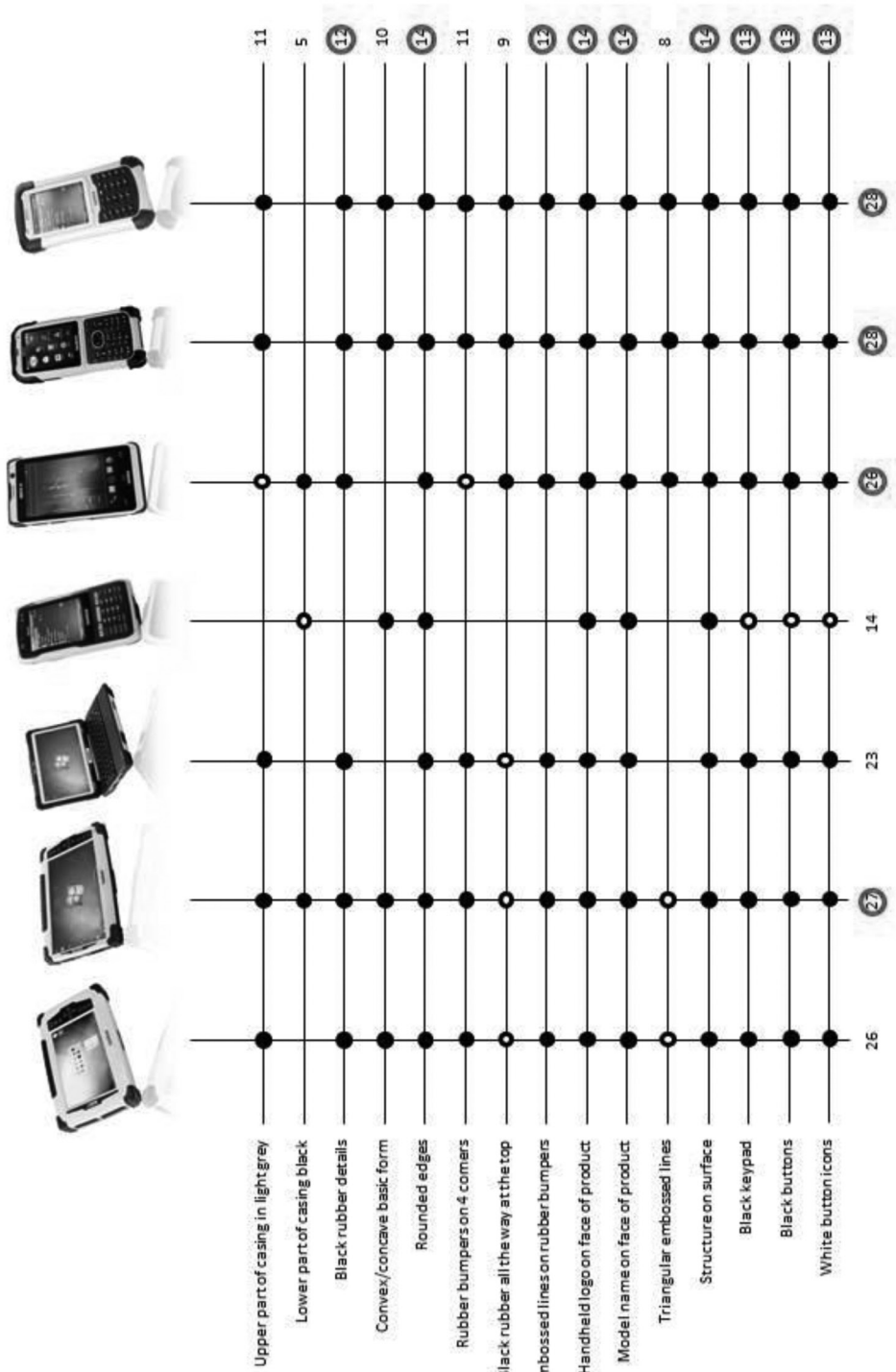
1. Vad är positivt med utseendet?
2. Vad är negativt med utseendet?
3. Vad är positivt med ergonomin?
4. Vad är negativt med ergonomin?
5. Vad är positivt med användarvänligheten?
6. Vad är negativt med användarvänligheten?
7. Hur kan produkten förbättras?
8. Saknas det någonting i produkten?
9. Uppfyller produkten sitt syfte helt och hållet?
10. Är anslutningarna placerade på bra platser?
11. Är funktionerna placerade på bra platser?
12. Vad tycker du är Handhelds design-kännetecken? Vad uttrycker att det är en Handheld-produkt?
13. Skärmen ska vara kapacitiv, är en penna då nödvändigt?
14. Vad tycker du om handremmen? Storlek?

1. What is positive about the appearance?
2. What is negative about the appearance?
3. What is positive about the ergonomics?
4. What is negative about this ergonomics?
5. What is positive about the usability?
6. What is negative about this usability?
7. How can the product be improved?
8. Is there anything missing in the product?
9. Does it fulfill its purpose efficiently?
10. Are the connections placed in good spots?
11. Are the features placed in good spots?
12. What do you think is Handhelds design cues? What express that it is a Handheld product?
13. The screen is going to be capacitive, is a stylus then needed.
14. What do you think about the size of the hand strap?

Appendix II – Questionnaire

Tålig / Tough	<i>Försvagar</i>	<i>Varken eller</i>	<i>Förstärker</i>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
instämmer ej			Instämmer helt
Professionell, Yrkesmässig / Professional	<i>Försvagar</i>	<i>Varken eller</i>	<i>Förstärker</i>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
instämmer ej			Instämmer helt
Premium, Top of the line	<i>Försvagar</i>	<i>Varken eller</i>	<i>Förstärker</i>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
instämmer ej			Instämmer helt
Kvalitet / Quality	<i>Försvagar</i>	<i>Varken eller</i>	<i>Förstärker</i>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
instämmer ej			Instämmer helt
Högteknologisk / High-tech	<i>Försvagar</i>	<i>Varken eller</i>	<i>Förstärker</i>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
instämmer ej			Instämmer helt
Genomtänkt, Attention to details	<i>Försvagar</i>	<i>Varken eller</i>	<i>Förstärker</i>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
instämmer ej			Instämmer helt
	<i>Försvagar</i>	<i>Varken eller</i>	<i>Förstärker</i>

Appendix III – DFA Handheld



Appendix V – List of Requirements Nautiz X7

ID	Requirement	D/W	Metric	Weight	Type	Source	Comment
X7							
Form and appearance							
1	Maximum size	D	179 x 97 x 37			Handheld	
2	Maximum width	D	< 75 mm			Ergonomical study	
3	Preferred width	W	< 70 mm			Ergonomical study	
4	Power button: black button with red icon	D				Handheld	Like on the Nautiz X1
5	Structure on surface	D				Handheld	Matte surface
6	Match Handheld's brand identity	D				Handheld	Design cues
7	Reflect the core values	D				Handheld	See list of "Core values"
8	Consider functional surfaces	D				Functional surfaces stud	Keypad, docking, grip area and display
Technical							
9	Minimum display size	D	4.7 inch			Brief, Handheld	
10	Display resolution	D	min 800 x 480			Brief, Handheld	
11	Preferred display resolution	W	960 x 540			Brief	Even with gloves
12	Hardware sharing with Nautiz X6	D				Handheld	Affects the dimensions.
13	Avoid water and dirt collection in the screen immersion	W				Handheld, User study	Chamfered edges and max 2 mm of immersion
14	Cutout around serial socket	W				User study	Make the connection as tight as possible.
15	No lids	D				Handheld/User study	
16	Connections at the bottom	D				Handheld/User study	Best for docking
17	Camera placement on backside, over the handstrap mounting	W				Handheld	
18	No letters on buttons	D				Handheld	Only provide icons and numbers on button.
19	Button layout: 1,2,3 in top row	D				Handheld	Like on the rest of Handheld's products.
20	Avoid handstrap covering the battery lid	W				User study	
21	Make it easy to change screen protector	W				User study	Chamfering the edges around the screen, less dirt in corners
22	Provide USB type A port	W				User study	
23	Provide stylus	W				User study, Handheld	
24	No stylus placement at the waist	D				User study	Because pole mounts are often placed there.
25	Stylus placed from top	W				User study, Handheld	Not from the bottom.
26	Stylus shall not fall out by accident.	D				User study	
27	Designed for double injection molding	D				Brief	If double injection is needed
28	IP67 classification	D				Brief, Handheld	Robust
29	Expected lifetime	D	3-5 years			Brief	
30	Flash to the camera	W				X6 brief	
Ergonomics							
31	Feedback both for where the button is and when it is pressed.	D				Handheld	Even with gloves
32	Flat buttons (makes it easy to find/"grip" the buttons)	W				User trip	
33	Customizable shortcut button	W				User study	Be able to assign a function, symbol etc. to one specific button
34	Suit both left and right handed	D				Handheld	Reachable buttons with hand that is used.
35	Enter button position suitable for both right and left handed.	W				User study	
36	Group buttons	W				Handheld	Group buttons by function
37	Rounded backside	D				Handheld/User study	Good ergonomics. No edges.
38	Larger stylus than for present x7	W	min. 11.2 mm x ø4mm			User study	
39	Non telescopic stylus	W				User study	

Appendix VI – List of Requirements Nautiz X6

X6		ID	Requirement	D/W	Metric	Weight	Type	Source	Comment	
		Form and appearance								
		1	Maximum size	D	200 x 90 x 35			Brief		
		2	Maximum width	D	< 75 mm			Ergonomical study		
		3	Preferred width	W	< 70 mm			Ergonomical study		
		4	Structure on surface	D				Handheld	Matte surface	
		5	Consider functional surfaces	D				Functional surfaces st.	Keypad, display, docking area, grip area and antenna	
		6	Smallest possible size that includes all features is desirable	D				Brief		
		7	Use colors from brief	D				Brief		
		8	Match X6 design language	D						
		Technical								
		9	Minimum display size	D	4.3 inch			Brief		
		10	Preferred display size	W	4.7 inch			Brief		
		11	Display resolution	D	min 800 x 480			Brief	Same as x7	
		12	Preferred display resolution	W	960 x 540			Brief	Even with gloves	
		13	Camera placement on backside, over the handstrap mounting	W				Handheld	Affects the dimensions.	
		14	Hardware sharing with Nautiz X7	D				Handheld	Chamfered edges and max 2 mm of immersion	
		15	Avoid water and dirt collection in the screen immersion	W				User study	Make the connection as tight as possible.	
		16	Cutout around serial socket	D				Handheld/User study	Best for docking	
		17	No lids	D				Handheld/User study		
		18	Connections at the bottom	D				User study		
		19	Avoid handstrap covering the battery lid	W				User study		
		20	Make it easy to change screen protector	W				User study	Chamfering the edges around the screen, less dirt in corners	
		21	Provide stylus	D				Brief, User study, Handheld		
		22	No stylus placement at the waist	D				User study, Handheld	Because pole mounts are often placed there.	
		23	Stylus placed from top	W				User study, Handheld	Not from the bottom.	
		24	Stylus shall not fall out by accident.	D				User study		
		25	IP67 classification	D				Brief, Handheld	Robust	
		26	Buttons suitable for both OS's shall be included such that button is	D				Brief		
		27	No need of tool like screwdriver when opening the battery comp	D				Brief	Ex. quarter turn thumbscrews or spring-mounted clamps	
		28	External antenna connector - female MMCX	D				Brief	Close to the board	
		29	Flash to the camera	D				Brief		
		30	Front camera	D				Brief		
		31	Possibility to attach a handstrap	D				Brief		
		32	Expected lifetime	D	5 years			Brief		
		33	2 LED's: battery status and bluetooth.	D				Brief		
		34	Use buttons from brief	D				Brief	Buttons: in total 13: 2 windows, 2 zoom in/out, esc button, on/off, gnss, measure, 4 navigation and 1 OK.	
		Ergonomics								
		35	Feedback both for where the button is and when it is pressed.	D				Handheld		
		36	Suit both left and right handed	D				Handheld	Reachable buttons with hand that is used.	
		37	Group buttons	W				Handheld	Group buttons by function. Maybe by shape?	
		38	Rounded backside	D				Handheld/User study	Good ergonomics. No edges.	
		39	Larger stylus than for present x7	W	min. 11.2 mm x ø4mm			User study		
		40	Non telescopic stylus	W				User study		
		41	Flat buttons (makes it easy to find/"grip" the buttons)	W				User trip		

Appendix VII – Result of final evaluation

