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Development of a flexible tablet mount focusing on market and user studies

Master of Science Thesis

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Gothenburg, Sweden 2014

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Preface

This mater thesis is the final project for me, Emil Söderquist, in my postgraduate studies at the Department of Product and Production Development at Chalmers University of Technology. The project has been carried out at i3Tex AB in Gothenburg, during January to June 2014.

I would like to thank i3Tex for the major support throughout the project, especially my supervisor Håkan Thorsson for a highly dedicated guidance throughout the project. Also big thanks to all i3Tex employees, for a warm welcome and making me feeling like one in the team from the start. I would like to thank my supervisor Dr. Erik Hulthén at Chalmers University of Technology for all the help with academic issues.

Also a huge thanks to my colleagues in the project, Andreas Andersson and Viktor Bennersten, for a good cooperation and high commitment throughout the project.

I would like to share my appreciation for all the participants involved in the user research and user feedback, where all the respondents embraced the task with a smile and excitement.

Thanks to Volvo Cars Corporation, especially Alexander Ekhem, for providing us with the information required and for feedback in the project. Also thanks to Volvo Cars Corporation and Göran Stigler for helping us to produce a rapid prototype of the final concepts.

Last but not least, thanks to my family for all the major support throughout the five years at Chalmers University of Technology.

Abstract

Volvo Cars Corporation is a global automotive company and among many other products, their accessory department develops entertainment systems for their cars. A desire to develop a tablet mount for the backseat was found and the purpose with this project was to develop a flexible tablet mount that could handle tablets between 7” and 10.1”, and hide the tablet’s edges that are less than 5 mm in radius to fulfil the safety requirements. The mount should at the same time not cover the buttons and sockets on the tablet.

The project was carried out on a consultancy company i3Tex AB. This makes the accessory department at VCC the clients of the project. Three participants with an individual research area carried out the project. The concept development was carried out in cooperation, but the researches in the prestudy and detailed design were individual.

The main challenge with the project was to find a solution that was enough flexible, but still fulfilled all the vital requirements. This report focused on the user and market studies and to maximise the output in a customer perspective. Market and customer researches were carried out first to be able to understand the physical situation, the market and what user needs that were important. After the concept development process, customer and user feedback were collected on the remaining concepts to finally decide which one or several concepts to detail design and show VCC.

The two winning concepts that were designed in detail had both high potential in ease of use. The primarily chosen concept, named Cog, was the most suitable concept to handle different tablet sizes frequently and the slightly less complex secondary concept was preferable when using the same tablet majority of the time. The concept got a high score in the later customer feedback research, which was seen as an important step in the decision-making. Market acceptance was carried out in terms of a cost estimation on the custom parts of Cog to be able to get an approximation to VCC how much such a product could cost them to produce.

The second concept was the best concept if the user attaches and detaches the same tablet for the most of the time. The ease of use for the same tablet is the best since the frame does not need to be re-adjusted for attaching it again. Prototypes of both concepts were generated to find improvement opportunities and also to show VCC the concepts in reality.

Future work for VCC is recommended to focus on deciding what concept is the most preferable according to their values and future plan and optimise and test the solution completely in order to make the final version market ready.

Publications

This project contains three master theses and each thesis covers a unique area of responsibility. The three theses relate to each other and will be referred when necessary to describe the content. The reports are following:

Report A Söderquist, E. *Development of a flexible tablet mount focusing on market and user studies. Gothenburg*: Chalmers University of Technology, 2014 [This report]

Report B Bennersten, V. *Development, design and construction of a flexible tablet mount. Gothenburg: Chalmers* University of Technology, 2014

Report C Andersson, A. *Development and finite element analysis of a flexible tablet mount. Gothenburg*: Chalmers University of Technology, 2014

The development process, including concept generation and concept selection, are carried out as a whole team and the concept development phase are therefore similar in every thesis.

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1 Introduction

1.1 Background

Volvo Cars Corporation (VCC) is a global automotive company that sells premium cars and the first car was delivered on 14th of April in 1927 (Volvo Cars Corporation). VCC has four core values that are a central part for every product; quality, design, safety and environment (Volvo Cars corporation).

VCC has an accessories department that develops various gadgets that can be ordered directly when a customer buys a car, but also on the aftermarket. One product within this area is entertainment systems that can be placed in the backseat of their cars and the purpose with such a product is to offer the passengers to watch film when travelling.

Since the entrance of the first iPad 2010, the tablet market has increased in sales rapidly (Marshall, 2013). From the second quarter of 2012 comparing to second quarter of 2013, the sales of tablets have increased with 42,9%, where over 34 million devices was sold in three months (Neal, 2013).

The technology and the performance of the tablets are continuously improving and the competition at the market is increasing rapidly, since iPad's competitors are trying to reach their sales. Apple sold over 70 million tablets in 2013 and that was an increasing number of nine million tablets comparing to the year before (Gartner, 2014). An interesting statistic is although the decreasing market shares for Apple's iPads that went from 52.8% in 2012 to 36.0% of the market in 2013. At the same time Android-based tablets made an impressive lift of market shares and went from 45.8% to 61.9%. The most popular Android-based tablet vendor was Samsung, who sold over 37 million tablets.

The growing market of tablets has opened up completely new ways of entertaining. The market department at VCC has seen this as an opening to a new important product for the accessory department at VCC. The market department found a need for a tablet mount in the backseat of their cars since many tablet owners use them as an entertaining system while travelling in their cars. And as can be seen above, the market is changing rapidly and new models and sizes are coming out with high frequency. To develop one mount for each tablet model would be an endlessly working process. It was therefore a desire to develop a flexible tablet mount solution that could hold tablets between 7" to 10.1".

There are several options of tablet mounts in cars at the market, mostly fastened on the headrest of the car. According to the benchmarking from VCC, they did not find any tablet mount that met their standards according to their core values and still flexible for different tablet models.

To be able to develop a state of the art tablet mount that is flexible, the focus should be put on the potential users and requirements from the customer, VCC. One important requirement is that the solution should meet all safety laws and recommendations to be able to meet VCC's core values.

1.2 Project description

This project was divided into three separate master theses, see Publications for the complete list. Parts of the work in the project was carried out together and thus some parts of the reports are also very similar but the project group members always had their own areas of responsibilities.

The prestudy and the detailed design phases were conducted individually. These parts in the reports are thus very different. More information about the project approach can be seen in Chapter 2.

1.3 Purpose

The purpose of the project was to satisfy the need for a way to better facilitate the use of tablets in cars, both for entertainment and work. The product will expand the assortment of accessories for VCC and it should be viable for every potential Volvo-buyer, no matter what tablet the customer has.

1.4 Objective

The aim with the project is to develop a flexible tablet solution that can handle tablets between 7”-10.1” and covers all edges of the tablet that has a smaller radius than 5 mm. The solution cannot hinder the user to get access to buttons and sockets. The project included and exploratory market and user research to be able to generate a wide solution space of concepts.

Based on customer and user feedback, the most promising concept could be detailed developed and analysed, supported by a secondary backup concept.

The project’s output was a market and user verified physical prototype of one or two concept and proposal for further work.

1.5 Boundaries

As mentioned above, the project was divided into three areas of interests. Therefore there will be parts of the project that this master thesis does not cover. In these cases, a reference to the concerned Report will be carried out.

The purpose with the user studies involved in the project was to collect vital information for the decision-making. The user studies were not however carried out globally, since it was not found plausible.

The thickness flexibility of the solution was not prioritised since the complexity of making a flexible solution for two dimensions. It was however considered in the detailed design phase. The concepts were not evaluated by special tablet shapes, as one found in the market research that had a cylindrical shape on one side of the tablet (Yoga Tablet 10 HD+, 2014).

The solutions were restricted to be connected to the safety system or be electrical.

2 Approach and methods

This chapter describes the chosen development approach from the prestudy until the detailed design and physical prototype was finished. The project was divided in three main phases; prestudy, concept development and detailed design. The methods used in the project can be seen in section 2.1-2.5 and are inspired by studied courses in product development master programme and also additional knowledge the value model (Lindstedt & Burenius, 2006) and VCC's own development process.

The VCC-inspired gates were used since they were the customers of the project and it was important to establish clear milestones where the project's state should be presented in terms of a follow-up meeting for the involved group at VCC. The gate system that was used in the project was following:

- TKO- Technology Kick-Off. An initial meeting with the customer, VCC, was established. This phase should form a time plan with its different phases and expected result from each. The output from TKO was the planning report that was established in the initial project phase.
- TS- Technology Strategy. The most important customer requirements should be stated and important researches in the prestudy are carried out, for example the user analysis and the competitive benchmarking. This gate ends when the project has four to six remaining promising concepts to show VCC and was presented for the involved department. The number of concepts that should procedure and be further developed was decided as a last step of the gate TS.
- CR- Concept Ready**.** One or several concepts should be produced that fulfils the requirements. The primary functions are virtually verified and the concept should be evaluated and optimised. The final presentation for the project was the end of gate CR and also the project.

The project was a combination of three different master theses with different focus areas as mentioned in section 1.2. The team worked with the different focus areas in parallel and an overview structure can be seen in Figure 1. The prestudy and the detailed design had one focus area per project participant and the concept development phase was carried out as a group.

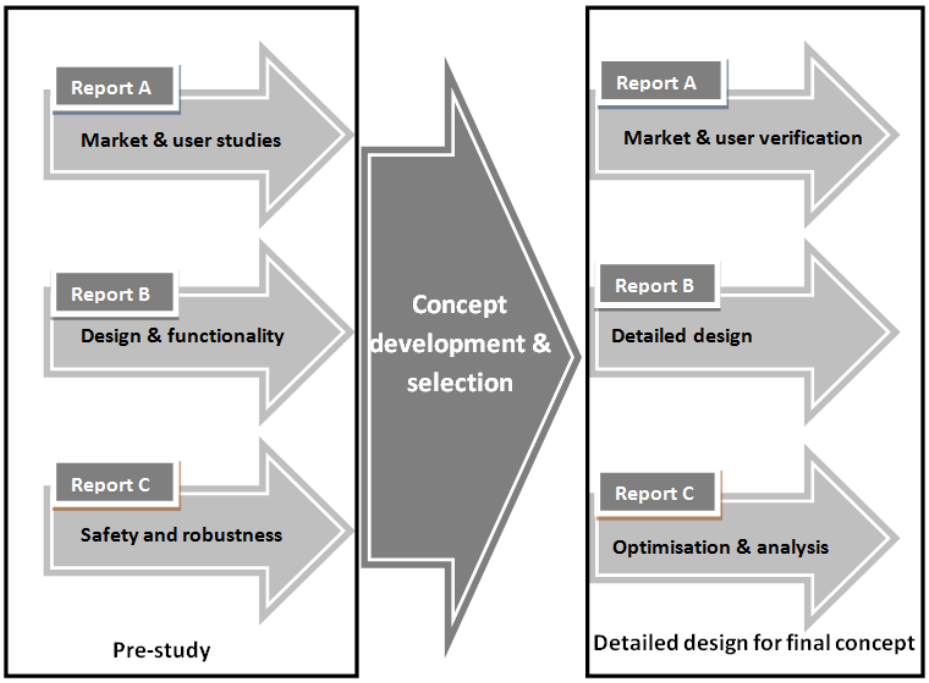

Figure 1- Representation of the working approach of the project

The project's main output was a combination of the analyses from the three focus areas and a physical prototype was presented together with a virtual final model of the winning concept from the detailed design phase. Below is a description of each process carried out in this thesis and what methods that were used in them.

2.1 Market research

Efforts were made to get an understanding of tablet mounts, but also the tablet market in general. It was decided to search for requirements in the tablet market, make a risk analysis to estimate the risks of the development and benchmark existing tablet mounts to get inspiration and how existing solutions function. According to Garvin's model, the market research's purpose was to maximise the quality in the product perspective (Bergman & Klefsjö, 2010). The market research and the user research were carried out in parallel throughout the prestudy to increase efficiency.

2.1.1 Stakeholder mapping

To find all demands that act on the project and the product, a stakeholder analysis was made. It was done to be able to see possible hidden stakeholders and also see which stakeholders that should be involved in big decision-makings. The study defined all persons or groups that were affected by the project or product and their influence on the results were analysed (Newcombe , 2010). After the mapping, each stakeholder demands were listed combined with the importance of meeting them.

2.1.2 Risk analysis

SWOT analysis was used to find possible strengths and weaknesses for VCC to develop a flexible tablet mount instead of develop a rigid mount aimed for just a majority of the current tablet market. The tool's initial purpose is to highlight strengths and weaknesses for

a company in reference to the competitors. That was not the aim of this analyis, the SWOT diagram was just used for the presentation of the different opportunities and threats that are created with the flexible tablet mount (McQuarrie, 2006). The different criteria is focusing on the product that should be developed and were defined as following (Mind Tools):

- **Strengths**: What can VCC gain to develop a flexible tablet mount?
- **Weaknesses**: What negative aspects can come up in this situation?
- **Opportunities**: Can the new product open up new markets or other advantages?
- **Threats**: What could the flexible tablet mount potentially cause for negative aspects?

2.1.3 What-if analysis

A What-If table was created to explore the possible hazards that could be a problem when developing a flexible mount. The What-If also states recommendations on how to prevent the hazards from happening. The risk analysis covered whole life cycle of the product to find hazards that was indirectly important to the development process.

The format of the What-if was based on Loss prevention & safety and involved following (Shahriari, 2011):

What-if?	Consequences	Recommendation	Actions by
Event happening	What are the consequences of the event?	Safeguards & recommendation	Responsible to prevent or observe the situation

2.1.4 Selecting market segments

Well-defined market segments were important for establishing an efficiently development process and deliver a high quality product to the end-users. A well-defined market segment was based three important aspects from the Value model (Lindstedt & Burenius, 2006):

- **Homogenous**. The customers in the segment have the same perception of the value, the functions and performance of the product. The price the customers are willing to pay should also be similar within a market segment. There is a trade-off to not make a segment too small to reach a homogenous level and to make a completely heterogeneous segment that does not share the similar requirements.
- **Profitable**. Depending on how many customers there are within the segment, it has to be certain that there can be a profit from it. If there are not many customers in the segment, a higher price has to be accepted by the customers to maintain the profit.
- **Workable**. The customers have to be available to communicate for researching purpose with to some extent get the information needed to be able to develop the product with high customer value. This can be done by interviews or a salesperson, and also with Internet.

The market segments were initially discussed with VCC and this process were a clarification for the segments. It was also done to narrow down and find possible boundaries the project had to take.

2.1.5 Size requirement

Literature studies were used to investigate tablet sizes. Internet was the source to gain required knowledge. Boundaries were conducted to get a clear vision of the required flexibility and was inspired by VCC's prestudy. It was also decided to not focus on some tablet models if they had unique edges or other special shapes, which deviated from the rest of the tablets.

2.1.5 Benchmarking matrix

A competitive benchmarking analysis was carried out to investigate the competitors to the potential future product and get inspiration on technical solutions. The investigation was carried out both on internet and physical exploration in stores. The concepts got evaluated by a benchmarking matrix based on Ulrich & Eppinger's method (Ulrich & Eppinger, 2012). The winning concept from the matrix was also later compared to the developed product. The concepts were evaluated by the found user needs in the user research.

2.2 User research

The user research was carried out to listen to what the users' requirements were of a tablet mount, and according to Garvin's model, maximise the user-based quality level (Bergman & Klefsjö, 2010). In section 2.2.1-2.2.5, a presentation of all methods in the user research is stated.

2.2.1 Product decomposition

Product decomposition was an efficient tool to describe the functions of the product. The tool's purpose is to break down a product in sub-functions to simplify the structure of the problem. The result was presented in a tree structure to maximise visualisation and the sub-functions main purpose was to be the base for the morphological matrix.

2.2.2 Product life cycle from the customer perspective

The study of the mount's life cycle was conducted to highlight important aspects for the product in the life cycle. The purpose to increase the understanding of the life cycle to be able to conduct a suitable user interview to find latent user needs. The research was based on *The value model* written by Lindstedt and Burenius (Lindstedt & Burenius, 2006).

2.2.3 User interviews

Interviews were carried out on possible users that belong in one of the two target segments. The respondents were both employees at i3Tex and outside the company and all the participants should also have experience with tablet usage. The interviews were carried out based on a semi-structural interview and the advantage with this method is the opportunity to formulate each interview depending on the answers to maximise the relevant information (McQuarrie, 2006). Some questions were formulated open and were supposed

to make the respondent interpreting his or her situation to find latent needs (Newton, 2010).

2.2.4 Observations

The observations' purpose, combined with the user interviews, was to find two optimal positions for the tablet mount in the backseat of the car to optimise customer value. To be able to draw any conclusions of the estimated preferable position and angle, physical observations were needed. The horizontal position, vertical position and angle of the tablet were interesting to study. It was also necessary to measure the front seat's position when the participant had adjusted the seat for their driving position, since this influences the mount position and angle.

The intention of the observations were not to make any statistical research, it was rather to get a hint how big differentiation it could be. Focus was therefore to find both tall and shorter people to see the difference and to see of there was a need for flexibility of the tablet mount's initial position.

In Appendix A.1, the choice of the observation method, preparation of the study and the implementation are described.

2.2.5 Needs-metrics matrix and target specifications

List of requirements from the users were based on the observations and interviews. To translate the user needs to engineering metrics and then show the relations, a needs-metrics matrix was used. The user needs were translated to engineering metrics by the needs-metrics matrix (Ulrich & Eppinger, 2012).

The complete target specifications were a combination of the requirements found from the complete prestudy and the prestudies from Report B and Report C. The complete target specification list was conducted before the concept phase to be able to evaluate the generating concepts.

2.3 Concept generation

The concept generation's overall objective was to generate concepts by quantitative and qualitative methods in order to cover as large area of solution space as possible. This was done using different brainstorming-methods. The concept generation started already in parallel with the prestudy and the reason that it started even before the concept development phase was because it seemed beneficial to generate ideas before all the boundaries were established.

The concept generation was the primary focus during the early concept development, however it did not stop as soon as the project started with the concept refinement. The concept generation, refinement and evaluation were done iteratively. To further facilitate the creativity, the project team worked in different environments during the concept generation, both by switching between different rooms, but also moving to other locations. Ideas were also gathered from people outside of the project group.

2.3.1 Functional brainstorming and morphological matrix

Brainstorming with focus on finding solutions for each sub-function that was conducted in the prestudy. The reason for doing functional brainstorming was both to create a morphological matrix, from which many concepts could then be generated, but also because many ideas might not surface when looking at entire concepts. During this brainstorming, the purpose was to cover all possible solutions and it is thus a quantitative method (Ulrich & Eppinger, 2012).

The solutions presented in the morphological matrix were combined in several different ways in order to produce many concepts. This was sometimes conducted qualitatively, trying to make solid, promising concepts and sometimes done quantitatively to produce many different solutions for later evaluation.

2.3.2 6-3-5 Brainwriting

The purpose of using this method was to quantitatively generate concepts. When done as intended it generates 108 concepts in just above 30 minutes (Wilson, 2013). It is supposed to be done by six people, where everyone has five minutes to write down three concepts on a piece of paper. After the five minutes, each person then sends his or her papers to the next person and receives the papers from another participant. Using the previous person's concepts as a source of inspiration, three new solutions are to be made on new papers, again in five minutes. The old inspiration papers are then set aside and the newly produced concepts are sent on. This is then done for a total of six times, so that when it is over each participant has produced 18 solutions (Wilson, 2013).

Since there were only three people in the project group, the internal session became a 3-3-5 brainwriting, but otherwise following the procedure described above. Breaks was also allowed between each of the six sessions so that the participants were given time to clear their minds.

Another session was also conducted with external participants. The group for the other 6-3-5 brainwriting session consisted of four people, friends to the members of the project group. The participants were allowed to overlook some of the main requirements in order to not feel too limited in their innovativeness.

2.3.3 Brainstorming with stimuli

The reason of brainstorming with stimuli is using some type of stimuli to trigger the brain generate new ideas for concepts. This can be done both with related stimuli and unrelated. The session conducted for the concept generation included a mix of both related and unrelated stimuli.

Images containing objects related to the subject are considered related stimuli. In this case, the related stimuli mainly consisted of benchmarked solutions for tablet mounts. When reflecting upon the solutions of other developers, new concepts could emerge (Ulrich & Eppinger, 2012).

Unrelated stimuli consisted of images of anything from a boat to a dishwasher. The project team iteratively picked three random images, presented them and then discussed if the stimuli could in any way be connected to the problem at hand (Ulrich & Eppinger, 2012).

2.3.4 Classification

To be able to keep all concept sketches organised and in order to make it easier to find a certain concept sketch, they were classified into one of six different categories. It was also established to make it easier to recognise if a certain category of concepts were thrown away too early in the evaluation process. The category a concept belonged to depended on its physical characteristic.

2.4 Concept evaluation and selection

The purpose of the concept evaluation phase was to move from the large amount of concepts created in the concept generation and iteratively funnel down the amount until only a final concept was left. Between each evaluation, all concepts were refined based on the evaluated weaknesses.

The concepts were evaluated several times with different methods and after each evaluation, the concept were refined and more detailed explained as the number of concepts decreased. In addition, the project groups own subjective thoughts were also allowed to weigh in heavily and the methods were only used as tools to aid the evaluation, not as definite truths.

To support the search for the most promising concepts, a screening and scoring process was carried out. For the final selection, additional feedback was conducted from VCC and potential users. Lastly, the project group's own reflections were the most important aspect of the final selection. The visual representation of the concept selection phase can be seen in Figure 2, and the number of concept decreases when getting further down in the figure.

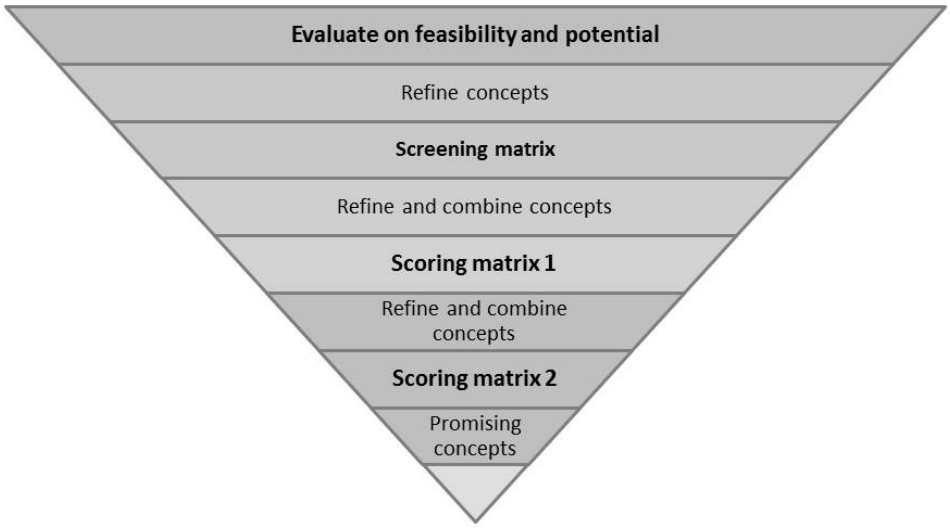

Figure 2 - Visual representation of concept evaluation phase

2.4.1 Initial screening

The purpose of the initial screening was to reduce the number of concepts that would be evaluated in the upcoming matrix methods. If the amount of concepts would have been too many when using the screening matrix, it could easily be overwhelming which would make it difficult to evaluate all concepts equally.

At the initial screening, the concepts were tested towards the major requirements, their improvement capabilities and their feasibility. Concepts not deemed to be suitable for further development were removed.

2.4.2 Screening matrix

The Screening matrix, also called Screening matrix, is a suitable tool for concept screening, to get rid of concepts that are inferior to other. It can also show patterns in what type of solutions are considered strongest for each specific requirement.

The Screening matrix compares concepts with a chosen reference. It lists the most important criteria, and each concept either gets a +, 0 or -, depending on how well it fulfils that criterion compared to the reference (Ulrich & Eppinger, 2012). The rating is judged by each criterion as:

- + is better performance than reference
- 0 is the same performance as reference
- - is worse performance than reference

The criteria for the screening matrix were chosen so that they would cover all the relevant aspects of the target specification. It was also highly desired to keep the amount of criteria as few as possible, to not go too deep into every detail yet. The reference concept was chose to be considered about average for all criteria.

2.4.3 Concept scoring

A concept scoring matrix is a tool for a more detailed evaluation of concepts, compared to the screening matrix. It further reveals the strengths and weaknesses of the concepts by adding a rating. This way it also highlights aspects of the concepts that need to be refined more or that could be beneficial to apply to other concepts. Thus it gives a good basis for refinement and suggestions for combining concepts (Ulrich & Eppinger, 2012).

The scoring matrix was used similarly as the screening matrix. The differences were that the criteria were weighed compared to each other and that no reference was used. Additionally the concepts were rated on a scale of one to five, instead of plus or minus, based on the following:

1. Much worse than average concept
2. Worse than the average concept
3. Average compared to the other concepts
4. Better than the average concept
5. Much better than the average concept

The concepts were spread out over the scale so that for almost each criterion, there would be a one and a five. The purpose to distribute the concepts as much as possible was to use the whole scale and highlight the differences better.

First concept scoring
For the first scoring matrix, there would still be quite many concepts left. Therefore the matrix should not include all requirements from the target specifications but rather a few criteria, as in the screening matrix.

Second concept scoring
The second scoring matrix was to be more extensive than the first. At this stage, only a few concepts would be left and those were to be thoroughly evaluated since this would be one of the final steps of the concept evaluation.

Before the second scoring matrix, a virtual model was created for each concept using CAD. The purpose was to create the concept with further detail as a part of the refinement. Additionally this would enable to concepts to be more objectively evaluated than they would have been from just handmade sketches.

2.4.4 Final evaluation and selection

This phase purpose was to decide one or two concepts to continue developing in the detailed design phase.

The final evaluation consisted of the project group's own evaluation combined with the input from two external sources. Feedback from both VCC and potential users were to be taken into consideration at this final step, see Figure 3.

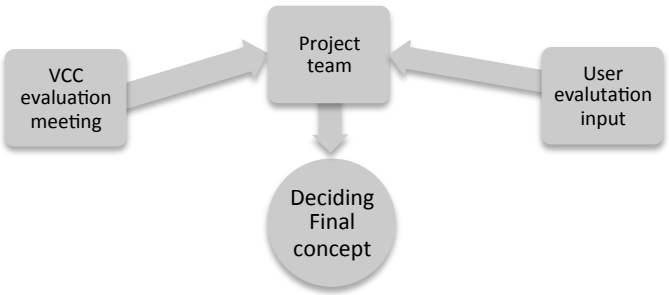

Figure 3- Visualisation of the final decision

As an additional refinement, the CAD models of the concepts were further improved. This was done mainly due to the fact that they were going to be presented to VCC and potential users, but also as a natural part of further refinement.

VCC evaluation meeting
The purpose of the meeting with VCC was to get feedback and suggestions from people with technical expertise. This would then act as a basis for the final selection.

The concepts remaining at this stage were presented for the experts at VCC. Each concept was described and some of its positive and negative features were pointed out, in order to

get feedback for improvements. After the concepts were presented, they were discussed in order to get suggestions for the final selection.

User evaluation input
User feedback was a central part in the whole project and it was important to get input from them to get valuable feedback. A concept video was established to make an objective and efficient study on the five remaining concept, where all concepts were presented by CAD-simulations and audio explanations. After the respondent saw the concepts and understood how they were functioned, the user answered a questionnaire.

2.5 User and Market verification

The purpose of the detailed design was to maximise the performance of the most promising concepts and to investigate the market and user acceptance. The chosen tools for the development and verification process are shown in section 2.5.1-2.5.3.

2.5.1 Virtual prototypes

CAD-models were used already from the final eight concepts to visualise the details better than handmade sketches. The virtual prototypes were also made to show VCC and potential users which concept that had most potential and also how they could be refined and combined to maximise the performance even further.

The detailed final models were also used to make physical prototypes and to provide VCC detailed models of the final concept or concepts.

2.5.2 Physical prototypes

Physical prototypes were made to verify the technical functionality and also identify possible flaws and issues with the construction for example in the aspects of design and user friendliness. The physical prototypes were therefore not the final version of the concepts, instead they were used in the detailed design phase to maximise the performance. Another vital purpose was to verify as many of the user requirements as possible for the prototype.

2.5.3 Cost estimation

Cost estimation was carried out on the final concept to establish an estimation of the parts involved on the developed solution as a market acceptance test. It was carried out to establish estimations on how many mounts that has to be produced for a reasonable manufacturing cost.

The cost estimation was carried out mainly supported by Swift and Booker's method and by CustomPartNet (Swift & Booker, 2003) (CustomPartNet, 2014). The tooling cost and the chosen manufacturing process were based on CustomPartNet. To reduce the complexity, it was decided to choose one manufacturing process for the complete estimation, even though some of the parts might earn on having a special manufacturing process.

The material and the total estimation cost were based on Swift and Booker. The total estimated cost was calculated with the formula (Swift & Booker, 2003):

$$M_i = M_c + T_c = V * C_m + T_c$$
$$V = volume\ of\ the\ estimated\ part$$
$$C_m = \frac{cost\ material}{part}$$
$$V = V_f * W_c$$
$$C_{mt} = Collected\ from\ CES\ for\ specific\ Material$$
$$V_f = final\ volume\ of\ the\ part$$
$$W_c = Waste\ coefficient$$

T_c was estimated by the CustomPartNet and the manufacturing process the estimation was based on was chose based on properties from the design study in Report B. The total cost for different levels of manufactured mounts was then conducted to show what the required parts would cost. No standard components were involved in the investigation, meaning screws, bolts or any other component that not need to be custom made are not included.

2.6 Software and hardware

The tools and equipment that was used in the project is stated in Table 1.

Table 1- Equipment and tools used

Function	Equipment & Tool
Prototyping	3D-printer
Computer Aided Design	CATIA V5R19
Calculations and plotting	Excel 2010
Tables	Excel 2010
Figures	Visio 2010
Graphs	MATLAB
Cost estimation	CES
Cost estimation	CustomPartNet
Observations	Volvo V70
Observations	SLR Camera
Observations	iPad 2 & iPad 3
Observations	Red electrical tape
Observations	Adobe Photoshop
Observations	Folding ruler
Observations	Bubble lever
Documentation	Word 2010

3 Market research

The results from the market research are presented in this chapter. In Section 4.1, the stakeholders are defined for the project and in section 4.2, the target segments the project was focused on presented. Section 4.3 explains the study of different tablets to establish the requirements involved for the necessary flexibility for size and accessibility for buttons and sockets. Section 4.4 and 4.5 present the market risk analysis that was carried out and section 4.6 involves the result of the competitor benchmarking.

3.1 Identification of stakeholders

The identified stakeholders within the project can be seen in Figure 4, where the stakeholder's estimated influence versus their interest is visualised. VCC Accessories is considered to be the most influential and has the highest interest of the project since they are the customer. Erik Hulthén and Håkan Thorsson have high interest and influence of the project since they are the project's supervisors from Chalmers University of Technology and i3Tex, respectively. Potential users, namely the participants in user interviews and observations have influence in the project since they are a central part of the decision making.

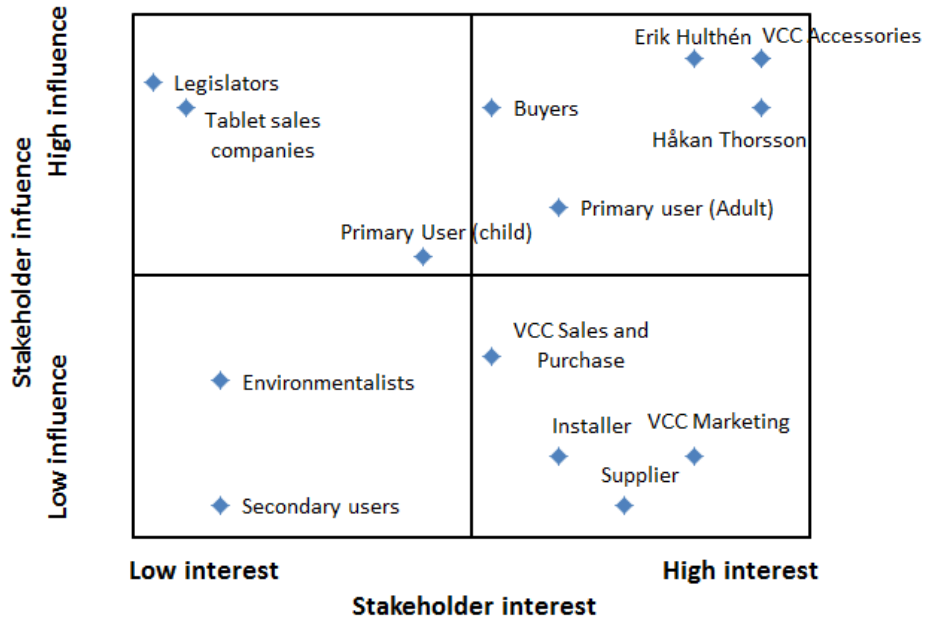

Figure 4- Visualisation of the stakeholders and their influence vs. interest in the development project

Below is a list of all stakeholders and their estimated influence and interest of the project:

- Legislators: Since the product has to follow all laws related to it, this highly influences the outcome of the project.
- Tablet sales companies: The product will be made to fit their products, which makes their influence very high and will have a slight interest in the product since it can increase their sales. This makes it their wish that it fits their product.

- Primary users: The people who will be actively using the tablet mount for its intended purpose. Demands will be the result of interviews and observations.
- Buyers: Often the same as an adult primary user, although may be e.g. a boss that is buying cars for the employees. High interest in and influence on price
- Erik Hulthén: The examiner of the project. High interest and influence in the project execution, although not necessarily the product.
- Håkan Thorsson: The supervisor of the project. High interest and influence in all parts of the project.
- VCC Accessories: The owner of the project.
- Environmentalists: People who want all products to be environmentally friendly. Will have demands on environmental impact and may give the product bad publicity if it does not meet them.
- Secondary users: Users who either comes in contact with the product when using a friend's car, either by using it or by seeing it. Can also be a potential buyer.
- VCC sales and purchase: Will be affected by the design and complexity of the product.
- Installer: The person(s) who will be installing the product into a car. Will be affected by the complexity of assembly and how ergonomically it can be assembled.
- Supplier: Dependent on which design the product has and thereby which manufacturing processes can be chosen and which tolerances are needed.
- VCC Marketing: Affected by design, functionality and costs. Will want the product to be easy to sell, meaning high functionality, high robustness and aesthetically appealing.

3.2 Selecting attractive market segments

Well-defined market segmentation is vital to reach success in the project. The broad definition of market segments was initially from VCC, but was developed further in the prestudy of the project to meet higher level of clarification.

The market segmentation was first discussed with VCC, but a scope of the most important customers had to be done. As mentioned in section 2.1.4, this is not a homogenous segment and "everyone" is not an efficient segment to reach for. Not all customers are equally important for this product and in the prestudy it was decided to focus on two clear and important market segments for the product, on behalf of VCC's desires, which are presented in section 3.2.1 and 3.2.2.

3.2.1 Business segment

The business segment was discussed at the initial meeting as one of their target groups the project should focus on. This segment was supposed to be initially based on business men and women, mostly from a globally market as for example China where often business men have a personal driver. They use a tablet when travelling to work and it is important to fulfil their special needs and desires.

This segment was although revised to be able to include it in the interviews and observations. Since the lack of opportunity to reach a global market for the interviews and the user feedback, business men and women from Sweden were asked to participate and represent this segment in the user research. The potential future product has a purpose to be sold globally, but the customer research was only made in Sweden and can therefore have missed important requirements from e.g. Asia or America.

3.2.2 Family segment

The family segment was also discussed with VCC at the initial meeting, but was also clarified in the market study. The tablet mount's purpose could be different from the business segment, where this segment involves children.

As mentioned in the stakeholder section 3.1, the buyer and the user are potentially not always the same person. VCC has several family cars at the market and the children are often the users and the parents are the buyers in this scenario. Therefore it was important to investigate both their needs to be able to satisfy the buyer and also the user needs. The interview focused on both segments to highlight if the two segments deviated in the requirements in order to develop a product that satisfied both segments.

3.3 Requirements of the flexibility

The prerequisite handed out by VCC in the initial project phase was explaining the developed mount should handle tablets between 7"-10.1". The market study of different tablet sizes were conducted based on the required size adjustment and covered following tablets:

- Amazon Kindle Fire 7": 189x120 mm
- Amazon Kindle Fire HD 7": 193x137.2 mm
- Samsung Galaxy TAB 2 7": 193.7x122.4 mm
- Google Nexus 7": 198,5x120 mm
- iPad Mini 7.9": 200x134,7 mm
- Samsung Galaxy TAB 8.9": 230.9x157.8 mm
- Sony Xperia S 9.4": 239.8x174.4 mm
- Amazon Kindle fire HD 8.9": 240x165 mm
- iPad AIR 10.1": 240 x 169.5 mm
- iPad 2 & 3 10.1": 241.2x185.7 mm
- Samsung Galaxy TAB 1 & 2 10,1": 256.7x175,3 mm
- Samsung Galaxy Note 10.1": 262x180 mm
- Asus Transformer TF300T, TG, TLTF700T 10.1": 263x180.8 mm
- Samsung Aktiv 10.1": 265.8x168.1 mm
- Sony Xperia Z 10.1": 266x172 mm
- Asus Transformer TF101 10.1": 271x171 mm

As can be seen in the list above, six different brands at the tablet market were studied in the requirement establishment and 20 tablet models were covered, distributed between sizes from 7” to 10,1”. Since the tablet models have different screen ratio they differentiate in size significantly and the solution needs to be flexible for different dimensional relations. The smallest and biggest models in width and height from the study were:

- Width: 120-180.8 mm
- Height: 189-271 mm

The size requirement was rounded to:

- Required width flexibility: 110-190mm
- Required height flexibility: 180-280mm

3.4 Risk analysis

The desire for a flexible tablet mount was initially from the market department at VCC, and it was found motivating to study and establish strengths and weaknesses on developing a flexible solution instead of rigid cases for each model like many competitors. The result of the investigation can be seen below in Figure 5.

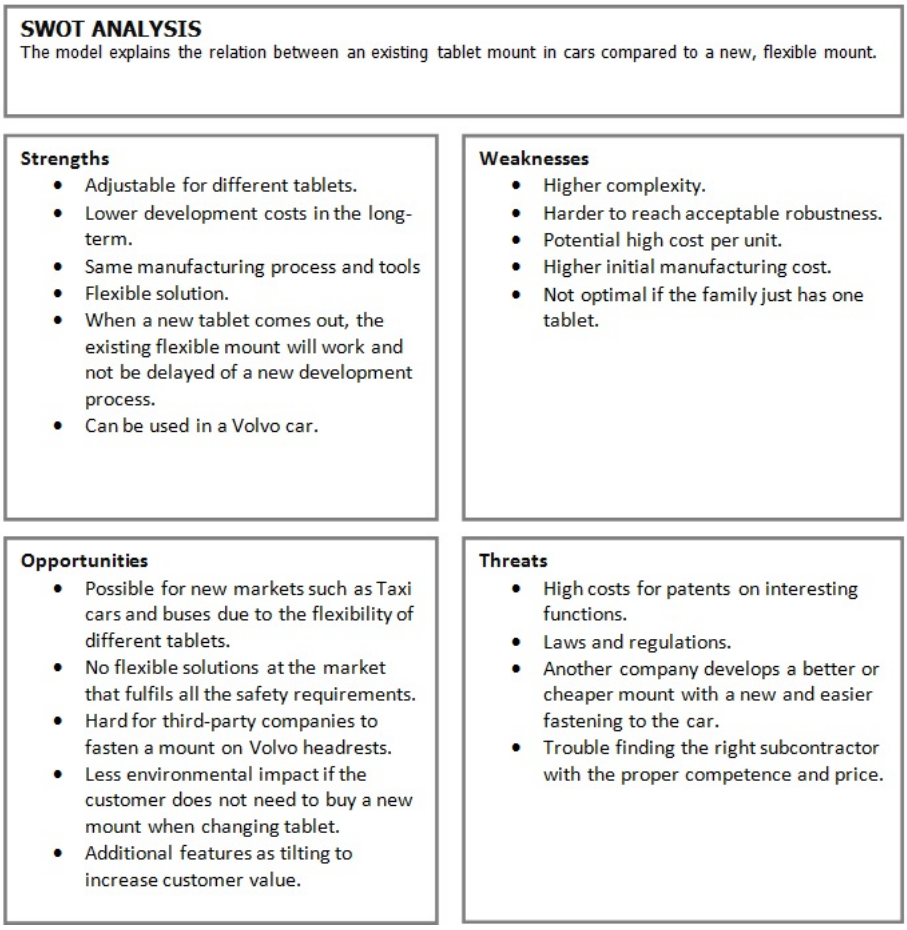

Figure 5- Risk analysis presented as a SWOT diagram.

There are different threats and opportunities for VCC to develop a flexible tablet mount. One possibility could be an opening to new market spaces such as taxi cars and buses, since the mount is flexible and is supposed to fit most of the commercial tablets. If more market space would be found, more mounts could be manufactured and this would result in lower manufacturing cost per mount, and in that case reduce weaknesses with the flexible tablet mount.

A flexible mount's identified threats and weaknesses that should be taken under consideration in the development phase was mainly the higher complexity that would most certainly make the price higher than a rigid mount. This was considered worth it if it gained additional value for the buyer. VCC also has to find a subcontractor that can create the mount with the correct manufacturing processes for the chosen concept and acceptable quality level.

VCC cars have a rigid headrest, where most of the solutions at the market fasten the tablet mount by detach the headrest and mount the product on the metal pins and attach the headrest again. The majority of these mounts cannot therefore be fastening in Volvo cars. This makes it hard for third part manufacturer to copy solutions and VCC has therefore an opportunity in the future to keep the majority of the market for tablet mounts in their cars.

The main advantage in a long-term perspective is that VCC does not have to develop a new tablet mount for each tablet model that releases in the future. When a model comes out with a new platform, a new mount has to be developed and it takes time for the new mount to reach the customers. VCC stated that this was one of the main reasons for the desire of a flexible tablet mount.

3.5 Market risk analysis

The complete market risk analysis can be seen in Appendix B as a What-if diagram (Shahriari, 2011). The first hazard in the table covers if the tablet market decreases in sales and gets less attractive. According to the technology adaption curve, the tablets will reach a peak and then be less attractive, as the majority of technical products are following that behaviour (Chasm Institute). It makes is important for VCC to keep track on the trends at the market to direct the production pace for their potential tablet mounts. If a better solution would be released anyway in the future, a new updated version of the mount would be preferable.

One of the main risks that are covering the work in the master thesis highly is if the tablet mount has too low functionality. For example if BMW and Mercedes has a tilting function in their solution, VCC should consider to make a product that makes the user think that the product feels ergonomic. Another risk could be if one vendor releases a better solution that is compatible to Volvo cars; it could affect the sales negatively. This was a risk that was involved in this project and the user study was a solution to trying to avoid the hazard. The quality is vital to match with VCC's brand identity to not harm it and also avoid unsatisfied customers. For the complete market risk analysis and recommendations how to avoid the hazards, see appendix B.

3.6 Competitive benchmarking

It was found several flexible mounts on the market, but the products were lacking in safety because they do not hide the tablet's sharp edges. There were although tablet mounts at the market that is covering the edges, but then it does not cover different tablets that are not built based on the same platform.

A benchmarking was made to see what kind of products that is already on the market. Other premium car brands have already released solutions and some are presented below as well as third-party manufacturers of tablet mounts. Interesting parts of this market analysis were the price in combination with the functions and the design the customer gets.

The Internet research of different tablets did not get enough impression of the detailed functionality and design. Therefore, an evaluation matrix was made based on 13 different tablets mounts or cases. The evaluated products were found in stores around Gothenburg, and were rated based on the conducted user needs from the user research, as can be seen in section 4.3. In Appendix C, the competitive benchmarking matrix can be seen where all the products were evaluated in the store by the subjective opinion of the researchers. The winner of the competitive benchmarking was BMW's car mount and the top three from the benchmarking are described below:

1. BMW tablet mount

The tablet mount is compatible to iPad generation one to four. The unique function for this mount that many of their competitors do not have is the rotating arm that changes the viewing mode to a writing position closer to the user (BMW). This was an interesting point in the user investigation and although the complexity increases with this function, a higher price can be taken from such a product.

Figure 6- BMW tablet mount

The mount can be rotated 360° to be able to have the iPad both in vertical and horizontal mode. The negative aspect is that this is just an iPad holder and can't handle all the different sizes. This model is restricted to iPad 2, 3 and 4, since these models are built on the same platform (BMW). The safety requirements on covering the edges are fulfilled and the price for the mount in the store was 1425 SEK inclusive VAT.

2. Ring0

Ring0 is a modular tablet holder that has different fastenings to different usage purposes. The car fastening is placed on the headrest. The mount is a normal case and covers for the iPad and is supposed to be used all the time. The mount is connected to the fastening in a unique and patented way with an easy connection procedure, as can be seen in Figure 7. The tablet's buttons and charger is always available in the mount and also there is a hole for the camera on the back of the mount.

Figure 7- Ring0, front and back view

This model only fits iPad and is therefore not flexible for more than different generations of iPads that are built on the same platform, namely generation two to four as for the BMW tablet mount. The mount can rotate and also be tilted to maximise the viewing angle to the user. The mount has passed a complete safety test and is delivered with a safety screen to the iPad's screen. Ring0 costs 899 SEK inclusive VAT, delivered with the car fastening module (Apple).

3. Mercedes tablet mount

Mercedes has a mount that is compatible with the second and third generation of iPad and the mount is installed on the headrest. Mercedes has a version of the mount that functions as a dock station, where the iPad is charged and the mount is also covering the edges (Mercedes-Benz). The solution has a tilt and rotating function, making the iPad to be able to stand up and lie down. The mount can be combined with an in-vehicle hotspot, allowing for WIFI-connection and according to Mercedes-Benz homepage the mount costs $400 inclusive VAT (Mercedes-Benz). The customer gets a protective iPad screen film to protect the passenger in case of a car crash.

Summarisation of the result

The top three performers in the evaluation matrix showed that rigid mounts or cases were preferable in many aspects. The developed product's main goal was be flexible to different tablets, but the concepts could still be evaluated against the three winning products in the concept phase and be inspirations for generating concepts in terms perspectives as design, robustness, price and adjustability to buttons and sockets.

4 User research

This chapter focuses on the end user of the product and was a base for generating requirements to the target specification from a user perspective. The market segments were used from the definition in section 3.1 as a base for the interview and observations, which can be seen in section 4.3 and 4.4.

4.1 Product decomposition

The flexible tablet mount was divided into sub-functions as can be seen in Figure 8. The three sub-functions found were fastening the tablet, protect the passenger from sharp edges and the interface to the fastening that the mount should be connected to. The interface was not a part of the project, since VCC developed the fastening to the car. The lowest sub-functions in the tree structure were interesting for the morphological matrix to be able to brainstorm various concepts based on functionality.

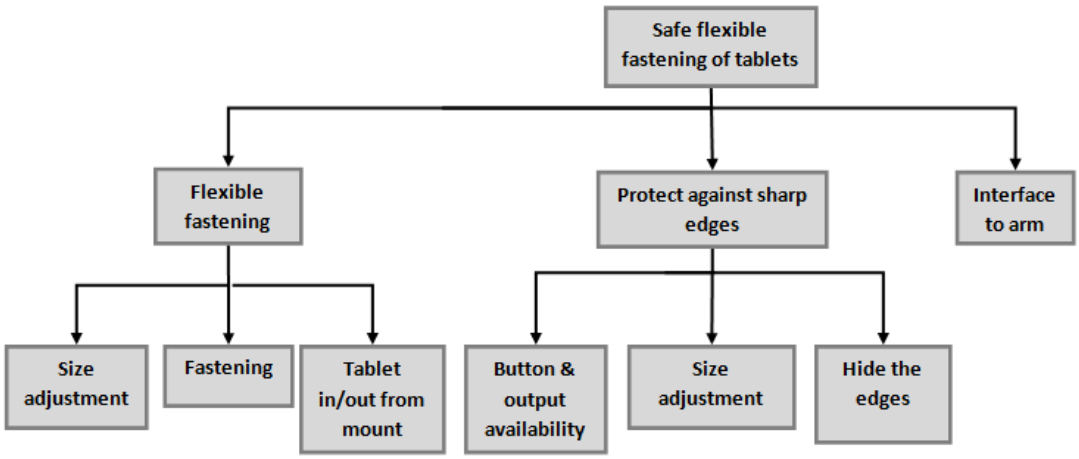

Figure 8- Representation of the functional decomposition of a flexible tablet mount

4.2 Product life cycle from the customer perspective

To deliver a product with high quality to the user, it was important to establish who the buyer was and what they expect of the product. In Figure 9 and below, an explanation of the tablet mount's whole product life cycle from a user perspective is shown. The study is based on the definition from the Value model (Lindstedt & Burenius, 2006).

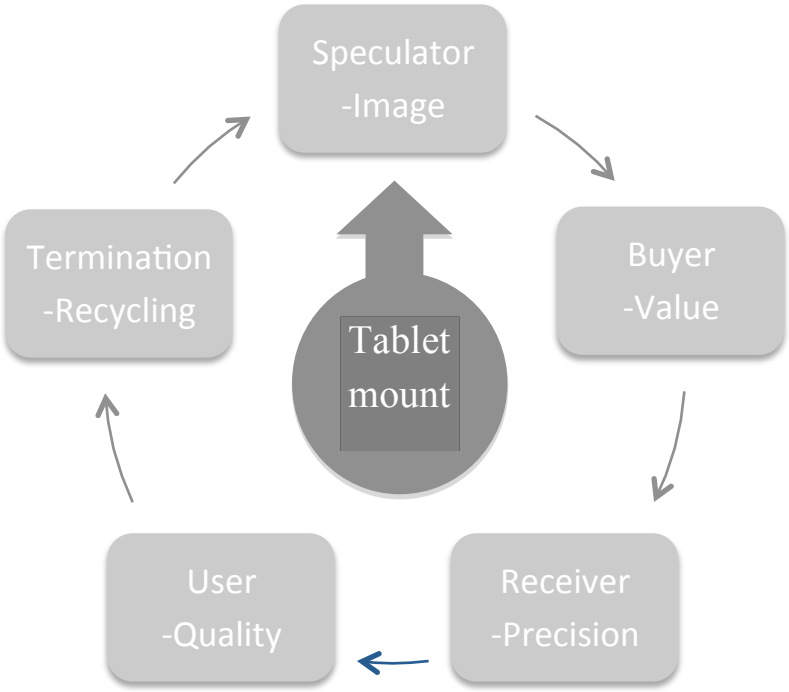

Figure 9- Schematic of the life cycle and characteristics from each phase, based on the Value model.

4.2.1 Speculator

A speculator for a tablet mount could potentially be all VCC's customers that have a tablet or are considering buying one. It is important to establish a high image for the product and meet the core values of the VCC, as described in chapter 1.1. Since competitors and third-party manufacturers already have tablet mounts on the market, it is vital to offer higher customer value than the others.

Focus on the additional functions could be important to show the increased customer value. The product image can also increase if the product is made by environmentally friendly material. A functional prototype and detailed CAD-models in the development phase can help to see which concept the users prefer.

One example of unique selling point that was one of the main goals with the project was to cover the edges of the tablet, and still be flexible for small and large tablets. The speculator could get a safer impression than third-party manufactured mounts for this additional functionality and would then increase.

Vital aspects to cover in the development phase:

- Additional functionality
- Use environmental friendly materials for the mount if possible

4.2.2 Buyer

When the customer going from the speculator to the buyer, it is important that the product covering all the needs and requirements the customer expects from the presentation in the previous phase. The technical information how the mount functions in detail is less vital in this phase, according to Lindstedt (Lindstedt & Burenius, 2006). It is more important that the product seems intuitive and there are clear instructions.

The customer is more focused on the price in this phase and it is vital to decrease the cost as much as possible in the development phase, but still maintain a high quality. Manufacturing process, material selection and level of complexity are some of the examples of decreasing the end product cost.

Vital aspects to cover in the development phase:

- Intuitive product and clear instructions
- Decrease to cost and complexity of the product to make the buyer more interested

4.2.3 Receiver

It is important that the product is easy to install. This phase does not involve the development project, since the fastening to the car will be developed by VCC.

4.2.4 User

The phase when the customer actually using the tablet mount is often perceived as the most crucial phase and therefore the part where the product could gain the most customer value (Lindstedt & Burenius, 2006). Since the service and marketing not was covered in the project on a detailed level, this was the phase to focus on and maximise the customer value. User interviews were conducted to find important and latent needs to fulfil the expectations.

It is crucial that the tablet mount achieves the expectations shown in the speculator and buyer phase and deliver what was promised. The quality and safety is evident and it should be able to fulfil the guaranteed life time.

Vital aspects to cover in the development phase:

- Increase user-based quality by interview user to find latent needs
- Make the product withstand wear and high forces to maximise the lifetime

4.2.5 Termination

When the mount is worn-out it gets important to choose materials in the development phase that are recyclable if it is possible, to be able to meet the environmental core value of VCC and also to take environmental aspects under consideration (Volvo Cars corporation).

Vital aspects to cover in the development phase:

- Use environmental friendly material if possible

4.3 Interviews

The results below are divided into different areas that were found interesting from the interviews. The aim of the business segment was to target women and men that could fit in under the business segment and can possible have a purpose for a tablet in their daily work. All of the interviewees had a relationship with a tablet to some extent, but it deviated how much the respondents used it. The qualitative study was conducted by 14 participants distributed between potential users from the two segments described in section 3.2. Three children were interviewed as a group interview to get an understanding of their user habits and this interview was customised for the children. The interview templates and the answers can be seen in Appendix D and they are presented in Swedish. Section 4.3.1-4.3.6 below describes the different interesting areas.

4.3.1 User habits

Most of the respondents from the considered business segments used tablets both for work and in their private life. Often during travelling, the tablet can work as a replacement of a laptop, since the ease of use and the mobility. Most of the respondents could see a purpose for the tablet in cars, but at the same time it was not optimal for them personally all the time. The Swedish businesspersons that were interviewed did almost always driving, and for that reason they felt that it was not always an optimal product for them. It is important to clarify that the respondents from the business segment also answered some of the questions from the parent perspective since they had children using tablets frequently. This could be a reason for the positive attitude towards a tablet mount even if they would not use it personally.

The usage from the family segment was not surprisingly more for the private usage. The areas of use were rather wide; everything from games and surfing to chatting on the internet, using applications like Facebook. Many of the adults were surprisingly also using the tablet to play games. The children from the group interview were also fond of the front camera.

Most of the respondents found that they were using the tablet individually and not sharing the view often. There were although about 25% of them, mainly the children that said sharing the tablet when playing games happened frequently. Other saw the usage as private and did not want to share their business.

Overall patterns:

- The usage area of tablets is huge and deviates a lot for the different user segments. The tablet replaces often a laptop when travelling and is a complement when the person is home.
- The older respondents in the interview were almost always driving by themselves.
- The tablet is mostly being used individual by the persons involved in this study except for the children.

4.3.2 Availability of buttons and sockets

The majority of the respondents said that they would either put in headphones or connect the tablet to the car's audio system if they wanted audio from the tablet. They did not find the tablet's speaker significantly interesting when it was mounted since the poor quality and low volume of sound from the tablet speaker. The latent need to not disturb the Bluetooth signal came from this; since it is used to wirelessly connect the tablet to the audio system in the car. Most of them did not have a 3G-version, which made them dependent on sharing from their phones. This signal was also important to not disturb with the mount and is important to take under consideration when designing and choosing material for the mount in the detailed design phase.

All the respondents in both segments said that all the buttons that their tablets had is necessary in normal use. The volume buttons were not important to reach if the tablet is connected to the audio system, but still it is important when not having that possibility.

The charging could increase customer value according to the respondents. One of them saw it as a requirement to be able to charge it and another meant:

> "It would be great to be able to charge it in the mount, but I can vision the complexity to make it flexible for different types of models".

There was no doubt that it would be an interesting feature, although the complexity would increase.

The children in the family segment thought that the front camera would be important since many applications use it for making funny pictures, to name one example. The parents and business persons did not find a need for the front camera to take pictures or using applications like video calls for meetings, although this could be a feature interesting for the global market.

Overall patterns:

- The headphone jack and all the buttons on the tablet is vital to not cover.
- The solution cannot prevent the Internet or Bluetooth signal.
- Charging the tablet in the mount would increase the customer value.
- Front camera seemed interesting at least for the children segment.

4.3.3 Adjustment issues

The adjustment issues were an interesting subject to get an overall idea what the respondents found most important; the ability to attach and detach the same tablet easily or the importance of adjusting the mount's size to different models easily. This was an open and rather complex question and therefore only discussed with adults. One answer from a respondent was summarising the issue properly:

> "I think it is a trade-off between both of them. Right now, I would only be interested in maximising for one, but I have a brother-in-law that has both an iPad and iPad mini and I can see that for him it would be perfect to be able to use both in the mount without too complex adjustments"

There were answers on both sides of the statement and also as above, in the middle. The result from this question is therefore that both could be important but is seems that many would use it with one specific tablet for most of the time. But it is not only vital to make the adjustment as effective as possible; the movements required should also be simple and intuitive. A quantitative study would have been necessary in this issue to be able to draw any statistical conclusions from it.

Overall patterns:

- The tablet should be easy to attach and detach from the mount.
- The flexible solution should be easy and as fast as possible to adjust for different tablets.
- There should not be unnatural movements and the solution should be intuitive to adjust.

4.3.4 Additional adjustments

The mount might need to be adjustable and flexible for the user and the purpose with the additional adjustment questions were to investigate if there was a need for it and if so, what features would be the most important for the users.

Initially it was found that there was a desire for flexibility and personal adjustments. There had to be a trade-off between features and complexity according to the respondents. It was two adjustments that were most and equally mentioned. These two were rotating the mount to make the tablet stand up vertically and lie down in a horizontal mode. The second need was tilting the mount to get a suitable viewing angle. One respondent said:

> "It is important that you sit in an ergonomic position, especially if it is a long time you travel. Tilting the tablet could therefore be important if the initial position is not perfect for your size."

Another respondent mentioned that some applications can only be used when the iPad is in portrait mode and therefore it is important that the mount can rotate.

It was also mentioned that the initial position is important. If this position is descent, it was not vital for the user to change it. The respondent said that the need for additional

adjustment only came if he thought that the position was abnormal. The observations were the tool to make a suggestion to VCC for the initial position and the results can be seen in section 4.4. This research was only supposed be used as a guidance however, since the amount of data are not enough to make a statistical decision.

Another interesting point that emerged when asking around the subject was that sun reflections are important to prevent since this can disturb the user a lot. According to the interviewees that talked about this issue, it could be prevented or minimised by tilting, twisting the tablet right and left or a reflection shelf on the screen.

Overall patterns:

- Trade-off between functions and complexity.
- Tilting the tablet would increase user value.
- Try to optimise the initial position.
- Prevent sun reflections to the tablet
- Confirmed that rotating is a necessary feature to use all of the applications.

4.3.5 Other important characteristics

The question was asked to the respondent in a complete open approach to see if they had any other specification or function needed that they had not mentioned earlier in the interview.

Two important issues that many mentioned were the robustness and the design. They thought that many children would use this product and therefore it has to be prepared for rough usage. The robustness cannot make the tablet mount too big or complex, since many respondents thought the design also was important. The most common answer about this issue was the importance for the design to be coherent with the rest of the car. They did not want the tablet mount to draw a lot of attention, especially when not being used. One respondent wanted to disconnect the whole product if they did not use it all the time. Another opinion in the same topic was:

> "It should not be in the passenger's way when not being used".

Therefore it should be a trade-off between the simplicity of design and the robustness, to not be too clumsy.

The children wanted, as mentioned before, the front camera being accessible and others mentioned the importance of stability that is included by a robust construction. When writing on the table it should not be perceived as unstable was a statement declared frequently.

Overall patterns:

- Make the mount robust as possible without having clumsy perception.
- The design should fit into Volvo cars. Discrete as possible, especially when the mount is not in use.
- The tablet should also feel stable when the user writes on it.

4.3.6 Acceptable price

The question about the acceptable price for the possible mount was an open question, and that resulted in different viewing angles in the answers. Some of the respondents thought directly that this mount was ordered when buying a new Volvo, installed and ready to use when you get your new car. When thinking in this way, regardless if the respondent would have enough money to possible buy a new Volvo car, said a much higher price than other respondents that thought of this question based on their situation in life.

The two viewing points is therefore interesting to compare because it was a big difference. The price was also based on the respondent's vision of the tablet holder, thus if the mount fulfilled all of his or her requirements. Some of the respondents did not have as many requirements as others, and they did often say a lower price since they had a simpler mount in their thoughts.

When respondents was thinking in terms of buying a new car with the mount installed, the maximum price was around 4000 SEK, and one mentioned for example that the line was drawn if the mount became higher than the tablet. The other category of respondents was rather spread. This can be explained due to their individual need or economic situation and the rest of the prices deviated mostly from 500 SEK up to 1500 SEK.

Overall patterns:

- The acceptable price deviates a lot depending on the respondent's situation and requirements.
- The maximum price should be around 4000 SEK if the intention is that this solution should mostly be for new cars and if it is installed when receiving the car.

4.3.7 Potential sources of errors in the qualitative study

The qualitative study was carried out by the other of this report and was developed further and refined after the first interview to change the approach of some questions. This was done to not lead the interviewee to a specific answer. The first interview was missing one question that was added later, but was asked afterwards since it was found interesting to get as many opinions as possible. Although the interviewer has carried out a customer research before this project and did a product life cycle analysis to find suitable questions, there is a lack of long experience from the field. There could likely be important questions that have been missed and therefore it could be more latent needs that were not found in the investigation.

The interviewees were mainly in three groups; children, parents or business persons. Many of the interviewees were suitable into both the group "parents" and "business person". The business segment´s opinion might deviate from the global market since the interviewees do not sit in the backseat often and found more purpose for their children to use it. The family segment was covered both with parents and a small focus group involving three children and the interviewer. The two segments were therefore not distinguished as much as first intended in the interviews. The business segment can be considered representative from a

Swedish point of view, but benchmarking and investigating extra on a global scale can be necessary to find unique needs for their usage.

Another aspect that could be questioned is the gender distribution and the amount of interviewees that was included in the study. The focus lied more on finding the suitable persons that were belonging to at least one of the two market segments, than finding as many people as possible and what gender they had. One important requirement was that all the interviewees should have some connection with tablets, either they used it on daily basis or have children who did it.

4.4 Observations

The observation analysis included 22 participants for the positioning of the tablet in the back seat and 15 persons also adjusted the driving seat for their preferable driving position. The participants were all Swedish but of different age, gender and size.

The summarised data from the investigation are shown in Table 2, where the mean value, max and min difference and highest-lowest measure are listed. All values are listed in millimetre [mm] and the data from both the tablet position and front seat are listed.

Table 2- Measurements from the observations

Measure in [mm]		Mean value	Max. dif. +	Max dif. -	Highest-Lowest
Tablet	Distance to back headrest	728,954	70,885	-149,528	220,414
	Distance to roof	422,747	111,150	-104,778	215,928
	Angle	52,607	17,695	-19,704	37,400
Front seat	Distance to back headrest	904,866	108,133	-111,866	220,00
	Angle	100,613	8,186	-10,313	18,5

Figure 10 shows the mean positions for the tablet and front seat in red, and all the measured observations in blue. Zero on the vertical axis represents the spot in the roof straight above the back headrest.

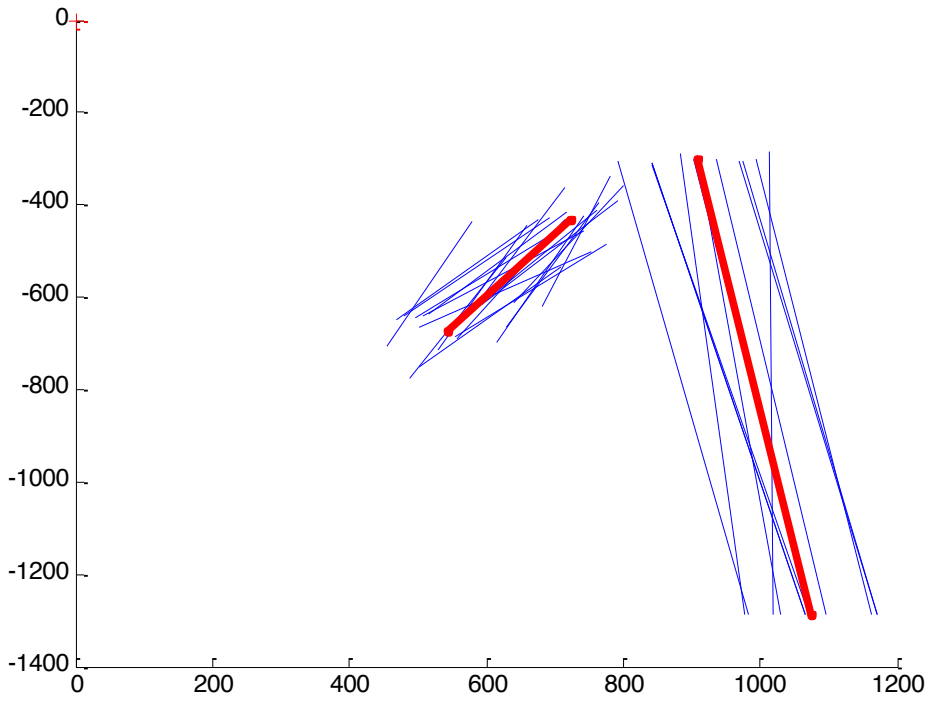

Figure 10- A representation of the measured position for the front seat and the tablet

There was no correlation found between the horizontal distance and the angle of the tablet, as can be seen in Figure 11. However, there could be a slightly pattern regarding the height position of the tablet and its angle, which makes sense because if the tablet would be preferred placed higher up, the tablet should probably be more vertical positioned for a proper viewing angle. As can be seen in Figure 12, it is although not a strong pattern and more measurements would be needed to make final conclusions.

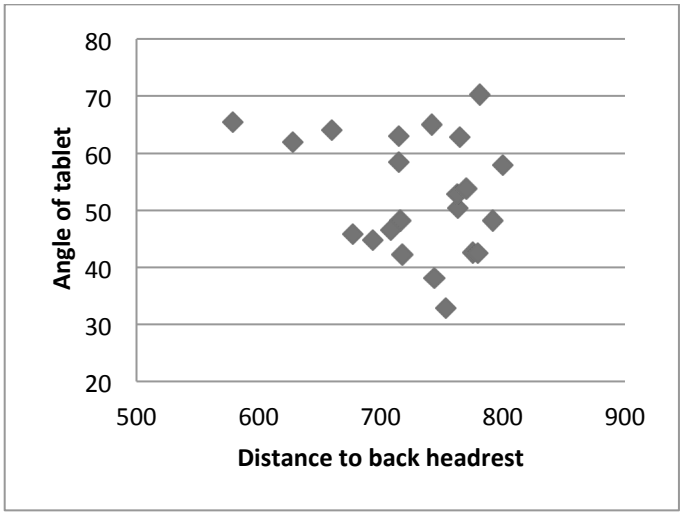

Figure 11- Horizontal length in relation to angle of the tablet

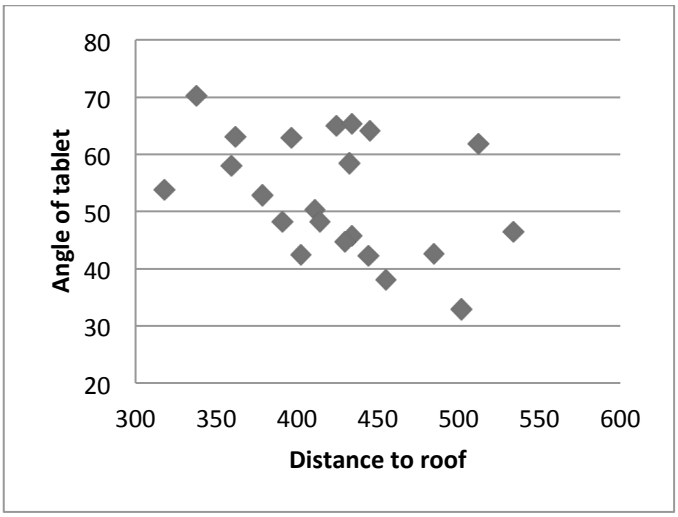

Figure 12- Vertical height in relation to angle of the tablet

Regarding correlations between horizontal and vertical positioning, ignoring the extreme values, there is a minor pattern that a person holding the tablet close to him or her would also hold it lower. The pattern is very weak though and more observations would be needed to confirm this.

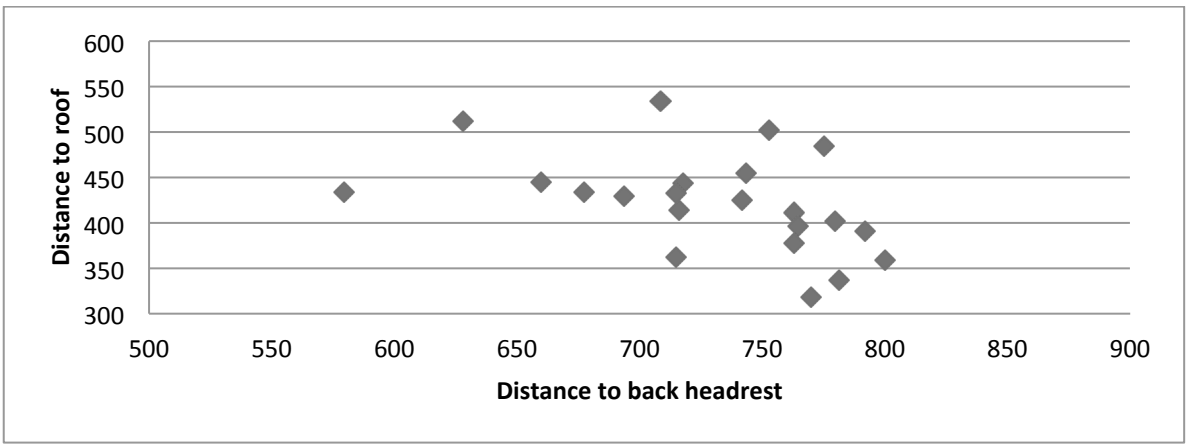

Figure 13- The relation between distance to roof and distance back headrest

Using the mean values, the tablet should be positioned 186.32 mm from the back of the front seat and position the tablet with an angle of 55.64°. As a result of this, the mean length of the arm should be 318.77 mm. This value is calculated from the tape on the front seat to the centre of the tablet.

Regarding the extreme values, a short person in the back seat with a short person in the driver's seat would require the length 433.5 mm. By the term short person means the one who held the tablet closest to him or her, or sat furthest forward in the driver's seat. In the opposite scenario, with two tall persons, the tablet would never even be useable in the writing mode. However, the tall person would probably not even fit in the back seat behind the other tall person.

The tablet angle varied surprisingly much in the study, all from about 32.90° to about 70.30°. Considering both the angle of the seat and the angle of the tablet, the angle between the arm and the seat the calculated span should be somewhere in the range of 29,20° – 79,70°. This should be the estimated tilting span of the mount, if this feature is implemented.

For potential sources of errors method and investigation, see Appendix A.2.

4.5 Establishment of target specification

The target specification came from the known information from the user and market study. These requirements were added to complete target specifications, combined with the requirements from Report B and Report C.

A list of 19 user needs from the interview was established and weighted from 1-5 in importance, according to the answers. These were carried out from the analysis of the interviews and were supposed to be the representation of requirements from the users and can be seen in Table 3.

Table 3- list of the found user needs

	Needs		Importance
1	The mount	does not hide the tablet's buttons and headphone jack	5
2	The mount	is not covering the speaker	3
3	The mount	cannot disturb the Bluetooth- and WIFI-signal	4
4	The mount	is able to charge the tablet	4
5	The mount	is not covering the front camera and mic	2
6	The mount	can attach and detach the tablet easily	4
7	The mount	is flexible for different tablet models	4
8	The mount	can preferably enable more than one viewer to the tablet	2
9	The mount	is tiltable	4
10	The mount	is preferably preventing sun reflections to the screen	2
11	The mount	is easy to adjust for different models of tablets	3
12	The mount	is initially placed in an ergonomic position for its typical users	3
13	The mount	is flexible for common types of tablet usage	4
14	The mount	feels stable when the user is writing on the tablet	4
15	The mount	has a robust construction to handle usage from children	5
16	The mount	has an appealing design that fit Volvo cars	4
17	The mount	is and feels safe	5
18	The mount	is not in the way when the user is getting in or out of the car	3
19	The mount	is affordable for a Volvo-owner	5

The user needs got translated to engineering requirements, called metrics according to Ulrich & Eppinger's methodology (Ulrich & Eppinger, 2012). They were established for the target specification and each are also weighted as the user needs. The metrics have units specified, to be able to estimate or validate if the concepts fulfil the requirements or not. The table of metrics can be seen in Table 4. The second column specifies which user need or needs the metric covers. To see the complete needs-metrics matrix and see their relations easily, see Appendix E.

Table 4- List of engineering metrics based on the user needs

Metric No.	Need affected	Requirement	Importance	Units
1	1	Headphone socket accessible	5	Binary
2	1	Buttons accessible	5	Binary
3	2	Sound distortion	2	Subjective
4	2	Volume deviation	2	dB
5	3	Wifi performance	4	%
6	3	Bluetooth performance	4	%
7	4	Charging accessible	4	Binary
8	5	Mic and front camera performance	2	Subjective
9	9, 10	Prevent reflections on screen	2	Subjective
10	8,12	Optimal initial angle for average user	3	Degrees
11	12	Optimal initial position for average user	3	mm
12	16	Design coherent with VCC's interior design	4	Subjective
13	16	Aesthetically appealing	4	Subjective
14	19	Unit manufacturing cost	5	SEK
15	9, 13	Tilt adjustment range	4	Degrees
16	14, 15	Minimum vibration while typing on the tablet	4	Subjective
17	17, 18	Instils safety	4	Subjective
18	6,11	Time to mount and dismount tablet	4	s
19	16,17	Instils quality	4	Subjective
20	7	Tablet flexibility range for the mount	4	mm
21	6,11	Time to adjust mount for different tablet sizes	3	s

The complete target specifications were conducted with the user research and market research, in combination with the found requirements from the prestudies in Report B and Report C. See Appendix F for the complete target specifications. The initial source or sources of each requirement is also stated in the list.

5 Concept development process

In section 5.1, the result of the concept generation is presented. Section 5.2-5.3 covers the selection of the final concept that should be detailed designed and evaluated. As mentioned in section 1.2, this phase was conducted by the complete project group and therefore the concept development process is nearly identical between the reports.

5.1 Exploration and establishment of concepts

The concept generation was supported by all the knowledge and inspiration from the prestudy. A lot of time and effort was invested in this phase since an extensive solution space had to be covered, due to the complexity of the product.

The functional brainstorming resulted in a morphological matrix, which can be seen Appendix G. It was based on the functions identified in the product decomposition. Each function was brainstormed separately and efforts were made to cover all potential technical solutions. However, many of the solutions were dependent on other solutions. For example a suction cup attachment was not deemed feasible together with a deformable structure. In order to enlighten these relations, additional columns where added to the morphological matrix. These columns where made to show which technical solutions fit with each other, which can be seen in Table 5. In the table, the suction cup is chosen for attachment solution, and the possible solutions for flexibility are marked with green.

Table 5- An example of the possible solutions for the attachment 'Suction cup' in the morphological matrix

Attachment	Flexibility	
Band	Elastic	
Flexible arms	Springs in structure	
Non-permanent glue	Deformable	
Clamping supports	Threaded rods	
Clamps	Separate, built-in solutions for different sizes	
Cushion	Nothing	
Magnets	Module-based	
Glue + solvent	Different attachment locations	
Case	Adjustable band	
Slot	Automatic roll	
Suction cup 1	Manual roll	
Resting supports	Rail system	
Clamping frame	Slideable in track	
	Track with springs	
	Telescopic inwards	
	Telescopic in tablet's plane with springs	
	Telescopic in tablet's plane with gears	
	Telescopic in tablet's plane with, manual	
	Telescopic along rigid structure	
	Rotatable parts in tablet's plane	
	Attached to frame	

The morphological matrix was used for both qualitative and quantitative concept generation. The qualitative approach meant carefully choosing technical solutions that seemed promising and would fit well together. These were then combined into complete concepts.

The quantitative approach meant choosing technical solutions with less thought for the intent of creating many concepts. This was also done by randomly selecting solutions and combining them into concepts to find more out-of-the-box solutions. Some examples of concepts generated from the morphological matrix can be seen in Figure 14- Figure 16. The combination of solutions into complete concepts continued until all feasible ideas had been used at least once.

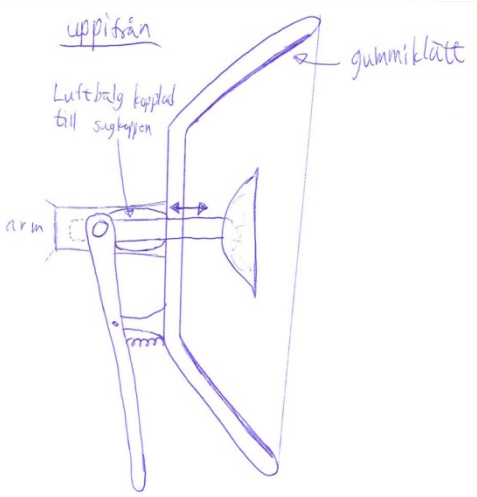

Figure 14 - Suction cup with rigid frame

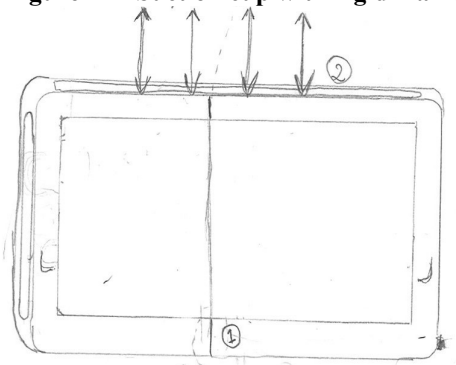

Figure 15 - Semi-flexible structure with VHS-insertion

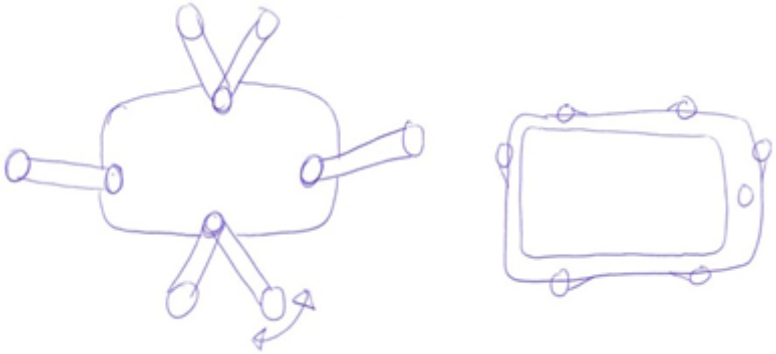

Figure 16 - Point attachment concept with rotatable arms

The internal 6-3-5 brainwriting was used with great success and resulted in 54 new concepts of varying quality. Due to the short time limits and the fact that entire concepts were generated instead of just technical solutions, the concepts generated generally differed quite much from those of the morphological matrix. One example of a concept can be seen in Figure 17.

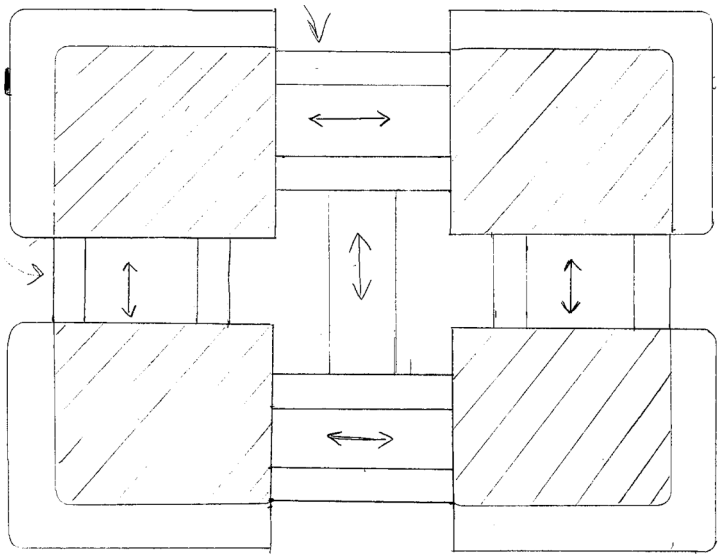

Figure 17 - A flexible frame-concept which was generated from the 6-3-5 brainwriting

The brainstorming with stimuli was used late in the concept generation process, when there was a need for support to generate more new ideas and concepts. For example the concept in Figure 18 was created with the stimuli inspired from a dishwasher and a rollercoaster, with the foldable frame in the concept resembling the retaining structure of a common rollercoaster.

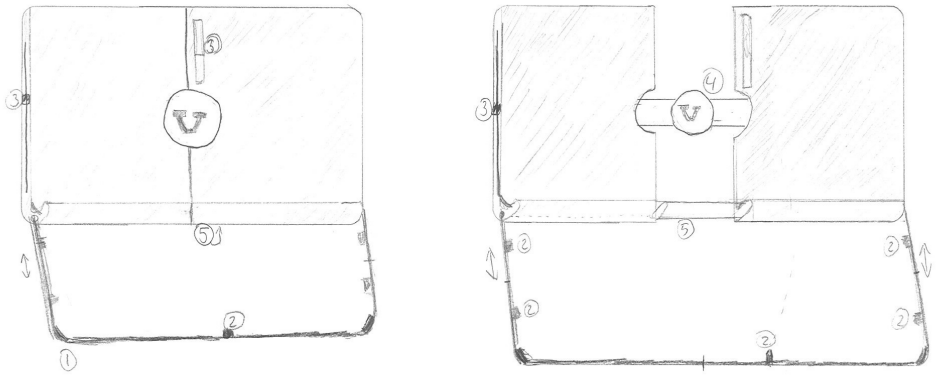

Figure 18 - Semi-flexible concept with rollercoaster-inspired frame from brainstorming with stimuli

The external concept generations were conducted both as a 6-3-5 brainwriting session and by discussing ideas with other students at Chalmers University of Technology. They were both conducted rather late in the concept generation phase and neither of the two gave any new concepts. They could therefore instead be used as a confirmation that a majority of the solution space had been covered. When it comes to the 6-3-5 brainwriting session, the participants found it hard to embrace all the information that was needed for generating complete concepts and this could be an additional reason why not so many new ideas emerged.

The final step of the concept generation consisted of going through all concepts. Many concepts were only rough sketches and sometimes only the sketcher could understand them and many were also identical or at least very similar to other concepts and could be

merged. Some concepts where removed too, due to their lack of completeness. These were generally concepts from the later stages of the 6-3-5 brainwriting.

All concept sketches that were not removed this way were refined with better detail and then categorised. The categories were based on the concepts' physical characteristics and the concepts were divided between them as:

- Flexible mounts (38 concepts)
- Semi-flexible mounts (6 concepts)
- Deformable mounts (8 concepts)
- Rigid frame mounts (20 concepts)
- Point-attachment mounts (2 concepts)
- Back-attachment mounts (3 concepts)

5.2 Finding the most promising concepts

This section describes the funnelling down from the initial 77 concepts down to the final concepts. A visual representation of the phase, together with the number of concepts for each level can be seen in Figure 19.

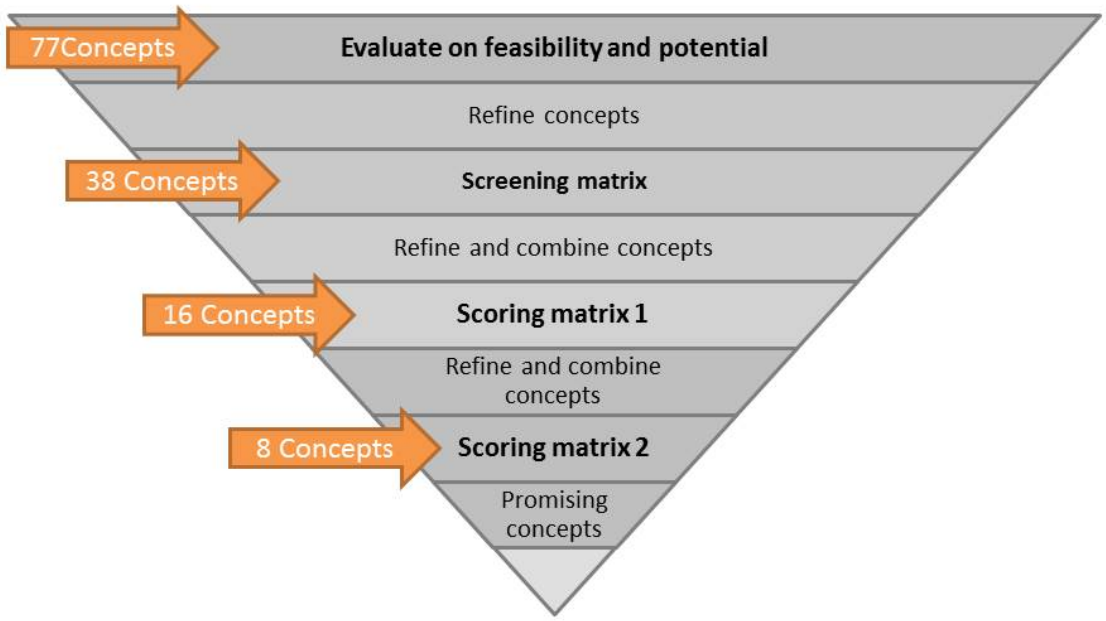

Figure 19 - Visual representation of the concept evaluation, with the number of concepts for each step

5.2.1 Initial screening

Each concept was evaluated based on if it had potential to live up to the following aspects:

- Ability to fulfil vital requirements such as minimum radii of components and holding the tablet securely in a crash.
- Feasibility to construct
- Potential for a premium handling and appearance

The similar concepts were evaluated and combined to decrease the number of concepts and the three criteria above were taken under consideration to evaluate if the concept should be

further developed or not. The first criterion covered potential to make the concepts fulfil the vital requirements, which in this case mostly involved being safe in a car crash. If a concept did not fulfil all vital requirements at this point, but was still found to have potential, it was kept to refine or combine with other concepts.

Several of the solutions failed on the second criterion, which was feasibility. If the concept was based on advanced technology or technical solutions with a high cost it was generally removed since the project had a strict time and budget plan.

A large portion of the concepts considered too lack potential when it came to the handling and appearance. The question asked for this criterion was: would VCC ever put a product like this in one of their cars? If the answer was no and no plan to refine the concept to fulfil the criterion to be good enough, it was removed.

After refining, combining and funnelling down there were 38 concepts left to make it to the next step of the concept evaluation phase. These concepts were given a name based on an abbreviation for their classification plus a number. The abbreviations for the classifications were:

- Flexible mounts - FL
- Semi-flexible mounts - SE
- Deformable mounts - D
- Rigid frame mounts - FA
- Point-attachment mounts - P

A collage of the concepts that were removed in the initial screening phase can be seen in Appendix H.1-H.6, divided into the categories above.

5.2.2 Screening matrix

One of the remaining concepts, named FL13, was chosen as the reference. It was a telescopic frame structure with one arm going from one corner to the opposite, connecting the frame to the back piece with the tablet being held at the corners. A sketch of the reference concept can be seen in Figure 20.

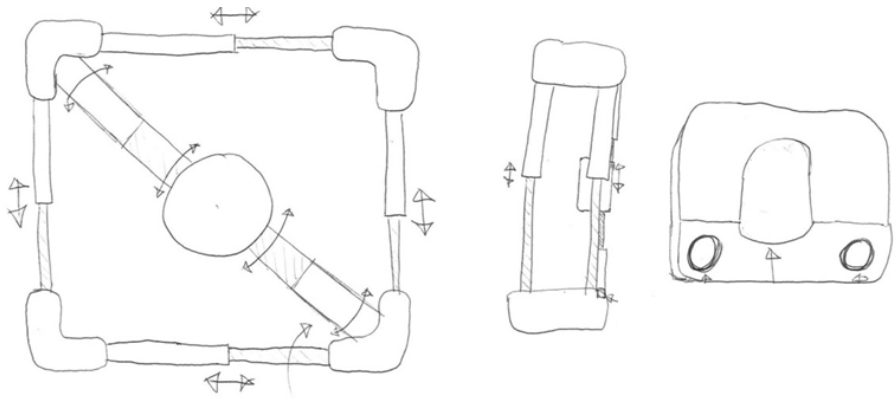

Figure 20 - Concept FL13, which was used as a reference in the screening matrix

Six criteria were chosen covering all relevant requirements and this can be seen in Table 6. The first column shows the different criteria, the second column explains the judgement aspects on which the concepts were evaluated and the covered requirements from the target specifications are listed in the third column.

Table 6- The chosen criteria for the screening matrix

No.	Requirement	Judgement criteria	Covered requirements
1	Crash safety	Coverage of edges, secure holding, unsafe deformations, protrusion	1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 3.29
2	Aesthetically appealing	Coherent with Volvo's design, instils quality/safety, good looking	2.2, 2.3, 2.4, 3.12, 3.18, 3.17, 3.19, 4.1, 4.4
3	Ease of use and flexibility	Intuitiveness, time, simplicity in use, range of flexibility	2.1, 3.18, 3.21, 3.20, 4.2, 4.3
4	Physical robustness	Strength, fastening strength, structural stability, stability in usage	2.5, 2.6, 2.7, 2.12, 3.16, 4.3, 5.1, 5.2, 5.3
5	Simplicity	Number of parts, complexity of connections	3.14, 4.5, 4.8, 4.9, 4.10, 4.11, 4.12
6	Accessibility for buttons & sockets	Charging, audio, volume buttons, on/off, home button, speakers	3.1-3.8

All 38 concepts were evaluated for each criterion in the matrix. The complete screening matrix can be seen in Appendix I.1. Short presentation of the results:

- 7 concepts got a score of +2
- 9 concepts got a score of +1
- 12 concepts got a score of 0
- 4 concepts got a score of -1
- 3 concepts got a score of -2
- 1 concept got a score of -3
- 1 concept got a score of -5

The project group now revisited each concept again, investigating why they got the score they got and deciding if they should be continued with. This was not directly based on the result of the screening matrix but rather used it as a guide for the evaluation. One of the important aspects from the matrix was if a concept had gotten a lot of + and - or if it had gotten mostly 0's. For example, a concept with a score of 0 that had +3 and -3 could have some really good features although it is being pulled down by other negative features. In such a case, the positive features could potentially be combined with the positive features of another concept and thus it is generally more interesting than a concept which has gotten all 0's. For example, concept P2, which can be seen in Appendix J.2, was kept with the ambition of combining it with a telescopic frame.

All five concepts, which ended up with a negative score, were removed as well as a lot of concepts that scored a zero. The concept FA5 got the result +1 in the matrix but was still removed due to the fastening being considered too weak. Additionally, the concept FA9

was also removed even though it scored a +2 in the matrix. The reason was that it just did not seem possible to make a cushion feel like a VCC product. The concepts chosen not to continue with can be seen in Appendix J.1.

15 concepts where chosen for further refinement and evaluation. Additionally three pairs of concepts where chosen for combination. One concept, the reference FL13, was chosen to both be continued with on its own and combined with another concept, FL4. The concepts chosen for further work can be seen in Appendix J.2.

During the refinement and combination of concepts, they were described in higher detail and minor calculations and analyses were made. During this stage, problems occurred with a few concepts.

The combination of FL4 and FL 13 was rejected, as was FL8. Additionally, the new version of P2 with a telescopic frame, Figure 21, encountered adversities when it became obvious that it would not be able to hold the smaller tablets. The rotatable arms would simply move one side's centre piece too far for the telescopic function to work. Since this was required to continue with the concept, it was therefore removed.

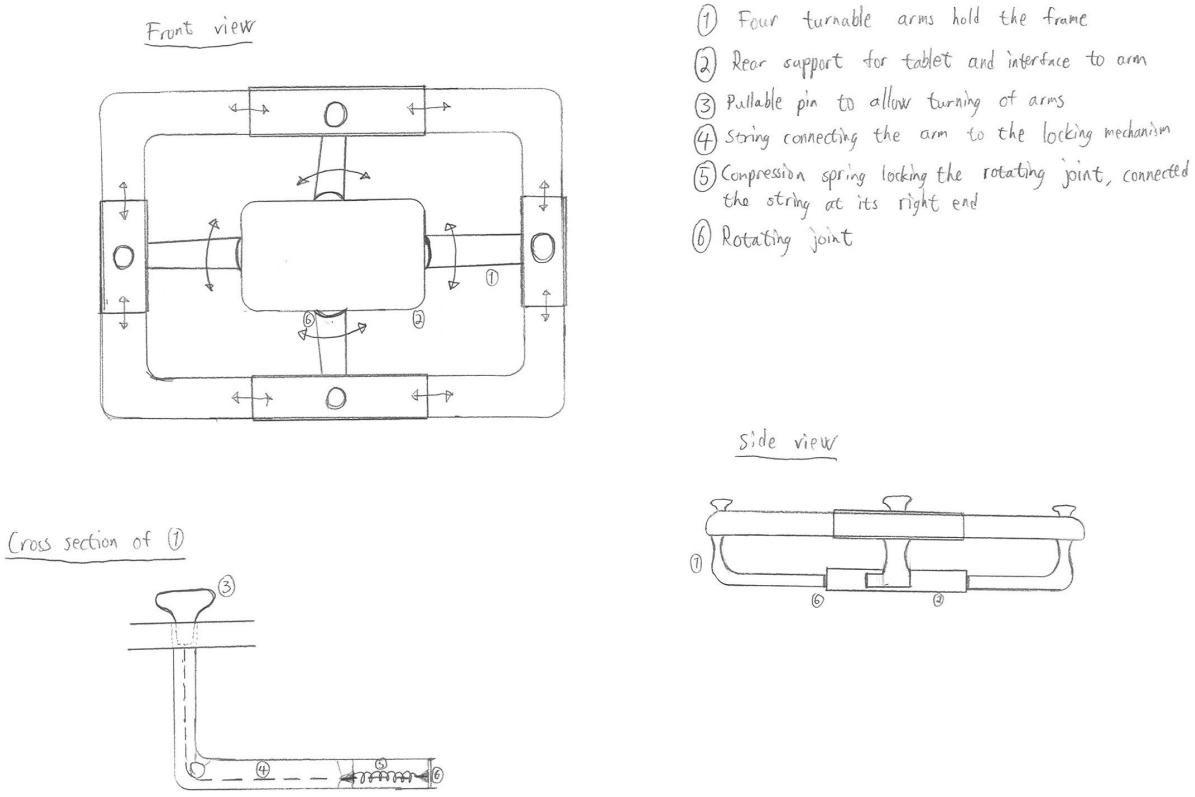

Figure 21 - New version of P2 with telescopic arms

What remained after the screening, refinement and combination was 16 concepts. These had been sketched with higher detail and they were also given new names based on their function and appearance rather than their old classifications. This was done to make it easier to remember their names. These 16 concepts can be seen in Appendix K.

5.2.3 Evaluation of technical function

Since there was some uncertainty during the screening regarding how well springs could hold the tablet, some tests were conducted before the first scoring matrix. A test rig was built out of chipboard and wooden strips. The test rig was built to resemble a tablet mount holding the tablet with the force from the springs and a thick metal plate was used as a tablet, see Figure 22. The springs were for shock absorbers for RC cars and these were chosen both because they also have a dampening effect and they also had a good stiffness. They could quite easily be compressed by just the push of a hand, but still had a chance of holding the tablet in place. The rig was tested both with one spring, as in Figure 22, and with the two springs.

Figure 22 – Test rig for evaluating the holding strength of springs

The test was conducted by dropping the test rig from a height so that it landed on its upper edge, which is the top edge in Figure 22. This way the force from the tablet would press directly at the springs. When dropped from about 1.5 m into asphalt, the test rig was able to hold on to the tablet and based on the results, springs were considered good enough for fastening even though a locking mechanism would most likely be preferred in the event of a crash.

5.2.4 First concept scoring

The first scoring matrix used the same criteria as the screening matrix, as can be seen in Table 6, except that it did not include the criterion for safety. The reasons for not including the safety aspect, which can seem quite important, were that all concepts at this stage were considered about equally safe. At least the differences were so small that the project group was unable to distinguish between which concepts were safer than others. The reason behind merging the two criteria for ease of use was that for a majority of the concepts, the

action for mounting/dismounting was the same as for adjusting the size. That function was thus counted twice.

The criteria were then weighted to each other and this is shown in Table 7.

Table 7- The chosen criteria and their weight for the scoring matrix

Criteria	Judgement aspects	Weight
Aesthetically appealing	Coherent with Volvo's design, instils quality/safety, good looking	22,00%
Ease of use and flexibility	Intuitiveness, time, simplicity in use, range of flexibility	18,00%
Physical robustness	Strength, fastening strength, structural stability, stability in usage	26,00%
Simplicity	Number of parts, complexity of connections	13,00%
Accessibility for buttons and sockets	Charging, audio, volume buttons, on/off, home button, speakers	21,00%

Robustness was considered most important, due to VCC's high demand on quality. They would simply not put a rickety product in a Volvo car. It is also very important that the product is functional and does not lose that functionality over time. The looks of the tablet mount comes next, again because VCC would not sell a product that is not aesthetically appealing and coherent with their interior design. The accessibility is the third most important aspect. The reason for this is because a customer would be really upset if they bought a flexible tablet mount, that is said to work for all tablets, and then it prevents some of the tablets main functions potentially making it unusable. The ease of use is still important, but was considered less relevant than the previous three. The least important criterion was the complexity. The reason for this is that as long as the concept falls within VCC's target cost, it was considered acceptable. Even if it would be more expensive, that might be justifiable provided the mount is functional, robust and good looking.

The 16 remaining concepts were evaluated and rated in the scoring matrix, which can be seen in Appendix I.2. Once again, each concept was revisited after the scoring to evaluate if they were worth continuing with or not, using the scoring matrix as guidance. Eight concepts were considered too deficient for continuous progress and it was also these eight concepts that turned out to get the lowest rating in the scoring matrix.

The eight concepts chosen for further development and evaluation, in order of rating, were:

1. Swatch
2. Ref
3. Cog
4. Modular
5. Lever
6. Flag
7. PBR
8. Side Slot

5.2.5 Presentation of eight final concepts

The remaining eight concepts were refined with regards to in what areas they scored poor ratings in previous evaluations. All concepts were 3D-modelled in CATIA v5 which also helped in enlightening more problems with each concept. These flaws and opportunities lead to the concepts being refined even further.

Tablets of different sizes were also modelled and the concept models were tested with the tablets. This lead to one of the major problems that was found at this stage because the tablet mounts would need a larger size range than earlier believed. The reason was that tablet size variations affected the solutions more than expected.

There were still eight concepts after the refinement process and these eight concepts are described in this section.

Concept 1- Ref

Ref is a concept that was used in the Screening matrix, but has been refined in the previous iterations. The initial Ref was only a diagonal arm, but was replaced with two arms in an X-formation as can be seen in Figure 23. Only one arm would not be as robust as the X-formation, and it would be harder to adjust the frame size.

The user pulls two corners to expand the frame and then the tablet can be put in place. The next step is to press the mount to the correct size for the tablet that has been attached. There are no cogwheels in this concept and this is positive for the simplicity of the construction but bad for the symmetry and the fact that the user needs to use two hands to adjust the mount.

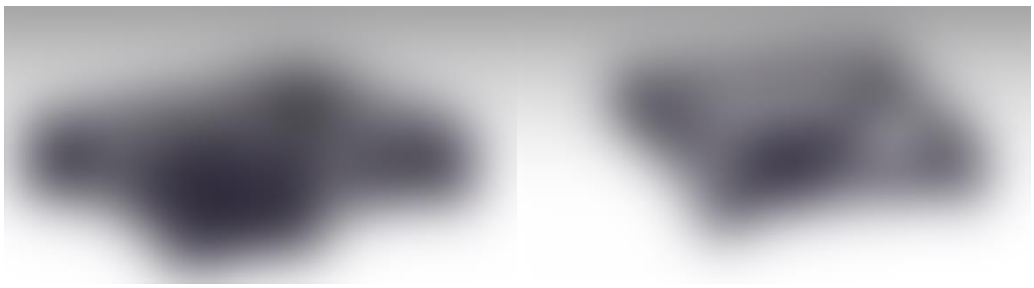

Figure 23- Visual presentation of the concept Ref

Ref has moveable supports on the side for the tablet to stand on and these make the frame also more robust. The movement feature exists because the supports never can hide a button or a socket in this concept.

Key features and drawbacks

+Simple construction
+Same procedure to mount a new tablet model
-Two hands required to adjust the mount
-The arms has to be in two planes makes the mount thicker
-The mounts relies on friction to lock the tablet in place

Concept 2- Cog

Cog has similarities in the design with concept 1, but this concept is more complex since the additional components. It was decided to evaluate both and see which concept that seemed the most promising of them. The biggest difference is the cogwheels in the middle; Cog is always symmetric and if the user moves and arm, the other one also changes size and/or dimension. This makes the concept easier for the user since it is possible to adjust the size of the mount with one hand, while attaching the tablet with the other hand.

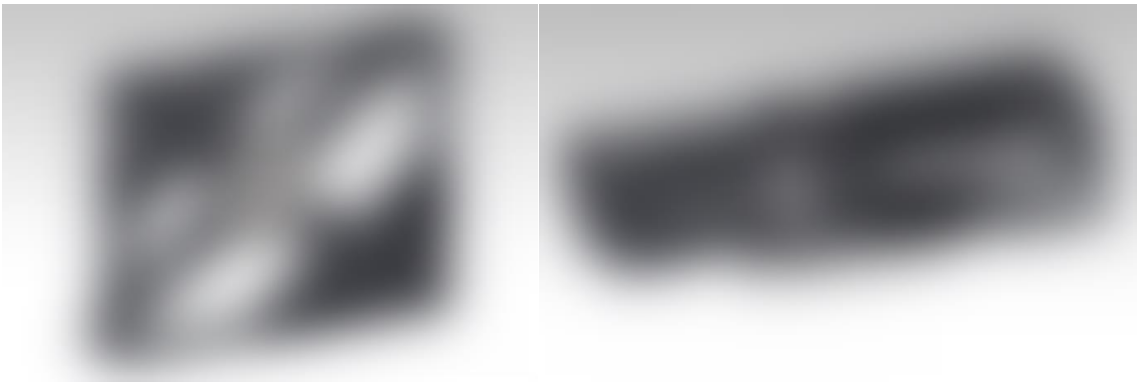

Figure 24- Cog from the front and the side

Cog has triangular back plates to strengthen the construction and make the design look solid when the mount is in minimal size. As the concept 1, Cog has moveable support on the sides to not cover any buttons and sockets. The construction has no buttons, which makes it intuitive but also not reliant to just depend on friction in for example a car crash to hold the tablet in place. At this stage no button solution to lock the position for this and the previous concept have been solved.

Key features and drawbacks

+Intuitive for the user
+One-handed adjustments
+Same procedure to mount a new tablet model
-Most complex construction
-No button that locks the mount
-Needs high tolerances, especially the cog-system
-The arms need to be in two planes

Concept 3- Side Slot

Side Slot is shown in Figure 25 is a concept that was initially inspired by a VHS-player and was supposed to have a hatch where the user can put in and out the tablet easily without being forced to adjust the size for the same tablet all the time. A problem with the hatch was found; the door could not be closed when a tablet slides in since the frame size should be the same as the tablet size. This problem was solved by taking away the door and replaces it with a springily pin.

Figure 25- Side slot, front and side view

The pin, as can be seen in Figure 26, has a special triangular shape so the user just has to slide the tablet in directly, without touching the pin. When the tablet should be released, the user pulls down the pin and slides the tablet out to the side.

Figure 26- Side slot's pin

Another unique thing about this concept is that the back plate is fastened on two long sides only. This makes the concept simpler and thinner, but in the other hand robustness and symmetry in one dimension suffers. The concept is although symmetric around the y-axis in the horizontal mode. The concept was initially fastened in one long side, but due to the weak construction it was decided to change it to two fastening sides.

The user has to adjust the mount size if a new tablet should be attached and this is done by the two buttons on the frame that can be seen in Figure 25.

Key features and drawbacks
+Easy to attach and detach the same tablet
+Only one motion to attach tablet
-Not as easy when a new tablet should be attached
-Not symmetric around x-axis
-The construction can be weak when the mount is in the biggest size.

Concept 4- PBR
PBR is the only semi-flexible solution that made it to the final eight concepts. As can be seen in Figure 27 the concept cannot adjust the height. The length is adjustable with the red buttons behind the mount on both sides to maintain symmetry.

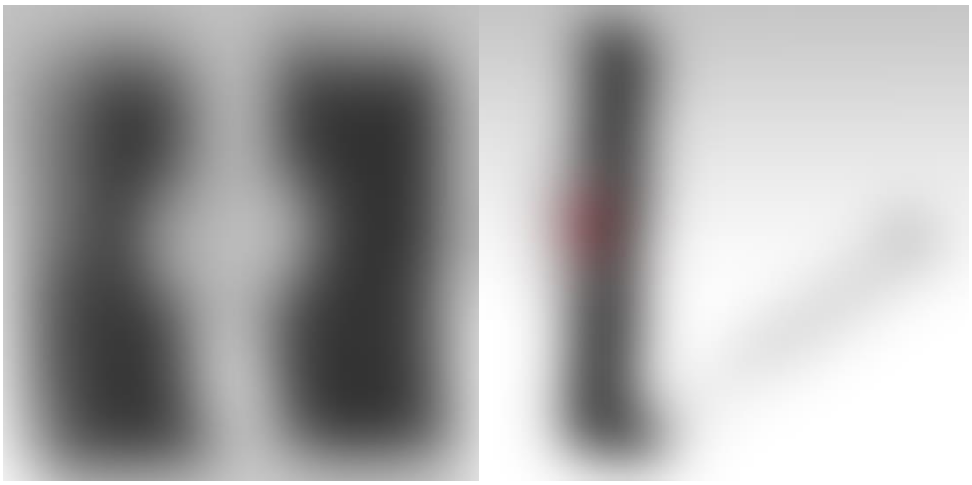

Figure 27- PBR front and side view

The bracket keeps the tablet in place and is adjustable to be able to fit all the tablets on the market. No buttons on the tablet are covered since the tablet is kept in place by the corners and the standing support.

One drawback with the concept was the design when a small tablet is mounted. As can be seen in Figure 28 the bracket is in place for a small tablet and there is a lot of space over the tablet. This could be fixed if the mount was completely flexible, but the concept would lose in robustness and in the simple construction design. Another drawback with the concept is the design when the mount and the tablet are in vertical mode. The standing support is on the side in vertical mode and does not provide the support it should.

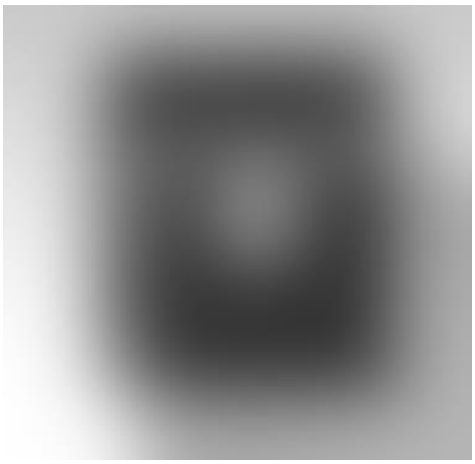

Figure 28- PBR for small tablets

Key features and drawbacks
+Simple construction
+Easy to attach and detach the same tablet
+Robust back plates
-The design is mostly made for big tablets
-The user can make the mount asymmetric
-Looks completely different in vertical mode

Concept 5- Flag
Flag is based on four back plates that are connected with rods, as can be seen in Figure 29. A back plate is connected to two rods, and this is to connect the mount to the arm's interface.

Figure 29- Flag for big tablets

In Figure 30 the buttons are shown which locks the concept and when the user shall attach the tablet, the buttons need to be pressed to be able to expand the mount. Then the tablet can be put in place and the user can push the mount to a size where to tablet is stuck.

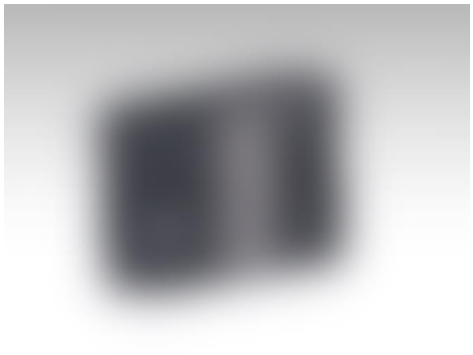

Figure 30- The back view of Flag

The blocks have holes on the side to not cover any buttons or sockets and this concept has a simple construction with few unique parts. A negative aspect that comes often with the simplicity is the asymmetry since the lack of cogwheels.

Key features and drawbacks
+Simple construction
+Robust impression with big back plates
-The user can make the solution asymmetric
-Complex to lock the construction in a smart way
-Attach and detach the tablet is not fast and many motions

Concept 6- Lever
Lever is a frame with a cross construction and is completely symmetric all the time due to the cogwheels in the middle. As can be seen in Figure 31, the construction is adjustable supported by two levers, one changing the length and one the height. These sliding buttons

lock the construction when the user does not move them. The levers are connected in the middle with cogwheels to be able to adjust the frame. The arms are in two planes, which make the construction thicker.

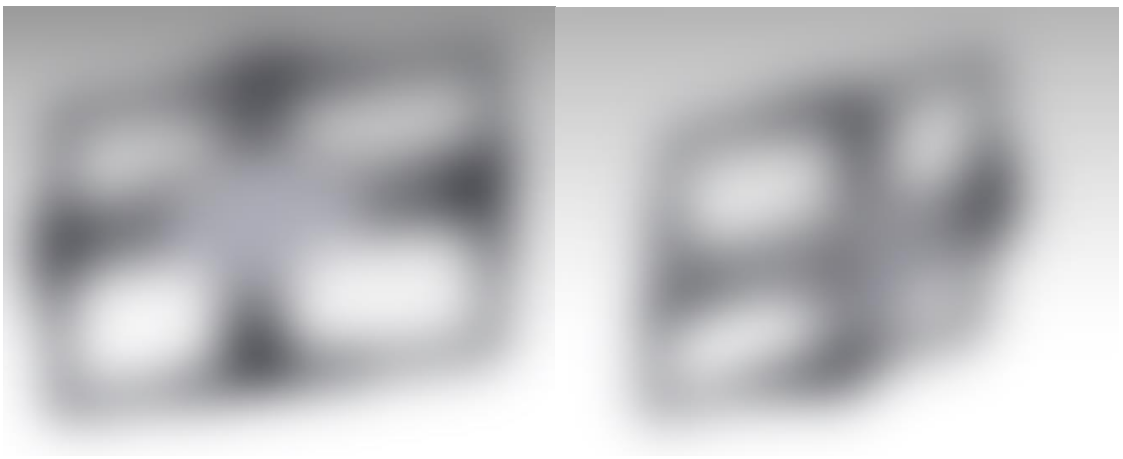

Figure 31- Lever from front and back view

Key features and drawbacks
+Completely symmetric
+One handed adjustment and small movements can be beneficial in a car environment
-Complex cogwheels system
-The gearing has to be very high on the cogwheels, but still not too heavy to slide the buttons
-Needs several motions to attach and detach tablets with one hand
-Thick construction

Concept 7- Modular

Modular handles the flexibility in a different way. According to the user interviews carried out in section 4.3, many tablet-owners use one tablet and this concept focuses on this kind of usage. When a small tablet shall be mounted, the user has the mount as Figure 32. The frame has a spring wall to keep the tablet in place and there is no adjustments needed for the user if he or she does not change the tablet model to a bigger.

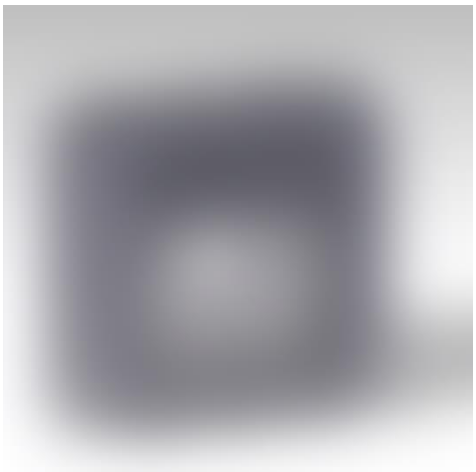

Figure 32- Modular for small tablets

In case the user has a big tablet model, the mount should be disconnected from the arm's interface and turned around 180 degrees. The mount looks then like Figure 33, where the big tablets can be placed. The spring wall has to be moved to this side and then the big tablet can be put in place.

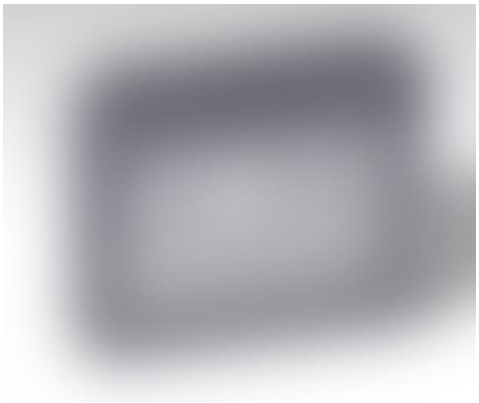

Figure 33- Modular for big tablets

Key features and drawbacks
+No adjustments needed to attach and detach the same tablet
+The simplest construction of all of the concepts
+One handed mount possible
-Most difficult to attach and detach different tablet sizes
-The size of the mount is always big, even when using a small tablet
-Can possibly cover buttons or sockets, or make it hard to reach them
-Asymmetric in vertical mode
-Gaps between the sides of the tablet and the frame

Concept 8- Swatch
The Swatch has a similar design as concept 6, with a flexible frame connected with a cross to the back plate, as can be seen in Figure 34. This concept has although a completely different functionality.

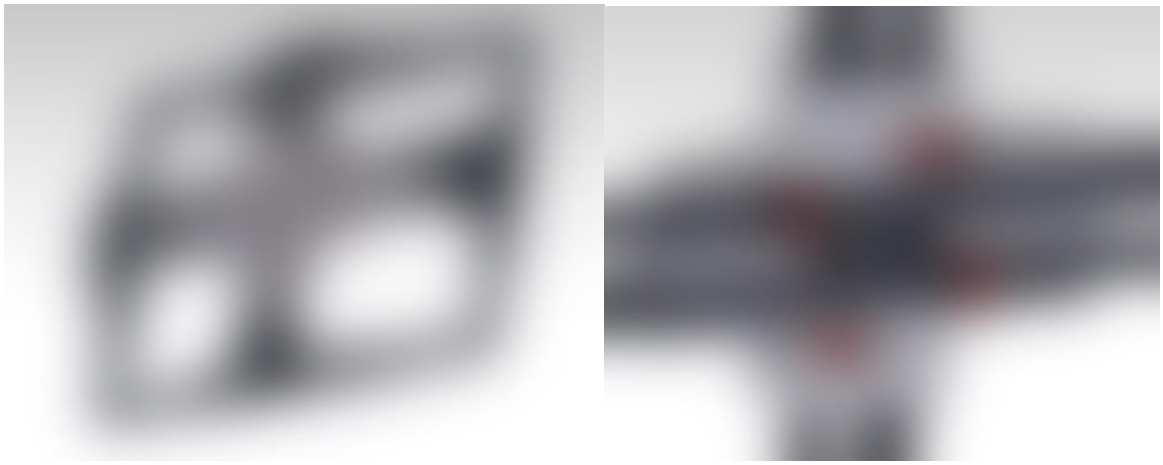

Figure 34- Swatch front and detailed view of the buttons

To mount the tablet the user pulls out the sides to a maximum locked size. The red buttons lock the arms in place until the user puts the tablet there and the buttons are pushed in, see Figure 34. There are springs in the frame and this makes the mount decrease in size automatically when the user puts the tablet in the mount that presses the red buttons.

Key features and drawbacks
+Automatic and innovative mounting when the arms are out
+Not a different mounting procedure when changing tablet models
+Can be used with one hand
-Many motions required to pull out the arms
-No locking the mount when the tablet is in place. Only relies on the springs.

5.2.6 Second concept scoring

The criteria for the second concept scoring matrix were chosen from the target specifications and consisted of a total of 24. These were sorted into groups based on the criteria from the first scoring matrix. The weights for the groups were kept the same as they were for the criteria in the first scoring matrix. These weights were then spread out among the sub-criteria as shown in Table 8.

Table 8- Criteria for the second scoring matrix

Criteria	Weight
Aesthetically appealing	**22,00%**
Instils quality	7,00%
Instils safety	4,00%
Design with tablet	5,50%
Design without tablet	5,50%
Ease of use and flexibility	**18,00%**
Time and simplicity to mount / dismount tablet	6,30%
Intuitiveness	1,80%
Range of flexibility	6,30%
Time and simplicity to adjust size between tablets	3,60%
Physical robustness	**26,00%**
Strength	5,20%
Fastening strength	6,50%
Structural stability	7,80%
Stability in usage	6,50%
Simplicity	**13,00%**
Number of parts	3,77%
Number of unique parts	4,42%
Complexity of connections	2,86%
Has as simple shapes as possible	1,95%
Accessibility for buttons and sockets	**21,00%**
Charging	2,94%
Audio jack	3,36%
Volume buttons	2,31%
On/off	4,20%
Home button	5,04%
Speakers	0,42%
Mic	1,68%
Front camera	1,05%

The weights of the criteria were based on the results of the prestudy, especially from the interviews and the benchmarking. Additionally the project group's personal opinions played an important role in setting the weights.

The eight concepts were rated for all criteria in the scoring matrix, as can be seen in Appendix I.3. The result was as follows, with their score within the brackets:

1. Modular (3,473)
2. Swatch (3,401)
3. Flag (3,345)
4. Cog (3,300)
5. PBR (3,218)
6. Lever (3,129)
7. Ref (3,123)
8. Side Slot (3,092)

First of all, not any concept completely deviated in score. All could be considered slightly above average score and it only differentiated 0.38 points between the highest and the lowest score.

Based on the results, the group discussed each of the concepts thoroughly, weighing positive and negative aspects as well as potential areas for improvement.

The first decision was between Ref and Cog. These two concepts were considered to be too similar to continue working with both. The major difference is that Cog, if working as intended, is significantly easier to use while Ref has a much lower level of complexity. Since the gear system also made the corners of Cog move dependently, it also had a lower risk of mechanical failure for the frame. On the other hand, the risk for mechanical failures in the gears and the racks could instead be an issue. Since simplicity in design was considered less important than ease of use, the decision fell in Cog's favour, thus eliminating Ref.

Modular got the highest rating in the scoring matrix due to its high level of simplicity and robustness. The same also applies to PBR, although to a lesser extent. Modular's major drawback was when changing from a large tablet to a small, or vice versa. To have to disconnect and turn the mount in order to then connect it so that one can mount a tablet there was seen as a major drawback. The visual aspect was also a drawback, as were the fact that there is nothing holding the tablet from the sides when centred on the mount.

PBR's drawbacks were similar to those for Modular. The major drawback here though, was when a small tablet was mounted, in which case PBR would look as in Figure 28. There were ideas of how to solve this issue, such as using modular parts for the back plates. This got rejected however since the user would need many operations to switch between sizes and also because loose parts can easily be misplaced and lost.

As mentioned earlier, comparing rigid frames and back plates with flexible, telescopic frame structures were difficult in the scoring matrices, since the flexible solutions possibly

did not get enough credit for their flexibility. The problem for Modular and PBR was that no solution seemed possible to improve their weaknesses. It would be too difficult to make them feel like premium products suited for a Volvo car. Therefore it was decided not to continue with any of the two, even though they, especially Modular, got good score in the scoring matrix.

The five remaining concepts had drawbacks as well, but the drawbacks seemed fixable and more analyses and technical calculations were required to verify them.

Side Slot had a unique mounting which seemed interesting and was considered to need further evaluation. Much of its poor ratings came from the robustness which mainly depended on the fact that it only had one arm connecting the frame to the back piece, which was easy to solve.

Swatch had its innovative mounting as a major strength and got overall high scores in the scoring matrix. Springs had already been tested for holding the tablet in place, but the tests were not thorough enough and further evaluation was needed.

Cog has an even larger problem when it comes to holding the tablet in place, since it relies only on the friction in its joints. Some kind of locking mechanism was very likely to be required and this was decided to be further analysed.

The issue with Lever was the high gear ratio that would be required. This could make the lever really tough to move, which seemed problematic and were to be investigated.

Flag was considered the simplest concept to make it into the final five, since it has no gears or springs. The issue with Flag was the fact that it can be made asymmetrical in relation to the back piece. The structure can, to a small extent, move freely in its own plane, which is what causes the problems. It was at the same time difficult to combine Flag with some kind of gear system so this could be problematic.

As a summary, all remaining concepts had some great features, but also some drawbacks. All issues did not have a solution at this stage but the important part was that they had potential to fulfil the target specifications. The final five concepts are thus:

- Cog
- Flag
- Lever
- Side Slot
- Swatch

5.3 Final evaluation and selecting the best concept

The final evaluation of the remaining five concepts is presented in this section. Section 5.3.1 describes the expertise feedback from VCC and section 5.3.2 describes the user feedback for the remaining concept. The result of the final selection can be seen under section 5.3.3.

5.3.1 VCC evaluation meeting

The first input of the final selection came from the experts from VCC, as can be seen in Figure 35.

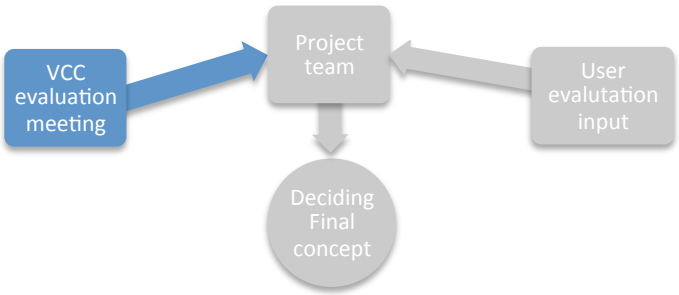

Figure 35- Visualisation of the decision making of the final selection

VCC's overall impression of the concepts seemed good and the project's coverage of the solution space was considered impressive. Some feedback was given for each concept, as well as some final recommendations:

- Cog – Great concept, also similar to concepts VCC has already been researching, even though their idea only had one diagonal arm instead of a cross. However the concept needs very fine tolerances for the gear system and for all the movable parts, which will be costly. It will require some kind of locking mechanism to be able to hold the tablet in the event of a crash. This concept is great when it comes to mounting and dismounting the tablet. It also looks really good in it smallest position without a tablet and the mount should always be in this state when no tablet is mounted.
- Flag – Looks robust and it was the only concept they could directly say that it was feasible to produce. It was also considered less costly than the other concepts. Could be a little awkward for the user when mounting and dismounting the tablet.
- Lever – The lever function could be a great locking mechanism with the sliding buttons, rather than a mean to change the size of the mount. The gear ratio will most likely be very high, which will make it difficult to adjust the mount.
- Side Slot – Really liked the idea of the mounting and dismounting of the same tablet. It was also great that the user will not need to adjust the frame every time when using the same tablet. The frame looked a little weak in its outer position however and the adjustment of the tablet needs to be made more intuitive.

- Swatch – they liked the innovative, automatic mounting. However, the mount needs some kind of locking mechanism because springs will most likely not be enough to hold the tablet in the event of a crash. They would also prefer if the buttons were moved to the frame instead of their current position on the back plate. Additionally it would be great if the springs could be used to constrict the mount to its smallest position when no tablet is mounted.

VCC also had some general points that should be considered:

- The tablet mount should constrict itself to its smallest state when no tablet is mounted. A mount in its outer state, with no tablet mounted, will break if the passenger for example bashes his or her head in it in the event of a crash.
- At the same time, it is great if the user does not have to readjust the mount every time when using the same tablet.
- Lastly, VCC stressed the fact that the mount must be intuitive to use.

When asked for a recommendation on which concept or concepts to choose, VCC suggested a combination of Swatch and Lever. They wanted Swatch's mounting feature together with the spring-feature to always strive to the inner position. At the same time they wanted it to lock in the outer position to be able to mount the tablet easily and also when the tablet is in place, the mount should lock.

5.3.2 User feedback

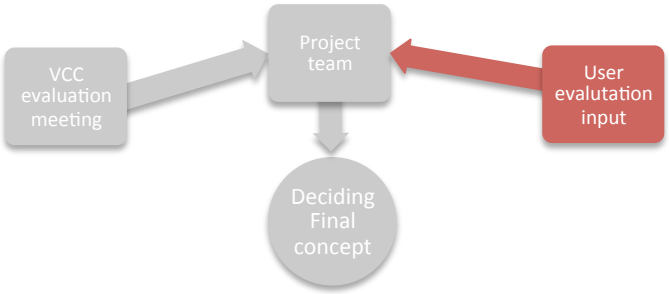

Figure 36- Visualisation of the final selection process

The user evaluation was the second input to the decision making, as can be seen in Figure 36 and was carried out on 29 possible users from the segments. No children were participating in this research since the information from the video that explained the concepts was considered too extensive and complex. Therefore only adults that covered at least one of the segments as a business person or parent were participating. Since they are the potential buyers, it was reflected as legit and valid input for the decision-making, even though their children would be the users.

Exclusiveness

The first question was a rating question where the respondent ranked the concepts from one to five, where one was the most exclusive concept and five was the concept the respondent perceived as least exclusive. This question was established since it was interesting to see if any concept perceptually deviated from the others by functionality or design, and the result can be seen in Figure 37. A low score means high exclusiveness related to each other and the result shows that the respondents felt Cog and Swatch were perceived more exclusive. The result shows that these two can be perceived as innovative and exclusive and one reason can be for their technical components they have in form of cogwheels, automatic mounting and springs in the frame.

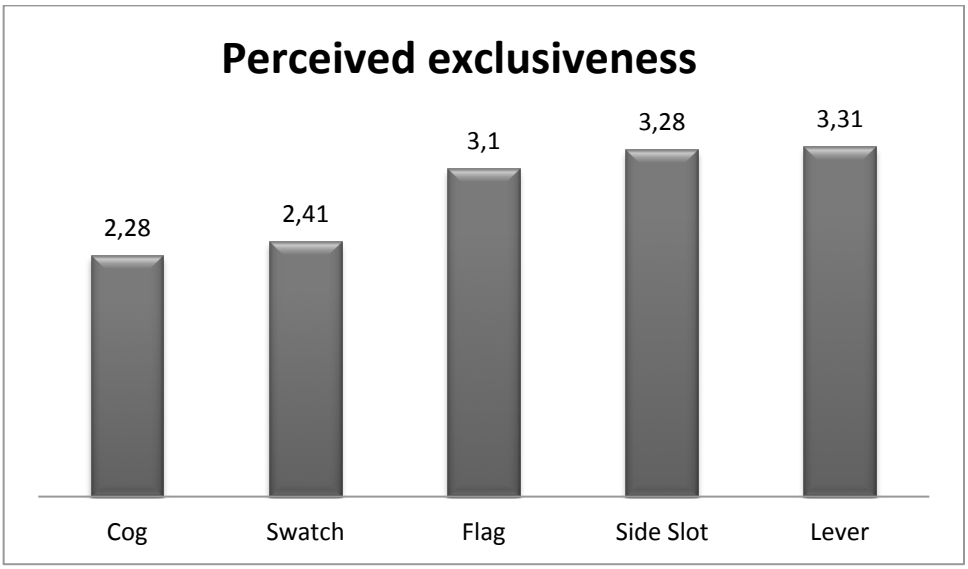

Figure 37- The result of the perceived exclusiveness

Ease of use

Question two covered which tablet mount was perceived the most easy to use. This question's purpose was which one the respondent preferred in sense of mounting and dismounting tablets. The respondents could answer just one, but if they had hard to decide they could answer two concepts and the second concept was worth a half point, while the first concept got a score of one point. As the results shows in Figure 38, Side slot got the highest score with the sliding mounting and dismounting. Swatch and Cog got relatively high score as well, where both are supposed to handle different tablet models the same as if the user has the same model all the time.

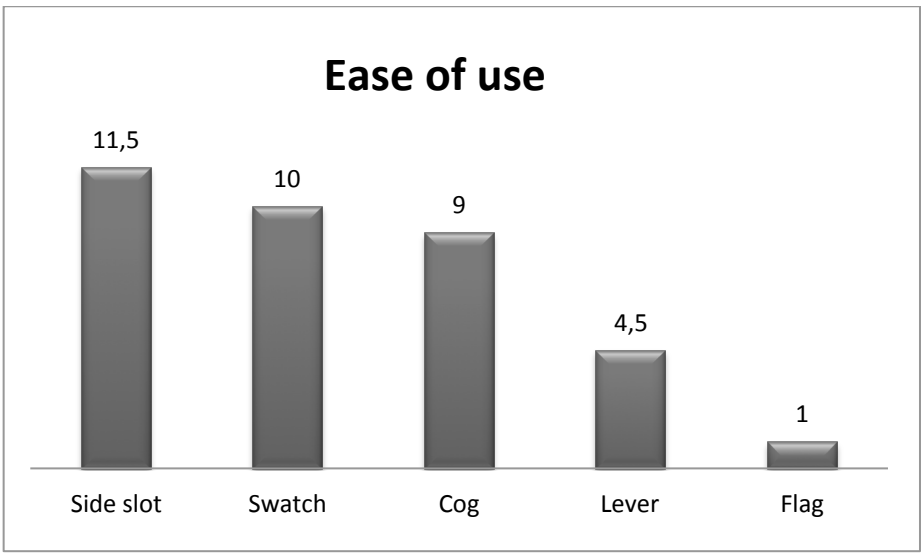

Figure 38- The result of the perceived ease of usage

Safety

When asking them about which concept that felt the most safe, the answer was deviating from the previous questions, as can be seen in Figure 39. In this area the winner was Flag without any doubt and it was obvious from the interviews that the respondents evaluated the design high and also if an existing locking mechanism existed. The respondents thought that Flag had a robust design impression since the big back plates and the locking buttons secured the tablet in place. One more notation on the result was the non-existing correlation between safety and exclusiveness.

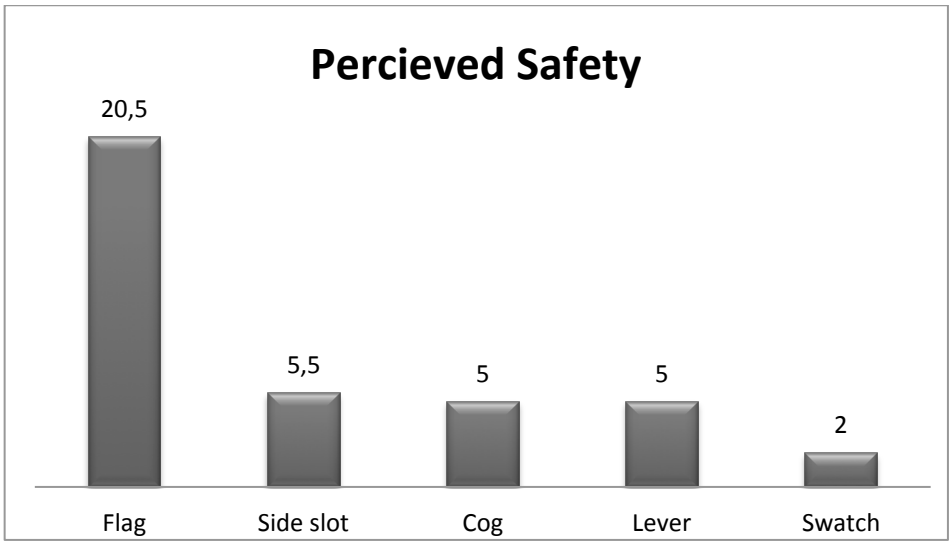

Figure 39- The result of perceived safety

Coherence with VCC

The respondents also answered which concept they felt was the most suitable in a Volvo car. This is a rather subjective question, but the important part was to dig deeper and understand what the respondents was important in a Volvo product. Cog and Flag got most of the votes as can be seen in Figure 40, where both have a robust and thick design in the virtual model. Several respondents based their answer on one or two of VCC's core values; especially quality and safety. Lever, Swatch and Side slot had too weak construction according to the majority of the respondents.

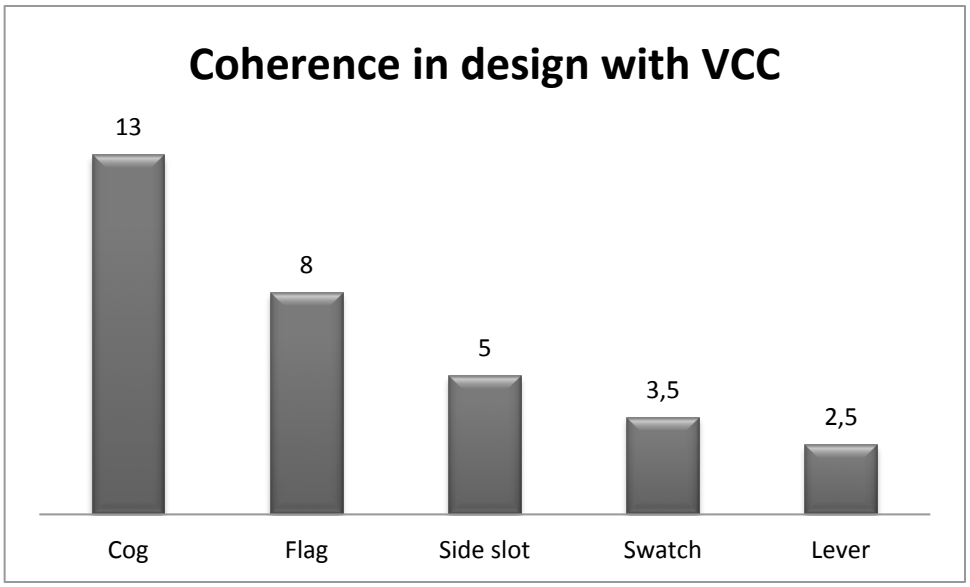

Figure 40- The result of the perceived coherence with VCC

Buy ranking

In the last question the respondents ranked all the concepts in which order they would buy them, if all of the mounts were sold in a store. The interviewees were told that the price is not relevant in this question, there were not any calculations at this phase on the production cost since the technical detailed designs were too fuzzy at this stage and the question's purpose was to evaluate what the user preferred without the cost in mind. Below the result is shown and the score is the mean value of the ranking points from one to five.

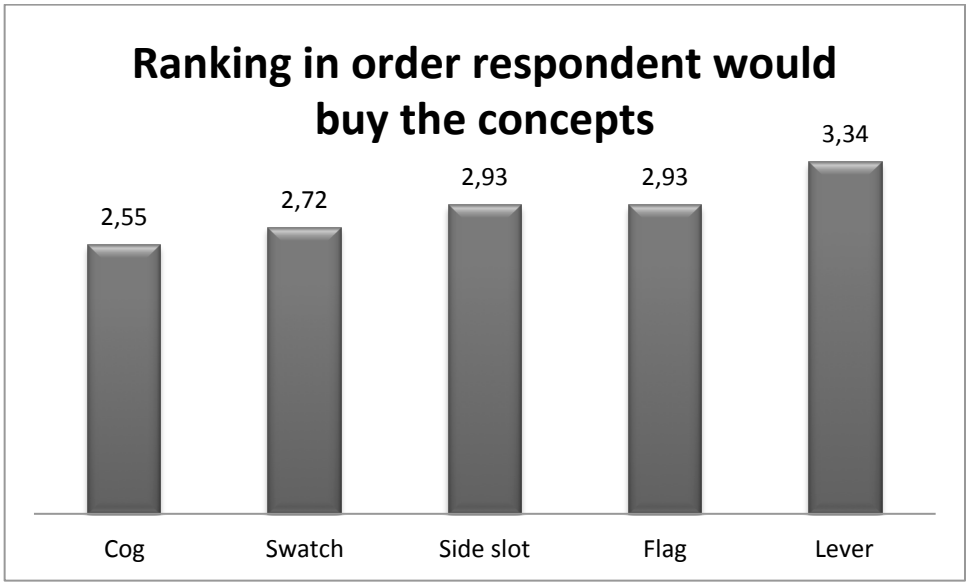

Figure 41- Desired buy ranking

Cog got the best mean score, where Lever had the highest score that was least interesting for the users. The concepts in the middle are slightly behind Cog and it was evident that the users had different favourites. If one of the concepts would be half as expensive as the other one, a totally different result would probably appear since the small deviation between them. Some respondents based their result on the technical features, where others prioritised the safety and robustness. A summary of the overall comments for each concept from the interviews is shown in Table 9.

Table 9- Summary of the user feedback for the five concepts

Concept 1- Flag	
Key features	**Drawbacks**
Robust construction	Requires two hands to operate
Simple design	Simple and not attention-grabbing
Impression of safety	Does not keep symmetry
Coherent with VCC identity	
Locks the tablet in place	
Good locking in smallest position	
Concept 2- Lever	
Key features	**Drawbacks**
Locks the tablet in place	Design looks too weak
Only require one hand to operate	Not intuitive mechanism
Simple motions	Expensive
	The sliding buttons can tough due to gear ratio
Concept 3- Swatch	
Key features	**Drawbacks**
Easy to mount	Unsure of functional robustness over time
Innovative mounting solution	Design looks too weak
Only require one hand to operate	Complex construction
Clean design	No locking mechanism
Exclusive impression	
Concept 4- Cog	
Key features	**Drawbacks**
No buttons	No buttons makes it unreliable
Good looking in smallest position	Unsure of functional robustness over time
Easily useable with one hand	Expensive
Intuitive	Complex construction
Coherent with VCC identity	Tough to operate due to friction joints
Exclusive impression	
Concept 5- Side slot	
Key features	**Drawbacks**
No adjustments required when using the same tablet	Design looks too weak
Easy to mount/dismount same tablet	Pin feels weak and may wear down
Clean design	Requires two hands to adjust mount size
Locks the tablet in place	Not intuitive
Only require one hand to mount/dismount	

One point to take under consideration from the overall comments is the feedback on weak design on some of the concepts. This is only the perception and not a calculated weakness and could be a result of some concepts was modelled with bigger and thicker parts, while some are modelled thin. This particular feedback was taken under consideration in the detailed design phase, where calculations was carried out on the final concept and this kind of feedback was considered relatively easy to fix for any concept. The thickness of the parts should be based on if the mount could withstand the force in a car crash and what materials that should be used, see Report B and Report C for these analyses.

Conclusions from the user feedback

The overall conclusions from the user feedback was Cog as the most exclusive concept and the design was considered legit for a VCC product, especially in the smallest size since the triangular back plates made the design look solid. Some questioned the functionality over time and the lack of locking with a button.

Side slot got a weak impression since the frame and pin were thin modelled, but at the same time, the majority thought the sliding function was great and the fact that the user would not have to adjust the size every time. This concept got weaknesses, but the required improvements were relatively easy.

Flag got many votes in perceived safety and the concept got also a high score in coherent with VCC since the robust impression, while some of the respondents thought the concept did not have anything special to offer.

Swatch got an innovative impression on the mounting, but still the concept did not have the highest score on any q. The lack of a button to lock the construction could be one factor, while others though the user could squeeze their hands when mounting the tablet.

Lever had a tougher time in the user feedback study, but a positive aspect with the concept was the small movements required to adjust the frame size. This factor was not taken under consideration before in the project to a big extent. One interviewee stated that there is limited movement space in a backseat of a car and therefore this concept could be the best. The concept got some drawbacks, where the most significant was the required high gear ratio for the sliding buttons to work. This would lead to the buttons would be tough to move for the user.

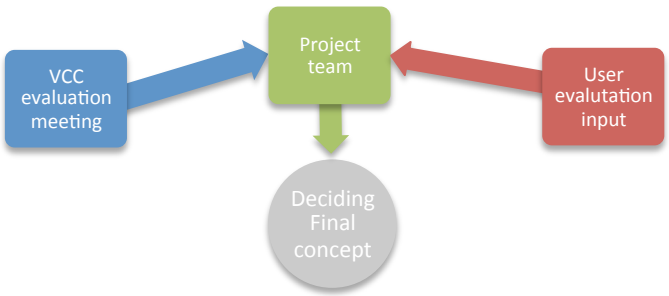

Figure 42- Visualisation of the final concept decision making

5.3.3 Final selection

Based on the feedback from VCC and the potential users, the project group could make a final decision. All concepts and all possible combinations were thoroughly evaluated and discussed. VCC's desire for the tablet mount to constrict to its minimal size when no tablet is mounted weighed in heavily in the evaluation. In addition to keeping some concepts as they were, seven alternatives were up for discussion as potential final concepts:

- Cog with tensional springs, as in Swatch, and a button in one corner, locking the structure. The springs' purpose was to always constrict the mount to its inner position when no tablet is mounted.
- Cog with a button in one corner, locking the structure.
- Swatch combined with Lever. Using the lever to lock the structure, not to change dimensions. This was VCC's recommendation.
- Flag combined with Swatch. The Flag, but with tensional springs constricting the structure, making it go to its inner position when no tablet is mounted.
- Side Slot but with a cross of arms, making it more robust.
- Side slot with Swatch. To use the tensional springs from Swatch, but only in the horizontal direction, i.e. when the mount is set in landscape mode. This constricts two sides to their inner position when no tablet is mounted, but still does not need readjusting each time when using the same tablet.
- Flag but with cross-shaped rear arms, which always cover the gaps between the four plates. It would still be a simple concept, and the user would not be able to see through it.

The positive aspects and drawbacks of each alternative concept were considered. The project group finally decided to choose Cog with tensional springs and a button for the final concept. If that concept would work as intended, it would be the simplest to use at the same time as it would be very intuitive for the user. Additionally, the design was highly appreciated in the user feedback. One issue remaining though was that the concept is very complex and there were still uncertainties, for example how to lock the construction. Due to this, a second concept was also chosen as a back-up, if too many problems would occur with the chosen concept.

The back-up concept was the new version of Side Slot, using tensional springs for the horizontal constriction. This was still not a very simple concept, but still considered feasible and it did not have as many uncertainties as the new version of Cog. The really simple concepts generally had too many drawbacks and were therefore rejected.

After this phase, the project moved on to the detailed design phase. The concepts was further developed and evaluated in higher detail. The new version of Cog was the priority, but a new design of Side slot was also produced. The work for the project got divided into three separate areas again, as mentioned in Chapter 2.

6 User and market verification

The chapter covers the verification of the concepts from a user and market perspective. In section 6.1 a short presentation summarisation of the concepts are presented and how their final design. Section 6.2 presents the user verification carried out by the physical prototype of Cog and section 6.3 covers a cost estimation of the custom parts of Cog.

6.1 Final concepts

In this section, the final Cog and Side slot are described. The completely design development of the concepts and safety calculations on Cog, read Report B and Report C, respectively. Table 10 shows unique features the concepts have and it describes the main differences between them.

Table 10- Key features for Cog and Side Slot.

Cog	Side slot
Suitable for frequently different tablet models	Suitable for mostly using one tablet model
Robust impression according to feedback	Robust back piece
Always symmetric	No adjustments of the frame when using the same model
Always striving to minimum position when not being used	Always striving (in horizontal dimension) to minimum position when not being used

6.1.1 Cog

In the user interview from the prestudy, there was a question covering the importance for the solution to adjust for different sizes easily or focusing to maximise the ease of use for one tablet. Cog was a concept chosen to be the best concept to adjust for different tablets. However, the concept had some obstacles in the development phase, not least to find a way to lock the construction. As described below in section 6.2, the reduction to one arm decreased the complexity since the lack of one gear and an arm. But the rotating problem occurred instead and a solution could be a button that the user had to push to adjust the dimensional ratio.

As can be seen in Figure 43, Cog has six side supports that hold the tablet in place combined with the corners. The triangular back plates were initially just for the design and robustness, but they were also beneficial to increase the stability for the tablet. Additional springs were implemented to the frame since the feedback from VCC that the solution should always strive to the inner position. The user pulls in one of the corners to adjust the size and dimension to mount the tablet. No locking mechanism was implemented for the concept, but a suggestion of a solution can be read in Report B.

Figure 43- New design of Cog when refined to one diagonal arm

A description of the arm components is described in Figure 44. The dilemma with the gear system was that it had to be small to fit in the arm, but yet function properly for the user.

Figure 44- Cog description, 1: Rack arm, 2: Middle arm, 3: Back piece, 4: Gear rack, 5: Cogwheel

6.1.2 Side slot

Side slot was considered to be the best concept when the user has one model and does not change the dimension of the mount frequently. After the feedback from VCC, Side slot got springs to not be too fragile when not a tablet is mounted. The frame would most likely be too weak to handle a car crash at that stage and the springs have another advantage. It makes the user only has to adjust the vertical dimension for different tablets. The springs in the frame make vertical sides always strive to the inner position and it also makes the solution to hold the tablet better and reduces the risk of gap between the tablet and the frame. The state where no tablet is mounted can be seen in Figure 45.

Figure 45- Side slot when there is no tablet mounted

The concept's principal feature is to function as a slot and tablets can be mounted from both sides. It became evident that the user would have problem to mount the tablet from for example the left side if the mount was fastened on the driving seat since the lack of space between the mount and the car door.

The side supports were redesigned after the user feedback, since the pin, as can be seen in Figure 26, was perceived too weak and the life time before worn-out was questioned. Since Side slot was the secondary concept, no analyses were carried out on this issue, but the new side support design can be seen in Figure 46.

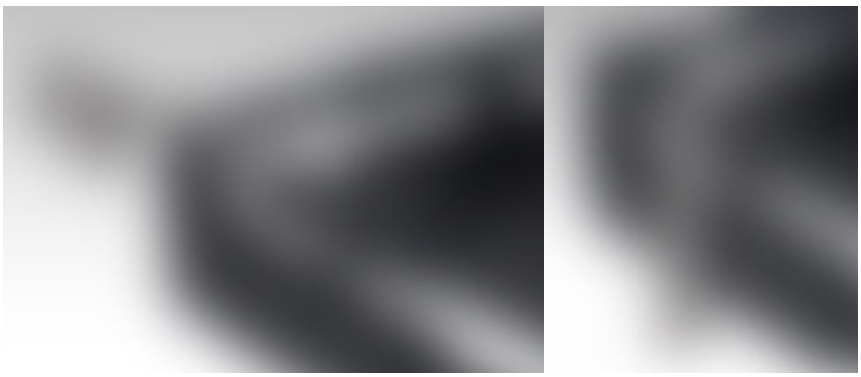

Figure 46- Visualisation of the new side supports

A negative aspect with the new side support design was that it would not be as easy to mount the tablet as before, but the solution was more sustainable in safety and that was prioritised higher. The final design of Side slot can be seen in Figure 47. The figure shows when the mount is expanded and the springs and the racks can be seen. When Side slot is in this state, a tablet is mounted and the tablet will hide the springs and the racks. A potential improvement could although be to hide the racks and the springs in the arms to improve this design further.

Figure 47- The final design of Side slot

Side slot can be adjusted for different tablets by the telescopic arms and the vertically adjustment can be seen in Figure 48.

Figure 48- Telescopic locking to vertically adjust the size

6.2 Physical prototypes

Physical prototypes were generated for both Cog and Side slot and the goal was to verify the functionality and maximise the performance for the end concept as much as possible. Cog's prototype was generated on Chalmers University of Technology, while VCC made the prototype of Side slot. Side Slot was prioritised secondary and the prototype was done too late to verify requirements with it. The Side slot prototype was therefore only used for present a physical representation of the concept for VCC.

The prototype process for Cog resulted in some problems, but also highlighted important issues that probably would not have been identified if it the prototype would not be produced.

The overall issue with the prototyping was that the prototypes were dependent of the rest of the detailed design phase and the models were therefore delayed more than initially planned since the dependency of work carried out in Report B.

When the prototype was printed, it was support material in the holes that was complex to get rid of to be able to assemble the frame and the arm. It was not possible to drill the holes deep enough and this made the prototype not work completely as planned. The tolerance levels from the rapid prototyping were said to be 0.2 mm to adjacent parts, but that was not enough for the model to run smoothly. However, part chunks could be tested separately to be able to verify the majority of the user requirements. For the prototype of Side slot that was built later, the tolerance level was changed to 0.8 mm to not have the same problem with the physical model.

One vital issue was found using the prototype of Cog. It occurred because of the reduction to one arm instead of two arms in an X-formation. The reduction to one arm was carried out to minimise complexity, but mostly to make the construction thinner and the design acceptable. Since the second arm and the gearing system between them were gone, nothing was stopping the mount from rotating, see Figure 49 for an illustration of this issue. The concept would need an external locking mechanism for the arm with the new design and this was the main reason for the continuing development of Side slot also. Cog's biggest advantage in a user perspective was the simplicity for the user to adjust the mount for different tablets and that advantage would be reduced if there had to be an external locking for the dimensional size. In Report B, this dilemma is presented in detail.

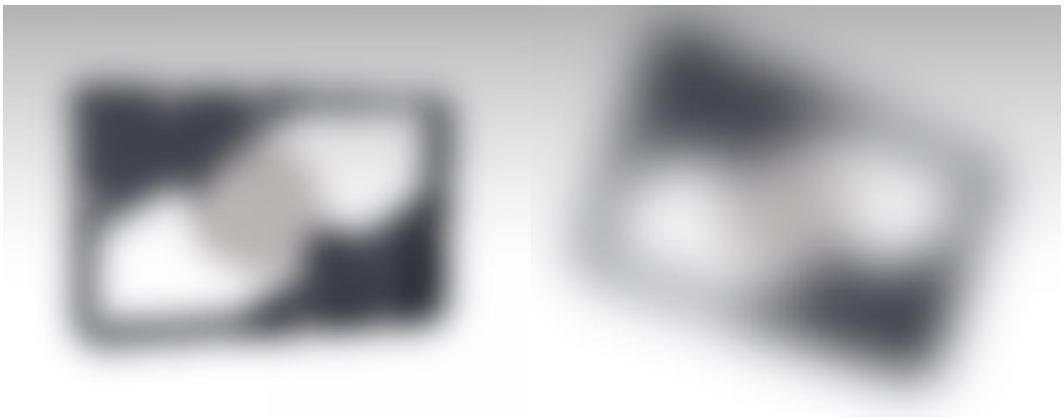

Figure 49- Illustration of the rotating issue that got evident with the prototype

6.2.1 Verification of user requirements

Supported by the physical prototype of Cog, several requirements from the users could be tested and verified. The tablets involved in the verification of user requirements were following models:

- iPad Retina generation 3, Size: 10.1”
- Google Nexus 7 generation 2, Size: 7”

The models were suitable for the test since Nexus 7 has a screen ratio of 16:9, while iPad had 4:3. In Appendix L, the complete table of user requirements are listed and the verification status is stated on each user requirement. All requirements were although not possible to be tested by the physical prototype. Below is a presentation of the most important results of the verification process.

Accessibility for buttons and sockets

The physical prototype was suitable to verify required open space on the frame’s sides to be able to get access to buttons and sockets. This was vital requirements found in the user interviews and were verified as successful for both concepts. User verifications were although not carried out, since the lack of completely functional prototypes due to the support material and tolerances. In Figure 50, the test with the tablets is shown and the charging socket was not a problem to reach.

Figure 50- Verification of accessibility for sockets

The side supports for Cog was not modelled and included in the prototype, therefore not a complete frame test could be carried out. The frame is not covering the home button and this vital requirement from the users and VCC was considered verified, as can be seen in Figure 50. It was neither any problem to reach the socket or the buttons on the tablets' sides.

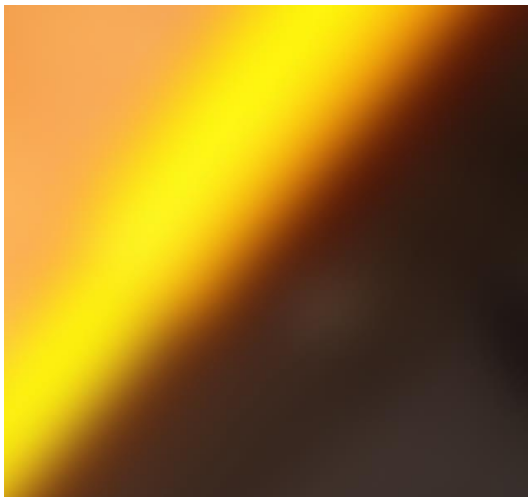

Figure 51- Verification of accessibility for buttons

Stability in usage

One aspect that was highlighted by using the prototype was that soft material in the corners like foam would make the frame handle different models better. Since the frame should be able to handle different shapes and thicknesses, a soft material in the corners and on the side supports could make the construction more stable by squeezing the tablet in place.

With the soft corners, the frame would handle different tablet thicknesses even better, making it less sensitive for the deviation.

The triangular plates on the thick frame parts were although strengthen the component significantly and the feature was also beneficial for the tablet stability since the tablet's backside could be supported by the area of the back pieces and not only by the diagonal arm and the side supports.

Flexibility
Cog's diagonal arm with the gear system was tested separately since the complexity to assemble the frame due to the support material as described above. A similar problem occurred for the rack arm, as can be seen in Figure 52 the holes should have been design bigger for the physical prototype to be able to drill away the material more properly.

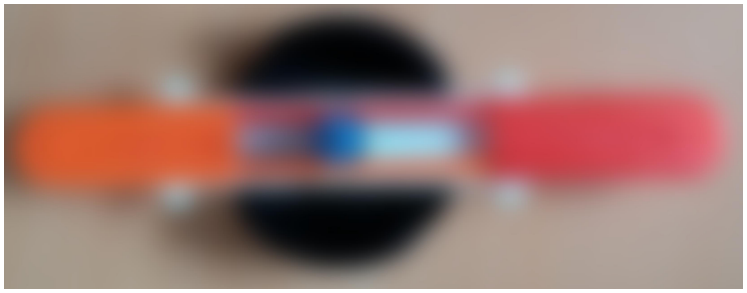

Figure 52- The arm prototype, without the cover

The complete mounting and dismounting were not possible to test since the problem to assemble the complete prototype of Cog, but the separate component chunks functioned properly. The rack arm could climb on the gear successfully, which is needed to change the ratio for different screen dimensions.

6.3 Cost estimation

The cost estimation for the custom parts were separated in two parts; tooling cost and material cost. The estimated number of products the calculation was based on were to produce up to 10 000 of the Cog concept.

6.3.1 Tooling cost

The manufacturing process the tool estimation was based on was decided by the parameters in Appendix M.1. The tolerance level was grounded from the tolerance study, carried out in Report B and the closest level was chosen and after translated to inches. Max wall thickness was put to 10 mm, since that was the thickest part. Most of the parts' shape was considered as thin-walled and especially the thick frame parts were considered to have complex shapes.

The result, as can be seen in Appendix M.1, injection moulding (low volume) was considered the most suitable option. Bearing in mind that there were not any studies on how many units that would most likely to be manufactured, it was considered as a reasonable approximation and the manufacturing process tools was considered suitable between 1 000-10 000 mounts.

The custom part list can be seen in Table 11, and the manufacturing process and number of parts per unit is also stated. The tooling cost was estimated on each part, supported by the CustomPartNet cost estimation tool, which is based on data from the industry averages and manufacturing practises (CustomPartNet, 2014). The tool should although only be perceived as an approximation of the real cost. Further analyses of chosen manufacturing processes and standard components before producing the mount would be necessary.

Table 11- List of components in Cog

Number of parts/ unit	Part Name	Manufacturing process
2	Arm cover	Injection Moulding (low volume)
2	Arm	Injection Moulding (low volume)
1	Back plate	Injection Moulding (low volume)
1	Front cover	Injection Moulding (low volume)
6	Side supports	Injection Moulding (low volume)
2	Frame thick part	Injection Moulding (low volume)
2	Frame thin part	Injection Moulding (low volume)

The estimated tooling cost is calculated separately on each part and the prototype was used to estimate the specifications of the tooling cost as for example complexity of shape and length. The different specifications in the estimation are described below and then presented by each component. The standard components as gear, bolts and screws were left out of the estimation, since the components would most likely not be custom manufactured by the company making the mount. The price the specific company would pay for the standard components were considered too fuzzy for the estimation of to be of any value for the investigation. The focus was instead put on the custom parts. Each tooling cost was translated to Swedish curacy 2014-06-05 with the rating 6.65 SEK for $1.

Terminology for the estimation

Below is a description of the chosen parameters for the tooling estimation based on cost estimation provided by CustomPartNet (CustomPartNet, 2014).

Quantity: 10 000 finished products were chosen to be the number of products the estimation were based on.

Envelope X-Y-Z: The geometry of the estimated component. Measured on the physical prototype and the lengths were translated to inches for the estimation program (convertworld, 2014).

Projected holes: If the component had holes in the X-Y-plane. If yes, the area of them should be stated.

Tolerance: The tolerance level was chosen supported by the tolerance analysis from Report B. It was translated to inches and chosen as close as possible. High precision (<=0.005) inches were to chosen level for all components of the estimation.

Surface roughness (Ra): No investigations of required surface roughness were carried out in the study. Normal roughness was chosen, because the difference between the levels was considered small in relation to the complete tooling cost.

Complexity: The estimation tool has different examples of shapes that are considered:

- Very simple
- Simple
- Moderate
- Complex
- Very complex

The complexity was based on how the physical prototype was shaped and a comparison to the examples was carried out by each part. It was also possible to choose custom and specify more parameters as following:

- Feature count: An estimate on how many features that one component has. The prototype's parts were compared to the examples in the program.
- Side cores: Additional mould piece that cannot be formed by the mould halves and therefore needs additional pieces.
- Lifters: An additional mould piece that makes it possible to loosen the moulded piece from the mould halves.
- Parting surface: The surface where the two mould halves meet or part.

SPI mould class: The tool had different mould classes and "Class 104" was chosen for all components since it could handle <=100 000 cycles and that was considered suitable and closest to the estimation of 10 000 produced mounts.

Rapid tooling: Was chosen "yes" for all components since Injection Moulding (low volume) was the manufacturing process, rapid tooling is a faster way to produce tools and is often used in low production volumes since it reduces the part cost significantly. The life of the tool's life is although reducing (CustomPartNet, 2014).

Number of cavities: Number of parts that can be produced on the same time by one tool. The number of cavities was chosen based on number of the same component in every mount.

Mould-making labour: The burdened hourly cost of manufacturing parts, manufacturing the tooling, or performing a secondary operation. This rate may include direct and indirect labour costs, overhead costs, as well as profit. The mould labour was chosen as the default value for the estimation program, $65/hour.

Below the components are presented separately and the estimated manufacturing cost are stated. To see the complete configurations of each component, see Appendix M.2.

Arm cover

Number of cavities was selected to two, since there should be two arm covers for every mount. The arm cover does not need any side cores or lifters.

The price for the arm cover tool was estimated to $38 249, meaning a tooling cost of 254 356 SEK with the curacy ratio above.

Arm
The tool was selected with two cavities since the number of components per product. For producing the arm, two side cores were estimated based on the physical prototype. The tooling cost for the arm was estimated to 233 475 SEK.

Thick frame
The thick part of the frame has two components and was considered as a complex component. Six side cores were estimated to produce the part and two cavities were chosen for an efficient manufacturing process. The design of the thick frame part should be analysed further to study if there could be other solutions to the design to make it simpler and therefore cheaper to produce. However, this was not covered in the project and with the chosen properties, it turned out to be the most expensive tool with a cost of 562 743 SEK.

Thin frame
The thin frame part was considered to need four side cores to be able to be produced. Two were needed for separating the space on the side of the frame to get access for the buttons on the tablet and two side cores were estimated for the position where the springs should fit. Another solution could be to drill the holes after the manufacturing process, but the estimated cost was based on four side cores. The estimated thin frame tool was 249 209 SEK for the thin frame model.

Back piece
The back plate was considered to be similar with a gas cap, which was estimated as a very simple shape in the program. One cavity was selected and no side cores were needed to produce the part. The estimated tooling cost for the back plate was 124 648 SEK.

Front cover for back piece
The back piece was designed with a simple cover to hide the cogwheel. The front cover was as the back plate considered having a very simple complexity and no side cores were needed. The tool for the front cover was estimated to 113 143 SEK.

Side support
There should be six side supports on each mount and therefore the estimation was based on eight cavities, since six was not an option for the estimation program. This made the tooling price slightly higher than the actual cost, but was considered well enough for the summarised cost estimation. No other side cores or lifters were needed for the part, and was estimated as very simple. The predictions made the price for the side supports' tool to be 180 042 SEK.

Total tooling cost
The total estimated manufacturing cost can be calculated for the custom parts by simply add the costs together:

$$T_c = 1\ 537\ 574\ \text{SEK}$$

The total cost estimation is based on the fact that a maximum of 10 000 mounts are produced, which rapid tooling is possible. If the market department finds the desire of the mount to be bigger, the tooling cost would increase but at the same time spread out on a higher number of mounts. The estimation is also based on the current state of the dollar price, translated to SEK. This has most likely a vital impact on the result of the estimation.

6.3.2 Material cost

The material cost was estimated for each component and was based on Swift & Booker's approach and the material cost from the CES database (Swift & Booker, 2003) (Granta Design, 2013). In Table 12, total material cost is calculated for each mount.

Table 12- The material cost for each mount

Part name	No. parts	V_f [mm^3]	W_c	V_{tot} [mm3]	C_{mt} [SEK/mm3]	M_c [SEK]
Thick frame	2	79000	1,3	205400	0,000055929	11,48
Thin frame	2	39000	1,2	93600	0,000055929	5,23
Back piece	1	75000	1,1	82500	0,000055929	4,61
Front cover	1	39000	1,1	42900	0,000055929	2,39
Side support	6	3900	1,1	25740	0,000055929	1,43
Arm cover	2	19000	1,1	41800	0,000055929	2,33
Arm	2	23000	1,3	59800	0,000055929	3,34
Total material cost/mount [SEK]						**30,86**

V_{tot} in the table is the actual required volume of material to produce the number of parts necessary for each mount, including material waste for the specific part. To calculate C_{mt}, the material had to be chosen and the sort that was found with the acceptable properties and could fulfil the requirements from the simulations in Report C was Polyamide (Type 6, 30% glass fibre, flame retarded) (Granta Design, 2013). For the detailed material selection, see Report B. According to CES, Polyamide has a mean cost on 36.20 SEK/kg and a mean density of 1545 kg/m^3. The cost per volume, C_{mt}, could then be calculated according to following:

$$C_{mt} = \frac{36{,}2 * 1545}{10^9} = 0.000055929\ kronor/mm^3$$

The material cost M_c was also multiplied by required of the same parts per mount. As Table 12 shows, the estimated total material cost M_c=30.86 SEK for each mount.

6.3.3 Total cost estimation

The material and manufacturing cost that was calculated above was carried out on only the required custom parts of the mount. Therefore, the estimation is not valid for the total product since it does not cover required standard components as screws, bolts and a gear. However, the estimated mount cost for different number of manufactured mounts can be calculated by following formula:

$$M_i = M_c + \frac{T_c}{x}$$

Where x represents number of manufactured mounts, up to 10 000 as the maximum limit of the estimation was based on. The result of the total cost was not surprisingly decreasing when the number of manufactured mounts increases. In Figure 53, different levels of manufactured mounts are presented and what the custom parts of each mount would cost.

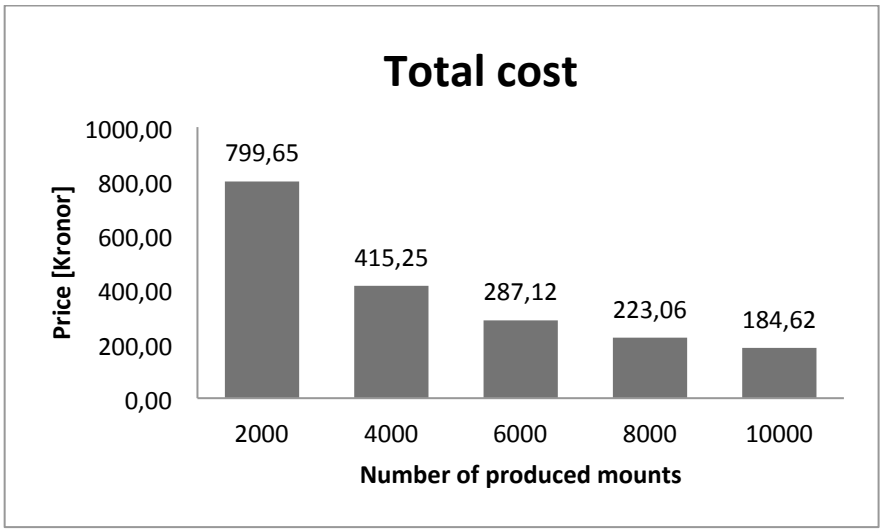

Figure 53- Total manufacturing cost for different number of produced mounts

Since not the standard components are included in this market acceptance study, the cost presented in Figure 53 is not the complete manufacturing price of the mount. Labour for producing the custom parts are included in the tooling estimation, but for example the assembly process, logistical costs and potential manufacturer profit are not involved in the estimation and are recommended to be investigated before any final conclusion can be drawn.

The results show however that if 10 000 mounts were produced, the cost of the custom plastic parts using injection moulding would be around 180 SEK, excluding assembly.

7 Discussion

This chapter covers the approach of important parts of the project and reflect on what turned out good and what parts that could have been done differently.

7.1 User and market studies

The market study was an important investigation to get insight within the field and see how competitors have solved the issue. The competitive benchmarking's result was that the rigid solutions got the highest score. The flexible solutions that were involved in the project did not come out on top from the market study and one hypothesis is that the user needs that were the criteria for the study did not favour the flexible solutions enough. It could also be that the flexible solutions on the market did not fulfil the safety requirements, which the three winners did. The main conclusion from the study was that no product with the high requirements in both flexibility and safety did exist on the market.

The market analysis was also focusing on risks and one important issue that was not covered and analysed enough was the size flexibility and if it was feasible to make a frame adjustable for tablets from 7" to 10.1" and still strong enough to fulfil the requirements in a car crash. Easier calculations could have highlighted possibilities and boundaries already in the prestudy. The What-If diagram could have focused more on modular and also two frame sizes to make the solution less flexible, but more robust. The completely flexible solutions overrode these solutions due to the main goal of total flexibility for the whole range.

The result from the interview was the most important from the prestudy, where various needs and desires emerged due to detailed information from potential users. The result could have been more accurate and valid if more people from different cultures and countries were involved in the interview research. The family segment was although evaluated well, which was important for the rest of the project.

The use of a semi-structural interview technique made it possible for the interviewee to describe in detail certain needs and desires for the product. Inspiration to solve the problems was often stated from the interviewees, which was positive to collect. The interviews made it possible to start brainstorming with a lot of different techniques in mind and also how to solve for example the coverage of the edges and make the mounting efficient.

The observations' purpose was to investigate additional features as tilting and the preferable position of it, since these aspects were brought up as desirable aspects in the user interviews. The result from the research showed that it would be preferable with a tilting function, which was confirmed in the interviews also. One reason for the tilting function's importance emerged from the interviews and stressed that this was a good way to prevent sun reflections. From the beginning the thought was only to get the user to have a good ergonomic position, which is also important.

7.2 Concept development

The concept development phase was focused highly on finding a wide solution space and the extensive prestudy was the base to find many different solutions that could fulfil the requirements. The result was extensive and various different concepts came out from the different generation methods. Testing different components as for example building a frame with telescopic arms and test the performance of suction cups would have required both time and money. It could although have resulted in more opportunities to the selection phase and would have been the best way to elaborate and validate the generation phase. This was done to some extent, but more testing technologies could have generated other final solutions.

The result using screening matrix and scoring matrices were overall positive, since they helped sorting and evaluate the concepts in an efficient way. The matrices were although only used as supporting tools and not completely deciding the concepts that should go further or not. Some of the concepts that did not score well, for example Side Slot in the second scoring matrix in Appendix I made in further anyway. Side Slot scored poorly and should be eliminated, but there was a clear pattern of the issues with the concept, that also got verified in the feedback from VCC and the users. The concept was modelled with too thin frame parts, which resulted in a weak impression and not robust enough for VCC. However, this was a relatively easy issue to fix because it was only because that the CAD-model did not have as thick parts as the other seven concepts. Therefore, the concept got punished in robustness in both of the last scoring matrix and in the user feedback. But there was also a clear pattern from the feedback that the mounting and dismounting function was smart on Side Slot, where no adjustments of the mount when using the same tablet were seen as advantageous and a good feature.

One possible way to approach a higher variety of the final promising concepts that went through the matrices and got presented to VCC could have been selecting a winning concept in each of the different categories of solutions. The flexible frames could have been favoured in a subjective manner and the modular solution that won the second scoring evaluation did not make it to the final five since the design was perceived as not good enough for a VCC product.

The users that were interviewed early in the project answered a trade-off question about the adjustability for different tablet models versus the ease of usage for the same tablet model. The question was rather complex for users to answer, and it became evident in the end of the project that it was an advantage that the user would not have to adjust the frame size all the time to mount and dismount the tablet. Most of the users had one tablet for the majority of the time, but still they did not want to buy a new mount when changing the tablet. However, in the end of the concept selection phase it was only Side Slot that had this feature. If this would have been more statistical proved in the prestudy, more focus on concept with the same feature could have been developed and evaluated.

The evaluation of VCC and the users when five concepts were remaining gave a lot of vital input for the final solution and generated great feedback that led to improvement

possibilities and combination opportunities for the concepts. It became evident in the user feedback that it was not obvious what concept that was the best one; it was mainly based on what aspects the respondent thought were the most important. Some of them thought for example design was the most vital and others thought a lot of that it should be a Volvo product where safety and robustness were vital. It was probably therefore the answers were varying and it was not more than one question, namely which concept that was perceived most safe that had a clear winner. If this process had been executed again, effort would have been aimed on modelling the concepts more coherent with the same wall thickness, part sizes and level of detail, as described earlier.

From a user perspective, which is one of the main focus areas of this report, Cog and Side Slot were rather different and had unique advantages. Cog focused more to be easy to use for different models and Side Slot focused more on the ease of use for one model. This was seen advantageous since it was more interesting to show two concepts that had different aim to VCC, than just one key advantage.

7.3 User and market verification

More time on working with the prototypes was needed than expected since the tolerances were not as fine as the specifications said. If the project would have been carried out with this knowledge, a special rapid prototype model could have been established with simpler forms of the frame and not so much focus to minimise the thickness. The complex shapes of the holes in the frame and the thin walls made it not feasible to drill them completely to get rid of the supporting material. The aim could have instead been to generate a prototype with simplified frame shape to verify the flexibility range.

The cost estimation of the custom parts turned out with a satisfied result, where 185 SEK for 10 000 units would most likely be within the frames of what is reasonable for VCC. A more detailed estimation can be carried out when the tablet mount manufacturer is decided, the material and manufacturing process is finalised chosen.

As can be followed in Report B, a lot of effort was to maximise the products quality and potential in this phase of the project. There were various aspects to take under consideration, where design, user friendliness, robustness and technical feasibility where the main focus areas for the whole project. For this report, the ease of usage was the main point together with the market acceptance. Side Slot got a new lock on the side that did the mounting slightly longer due to the robustness issue as can be read in Report C. The solution although got springs in the frame in horizontal direction, which made the change for different tablets quicker. The trade-off was important to have to make as much value to the user in the important aspects named above.

7.4 The final concepts

In chapter 7.4.1, the result of the primary concept Cog is discussed. In 7.4.2, Side Slot is discussed, which was the secondary concept of the project.

7.4.1 Cog

The user feedback when having the five most promising concepts resulted in a majority of the respondents commented on Lever's design was too thick. Cog did not get this feedback at this stage but when the concept got remodelled with the required properties in the detailed design phase carried out in Report B, it had a thicker design.

With the feedback in mind from the users, it was decided to reduce the thickness as much as possible. The concept might have been favoured slightly because of the optimistic modelling in the earlier stage, as the opposite of the secondary concept Side Slot that gave a weak impression. One arm was reduced, keeping only one diagonal arm to make it thinner created a concept with acceptable thickness.

Although other difficulties got generated with this decision, mainly that the mount could rotate around its axis since the cog system between the arms did not exist anymore. A locking mechanism would be required to prevent the issue and this mechanism could also preferably solve the locking of the frame size that would be necessary to fulfil the safety requirements. If this feature would be implemented, it would affect the ease of use negatively from a user perspective since the ease the concept would be less intuitive and also more effort would have been required to mount and dismount.

Cog turned out to be a complex concept but it has still a lot of potential to be easy for the user if the issues as described above can be solved properly. There have to be a trade-off in functionality, design and ease of use to decide the improvement possibilities of the concept and which is most important for the users. The final design in this project is mainly based on the input from VCC and potential users, which was the most vital area of this master thesis.

7.4.2 Side slot

Side slot was the concept that had the lowest score in scoring matrix two, although it went through to the final five concepts for its unique mounting feature. A hypothesis concerning the low score is that the frame was modelled too thin and the concept gave a weak impression. However, the users and VCC thought that the concept had a lot of potential since the user would not have to adjust the frame for the same tablet. Many would most likely use the same tablet for the majority of time and the additional required effort to adjust the mount for another tablet after its refinement is not significant. The springs that were added in the frame after the feedback was not only for the robustness in case of a crash, the user would just have to adjust the vertical size when changing tablet model.

The new design of the side supports would most likely make the mounting process a little longer, but the component was redesigned to reach a higher robustness to handle the forces and not give a weak impression for the customer.

Further work of Side slot should involve strengths and safety analyses that were only carried out for the Cog concept, as can be seen in Report C. The mount design has to be able to withstand the required forces in the safety simulations to be verified in this area as a suitable concept.

An investigation on material for the inside of the frame should also be studied for the tablet to be able to be mounted without any harm or scratches on it. The tablet should also be able to run smoothly without getting stuck on the way.

The concept seems although feasible with a defined locking mechanism in the vertical position and robust side supports that will keep the tablet in place. If further work would be done with the concept, it has the potential to be the most interesting from a user perspective, especially since there is no need to always adjust the frame size when using the same tablet.

7.5 Other possible concepts

The wide solution space made many possibilities arose for selecting the most promising concepts. The bar was set high in the project and from the start it was evident that a completely flexible solution was the goal to try to reach for. However, a concept like Modular as can be seen in Figure 33, could have been refined and further developed to reach a better design and be a simpler to build. It would most likely be cheaper and the fact that the majority of the users would have the same tablet size for most of the time, this concept would handle all big or small tablets without having to readjust the frame.

8 Conclusions

Two possible solutions of a tablet mount have been developed and initial prototypes of them have been generated to verify requirements and increase the performance of the final version. The versions have high potential, although both need further improvements stated in section 6.1 and 7.5. Cog needs to have a locking mechanism for the dimensional and size adjusting implemented. Side slot needs to be analysed in safety and optimised to withstand the forces. Completely functional prototypes could then be made on both of the concepts to evaluate which one that is the most promising for the future costumers. Both of the current prototypes have drift problems that led to all user requirements could not be tested.

No such tablet mount as Side slot or Cog has been identified on the market throughout the project that has the ability to handle different sizes and still fulfilling the safety requirements. This can lead to VCC gains a competitive advantage if further necessary development is carried out of the concept they believe in most.

From a user perspective, the conclusion is that Cog is preferable if the adjustment for different tablets is prioritised and Side slot is preferable if the user does not change tablet model frequently in the mount.

The wide solution space covered opened up many possible opportunities and many concepts that got removed on the way could be promising. If the flexible mounts are not enough robust, the modular solution could be a great mount to refine and develop further. Modular's strengths were the robustness and simplicity and if the design could be refined it would be a highly interesting concept.

The objective has been fulfilled within the time frame and suggestions for further development have been discussed.

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Appendix A

Observation

A.1 Procedure for observation

Choice of test method

The observations were conducted normally direct after the qualitative interview, but additional observations were carried out to get more measurements for the analysis.

The test methods were chosen between six different options, conducted by the project group. After an evaluation, it was decided to use reference tape placed on the front and back headrest in the car. A reference tape was also put in the roof, for the vertical measurements. The method was chosen because it requires no physical measurement in the actual observation, which was perceived beneficial for the people involved in the investigation.

Preparation

The car used in the observation was prepared before each observation and the first step was to park the car on e flat surface, controlled by a spirit level. The back of the front seat was adjusted to be completely vertical, also controlled by a digital goniometer.

Red tape was placed on the driver's headrest on the right side and the same for the passenger's headrest behind the driving seat. The front seat was then adjusted to be 1100mm between the tapes, using a folding ruler and a spirit level. The last reference tape was placed on the roof, straight above the line of the other two tapes, forming a 2-dimensional coordinating system.

The tapes were not removed from the car until all measurements were done, but the measurement of the angle and position of the front seat had however to be readjusted after each measurement. For the list of equipment and software being used for the observation, see section 2.6.

Implementation

The observed participant sat initially down in the left back seat and a tablet was presented for them. The interviewer asked the participant to move the tablet to a preferable writing position. A photo was taken by another project member form the right side, relative the car. The camera was hold in the same height for every observation and 90˚ relative the measurement plane to get as precise measurement as possible, see Figure I for a visualisation of the measurement.

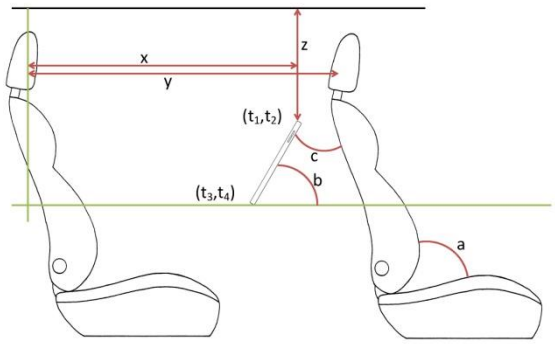


Figure I- Illustration of the measurement

If the participant had driving licence, he or she was measured sitting in the front seat and adjusting it for their personal preferable driving position. The angle of the back rest, relatively to the seat was then measured supported by the digital goniometer. The horizontal length between the reference tapes was also measured with the folding ruler and the spirit level. The participant of the study did not have to sit in the car when the physical measuring was carried out.

The measurements from the photos were conducted with Adobe Photoshop in the following way:

1. The coordinates for each tape was measured in pixels and noted in the excel file.
2. The coordinates for the upper and lower edge of the tablet was measured and noted. In some photos the lower edge was covered by the interviewee's hand and in those cases the coordinates for the middle of the tablet was used instead, together with a comment.
3. The angle of the camera had to be compensated for since not all photos were taken absolutely horizontal. This was done by calculating the angle between the two tapes on the headrests, d, according to figure XXX.
4. The horizontal distance from the upper edge of the tablet to the back headrest was calculated as $\frac{y}{1100} * x * \cos d$. Measurementsx and y are explained in figure XXX. The reason for the cosine-term is because of the compensation for the camera angle.
5. The vertical distance from the upper edge of the tablet to the roof was calculated as $\frac{186}{\sqrt{(t2-t4)^2+(t1-t3)^2}} * \frac{z}{\cos d}$, where t_1, t_2, t_3, t_4 and z are measurements explained in figure XXX and 186 mm is the length of the tablet used. In the cases where measurements on the tablet could only be made to the middle of the tablet, t_3 and t_4 represents that middle point and the tablet length was halved. The cosine-term is once again to compensate for the angle of the camera.
6. The angle of the tablet was calculated as $\tan\left(\frac{t2-t4}{t1-t3}\right) - d$, where d once again is to compensate for the angle of the camera.
7. All calculations and values were documented for comparisons.

When all measurements were made, the mean values and differences were calculated.

A.2 Potential sources of error

Since the observations were an exploratory study and not based on an exact fact, there could be some potential errors involved. First of all, more measurements should have been made to validate the test method.

Secondly, the tests were carried out in two different vehicles, with two different tablets and with two different cameras. These factors are considered to have minor, or no, influence on the results since both tablets used had the same dimensions, the cars used were of the same model and the difference between the cameras are considered to not affect the results in any substantial manner.

One thing that could cause significant errors was that some photos were taken from a slight angle relative to the tablet's side, so the tablet screen could be seen in the photo, which was supposed to happen. This could affect the angle of the tablet to appear larger than it actually was. It is unclear how much this has affected the results.

The study was carried out by three different observers. For nine measurements, only one participant made the observations but with an instructed assistant to help out. Before the study, test measurements were conducted to clearly instruct everyone in the same way how to perform the observations so this should not cause any major errors in the results.

All participants of the study were Swedish, yet the aim for the tablet mount is to be sold globally. Therefore there could be anatomical and anthropological differences between people in different countries which were not covered by this study. At the same time, the observations were not supposed to be used for statistical purposes or complete market research but rather as guidelines, for example of how large the variations could be.

The participants of the study only put the tablet in their favoured position after which they exited the car for a short time. There is a risk that the position they chose is not optimal for use over a long time in the car.

Lastly, when the interviewees adjusted the front seat to their favoured driving position there is a risk that they kept the seat more vertical than they usually would due to the fact that the seat back was vertically placed when they entered the front seat.

Overall though, the purpose of the observations was not to gather statistical data but rather to show how big the differences can be and how much the position of the tablet changes, and should change, between different users. This in combination with the fact that most sources of error most likely had little effect on the results, they were still considered valid for their purpose.

Appendix B

What-if diagram

What-if analysis that covers the market risks for develop flexible tablet mounts

Study Area: Market risk analysis	Meeting date: 2014-02-28		
What-If?	**Hazards**	**Safeguards & Recommendation**	**Actions by**
The tablet market is decreasing in sales	The market need of tablet holders decrease	Keep track on tablet sales volume and possible new trends on the tablet market to adjust the production	VCC
Volvo is decreasing in sales	Can decrease the tablet mount's sales volume	Develop safe and quality cars to a market acceptable price. Try to get competitive advantage in terms of performance, service and additional functions	VCC
An terrible accident occurs involving a tablet mount in a car	Decreased perception in terms of safety even if it is not VCC's car mount	Sharper laws and regulations to prevent accidents. VCC should also promote their tablet mount as safe in terms of crash test	Politicians and VCC
The mount costs more than the acceptable market price	Low sales volumes and a potential product fiasco	Look at competitors, research the acceptance of price and discuss the target cost with VCC	Development group
The installation is too complex	Decreased sales in aftermarket	Make the design and instalment as easy and fast as possible. Make a special price for the mount plus instalment for used cars in the beginning to get the product out to the customer faster	VCC and workshops
The market analysis from VCC showed exaggerated results of the need of a tablet mount	Sales fiasco, even if the product is good or not	Additional market study. Find the right market segments to focus on	Development group
The design does not fit in the Volvo car or does not have an appealing design	Decreased sales volume even if the performance is exceptional	Study Volvo brand identity and include the customers in the design process	Development group
Poor marketing	Sales fiasco, even if the product is good or not	Marketing in the correct segments	VCC

Too low functionality	Unsatisfied customers and can lead to bad word of mouth	Include possible customers in the development process	Development group
Better or cheaper alternatives that is compatible with Volvo cars	Increased competition can force decreased margins or decreased sales	Make a state of the art product to an acceptable price	VCC and development group
Cheap copies	Decreased market share. Could also damage the brand identity.	Develop unique solution and take patent on the functions.	VCC
Too low quality	Unsatisfied customers and damage the brand identity	Develop and optimize the robustness and construct based on possible hazards	Development group

Appendix C

Benchmarking matrix

Competitive benchmarking

Needs			Importance	Targus		Military		Griffin	
Number				Score	Weighted	Score	Weighted	Score	Weighted
1	The mount	does not hide the tablet's buttons and headphone jack	5	5	25	3	15	4	20
2	The mount	is not covering the speaker	3	3	9	2	6	3	9
3	The mount	cannot disturb the Bluetooth- and WIFI-signal	4	5	20	5	20	5	20
4	The mount	is able to charge the tablet	4	4	16	3	12	3	12
5	The mount	is not covering the front camera	2	5	10	5	10	5	10
6	The mount	can attach and detach the tablet easily	4	3	12	2	8	5	20
7	The mount	is flexible for different tablet models	4	5	20	1	4	2	8
8	The mount	can preferably enable more than one viewer to the tablet	2	2	4	-		2	4
9	The mount	is tiltbale	4	1	4	-		1	4
10	The mount	is preferably preventing sun reflections to the screen	2	*	*	*	*	*	*
11	The mount	is easy to adjust for different models of tablets	3	3	9	-		2	6
12	The mount	is initially placed in an ergonomic position for its typical users	3	*	*	*	*	*	*
13	The mount	is flexible for common types of tablet usage	4	2	8	-		1	4
14	The mount	feels stable when the user is writing on the tablet	4	2	8	-		1	4
15	The mount	has a robust construction to handle usage from children	5	2	10	5	25	1	5
16	The mount	has an appealing design that fit Volvo cars	4	1	4	4	16	2	8
17	The mount	is and feels safe	5	2	10	5	25	4	20
18	The mount	is not in the way when the user is getting in or out of the car	3	5	15	-		5	15
19	The mount	is affordable for a Volvo-owner	5	5	25	4	20	5	25
	Score:			55	209	39	161	51	194

	Belkin		Golv kjell		Barn		iGrip		BMW		Mercedes	
Number	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted
1	4	20	5	25	1	5	5	25	5	25	5	25
2	4	12	4	12	1	3	4	12	1	3	1	3
3	5	20	5	20	5	20	5	20	5	20	4	16
4	2	8	3	12	1	4	4	16	4	16	5	20
5	5	10	5	10	5	10	5	10	5	10	5	10
6	4	16	2	8	5	20	5	20	5	20	4	16
7	4	16	3	12	1	4	4	16	1	4	1	4
8	1	2	4	8	-		5	10	2	4	1	2
9	-		5	20	-		0		4	16	5	20
10	*	*	*	*	*	*	*	*	*	*	*	*
11	4	12	2	6	-		5	15	-		-	
12	*	*	*	*	*	*	*	*	*	*	*	*
13	1	4	3	12	2	8	1	4	4	16	2	8
14	3	12	2	8	-		3	12	4	16	5	20
15	5	25	3	15	2	10	2	10	4	20	5	25
16	3	12	1	4	1	4	2	8	5	20	5	20
17	3	15	2	10	4	20	1	5	5	25	5	25
18	-		-		-		5	15	4	12	5	15
19	5	25	5	25	5	25	5	25	3	15	1	5
Score:	53	209	54	207	33	133	61	223	61	242	59	234

	RingO		Konig		SKU:PHFLHRB		Modular		Best of each		Potential best	
Number	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted
1	5	25	4	20	4	20	4	20	5	25	5	25
2	3	9	4	12	3	9	4	12	4	12	5	15
3	5	20	5	20	4	16	5	20	5	20	5	20
4	4	16	3	12	1	4	3	12	5	20	5	20
5	5	10	5	10	5	10	5	10	5	10	5	10
6	4	16	3	12	5	20	5	20	5	20	5	20
7	1	4	5	20	2	8	3	12	5	20	5	20
8	1	2	1	2	1	2	1	2	5	10	5	10
9	5	20	2	8	4	16	4	16	5	20	5	20
10	*	*	*	*	*	*	*	*		0		0
11	-		3	9	-		1	3	5	15	5	15
12	*	*	*	*	*	*	*	*	*	*	*	*
13	2	8	2	8	2	8	1	4	4	16	5	20
14	4	16	4	16	2	8	3	12	5	20	5	20
15	3	15	2	10	4	20	3	15	5	25	5	25
16	5	20	2	8	3	12	3	12	5	20	5	20
17	4	20	1	5	4	20	4	20	5	25	5	25
18	5	15	5	15	5	15	-		5	15	5	15
19	4	20	5	25	4	20	4	20	5	25	5	25
Score:	60	236	56	212	53	208	53	210		318		325

Appendix D

B.1 Interview template

Generella förutsättningar och användandet:

- Vad heter du och hur gammal är du? Hur lång är du?
- Hur många familjemedlemmar ni?
- Har ni någon läsplatta inom hushållet och i så fall vilken/vilka?
    - Vad använder du den till? (Privat eller jobb, film eller spel?)
    - Används läsplattan något när ni åker bil och i så fall vilka inom familjen utnyttjar den?
    - Har läsplattan tillgång till internet i bilen?

Hållare för läsplattor:

- Vad används läsplattan till vid en bilfärd eller när du är ute och reser? Samma eller skiljer det sig från vanligt användande?
- Vilka uttag och knappar behöver du komma åt på läsplattan under bilfärden?
    - Kategorier: Knappar, ljud, kamera, laddning.
- Används olika surfplattor i bilen?
    - (Bättre att ställa in hållaren för en som då går jättelätt att ta i/ur eller bättre med en som fungerar lätt för alla?)
- Är det ofta mer än en person som använder läsplattan samtidigt under en bilfärd? (Exempelvis flera vill kolla på en film?)
- Var hade du föredragit att plattan skulle vara positionerad? (Mer än ett läge?)
    - Hur hade du velat kunna ändra positionen av läsplattan? (Ex. justerbar upp och ner, vridbar, snurrbar…)
- Tänker du mycket på säkerheten när det kommer till bilar?
    - Tänker du på var du lägger saker i bilen när du kör? (Tex en tablet, väska, etc.)
- Om du skulle köpa en hållare till en läsplatta, vad hade varit de viktigaste egenskaperna för dig?
- Hur mycket skulle du tycka en hållare som uppfyller alla dina krav kosta som mest?

Barnintervju

- Vad heter du och hur gammal är du? Hur lång är du?
- Har ni någon läsplatta inom hushållet och i så fall vilken/vilka?
    - Vad använder du den till?
    - Används läsplattan något när ni åker bil och i så fall vilka inom familjen utnyttjar den?
    - Har läsplattan tillgång till internet i bilen?
- Vad används läsplattan till vid en bilfärd eller när du är ute och reser? Samma eller skiljer det sig från vanligt användande?
    - Används olika surfplattor i bilen?
- Vilka uttag och knappar behöver du komma åt på läsplattan under bilfärden?
    - Kategorier: Knappar, ljud, kamera, laddning.
- Är det ofta mer än en person som använder läsplattan samtidigt under en bilfärd? (Exempelvis flera vill kolla på en film?)
- Var hade du föredragit att plattan skulle vara placerad? (Mer än ett läge?)
    - De får visa hur de använder plattan och se vilka rörelser som är involverade.
    - Håller de den exempelvis den upprätt eller liggandes?

B.2 Interviews

Intervjuare: (E)
Q: Fråga
A: Svar

Man 50 år, 187 cm
Q: Har du familjemedlemmar?

A: Jag har 4 barn och en fru. Tre är nästan vuxna, 22, 20 och 18. Den lilla är 7 år eller 8 alldeles strax.

Q: Okej, har ni någon läsplatta inom familjen?

A: Nej, men jag tänkte mig köpa en IPad till frun nu när hon fyller år snart.

Q: Okej, vad skulle du tänka dig att ni kommer att använda den till då?

A: Först och främst är det väl privat. Hon är anställd på VCC, så det hon behöver till jobbet får hon genom Volvo då. Men privat använder hon en Iphone väldigt flitigt i dagens läge att surfa på, så jag kan tänka mig att en IPad skulle bli väldigt användbar och uppskattad för henne.

Q: Skulle ni ha någon nytta av en IPad när det kommer till bilåkande och resande i allmänhet?

A: Absolut jag tror det skulle bli hugg-sexa om den mellan frun och barnen som är med i bilen. Jag behöver ju såklart köra. Antingen vill någon kolla på film, eller så vill de kanske ha den som musikupplägg. Ibland skulle man kunna tänka sig att den skulle kunna användas till skolarbete kanske.

Q: Okej, vilka uttag tror du skulle vara användbara att kunna komma åt i en bil?

A: Hörlursuttaget tror jag är en vital utgång för man vill inte att alla andra ska höra det som man håller på med. Sen tror jag inte man använder paddans högtalare för om man bestämmer att det ska höras ut tror jag man vill koppla in den till bilens högtalarsystem. Man behöver ju komma åt knapparna för att stänga skärmen osv. samtidigt som laddning är en funktion jag tycker man förutsätter bara ska funka. Det ska inte vara någon lös sladd heller utan när man sätter i den i bilen ska det se bra ut och den ska laddas. Volymknappar är viktigt om man inte kan göra det via bilen eller hörlurarna.

Q: Vad är viktigast tror du: Ställa in plattan en gång för DIN läsplatta och sen fungerar det smidigare att sätta i och ta ur den eller tycker du det är bättre att ha en lösning som är enkel att ställa in för olika storlekar och sedan lite svårare att ta ut eller in den.

A: Som vi kommer ha det så lär vi bara ha en platta i början och då skulle jag ju föredra att det skulle funka smidigt med den. Men jag skulle ändå kunna föredra att kunna ställa in den i framtiden för fler modeller. Som jag ser det just nu skulle vi inte köpa en IPad mini, men samtidigt har jag en svåger som har både en mini och en vanlig och använder båda mycket, så som jag ser det skulle en fastsättning av olika storlekar vara användbar.

Q: Skulle många använda plattan samtidigt under en bilfärd, du nämnde t.ex. titta på film innan.

A: Jag tror nog att man skulle vilja ha den som ”min grej”, alltså den som använder den. Entertainment-paketet som finns idag sitter väl oftast på båda nackstöden och de kan jag tänka mig är till för den som sitter i mitten också. Men om man exempelvis surfar och så vidare känns det mer som en enmans-pryl. Eller den som använder den för tillfället.

Q: Vad hade du föredragit att plattan skulle vara positionerad?

A: Det beror på vad den skulle användas till. Om jag tittar så skulle jag vilja ha den uppe vid nackstödet, men om det skulle vara så att man skulle använda den, t.ex. skriva eller surfa så skulle jag vilja ha den i ett läge som man finner behagligt. Och det är ju väldigt olika beroende på om man är lång, kort, smal eller tjock, osv.

Q: Okej, hur skulle du vilja kunna ändra läsplattan utifrån utgångspositionerna som vi pratade om?

A: Jag tror man skulle vilja hitta en reflexfri vinkel, man vet ju att skärmar har en tendens att spegla sig mycket. Och om man åker bil och det är mycket sol kan det bli ett problem. Ibland får man ställa den ganska snävt får att det ska bli bra och dessutom ändras ju förutsättningarna sig ofta eftersom bilen svänger osv. Så man skulle vilja ha en justering på den så man kommer undan reflexer och även då ha en flexibilitet mellan skriv- och filmläge.

Q: Tänker du mycket på säkerheten när det kommer till bilar?

A: Ja det gör jag vill jag påstå. Med tre barn som har övningskört och en som är liten så är det mycket säkerhetstänk. När jag var yngre så använde jag inte säkerhetsbälte för jag tyckte inte det var så jätteviktigt. Idag startar jag inte bilen förrän alla är fastspända.

Q: Tänker du även på lösa saker som ligger i bilen?

A: Ja det gör jag.

Q: Om du skulle köpa en läsplatta idag, vad skulle vara de viktigaste egenskaperna utifrån ert användningsbehov?

A: Att den passade min padda utan problem, och att den fungerade för alla möjliga användningsområden som t.ex. surfa, skriva mail, titta på film och det skulle kännas som den var anpassningsbar för de olika områdena. Den ska inte glida undan när man trycker på den.

Q: Vad skulle den kunna kosta om den uppfyllde alla dina krav och du ville köpa en sådan här till din Volvo?

A: Jag skulle säga att jag hade varit beredd på att ge ungefär lika mycket som den läsplattan man har. Så upp emot 4000 går min smärtgräns om man då har en IPad Air eller liknande. Men då ska den som sagt vara av hög kvalitet.

Q: Tack så mycket! Då var vi klara.

Kvinna 26 år, 169 cm
Q: Har du några familjemedlemmar?

A: Jag har en son som är 1,5 år. Så han använder inte läsplatta än men om några år så. Han är redan intresserad av min.

Q: Ja förstår, vad har du för någon sorts läsplatta?

A: Jag har en iPad, den med retina-skärm. Inte iPad Air utan den innan.

Q: Ja det stämmer bra! Har den en bred ladd-sladd eller den nyare smala?

A: Det är den smala varianten.

Q: Okej då är det iPad gen 4. Använder du den privat eller jobb-relaterat?

A: Det är bara privat. Mycket recept slår jag upp på den. Jag streamar även Spotify till högtalaren från den. Om man ska surfa lite snabbt och inte orkar starta upp datorn så är den smidig då telefonen är för liten för att det ska vara bekvämt.

Q: Har den tillgång till internet när ni exempelvis är på resande fot?

A: Ja den har 3G-internet i sig.

Q: Använder du den i bilen något?

A: Nja, jo jag har använt den som GPS ibland, men inte så mycket. När vi åker iväg är det ju jag som kör så då kans jag inte använda den. Och sonen är för liten än så länge, men senare kanske han vill ha en att leka med.

Q: Om du skulle åka bil en längre sträcka skulle du använt din läsplatta då?

A: Ja när man åker bil så är det jättebra att underhålla sig med den, och när sonen blir lite större tänker jag mig att det hade varit perfekt att kunna slänga på en film så det hade blivit lugnt och skönt när man kör. Det hade varit väldigt smidigt att höja underhållsvärdet för barnet vid bilåkande.

Q: Om vi säger scenariot att pojken har blivit lite äldre och du skulle haft en hållare för att sonen ska kunna kolla på en film i bilen, vad skulle du vilja komma åt för knappar och uttag?

A: Hörlurar skulle ju varit väldigt bra. Volymknapparna är ju inte fel heller. Hem-knappen är ju viktigt med. Laddning skulle varit jättebra att ha integrerat i hållaren men det kan jag tänka mig är jättesvårt att anpassa för olika modeller.

Q: Det kan det säkert vara, men det skulle vara en sak som skulle höja kundvärdet.

A: Ja verkligen, jag vet ju att min dockstation som laddar samtidigt är väldigt användbar. När man strömmar musik eller film går det ju åt mycket batteri.

Q: Ja det är ett ständigt problem! Tror du att framkameran är en viktig funktion i bilen?

A: Nej inte för mitt vidkommande. Jag kan inte se det för mitt eget användande i alla fall.

Q: Vad är viktigast tror du: Ställa in plattan en gång för DIN läsplatta och sen fungerar det smidigare att sätta i och ta ur den eller tycker du det är bättre att ha en lösning som är enkel att ställa in för olika storlekar och sedan lite svårare att ta ut eller in den.

A: Eftersom jag bara har en läsplatta så har jag bara behov av en storlek just nu, men jag kan väl tänka mig att sonen kommer få en egen om något år och då lär det ju vara en nyare modell med andra mått såklart. Så du hade jag ju velat att båda skulle passa. Samtidigt så känner jag att hela anordningen måste vara barnsäker om man säger. Alltså väldigt hållbar. Barn är ju inte riktigt lätthänta alltid. Det är nog något ni borde tänka på: att den måste vara robust men samtidigt ska det ju vara en lätt konstruktion som är tillräckligt snygg.

Man 52 år, 181 cm
Hur många familjemedlemmar bor i hushållet?

A: 4 stycken, varav 2 barn som är 20 och 18.

Q: Vad har ni för sorters läsplattor?

A: 1st 7-tums andoidplatta och sen har vi 2 stycken 10-tums Samsung, varav en är min.

Q: Vad använder du läsplattan till?

A: Jobbmässigt så kollar jag mycket mail men annars privat så är det mycket blocket-annonser.

Q: Är läsplattan något ni använder när ni reser och åker bil?

A: Vi har skaffat plattorna innan jul precis så vi har inte haft med den så jättemycket än.

Q: Okej, har ni tillgång till internet på läplattorna när ni är iväg eller?

A: Ja via mobilens bara. Inget SIM-kort i dem.

Q: Vilka uttag, knappar osv. är bra att kunna ha tillgång till i fall den skulle sitta i en hållare?

A: Att kunna ladda den hade ju varit bra. Hörlurar är med viktigt kanske. Annars är det ju volymknapparna och sånt.

Q: Vad är viktigast tror du: Ställa in plattan en gång för DIN läsplatta och sen fungerar det smidigare att sätta i och ta ur den eller tycker du det är bättre att ha en lösning som är enkel att ställa in för olika storlekar och sedan lite svårare att ta ut eller in den.

A: För oss hade ju varit en fördel om det hade varit ganska lätt att kunna ställa den till olika.

Q: Är det ofta mer än en person som använder eller tittar på skärmen på samma gång?

A: Nej det är bara en person åt gången skulle jag säga.

Q: Hur skulle du vilja ändra positionen av skrivlägets utgångsposition?

A: Den får vara någon typ av ledbar. Sen måste den kunna låsas i den positionen så den inte rör sig och att den känns stabil är viktigt. Den kan nog vara helt fast i ett läge skulle jag säga (i skrivläget).

Q: Tänker du mycket på säkerheten när det kommer till bilar i allmänhet?

A: Jo det är klart man tänker på. Fast just plattorna vet jag inte hehe.

Q: Men tänker du på hur och var du lägger föremål i bilen som är lösa?

A: Ja i fall det är tyngre saker lägger jag det långt ner så det inte kan åka fram.

Q: Vilka egenskaper utöver det du har nämnt skulle du vilja att hållaren uppfyller?

A: Ja att den skall vara lätt att ställa in då. Att den har de här två lägena, för det känns som det är de två lägena man behöver för att täcka in behoven av användandet av en läsplatta.

Q: Hur mycket tror du att en sådan här hållare skulle kunna kosta om den uppfyller alla dina krav?

A: Oj, bra fråga! 600-700 kronor skulle jag säga. Beror ju lite på bil och läsplatta men åtminstone i den prisklassen.

Man 54 år, 190 cm
Familjemedlemmar: Fru och 2 barn

Q: Har ni någon läsplatta inom familjen?

A: Ja vi har en IPad 2 som vi har haft i några år nu.

Q: Vad använder ni den till?

A: Den används att surfa med och sen har jag den på jobbet ibland för att titta på ritningar och andra dokument.

Q: Smidigt, har den SIM-kort eller är det endast WIFI som gäller?

A: Den har SIM-kort så det finns internet i den utan WIFI med.

Q: Använder ni den något när ni är iväg och reser?

A: Vi har använt den bland annat för navigation, och den är ofta med på resor framförallt för surf.

Q: Om man säger att den ska sitta i en hållare i bilen, vilka uttag och knappar skulle vara intressanta att kunna komma åt?

A: De få knappar som finns tror jag är vettigt att kunna komma åt. SIM-kortets lucka är ju inget som behövs. Högtalaren tror jag inte man hade använt, jag hade kopplat den antingen till hörlurar eller till bilens högtalare.

Q: Är det ofta mer än en som tittar eller använder plattan samtidigt?

A: Nej jag skulle säga att det är ganska uteslutet en person.

Q: Hur skulle du vilja ändra positionen på skrivläget utifrån utgångspositionen?

A: Oj det var svårt att säga, det är nog en sådan sak man tänker på när man väl sitter där. Fungerar det och känns bra tror jag inte man tänker på det, men skulle det inte kännas naturligt så skulle man märka det.

Q: Tänker du mycket på säkerhet när det kommer till bilar?

A: Ganska mycket, ja.

Q: Tänker du även på var du placerar lösa föremål i bilen?

A: Jag är ju medveten om det, jag menar jag packar inte över ryggstödet och använder lastnät om jag skulle göra det.

Q: Om du skulle skaffa en hållare till läsplattan för din nya bil, vilka skulle varit de viktigaste egenskaperna för dig, utöver det vi har pratat om?

A: Jag tror att egentligen skulle detta varit någon av mina familjemedlemmar som hade använt en sådan produkt för jag är ju den som kör. Men den ska ju passa in i bilen och vara stabil. Om man har mindre barn så behöver den ju vara tålig.

Q: Vad tror du en sådan här pryl skulle kunna kosta om den uppfyller alla krav på säkerhet, kvalité och funktioner?

A: Det beror ju på men det skapar ju säkert ett stort behov för människor som har yngre barn och ungdomar i Sverige. Jag skulle säga i alla fall en tusenlapp.

Kvinna 40 år, 158 cm
Familjemedlemmar: 2 barn, flicka 10 och pojke 14 år

Q: Har ni några läsplattor inom familjen?

A: Vi har 2 stycken läsplattor inom familjen. 2st IPad gen 2 och 3.

Q: Vilka är det som använder dem och vad använder ni dem till?

A: Det är bara barnen som använder dem. Den ena (14åringen) har fått den genom skolan, så han använder den både till skolarbete och på fritiden. Min andra använder den bara privat. Videos, surfande och spel du vet.

Q: Har plattorna tillgång till internet om ni skulle vara på resande fot?

A: Ja vi kopplar upp oss via telefonerna med internetdelning.

Q: Okej, och skiljer sig användandet från det normala när ni åker bil t.ex.?

A: Ja möjligtvis att pojken läser mer nyheter och kanske tar upp GPS:en på plattan och lite sånt.

Q: Och vilka knappar och uttag använder de när de sitter i bilen med läsplattorna?

A: Det är hörlurar till ljudet och knapparna för volym med mera. Laddningen kan de använda också ibland. Det skulle vara smidigt om det fanns i hållaren.

Q: Och du sa att det var två olika modeller på era iPads, skulle det vara en fördel om den fungerade till båda?

A: Ja absolut, eftersom det hade säkert bytts vilt mellan de olika plattorna och det skulle vara skitjobbigt att behöva ha 2 stycken olika hållare för olika läsplattor.

Q: Jag förstår, är det ofta mer än en som tittar på läsplattan på samma gång?

A: Nej det skulle jag säga att det i princip aldrig är i vår familj. De vill hålla sin platta privat.

Q: Jag förstår! Med tanke på hur de använder den. Vilken position skulle de vilja ha plattan i bilen?

Q: Ja idag har de sådana ställ (Cover som går att göra till ställ) och de viker ofta upp den för att få vinkeln bättre i bilen än att bara hålla i den eller ha den liggandes i knäet. De måste kunna nå den när de ska spela till exempel. Men det är klart om de bara tittar på film så är det ju bättre att ha den en bit bort. Så det är nog lite olika.

Q: Okej, för den här hållaren ska ha två ursprungsläge, ett skrivläge och ett filmläge (visar hur de sitter), precis som du beskrev det. Men om man snackar om skrivlägets ursprungsposition, vilka justeringar tror du skulle vara fördelaktiga för att få fram ett bra användande?

A: Ja, lite beroende på vad man gör men jag skulle säga att kunna tilta den upp och ner för att få en rätt vinkel och det skulle vara bra om man kunde justera mot solljus på något sätt.

Q: Ja, det låter som du har bra koll!

A: Även om man behöver ha den upprätt för annat använde so m vissa appar kräver!

Q: Tänker du mycket på säkerhet när det kommer till bilar?

A: Ja, det gör man väl. Till viss del med bälten, barnstolar och sådant.

Q: Tänker du även på var du placerar lösa föremål?

A: Nej det har jag varit dålig på, det är inte ofta jag tänker på sådant faktiskt.

Q: Okej, men om du skulle införskaffa en sådan hållare till läsplattor till din familj, vilka egenskaper skulle vara viktigast för er?

A: Ja det var det här med att den ska kunna passa olika läsplattor skulle jag säga. Det hade jag lagt extra pengar för! Sen att den sitter fast ordentligt och att den ändå är ställbar i olika lägen.

Q: Okej, det vara alla frågor jag hade till dig. Tack så mycket för du ställde upp på intervjun.

A: Mm okej, ingen fara.

Kvinna 40 år, 166 cm.

Q: Har du några familjemedlemmar?

A: En son på 11 år.

Q: Har ni någon eller några läsplattor inom hushållet?

A: Vi har en IPad 2 och en IPad mini.

Q: Okej, vad använder ni den till?

A: Det är mest leka haha. Spela och även streama TV.

Q: Okej, använder ni den när ni är ute och åker bil eller reser också?

A: Ja vi använder den mycket när vi reser. Vi reser mycket mellan Göteborg och Norrland så då används den mycket.

Q: Jag förstår, använder ni båda läsplattor då?

A: Ja han har minin och jag har IPad 2.

Q: Han någon av läsplattan tillgång till internet utanför WIFI-zoner.

A: Ja vi internet-delar från telefonerna.

Q: Skiljer sig användandet från resandet från vad ni brukar använda läsplattorna till.

A: Nej det gör det inte. Vi har tillgång till internet så det är samma användningsområden.

Q: Vilka uttag och knappar skulle vara bra att ha tillgång till om den sitter i en hållare?

A: Skärm, volymknapp. Laddningsfunktion skulle varit guld. Vi har ju billaddare i dagens läge.

Q: Tittar ni ofta på samma skärm? T.ex. om ni skulle streama en film osv?

A: Nej vi har en var så det gör vi inte.

Q: Hur skulle du vilja kunna ändra utgångspositionen ”skrivläge”?

A: Det har nog mer med vinkling att göra främst (upp och ner). Vrida så att plattan ligger ner respektive står upp är ju också bra. Men även solljus som kan komma in från fönstren hade ju varit bra om man kan få bort genom att vinkla den eller något ifrån.

Q: Tänker du mycket på säkerhet när det kommer till bilar?

A: Haha nej jag tror inte det. Jag är ingen bil-människa egentligen. Jag åker hellre med någon annan eller kollektivt.

Q: Tänker du på var du lägger lösa föremål i bilen när du kör eller åker?

A: Nej inte alls, i alla fall inte smågrejer. Men kanske kartonger som är stora.

Q: Vad är de viktigaste egenskaperna för en sådan här produkt utöver det du har nämnt?

A: Lätt att ta bort hållaren om man inte använder den. Och att det ska vara lätt att justera den till mig. Att den ska vara snygg är sekundärt, den skall vara funktionell främst.

Q: Om vi säger att du skulle köpa en bil och skaffa en hållare till era läsplattor som är flexibel och klarar era önskemål, hur mycket skulle du kunna ge för en sådan produkt?

A: Eh, jag tror runt 500 kronor för vår del.

Man 20 år, 193 cm
Q: Familjemedlemmar?

A: Plastfar, mamma och en lillebror.

Q: Och du hade en läsplatta?

A: Ja, en nexus 7 som är en androidplatta.

Q: Vad använder du den till?

A: Det är allt ifrån filmer till facebook och annat surfande.

Q: Använder du den gång när du är ute och reser, med andra ord inte är i hemmet.

A: Ja allt ifrån bil, tåg, buss och hotell. Det är så pass enkelt att ta med en sju-tums platta så där är den perfekt.

Q: Ja precis! Har den tillgång till internet utanför wifi?

A: Ja när jag inte har WIFI kan jag dela från mobilen.

Q: Skiljer det sig någonting från användandet hemma och när du är på resande fot?

A: Ja när man reser ersätter den datorn och när man är hemma kompletterar den mer datorn, det vill säga man slö-surfar i soffan och så vidare. Mer allround när man är iväg.

Q: Vilka uttag skulle du vilja kunna komma åt om plattan skulle sitta i en hållare?

A: Laddare, koppla in hörlurar känns viktigast. Framkameran känns inte aktuell i mitt fall men finns säkert ungdomar som tycker det skulle vara viktigt.

Q: Vad är viktigast tror du: Ställa in plattan en gång för DIN läsplatta och sen fungerar det smidigare att sätta i och ta ur den eller tycker du det är bättre att ha en lösning som är enkel att ställa in för olika storlekar och sedan lite svårare att ta ut eller in den.

A: Hellre att det tar lite längre tid att ställa in den från början men att det går att ta ut/in samma platta lätt.

Q: Är det ofta mer än en som tittar eller använder samma platta samtidigt?

A: Nej så gott som aldrig skulle jag säga. Kanske bara om man vill visa något fort men inte generellt sett.

Q: Hur skulle du vilja ändra utgångspositionen av skrivläget?

A: Hade man kunnat ställa in vinkeln så skulle det vara bra.

Q: Tänker du mycket säkerhet när det gäller bilar?

A: Haha , njae på med bältet bara.

Q: Inte var du lägger lösa föremål?

A: Nja om det är tunga grejer så placerar man ju dem bra, men inte annars.

Q: Vad är de viktigaste egenskaperna utöver det du har nämnt?

A: Byggkvalité står mig ganska varmt om hjärtat så det är viktigt. Och att vinkeln är klockren till den som använder den.

Q: Om ni skulle köpa en sådan här pryl och den skulle uppfylla alla dina krav, vad skulle den kunna kosta?

A: Uppfyller den alla krav och den är liksom välbyggd så skulle jag säga en tusenlapp eller drygt det.

Kvinna 22 år, 165 cm
Familjemedlemmar: Sambo

Q: Har du någon läsplatta i hemmet?

A: Ja, jag har en IPad 2.

Q: Använder du den för jobb eller privat?

A: Mest för utbildningen, men även privat för att surfa.

Q: Använder du den när du reser någonting?

A: Ibland, när jag till exempel åker tåg långt.

Q: Har den tillgång till internet utan WIFI?

A: Nej den har inget SIM-kort.

Q: När du väl har med dig den när du är iväg och reser, skiljer sig användandet från det normala då?

A: Ja när jag har med den så använder jag den istället för datorn, och hemma är det mer om jag vill kolla upp något snabbt så tar jag den istället för att starta min dator.

Q: Om din iPad skulle sitta i en hållare i bilen, vilka knappar och utgångar skulle du vilja ha tillgång till?

A: Ljudknapparna är ju viktigt, eller egentligen samtliga knappar behövs. Hörlurar är också viktigt, men jag vet inte om man skulle behöva laddaren. Jag brukar inte behöva ladda den när jag är iväg i alla fall.

Q: Vad är viktigast tror du: Ställa in plattan en gång för DIN läsplatta och sen fungerar det smidigare att sätta i och ta ur den eller tycker du det är bättre att ha en lösning som är enkel att ställa in för olika storlekar och sedan lite svårare att ta ut eller in den.

A: Jag tänker mig om man skulle ha en större mobil/liten läsplatta och en vanlig IPad exempelvis skulle det ju varit bra att kunna skifta.

Q: När du använder läsplattan, är det ofta mer än bara du som tittar eller använder den samtidigt?

A: Nej jag skulle säga att den oftast är en själv bara, jag tror det är för att skärmen ändå är ganska liten så det blir rätt jobbigt att vara fler vilket är lite synd.

Q: Hur hade du velat kunna ändra utgångspositionen av skrivläget?

A: Jag funderar mest på hur ställ brukar se ut, men det kanske inte är det smidigaste. Men man vill väl antagligen flytta den till en skön position för en själv. Så vinkeln borde kunna gå att ställa och helst höjden. Man vill ju kunna ställa in den snabbt.

Q: Tänker du mycket på säkerheten när det kommer till bilar?

A: Nej, alldeles för lite! Jag har ju bälte men…

Q: Tänker du på var du placerar saker som är lösa i bilen?

A: Jag försöker ha tyngre grejer på golvet.

Q: Ja men det är ju bra! Om vi nu säger att det kommer en hållare för plattor i framtiden, vad är de viktigaste egenskaperna utöver det vi har varit inne på?

A: Hm, det måste vara stabilt så den inte hoppar upp och ner när man åker. Robust design kan man säga. Annars ska den ju vara på ett bra avstånd till personen som använder den.

Q: Vad tror du, om den uppfyller alla krav, att en sådan här produkt skulle kunna kosta?

A: Det är svårt, man hade nog behövt jämföra med konkurrenterna. Det beror nog väldigt mycket på det personliga behovet för mig, om jag exempelvis skulle bila i Europa så hade det ju varit värt att investera i. Kanske barnfamiljer som köper en ny bil för mycket pengar skulle kunna ge mycket för en sådan här produkt med. Kanske ett par tusen i alla fall.

Q: Tack för all information!

Kvinna 24 år, 164 cm
Familjemedlemmar: Sambo

Q: Har du någon läsplatta?

A: Ja, jag har en iPad AIR.

Q: Använder du den privat eller är det till jobb?

A: Det är både till min utbildning och till privat bruk.

Q: Har din läsplatta tillgång till internet när den inte har WIFI?

A: Nej det har den inte. Den har inte plats för SIM-kort.

Q: Använder du den när du reser, exempelvis åker bil eller tåg?

A: Ja det gör jag!

Q: Skiljer det sig från det vanliga användandet något?

A: Ja, då spelar man mer på den eller ser på film.

Q: Vilka uttag, knappar och annat skulle du vilja komma åt om den satt i en hållare. Alla knappar, hörlursuttaget och kanske laddning, men det är väl inte alltid jättenödvändigt. Högtalarna är ju bra om de är fria med. Framkameran är väl inte så viktig för min del. Helst inte om man inte har internet där man är.

Q: Vad är viktigast tror du: Ställa in plattan en gång för DIN läsplatta och sen fungerar det smidigare att sätta i och ta ur den eller tycker du det är bättre att ha en lösning som är enkel att ställa in för olika storlekar och sedan lite svårare att ta ut eller in den.

A: Den är nog bättre att det är lätt att ta ut och in samma, och sen kanske lite krångligare om man skulle byta platta.

Q: Är det ofta mer än du som använder eller tittar på iPaden samtidigt?

A: Nej det kan jag väl inte påstå.

Q: Hur skulle du vilja kunna ändra utgångspositionen av skrivläget?

A: Hmm, om det sitter där nere hade man velat ha någon form av någon slags spärr som släpper så man kan reglera den i längdriktning. Sen skulle det kanske vara bra om det gick att ändra höjd eller vinkeln på den så man har en bra synvinkel till den.

Q: Tänker du mycket på säkerheten när det kommer till bilar?

A: Ja

Q: Tänker du på var du lägger lösa föremål i bilen exempelvis?

A: Inte i första hand men om man ska åka långt så tänker man mer på sådant.

Q: Om du skulle köpa en sådan här pryl, vad skulle varit de främsta egenskaperna utöver det vi har pratat om?

A: Den ska smälta in normalt i bilen i stort. Det ska inte se konstigt ut när man inte använder den heller, då ska den helst synas så lite som möjligt. Den ska inte heller vara i vägen när man inte använder den.

Q: Vad skulle en sådan här hållare kunna kosta tror du. Om den uppfyller alla kraven?

A: Om jag skulle köpa en ny Volvo-bil som är en stor investering så tror jag man ändå skulle kunna lägga några tusen, säg ungefär som läsplattan. Jag tror det om den blir riktigt bra. Men smärtgränsen går nog vid 4 tusen.

Kvinna 51 år, 163 cm
Familjemedlemmar: Sambo, 2 döttrar

Q: Har ni någon eller några läsplattor inom familjen?

A: 2 stycken, en Samsung 10 tum och en mindre androidplatta som är 7 tum. Nexus 7 tror jag den heter.

Q: Vad använder ni plattorna till?

A: Det är ju mest att surfa privat.

Q: Har läsplattan tillgång till internet utanför WIFI-zoner?

A: Nej men vi kan ju koppla upp dem via telefonernas internet. Sen på hotell och sådant när vi reser så brukar de ju ha WIFI med så det är bra.

Q: Ja precis, om vi säger att plattan skulle sitta i en hållare med kanter runt, vilka uttag och knappar, m.m. skulle vara viktiga att komma åt?

A: Alla knappar, egentligen. Bakåtknappen som sitter framme på skärmen använder jag ju också mycket. Hörlurar är det man skulle använda till ljudet tycker jag nog. Men om man är två är det lite svårare. Fast då hade jag accepterat att man hade kopplat in det till bilens högtalare.

Q: Tittar ni ofta samtidigt på skärmen eller använder ni läsplattan var för sig?

A: Vi tittar rätt ofta tillsammans faktiskt. Både att kolla recept och surfa i allmänhet.

Q: Hur skulle du vilja kunna ändra utgångspositionen av skrivläget?

A: Jag hade ju velat ha den lite halvliggande så att säga. För jag är ju emot det att man ska kröka på nacken för mycket. Det är inte bra, det är viktigt att man inte sitter fel och man ska tänka på att man sitter ergonomiskt. Det är viktigt att kunna vinkla den upp och ned med andra ord. Det är nog bättre att den är lite för högt upp än att den är för lågt. Vissa appar, som när jag laddade ner sudoku, märkte jag att den behövde vara stående, så det är bra om man kan ändra mellan stående och liggande läsplatta på något sätt i hållaren så att man kan använda alla appar. Annars använder jag plattan mest liggandes så det skulle jag säga var utgångspositionen.

Q: Tänker du mycket på säkerhet när det kommer till bilar?

A: Ja.. Det är klart man gör. Normalt i alla fall. Men kanske mer när man hade yngre barn faktiskt!

Q: Tänker du på var du lägger lösa föremål i bilen?

A: Jo det gör man ju. Det är typiskt en sådan grej man blev mer uppmärksam över när man fick barn.

Q: Om du skulle köpa en sådan här pryl, vad skulle varit de främsta egenskaperna utöver det vi har pratat om?

A: Nu hör jag genast min sambos ord, ”det måste vara estetiskt”. Det får vara smäckert tycker jag, det får inte vara någon ful grej som sticker ut någonstans i en ny och fin bil. Då hade man inte skaffat den. Den ska inte exponera uppmärksamhet när den inte används utan då får den smälta in. Om man har yngre barn är hållbarheten vitalt. Den måste ju sitta fast ordentligt, de är ofta hårdhänta av sig naturligt trots sin storlek.

Q: Estetiskt och robust är det viktigaste med andra ord?

A: Ja, det tycker jag!

Q: Vad tror du att en sådan här skulle kunna kosta när vill ha en hållare för sin nya Volvo-bil?

A: Jag tänker mig att hållaren vi har i köket kostar en tusenlapp. Så runt där, beroende på funktioner och så. Att köpa en hållare för 199 kr till bilen är inget jag skulle gjort i alla fall, utan jag hade hellre köpt en som uppfyllde alla kraven och med det kostade mer.

Q: Tack för din tid och för all bra information!

Kvinna 18 år, 155 cm
Q: Har ni någon läsplatta inom hushållet?

A: Ja det har vi, en iPad 3.

Q: Vilken/vilka använder den och till vad?

A: Det är pappas egentligen men jag lånar den ganska mycket. Pappa använder den ibland när han surfar hemma men mest när vi är iväg och reser. Han tittar på nyheter och läser om aktier. När jag lånar den använder jag den till att surfa, chatta och se på film.

Q: Okej, har läsplattan tillgång till internet när ni är ute och reser.

A: Ja, man kan ju dela från telefonen så om det är täckning så har man ju alltid internet.

Q: Använder du den på resande fot, t.ex. i bilen och vad använder du den till då i så fall?

A: Jag skulle säga att filmtittande är vanligast när jag åker längre i bilen. Då lånar jag den, men ska vi åka till stan bara så har jag inte läsplattan utan bara mobilen. Men när vi reser ser jag mycket på film för det är tråkigt att åka bil och flyg.

Q: Jag håller med. Så du sade att du ibland använder den i bilen. Är det ofta mer än du som tittar på läsplattan på samma gång?

A: Nej! Det får de inte göra om jag surfar. Kanske om jag tittar på film men troligen inte då heller.

Q: Om hållaren skulle ha två utgångspositioner, ett surfläge och ett filmläge. Hur skulle du vilja ändra på utgångspositionen av surfläget för att maximera användarupplevelsen?

A: Den ska ju kunna gå att vinkla så man ser bra (upp och ner). Sen ska den ju kunna ligga ner och stå upp för t.ex. Instagram går ju inte att ha appen liggandes. Om man ska ta kort så är det ju också bra om den står upp. Det är också jobbigt om solen speglar på glaset har jag märkt. Men det kanske är svårt att lösa. Men någon slags grej så inte glaset speglar sig så mycket hade ju varit jättebra.

Q: Okej, jättebra! Är det några andra egenskaper du tycker en sådan här hållare för läsplattor borde ha?

A: Nja, den borde väl vara snygg helst. Men ändå vara i samma stil som resten av bilen.

Q: Hur mycket skulle du tycka en hållare som uppfyller alla dessa krav att kosta?

A: Det får du fråga min pappa, jag tror det hade varit han som hade betalat den. Men om man skulle köpa en Volvo som är ganska dyr så är det nog 3-4 tusen. Det skulle nog inte skrämt iväg de som har behov för en sådan här produkt.

Q: Tack för du tog dig tid.

A: Varsegod!

Gruppintervju
Barnen som var med: Pojke 9 år, Tjej 12 år, Tjej 13 år. De kommer kallas P9, T12 respektive T13.

Ansvarig och frågeställare under fokusgruppen var Emil Söderquist (E).

E: Hur långa är ni?

A: P9: 132 cm, T12: 145 cm, T13: 150 cm

E: Vad har ni för läsplattor inom familjen?

A: Vi har en iPad 2 som vi delar på. Men sen har Mamma en också som vi ibland lånar och pappa har en iPad Air (Gen 5). Den lånar vi ibland med men han spelar på den massa själv.

E: Okej, brukar ni använda läsplattan i bilen när ni är på väg till tävlingar och andra resor?

T12: Ja det gör vi ju, eller så använder vi mobilen om det inte finns någon ledig. Men oftast har någon med en i alla fall.

E: Har ni internet på läsplattan när ni sitter i bilen då?

T13: Ja Pappa kan dela med sig internet från mobilen. P9: Ja vissa spel behöver internet för att fungera så då får han starta det.

E: Vad brukar ni göra när ni sitter i bilen?

T12: Vi håller på med mobilen eller läsplattan mest. Oftast spelar vi eller håller på med andra appar.T13: Det finns ju appar man kan göra roliga bilder på med hjälp av kameran. Det är ofta roligt när man åker långt att leka med. P9: Jag gillar att spela Clash of Clans mest, men då måste jag ha internet. T12: Ibland använder jag youtube för musikvideos men det är inte så mycket i bilen.

E: Används olika läsplattor i bilen?

Ja alla tre används ju men kanske inte samtidigt.

E: Har ni någon gång råkat ut för att batteriet har tagit slut i bilen?

P13: JA det har vi. Vi har en mobilladdare som fungerar till läsplattan med men den är ofta upptagen till pappas mobil. Och sladden är kort så vi kan inte använda den om vi sitter i baksätet och den ligger på laddning.

E: Okej, hur använder ni kameran när ni sitter i bilen och vad tar ni kort på?

P12: Oss själva haha. För att göra konstiga bilder med vissa appar. Man kan göra så att man ser tjock ut eller jättegammal. P9: Jag gör ibland sådana bilder på andra med.

E: Är det ofta mer än en person som använder läsplattan på samma gång? Tittar flera på skärmen samtidigt?

P9: Ja ibland, det beror på om vi bara spelar eller tar kort. T12: Ibland kanske men oftast håller vi på med mobilen som inte har en läsplatta haha.

Hur hade ni velat att hållaren skulle kunna ändras i position om den skulle sitta i bilen? (E visar med läsplattan hur den ungefär ska sitta i bilen och de förklarar hur de hade velat ändra den.

P9: Jag vill kunna svänga den om man kör bilspel så behöver man det.

P12: Svänga den för att kunna använda alla appar. Vissa har bara stående läge. Jag vill även kunna vinkla den upp och ner.

P13: Vinkla upp och ner så man ser bra. Kanske som P12 sa att man kan ställa den upp för att vissa appar inte fungerar liggandes.

E: Okej det var nog allt, tack så mycket för att ni tog er tid att snacka lite läsplattor med mig!

A: Ingen fara, det var kul.

Appendix E

Needs-metrics matrix

	Needs		Metric	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
				Headphone socket accessible	Buttons accessible	Sound distortion	Volume deviation	Wifi performance	Bluetooth performance	Charging accessible	Mic and front camera performance	Prevent reflections on screen	Optimal initial angle for average user	Optimal initial position for average user	Design coherent with VCC's interior design	Aesthetically appealing	Unit manufacturing cost	Tilt adjustment range	Minimum vibration while typing on the tablet	Instils safety	Time to mount and dismount tablet	Instils quality	Tablet flexibility range for the mount	Time to adjust mount for different tablet sizes
1	The mount	does not hide the tablet's buttons and headphone jack		•	•																			
2	The mount	is not covering the speaker				•	•																	
3	The mount	cannot disturb the Bluetooth- and WIFI-signal						•	•															
4	The mount	is able to charge the tablet								•														
5	The mount	is not covering the front camera and mic									•													
6	The mount	can attach and detach the tablet easily																			•			•
7	The mount	is flexible for different tablet models																					•	
8	The mount	can preferably enable more than one viewer to the tablet											•											
9	The mount	is tiltable										•						•						
10	The mount	is preferably preventing sun reflections to the screen										•												
11	The mount	is easy to adjust for different models of tablets																			•			•
12	The mount	is initially placed in an ergonomic position for its typical users											•	•										
13	The mount	is flexible for common types of tablet usage																•						
14	The mount	feels stable when the user is writing on the tablet																	•					
15	The mount	has a robust construction to handle usage from children																	•					
16	The mount	has an appealing design that fit Volvo cars													•	•						•		
17	The mount	is and feels safe																		•		•		
18	The mount	is not in the way when the user is getting in or out of the car																		•				
19	The mount	is affordable for a Volvo-owner															•							

Needs-metrics matrix

Appendix F

Target specification

The complete Target specification

No.	Requirement	Importance	Target value	Units	From
1	**Legal requirements**				
1.1	Not conflict with any material restrictions or regulations	*		Binary	Laws
1.2	Minimum radii a head can hit during crash	*	5	mm	Laws
1.3	Minimum radii for components for the mount and tablet	*	2.5	mm	Laws
1.4	Maximum head deacceleration for a head during crash	*	120	g	Laws
1.5	Maximum head deacceleration for longer than 3 ms for a head during crash	*	80	g	Laws
1.6	No local deformations that might be harmful for occupants are allowed after a crash	*		Binary	Laws
1.7	Holds the tablet securely locked in the mount during a crash	*		Binary	Laws, VCC
1.8	No exposed sharp edges during or after a crash	*		Binary	Laws
1.9	All accessories shall remain attached during and after impact	*		Binary	Laws
1.10	Head Injury Criteria (d)	*	1000	HIC	Laws
2	**Volvo Cars Corporation requirements**				
2.1	Usable for a wide variety of commercial tablets	**		%	VCC
2.2	Feels and looks like a Volvo product	**		Subjective	VCC
2.3	Has a premium handling	**		Subjective	VCC
2.4	Has a premium appearance	**		Subjective	VCC
2.5	Not damaged in any way during normal handling	**		Binary	VCC
2.6	Has a linear, soft, muffled damped and non-chafing motions	4		Subjective	VCC
2.7	Consistent forces over the operation	3		N	VCC
2.8	Fits VCC's interface	**		Binary	VCC
2.9	Withstands VCC's standard tests	**		Binary	VCC, Interviews
2.10	Resistant to common chemicals and substances that are regularly used in the car	**		Binary	VCC
2.11	No corrosion	**		Ocular	VCC
2.12	Does not loose functionality over time	**		Binary	VCC
2.13	No unwanted sounds during normal operation	**		Aural	VCC

No.	Requirement	Importance	Target value	Units	From
3	**User requirements**				
3.1	Headphone socket accessible	5		Binary	Interviews, VCC
3.2	Buttons accessible	5		Binary	Interviews, VCC
3.3	Sound distortion	2		Subjective	Interviews
3.4	Volume deviation	2		dB	Interviews
3.5	Wifi performance	4		%	Interviews
3.6	Bluetooth performance	4		%	Interviews
3.7	Charging accessible	4		Binary	Interviews, VCC
3.8	Mic and front camera performance	2		Subjective	Interviews
3.9	Prevent reflections on screen	2		Subjective	Interviews, VCC
3.10	Optimal initial angle for average user	3	57	Degrees	Interviews, Observation
3.11	Optimal initial position for average user	3	300	mm	Interviews, Observation
3.12	Design coherent with VCC's interior design	4		Subjective	Interviews, VCC brand identity
3.13	Aesthetically appealing	4		Subjective	Interviews, Project Group
3.14	Unit manufacturing cost	5	< 1000	SEK	Interviews, Project Group
3.15	Tilt adjustment range	4	± 30	Degrees	Interviews, Observation
3.16	Minimum vibration while typing on the tablet	4		Subjective	Interviews
3.17	Instils safety	4		Subjective	Interviews, VCC brand identity
3.18	Time to mount and dismount tablet	4	2-8	s	Interviews, VCC, Project Group
3.19	Instils quality	4		Subjective	Interviews, Project Group
3.20	Tablet flexibility range for the mount	4	Height: 180-280 Width: 110-190	mm	Market study
3.21	Time to adjust mount for different tablet sizes	3		s	Interviews

No.	Requirement	Importance	Target value	Units	From
4	**Design requirements**				
4.1	Holds as high quality as the rest of the car's interior	5		Binary	VCC Brand Identity
4.2	Intuitive to use	3		Subjective	VCC Brand Identity
4.3	Functionally robust	5		%	Project Group
4.4	Aesthetically robust	4		%	Project Group
4.5	Uses standard components	3***		%	Project Group
4.6	Designed to allow for variance in production	4***		%	Project Group
4.7	Does not have negative effects on the driver	5		Binary	Project Group
4.8	Has as few components as possible	4		Number	Project Group
4.9	Has as simple shapes as possible	2		Subjective	Project Group
4.10	Has a simple product architecture	2		Subjective	Project Group
4.11	Contains as few different materials as possible	2***		Number	Project Group
4.12	Easy to assemble	2		s	Project Group
4.13	No hazardous contamination during the life cycle	5***		g/m^2/year	Project group, VCC
4.14	Made from materials and manufacturing processes with low enviromental impact	4***		ELU	Project group, VCC
4.15	Low enviromental impact after product life	2***		%	Project group, VCC
4.16	Recyclable	2***		%	Project group, VCC
5	**Strength requirements**				
5.1	Withstand a force to the side without any plastic deformations	****	443	N	Project group, Interview
5.2	Withstand a force in the direction of the arm without any plastic deformations	****	160	N	Project Group
5.3	Withstand a force in direction xxx without any plastic deformations	****	*****	N	Project Group

* Laws and regulations have to be met and are not graded in importance
** Requirements from VCC that have to be fulfilled
*** Requirements for detailed construction (irrelevant for early concept evaluation)
**** Requirements from the Project Group
***** Cannot be explained due to confidentiality reasons

Appendix G

Morphological matrix

The morphological matrix with the six functions

Connection to interface	Attachment	Flexibility
Velcro	Band	Elastic
Non-permanent glue	Flexible arms	Springs in structure
Nothing	Non-permanent glue	Deformable
Magnet	Clamping supports	Threaded rods
Snap function	Clamps	Separate, built-in solutions for different sizes
Suction cup	Cushion	Nothing
Screwed	Magnets	Module-based
Glue + solvent	Glue + solvent	Different attachment locations
Rigid	Case	Adjustable band
Clamp	Slot	Automatic roll
Straps	Suction cup	Manual roll
	Resting supports	Rail system
	Clamping frame	Slideable in track
		Track with springs
		Telescopic inwards
		Telescopic in tablet's plane with springs
		Telescopic in tablet's plane with gears
		Telescopic in tablet's plane with, manual
		Telescopic along rigid structure
		Rotatable parts in tablet's plane
		Attached to frame

Mount/Dismount	Cover edges	Allow access to buttons & sockets
Direct lever	Hashtag	Bend away
IKEA-lock	Straps along the edges	Zippers along the sides
Fitting	Pulls away the mount	Does not cover sides, only corners
Button, pushable	Vacuum cleaner function in neck	Holes adapted to common tablets
Button, sliding	Accordion frame	Holes with slidable partitions
Button, pullable	Elastic frame	Nothing
Ski boot function	Rigid frame in front of tablet	Bend away or push through
Rotary control	Rigid frame in tablet's plane	Awesome viscoelastic material
Rotary control with lever	Helmet	Modular with holes
Rotary control with button	Edge protection tape	Slidable windows
Force	Thick, short arms	User punches holes
Ski binding	Airbag	Large holes along the sides
	LL	Separable structure
	Air pulse	VHS-hatches
	Long arms along the edges	Hatches opening outwards
	Modular frame	Adjustment of structure
	Modular case	
	Several point coverage	
	Many short arms	
	Headbands attached to seat	
	Frame module	
	Screen in front of tablet	
	Telescopic arms-frame	
	Tilts the tablet 180 degrees at crash	
	Cover edges when crash-function	
	Intercept head when crash	
	Stretched frame	
	Structure extends along the sides	

Appendix H

Removed concepts in initial screening

H.1 Deformable frames

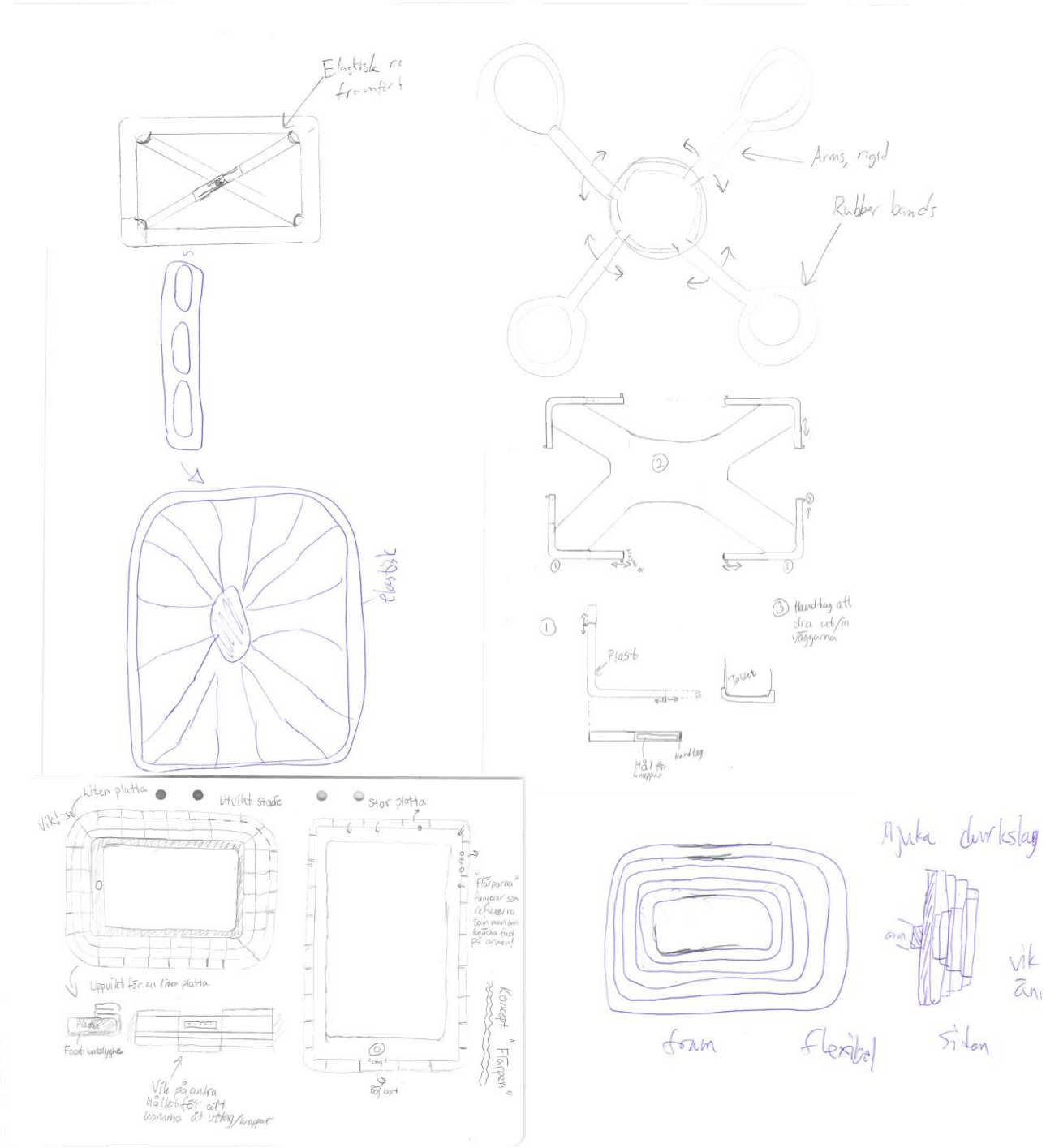


Figure 1- Removed deformable concepts in the initial screening

H.2 Flexible frames rejected in initial evaluation

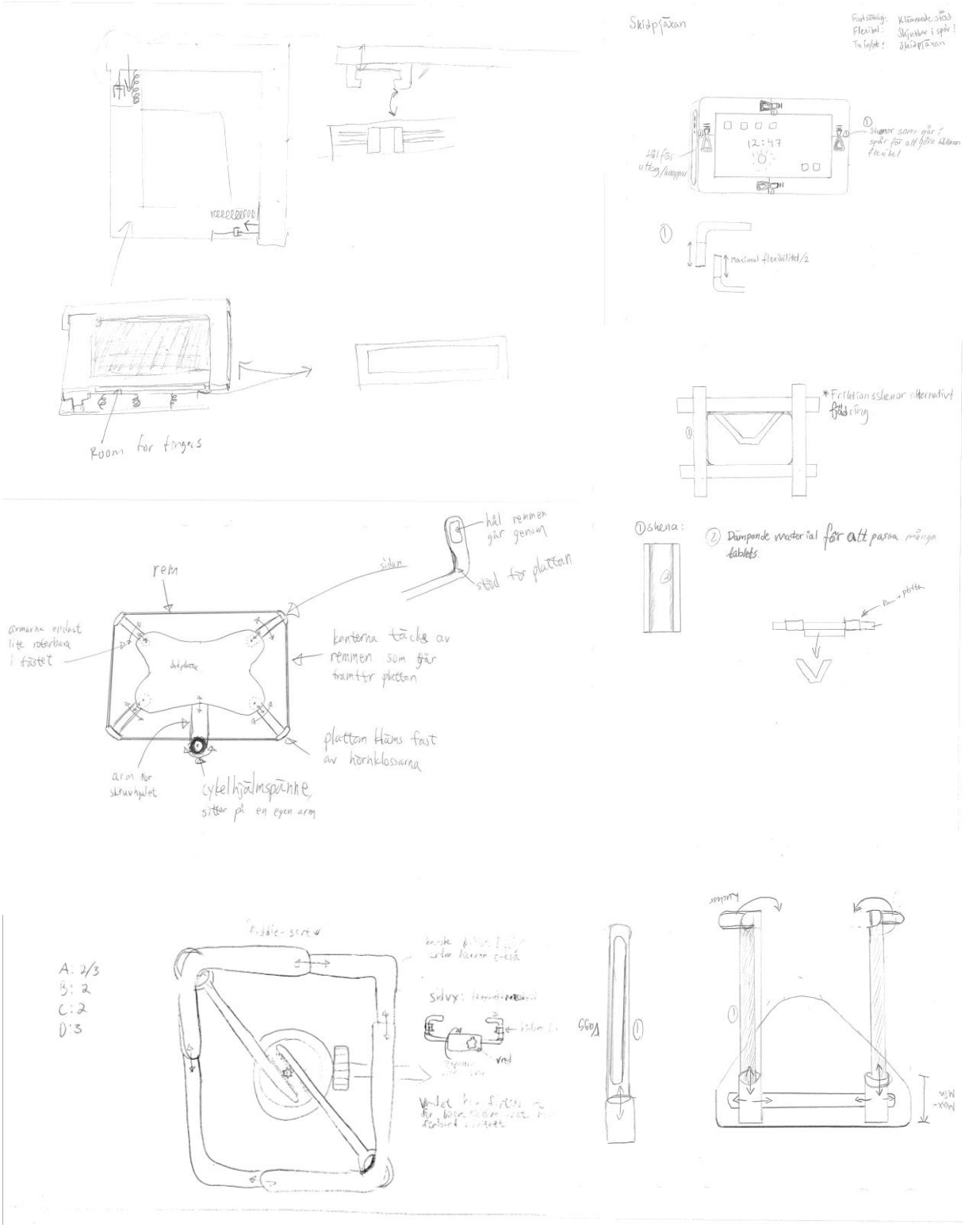
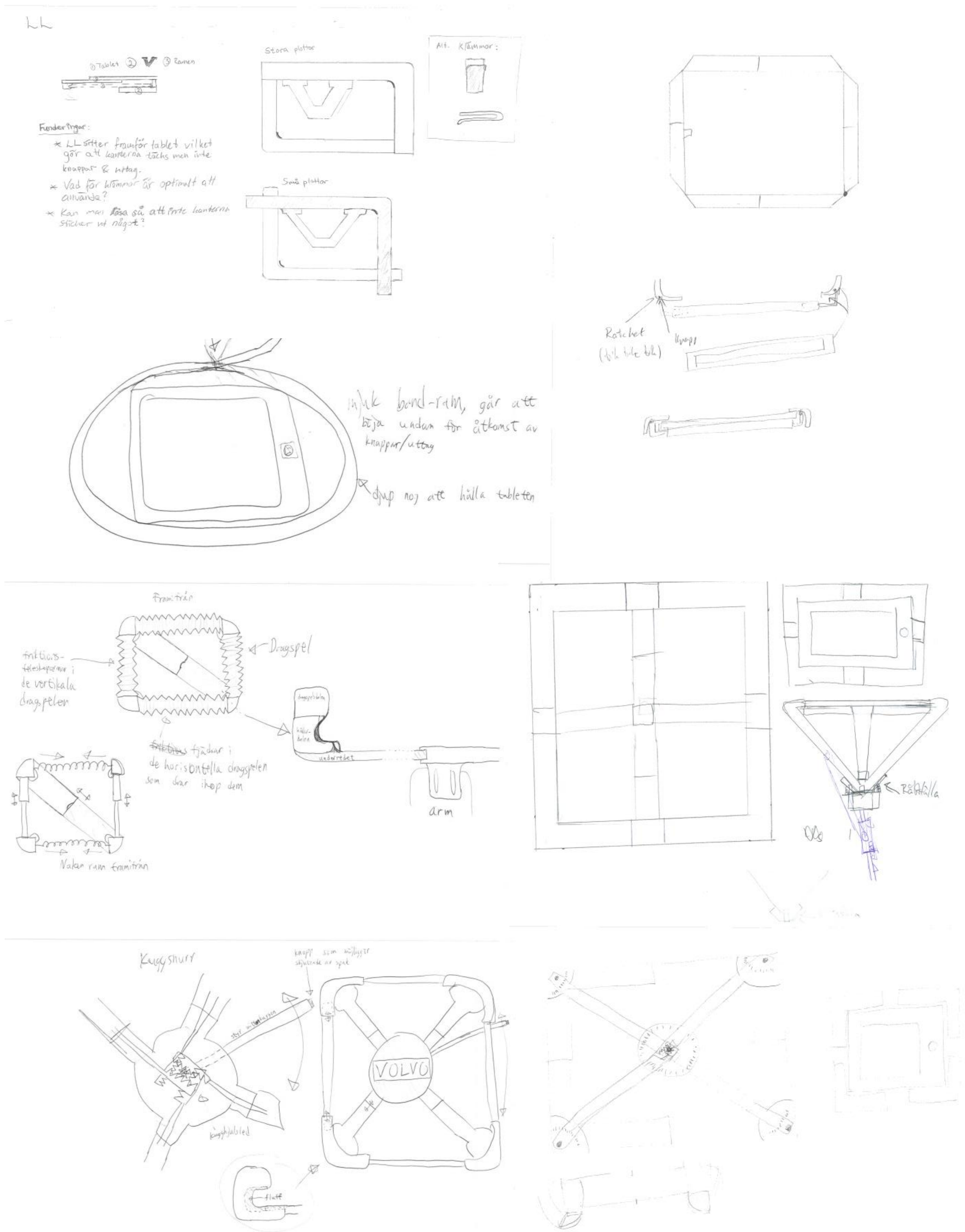
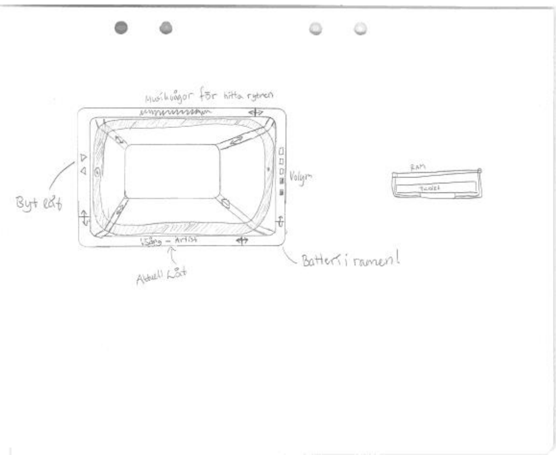
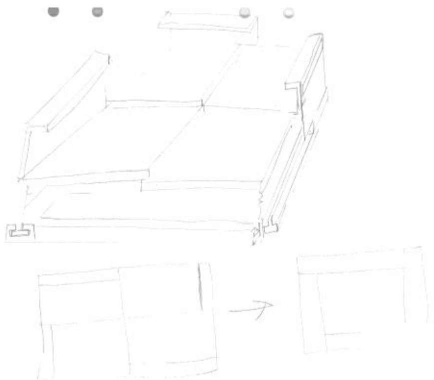


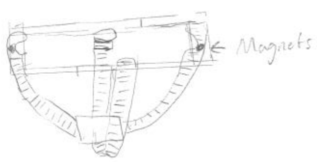
Figure 2- Removed flexible frames in the initial screening

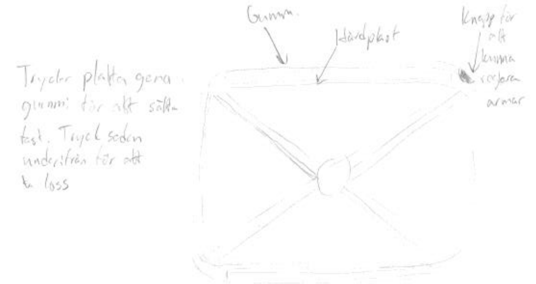


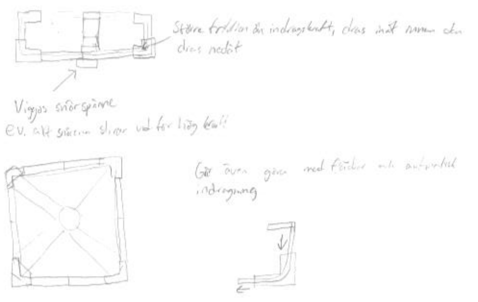
Tablet
Ramen
Funderingar:
* LL sitter framför tablet vilket gör att kanterna täcks men inte knappar & uttag.
* Vad för klämmor är optimalt att använda?
* Kan man lösa så att inte kanterna sticker ut något?
Stora plattor
Alt. klämmor:
Små plattor
mjuk band-ram, går att böja undan för åtkomst av knappar/uttag
djup nog att hålla tabletten
Rotchet
Framifrån
Dragspel
de vertikala dragspelen
de horisontella dragspelen som drar ihop dem
arm
Naken ram framifrån
Kuggsnurr
VOLVO
kugghjulsled

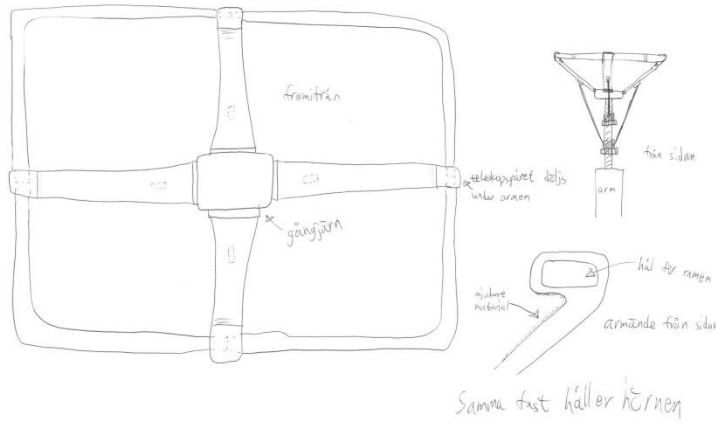

Musikvågor för hitta rytmen
Byt låt
Volym
Sång – Artist
Aktuell Låt
Batteri i ramen!




Magnets


Hårdplast




framifrån
gångjärn
under armen
från sidan
arm
hål för ramen
armände från sidan
Samma fäst håller hörnen

H.3 Point attachment mounts

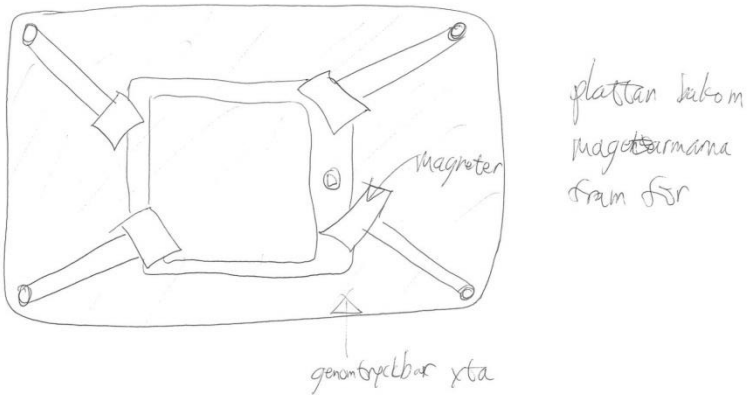


Figure 3- Removed point attachment mount in the initial screening

H.4 Fixed frames

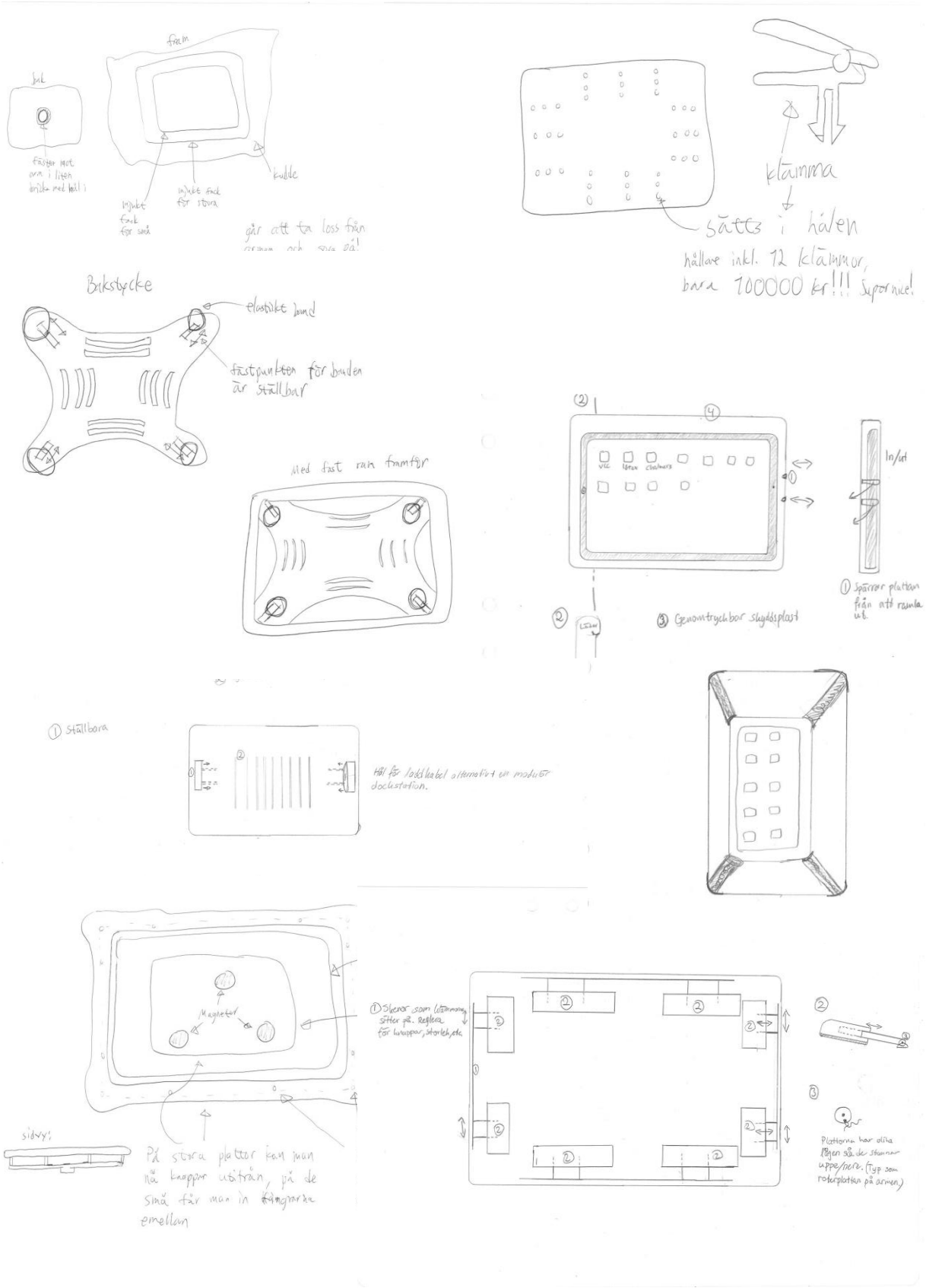


Figure 4- Rejected fixed frames in the initial evaluation

H.5 Back fastening

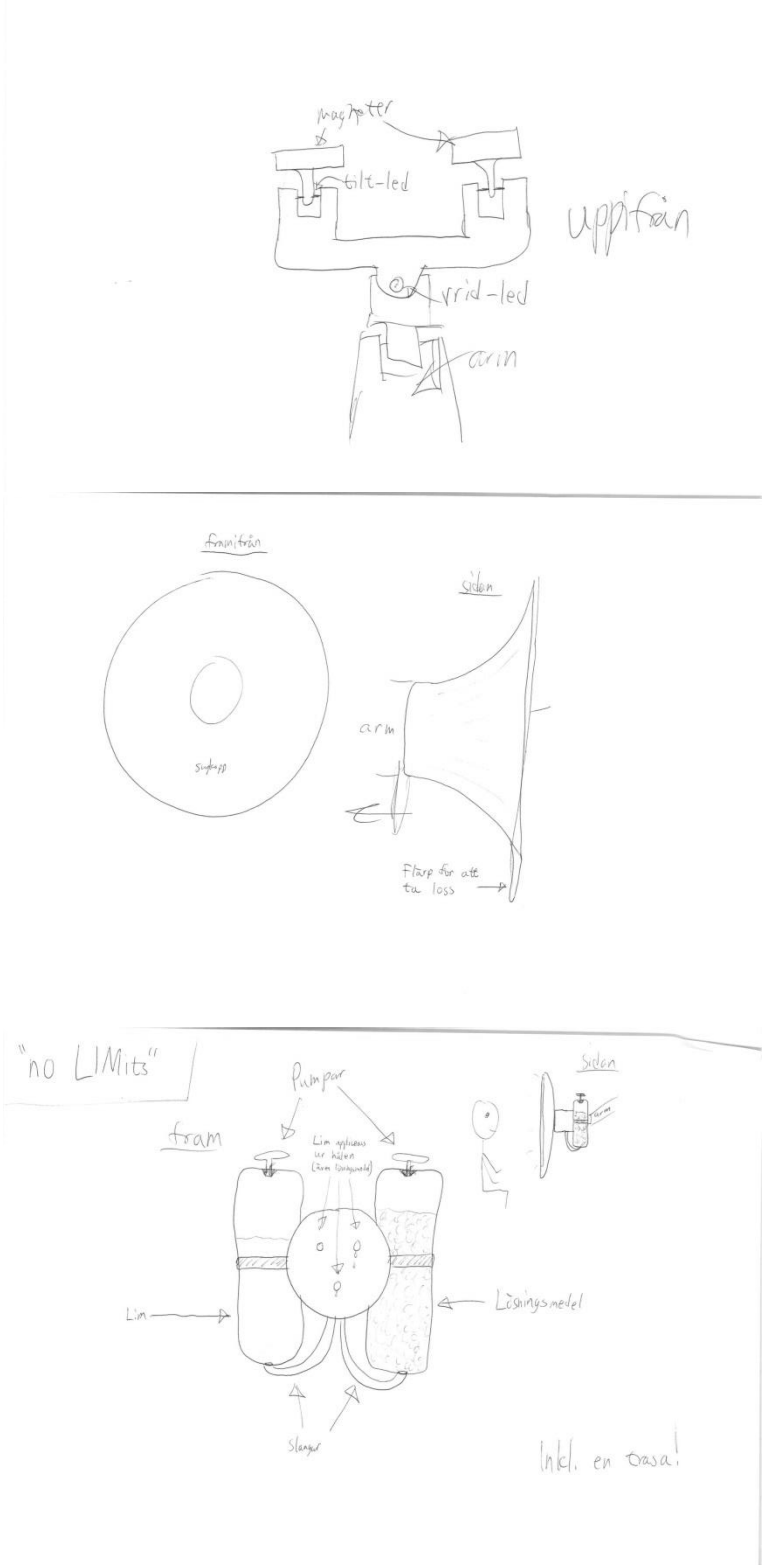


Figure 5- Rejected fixed frames in the initial evaluation

H.6 Semi-flexible frames

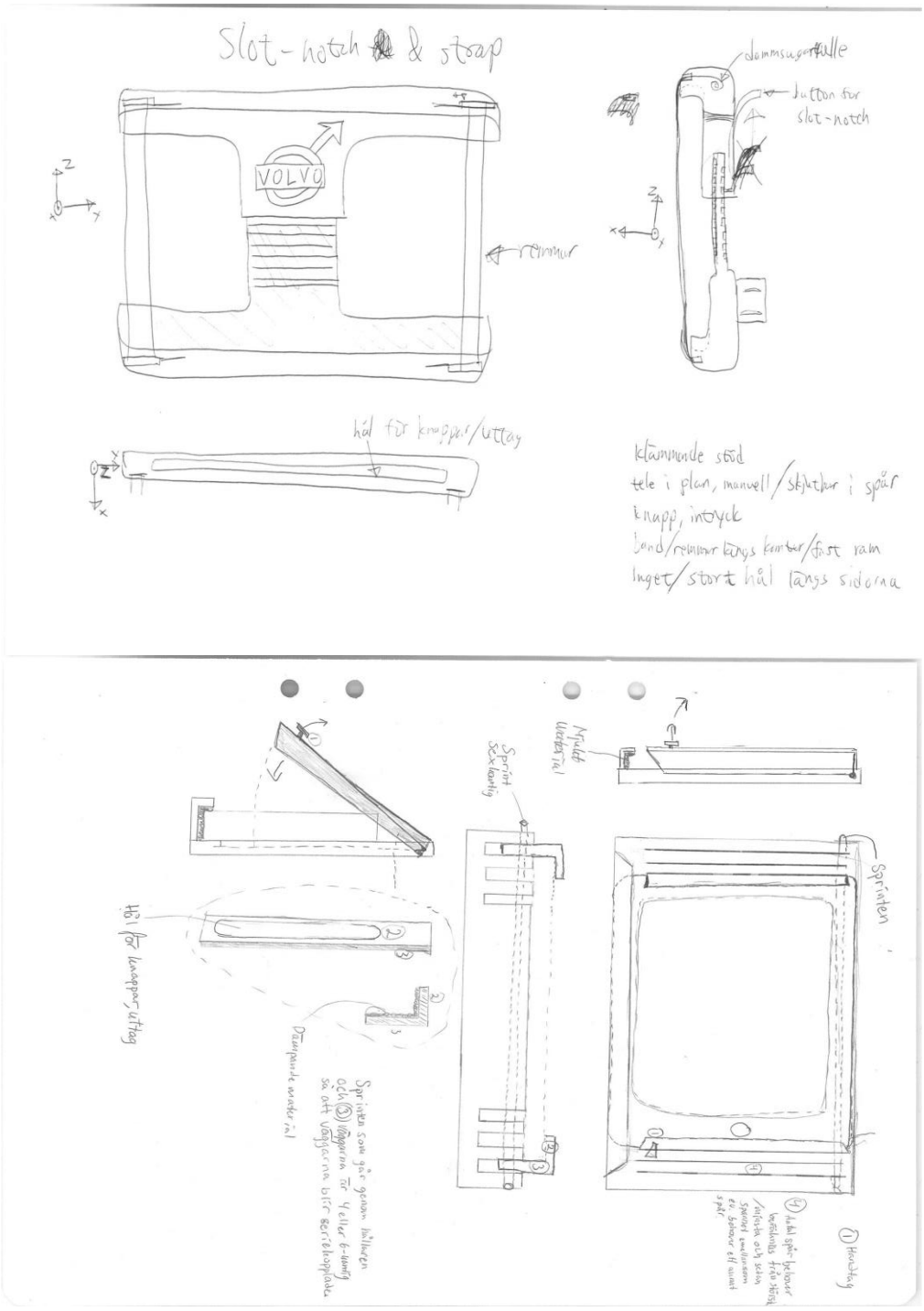


Figure 6- Semi-flexible frames rejected in the initial screening

Appendix I

Evaluation Matrices

I.1 Screening matrix

No.	Requirement	Judgement criterias	Covered requirements
1	Crash safety	Coverage of edges, secure holding, unsafe deformations, protrusion	1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 3.29
2	Aesthetically appealing	Coherent with Volvo's design, instills quality/safety, good looking	2.2, 2.3, 2.4, 3.12, 3.18, 3.17, 3.19, 4.1, 4.4
3	Ease of use and flexibility	Intuitiveness, time, simplicity in use, range of flexibility	2.1, 3.18, 3.21, 3.20, 4.2, 4.3
4	Physical robustness	Strength, fastening strength, structural stability, stability in usage	2.5, 2.6, 2.7, 2.12, 3.16, 4.3, 5.1, 5.2, 5.3
5	Simplicity	Number of parts, complexity of connections	3.14, 4.5, 4.8, 4.9, 4.10, 4.11, 4.12
6	Accessability for buttons & sockets	Charging, audio, volume buttons, on/off, home button, speakers	3.1-3.8
			Sum+
			Sum0
			Sum-
			Net score
			Rank
			Continue?

FL13	FL1	FL2	FL3	FL4	FL5	FL6	FL7	FL8	FL9	FL10	FL11	FL12	FL14	FL15	FL16	FL17	FL18	FL19
0	0	-1	0	1	1	0	1	1	-1	-1	-1	1	1	1	0	0	0	1
0	-1	-1	1	-1	1	1	-1	-1	-1	-1	0	1	0	0	1	-1	0	-1
0	1	0	-1	1	0	1	0	1	1	0	0	0	1	1	1	1	1	1
0	-1	0	1	0	1	0	0	0	-1	0	-1	1	0	1	0	0	1	0
0	1	0	-1	-1	-1	-1	-1	1	0	1	1	-1	-1	-1	-1	-1	-1	0
0	1	0	0	1	-1	-1	1	-1	0	-1	1	-1	1	0	0	0	-1	0
	3	0	2	3	3	2	2	2	1	1	2	3	3	3	2	1	2	2
	1	4	2	1	1	2	2	2	2	2	2	1	2	2	3	3	2	3
	2	2	2	2	2	2	2	2	3	3	2	2	1	1	1	2	2	1
0	1	-2	0	1	1	0	0	1	-2	-2	0	1	2	2	1	-1	0	1
3	2	5	3	2	2	3	3	2	5	5	3	2	1	1	2	4	3	2
R + C2	R	N	N	C2	C3	C3	R	R	N	N	N	R	R	R	R	N	R	R

FL20	P1	P2	FA1	FA2	FA3	FA4	FA5	FA6	FA7	FA8	FA9	FA10	D1	D2	SE1	SE2	SE3	SE4
-1	-1	-1	1	0	0	-1	-1	-1	-1	-1	0	0	0	0	-1	-1	0	0
-1	-1	0	0	0	0	-1	0	-1	1	0	-1	-1	-1	0	1	0	-1	1
-1	-1	0	0	0	1	1	1	-1	1	-1	1	1	-1	-1	1	1	1	1
0	-1	0	1	1	1	1	1	0	1	1	1	0	-1	-1	1	1	0	1
1	-1	1	1	0	-1	1	1	1	1	1	1	1	1	1	1	0	0	0
1	0	1	-1	-1	-1	-1	-1	1	-1	0	0	-1	-1	1	-1	-1	-1	-1
2	0	2	3	1	2	3	3	2	4	2	3	2	1	2	4	2	1	3
1	1	3	2	4	2	0	1	1	0	2	2	2	1	2	0	2	3	2
3	5	1	1	1	2	3	2	3	2	2	1	2	4	2	2	2	2	1
-1	-5	1	2	0	0	0	1	-1	2	0	2	0	-3	0	2	0	-1	2
4	7	2	1	3	3	3	2	4	1	3	1	3	6	3	1	3	4	1
N	N	R	R	C1	C1	N	N	N	R	N	N	N	N	N	R	N	N	R

Screening matrix

I.2 First scoring matrix

Criteria	Judgement aspects	Weight	The ref	
Aesthetically appealing	Coherent with Volvo's design, instills quality/safety, good looking	**22,00%**	4	0,88
Ease of use and flexibility	Intuitiveness, time, simplicity in use, range of flexibility	**18,00%**	3	0,54
Physical robustness	Strength, fastening strength, structural stability, stability in usage	**26,00%**	3	0,78
Simplicity	Number of parts, complexity of connections	**13,00%**	4	0,52
Accessability for buttons & sockets	Charging, audio, volume buttons, on/off, home button, speakers	**21,00%**	5	1,05
			19	3,77
				2
		Continue?		Y

The cog		Colander		Baking tray		The croc		Sho-tisch		Side slot		PBR		The flag	
4	0,88	1	0,22	3	0,66	3	0,66	2	0,44	4	0,88	2	0,44	4	0,88
4	0,72	2	0,36	3	0,54	1	0,18	3	0,54	3	0,54	4	0,72	3	0,54
3	0,78	5	1,3	1	0,26	1	0,26	4	1,04	3	0,78	4	1,04	3	0,78
1	0,13	5	0,65	1	0,13	1	0,13	4	0,52	3	0,39	4	0,52	3	0,39
5	1,05	1	0,21	5	1,05	4	0,84	2	0,42	3	0,63	3	0,63	4	0,84
17	3,56	14	2,74	13	2,64	10	2,07	15	2,96	16	3,22	17	3,35	17	3,43
	3		14		15		16		11		8		7		6
	Y		N		N		N		N		Y		Y		Y

The clamp		The lever		Hashtag		Twister		Modular		Swatch		Spring-frame	
3	0,66	4	0,88	2	0,44	1	0,22	2	0,44	5	1,1	4	0,88
3	0,54	4	0,72	3	0,54	1	0,18	3	0,54	5	0,9	2	0,36
3	0,78	3	0,78	2	0,52	5	1,3	5	1,3	3	0,78	2	0,52
4	0,52	2	0,26	4	0,52	5	0,65	5	0,65	2	0,26	3	0,39
3	0,63	4	0,84	4	0,84	2	0,42	3	0,63	4	0,84	5	1,05
16	3,13	17	3,48	15	2,86	14	2,77	18	3,56	19	3,88	16	3,2
	10		5		12		13		4		1		9
	N		Y		N		N		Y		Y		N

First screening matrix

I.3 Second scoring matrix

Table 1- Second scoring evaluation matrix

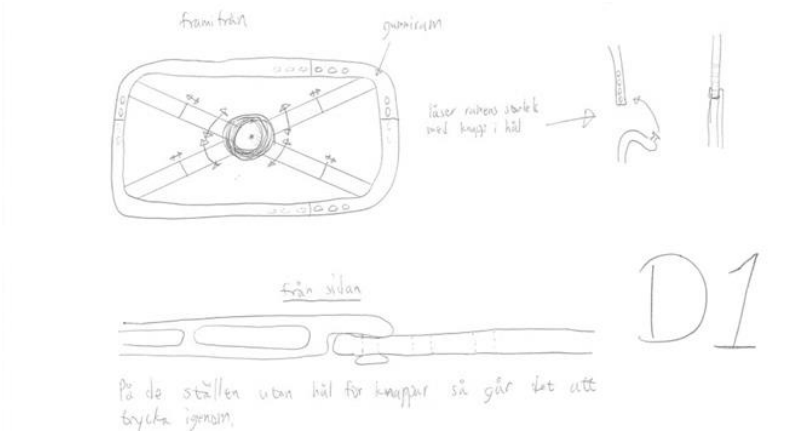
	Weight	Ref		Cog		Side slot		PBR	
Aesthetically appealing	**22,00%**	**14**	**0,755**	**16**	**0,865**	**11**	**0,605**	**8**	**0,44**
Instills quality	7,00%	3	0,21	3	0,21	2	0,14	3	0,21
Instills safety	4,00%	4	0,16	4	0,16	2	0,08	3	0,12
Design with tablet	5,50%	4	0,22	4	0,22	4	0,22	1	0,055
Design without tablet	5,50%	3	0,165	5	0,275	3	0,165	1	0,055
Ease of use and flexibility	**18,00%**	**11**	**0,477**	**13**	**0,576**	**13**	**0,603**	**11**	**0,504**
Time and simplicity to mount / dismount tablet	6,30%	2	0,126	3	0,189	4	0,252	3	0,189
Intuitiveness	1,80%	3	0,054	3	0,054	3	0,054	3	0,054
Range of flexibility	6,30%	3	0,189	3	0,189	3	0,189	3	0,189
Time and simplicity to adjust size between tablets	3,60%	3	0,108	4	0,144	3	0,108	2	0,072
Physical robustness	**26,00%**	**10**	**0,65**	**13**	**0,845**	**12**	**0,78**	**16**	**1,04**
Strength	5,20%	3	0,156	3	0,156	2	0,104	4	0,208
Fastening strength	6,50%	3	0,195	3	0,195	5	0,325	4	0,26
Structural stability	7,80%	3	0,234	3	0,234	2	0,156	4	0,312
Stability in usage	6,50%	1	0,065	4	0,26	3	0,195	4	0,26
Simplicity	**13,00%**	**14**	**0,4784**	**7**	**0,2561**	**10**	**0,3419**	**15**	**0,4758**
Number of parts	3,77%	3	0,1131	2	0,0754	3	0,1131	4	0,1508
Number of unique parts	4,42%	5	0,221	3	0,1326	3	0,1326	3	0,1326
Complexity of connections	2,86%	3	0,0858	1	0,0286	2	0,0572	4	0,1144
Has as simple shapes as possible	1,95%	3	0,0585	1	0,0195	2	0,039	4	0,078
Accessability for buttons and sockets	**21,00%**	**29**	**0,7623**	**28**	**0,7581**	**29**	**0,7623**	**28**	**0,7581**
Charging	2,94%	4	0,1176	4	0,1176	4	0,1176	4	0,1176
Audio jack	3,36%	4	0,1344	4	0,1344	4	0,1344	4	0,1344
Volume buttons	2,31%	4	0,0924	4	0,0924	4	0,0924	4	0,0924
On/off	4,20%	4	0,168	4	0,168	4	0,168	4	0,168
Home button	5,04%	3	0,1512	3	0,1512	3	0,1512	3	0,1512
Speakers	0,42%	4	0,0168	3	0,0126	4	0,0168	3	0,0126
Mic	1,68%	3	0,0504	3	0,0504	3	0,0504	3	0,0504
Front camera	1,05%	3	0,0315	3	0,0315	3	0,0315	3	0,0315
Score		78	3,1227	77	3,3002	75	3,0922	78	3,2179
Rank			7		4		8		5

	Weight	Flag		Lever		Modular		Swatch	
Aesthetically appealing	**22,00%**	**14**	**0,755**	**10**	**0,55**	**11**	**0,59**	**11**	**0,605**
Instills quality	7,00%	3	0,21	2	0,14	4	0,28	2	0,14
Instills safety	4,00%	4	0,16	2	0,08	5	0,2	2	0,08
Design with tablet	5,50%	3	0,165	4	0,22	1	0,055	5	0,275
Design without tablet	5,50%	4	0,22	2	0,11	1	0,055	2	0,11
Ease of use and flexibility	**18,00%**	**12**	**0,495**	**13**	**0,531**	**14**	**0,63**	**14**	**0,657**
Time and simplicity to mount / dismount tablet	6,30%	2	0,126	2	0,126	5	0,315	4	0,252
Intuitiveness	1,80%	4	0,072	4	0,072	5	0,09	2	0,036
Range of flexibility	6,30%	3	0,189	3	0,189	3	0,189	3	0,189
Time and simplicity to adjust size between tablets	3,60%	3	0,108	4	0,144	1	0,036	5	0,18
Physical robustness	**26,00%**	**13**	**0,845**	**15**	**0,975**	**17**	**1,105**	**14**	**0,91**
Strength	5,20%	3	0,156	3	0,156	5	0,26	3	0,156
Fastening strength	6,50%	5	0,325	5	0,325	2	0,13	4	0,26
Structural stability	7,80%	3	0,234	3	0,234	5	0,39	3	0,234
Stability in usage	6,50%	2	0,13	4	0,26	5	0,325	4	0,26
Simplicity	**13,00%**	**15**	**0,4914**	**6**	**0,2119**	**20**	**0,65**	**11**	**0,3679**
Number of parts	3,77%	4	0,1508	2	0,0754	5	0,1885	2	0,0754
Number of unique parts	4,42%	4	0,1768	2	0,0884	5	0,221	4	0,1768
Complexity of connections	2,86%	3	0,0858	1	0,0286	5	0,143	2	0,0572
Has as simple shapes as possible	1,95%	4	0,078	1	0,0195	5	0,0975	3	0,0585
Accessability for buttons and sockets	**21,00%**	**28**	**0,7581**	**32**	**0,861**	**19**	**0,4977**	**32**	**0,861**
Charging	2,94%	4	0,1176	4	0,1176	2	0,0588	4	0,1176
Audio jack	3,36%	4	0,1344	5	0,168	2	0,0672	5	0,168
Volume buttons	2,31%	4	0,0924	5	0,1155	2	0,0462	5	0,1155
On/off	4,20%	4	0,168	5	0,21	2	0,084	5	0,21
Home button	5,04%	3	0,1512	3	0,1512	3	0,1512	3	0,1512
Speakers	0,42%	3	0,0126	4	0,0168	2	0,0084	4	0,0168
Mic	1,68%	3	0,0504	3	0,0504	3	0,0504	3	0,0504
Front camera	1,05%	3	0,0315	3	0,0315	3	0,0315	3	0,0315
Score		82	3,3445	76	3,1289	81	3,4727	82	3,4009
Rank			3		6		1		2

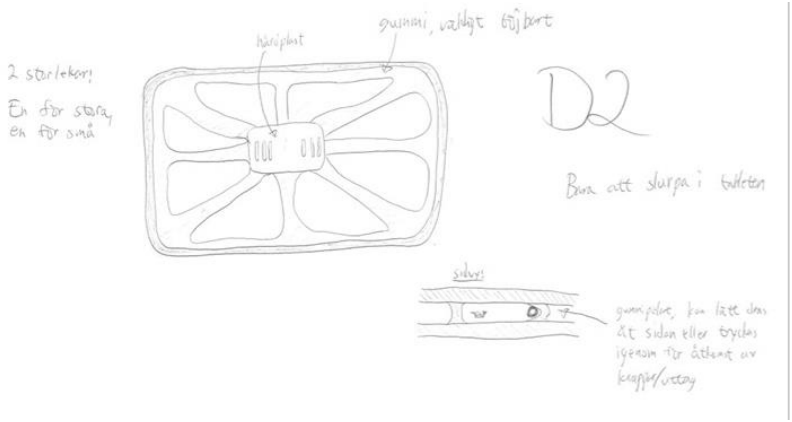
Appendix J

All concepts in the screening evaluation

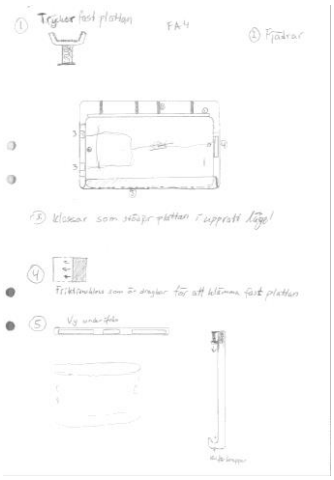
J.1 Concepts rejected in the screening matrix



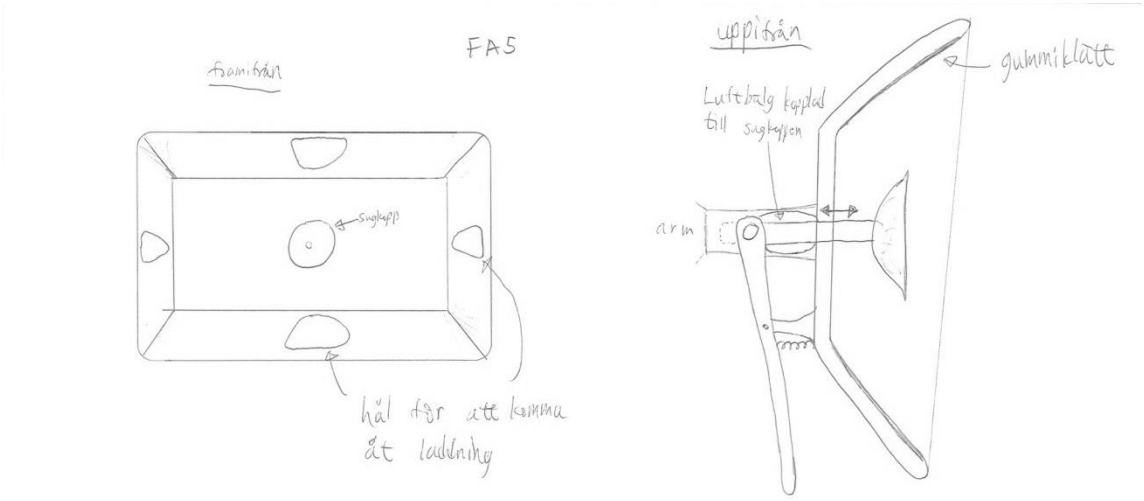
Concept D1



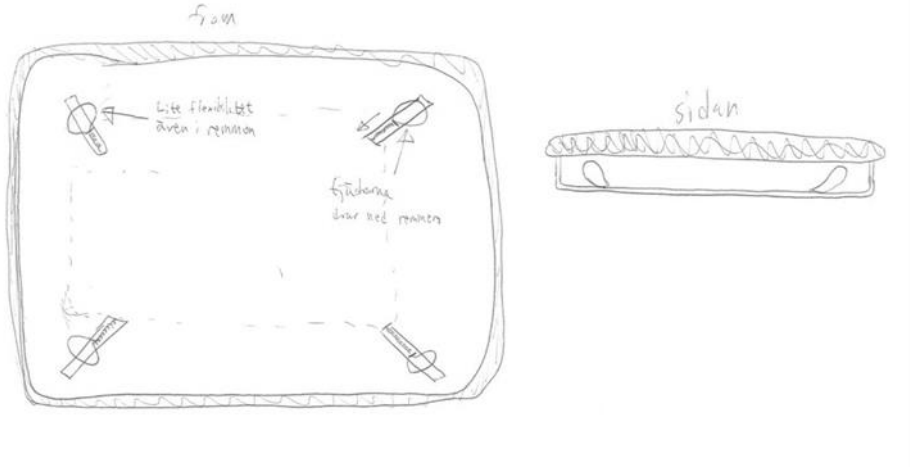
Concept D2



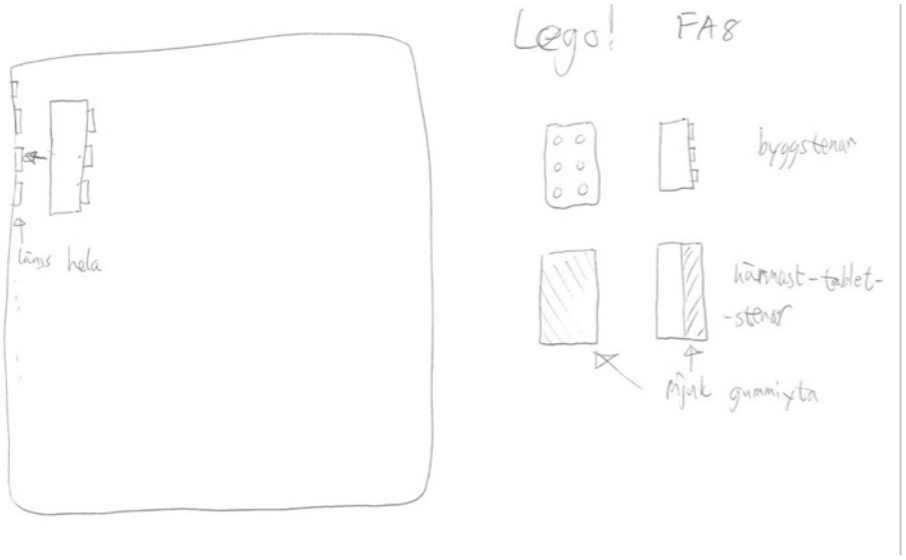
Concept FA4



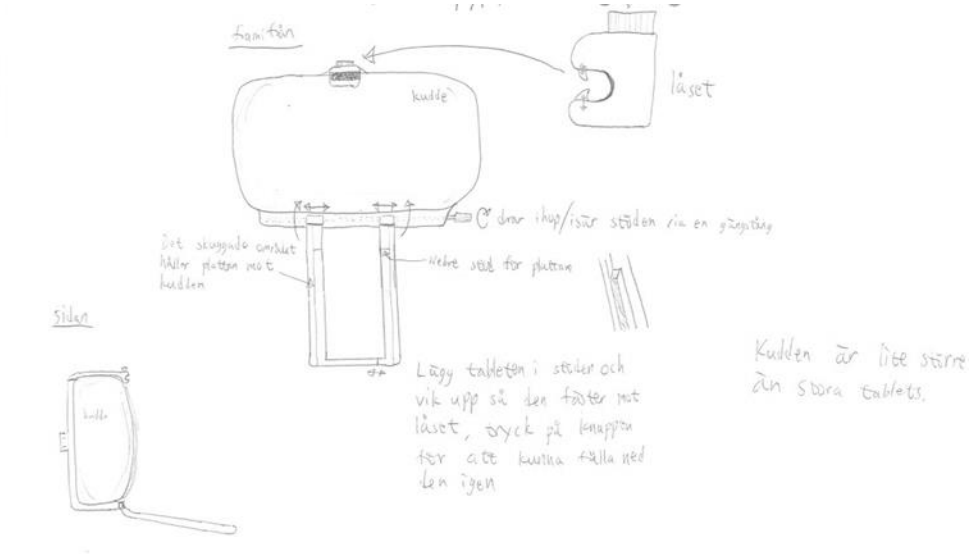
Concept FA5



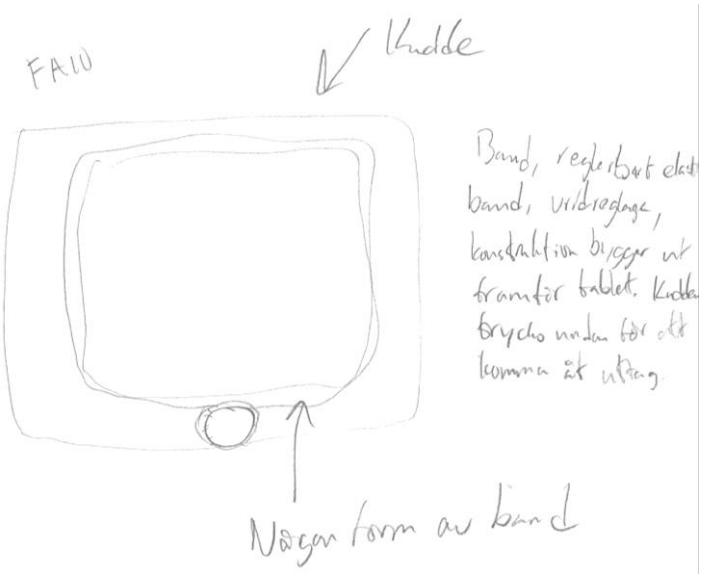
Concept FA6



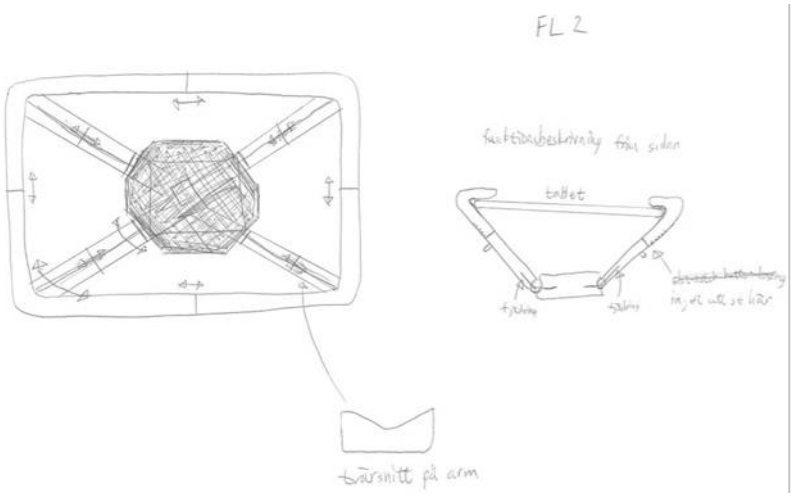
Concept FA8



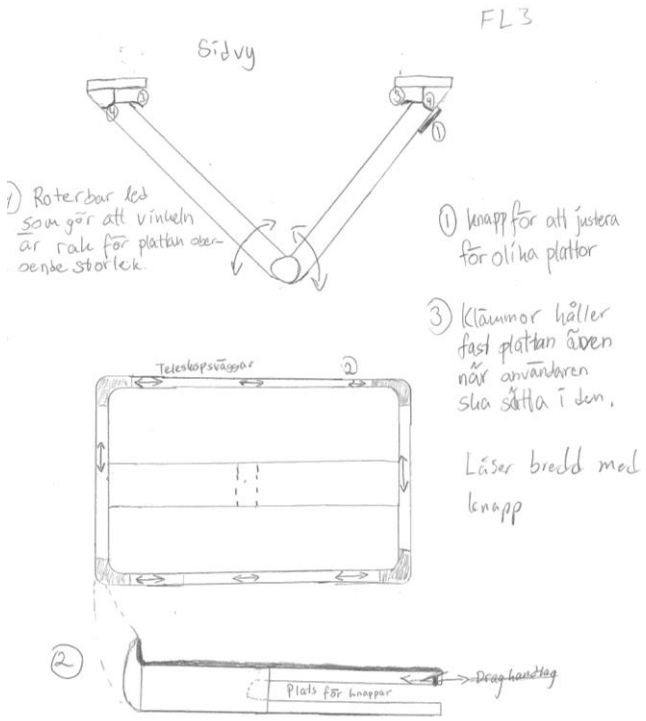
Concept FA9



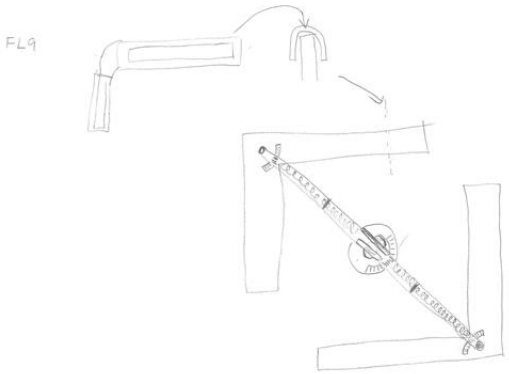
Concept FA10



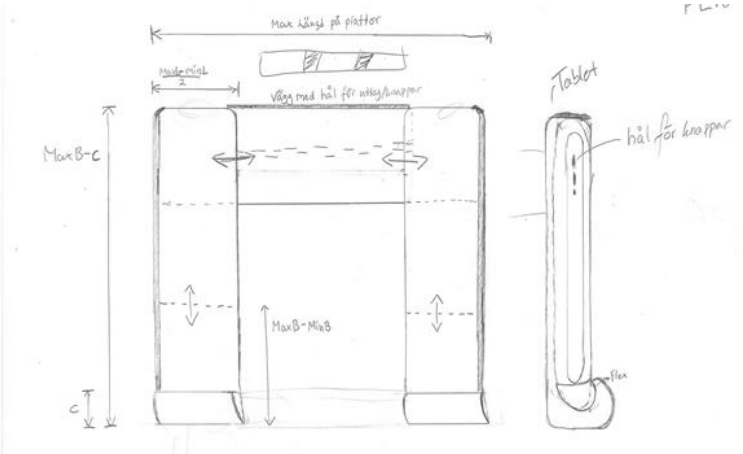
Concept FL2



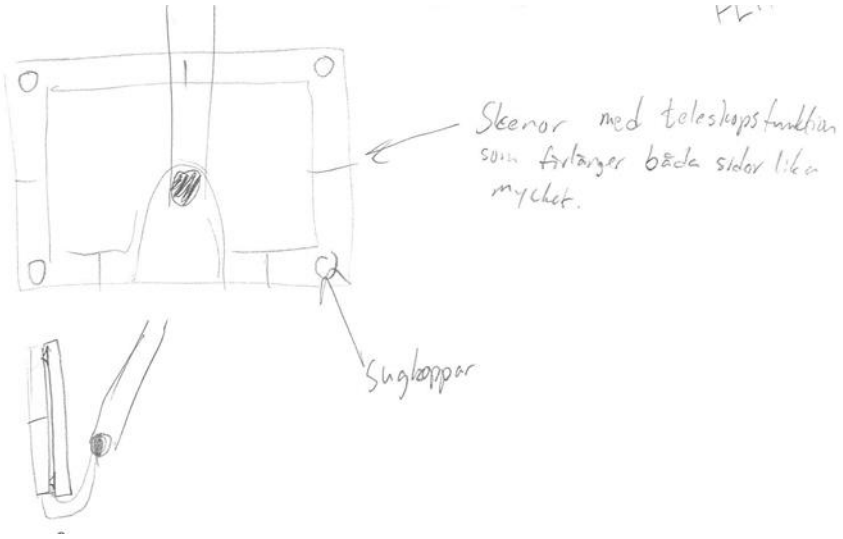
Concept FL3



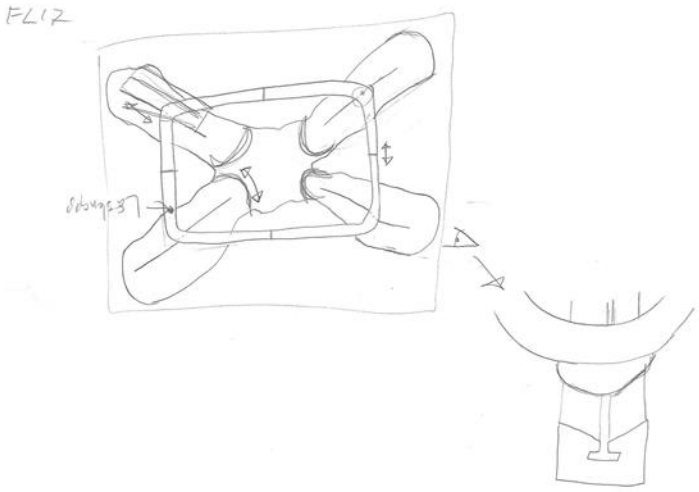
Concept FL9



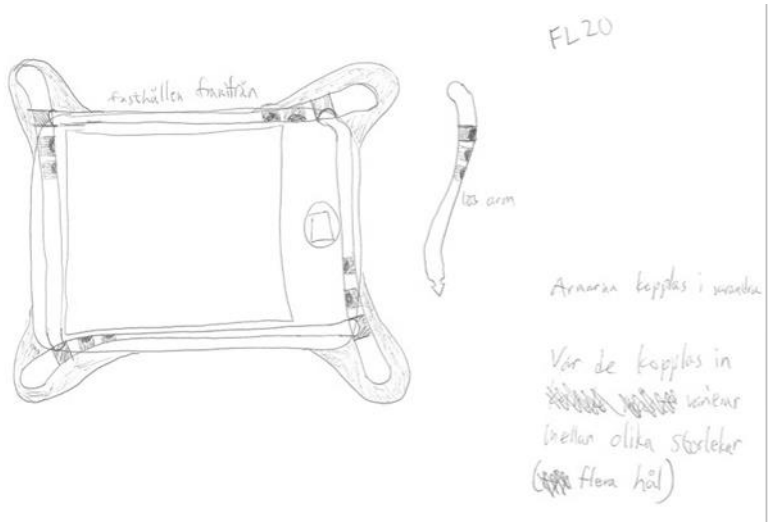
Concept FL10



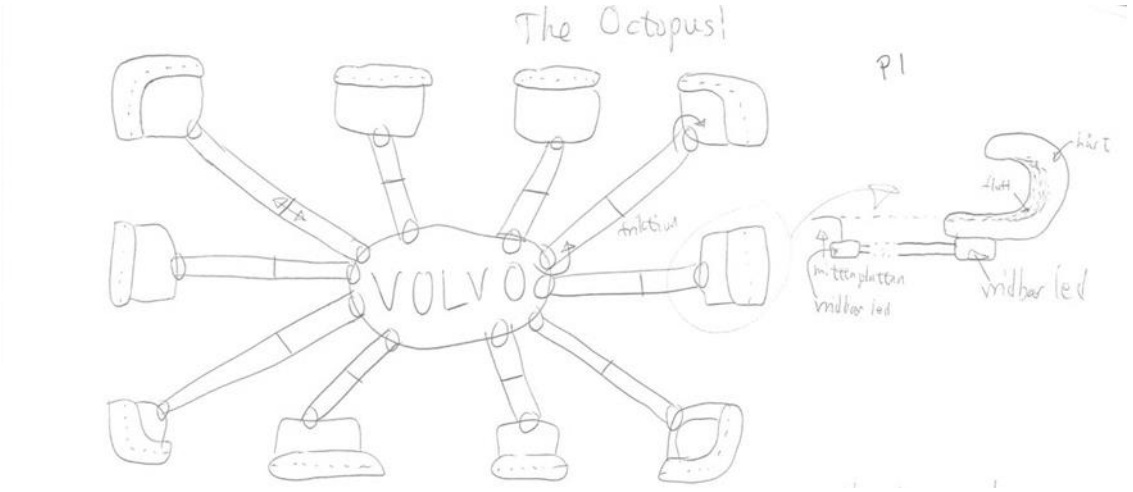
Concept FL11



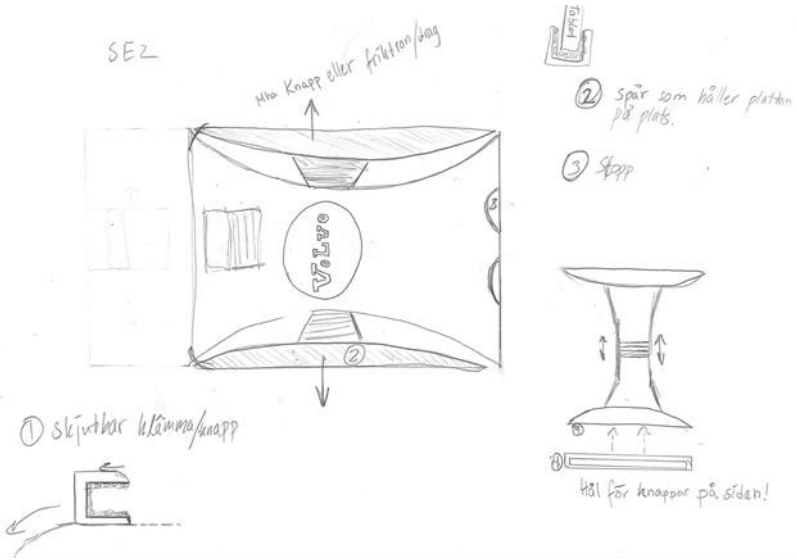
Concept FL17



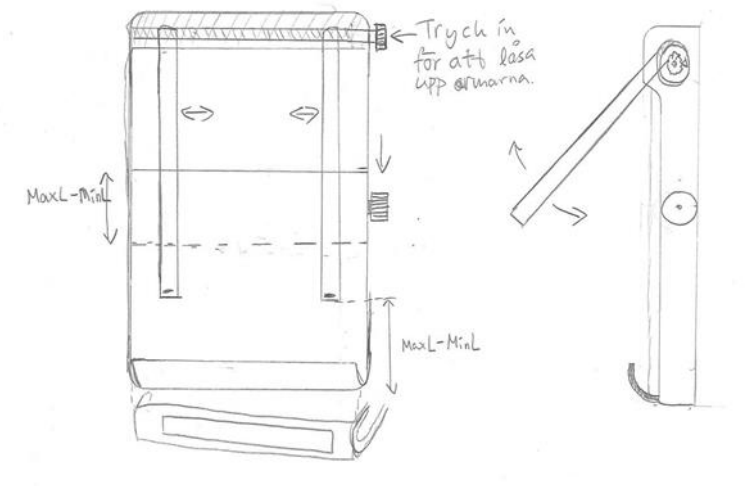
Concept FL20



Concept P1

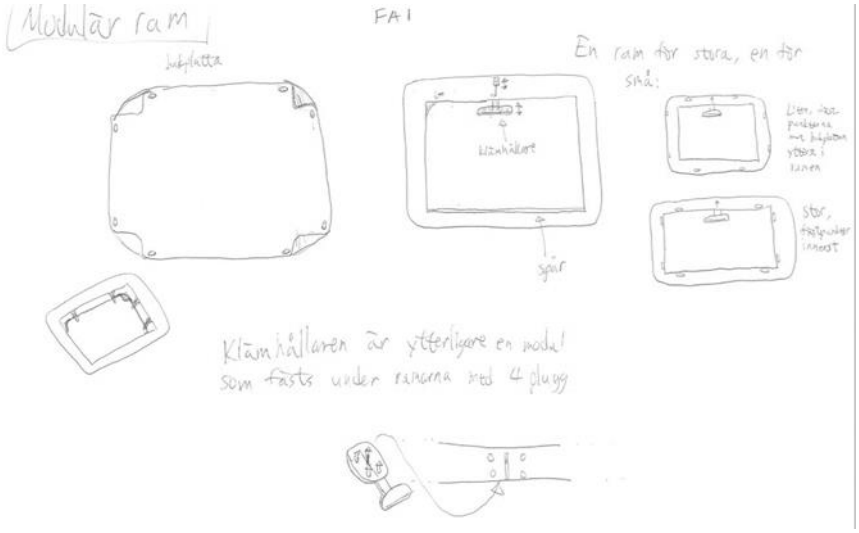


Concept SE2

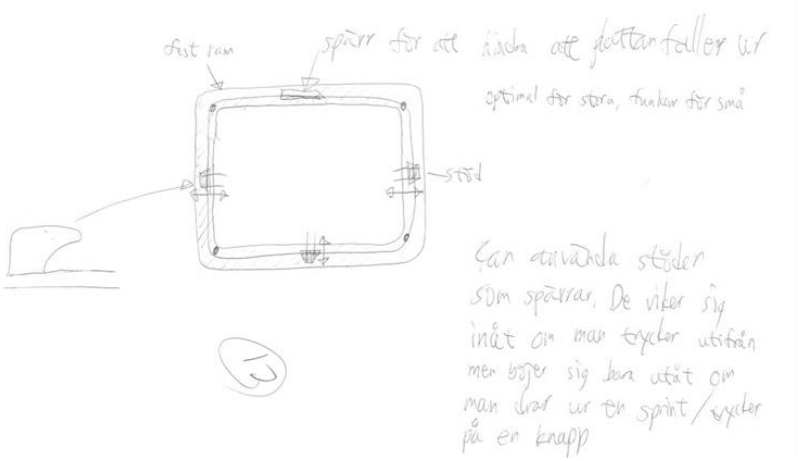


Concept SE3

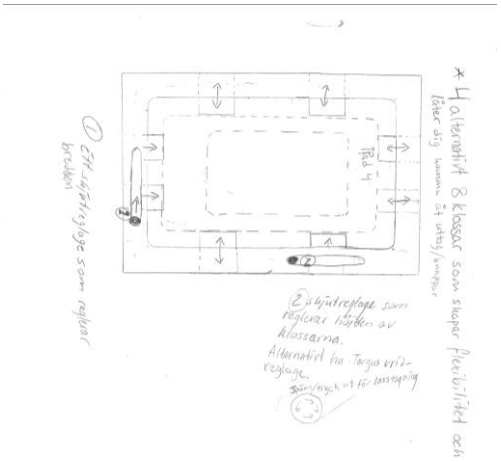
J.2 Concepts passed the screening matrix



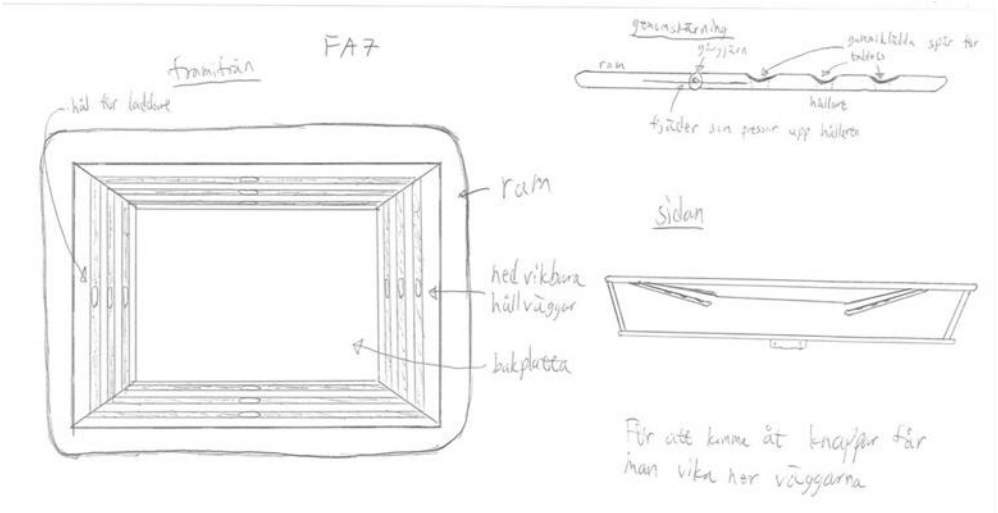
Concept FA1



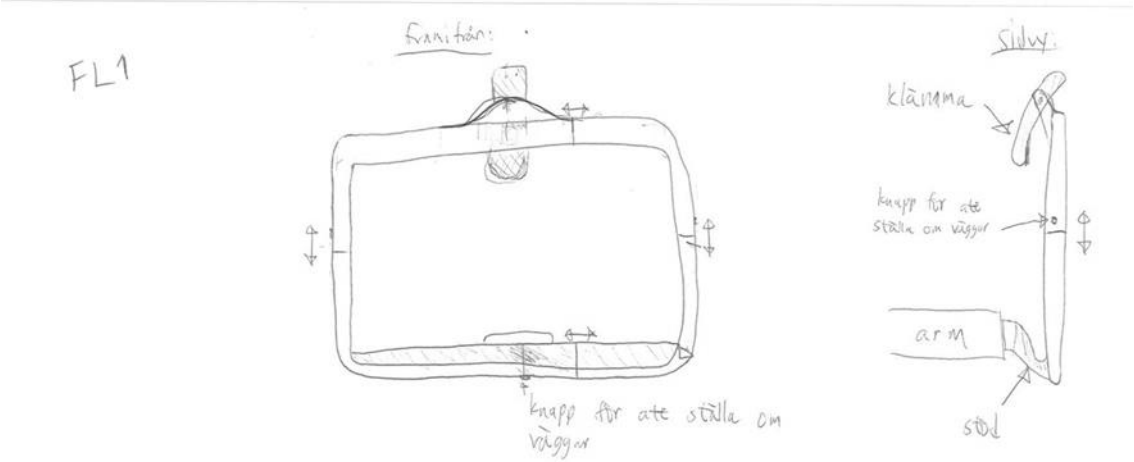
Concept FA2



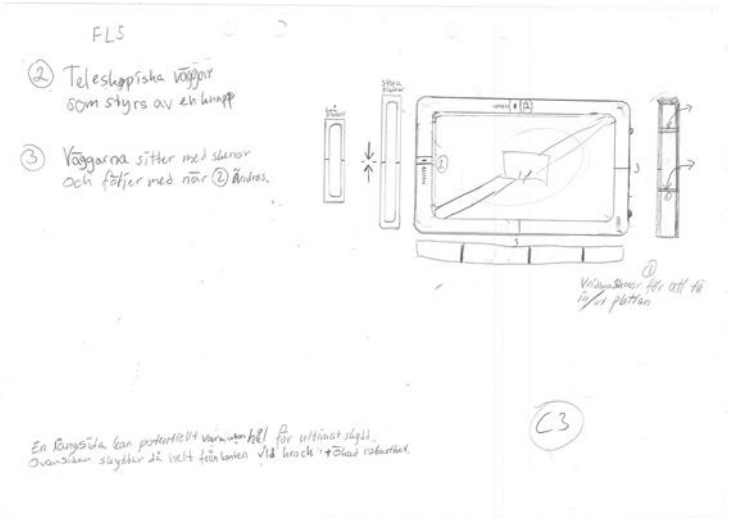
Concept FA3



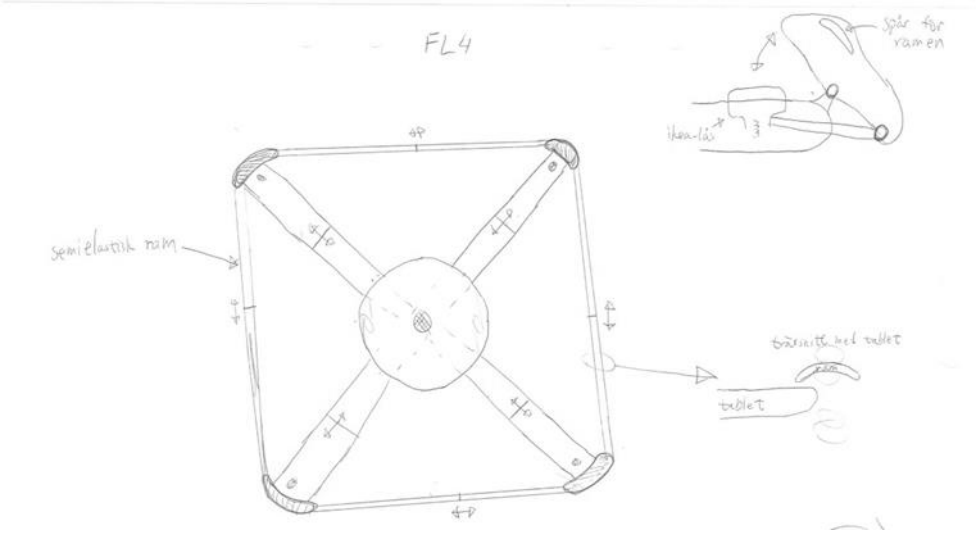
Concept FA7



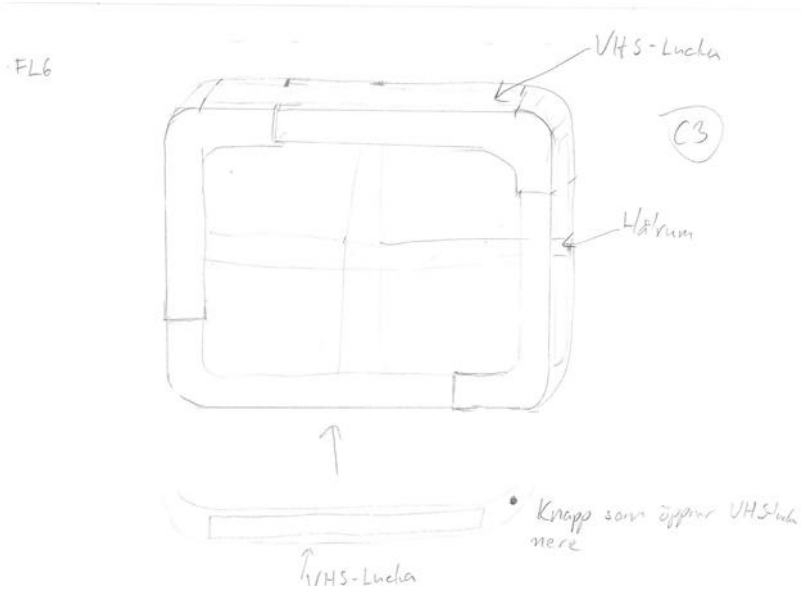
Concept FL1



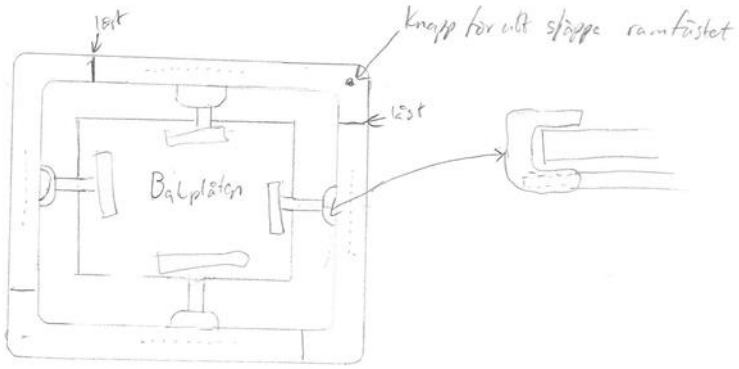
Concept FL5



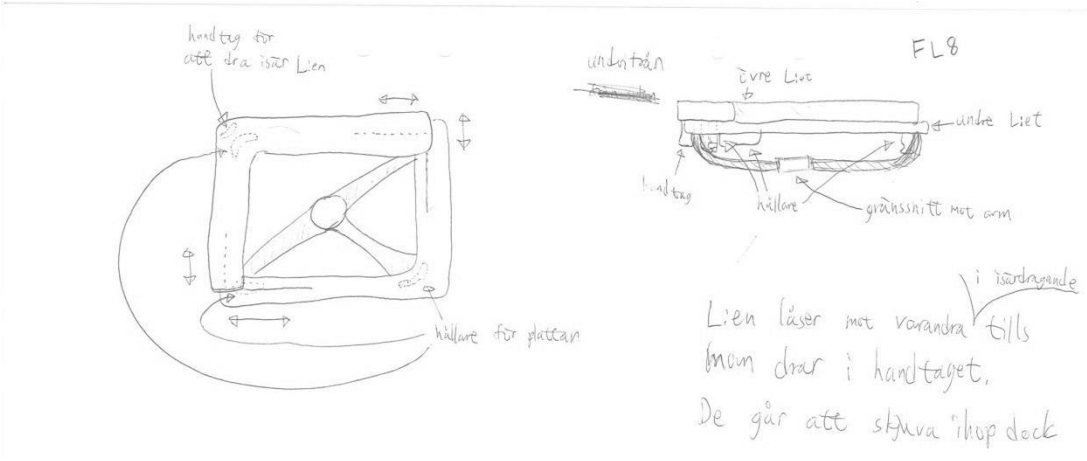
Concept FL4



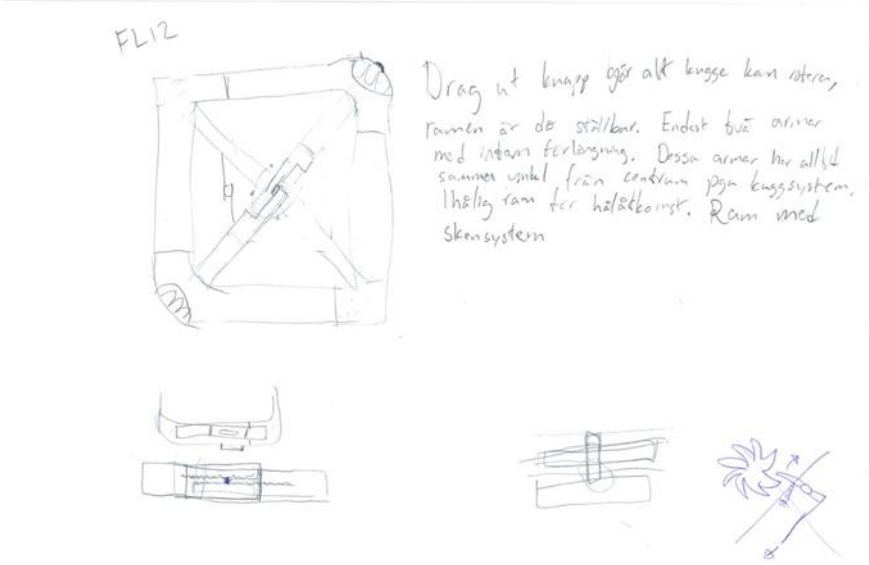
Concept FL6



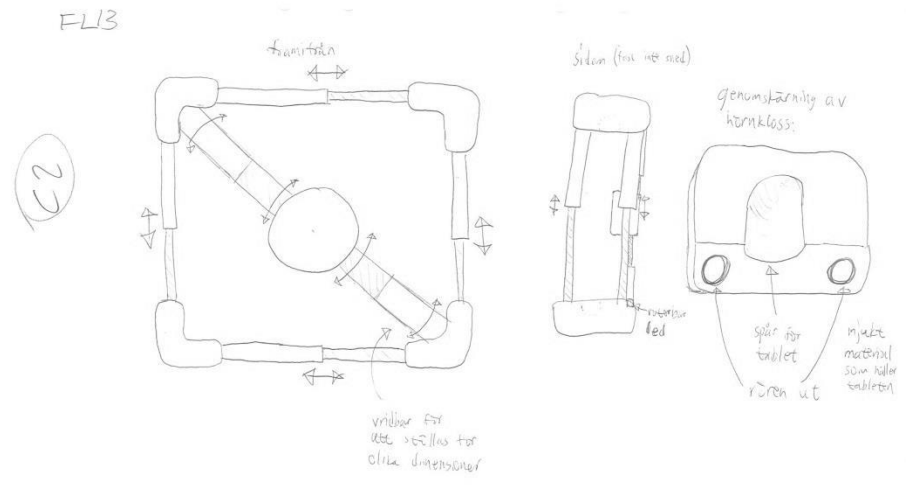
Concept FL7



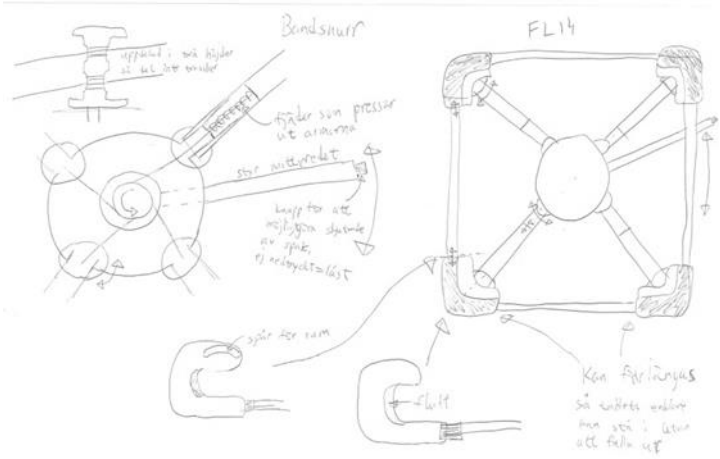
Concept FL8



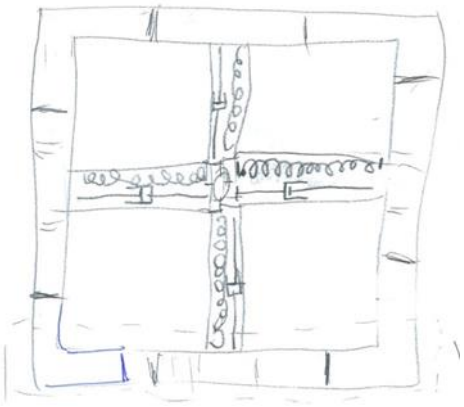
Concept FL12



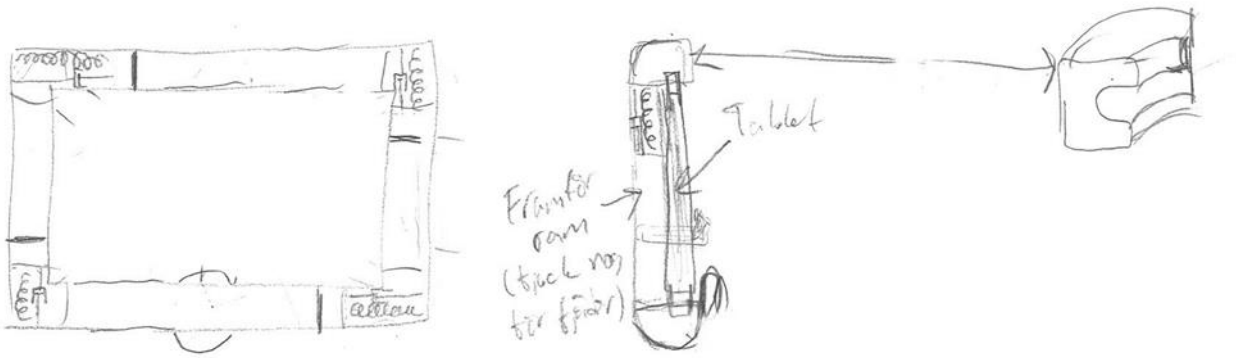
Concept FL13



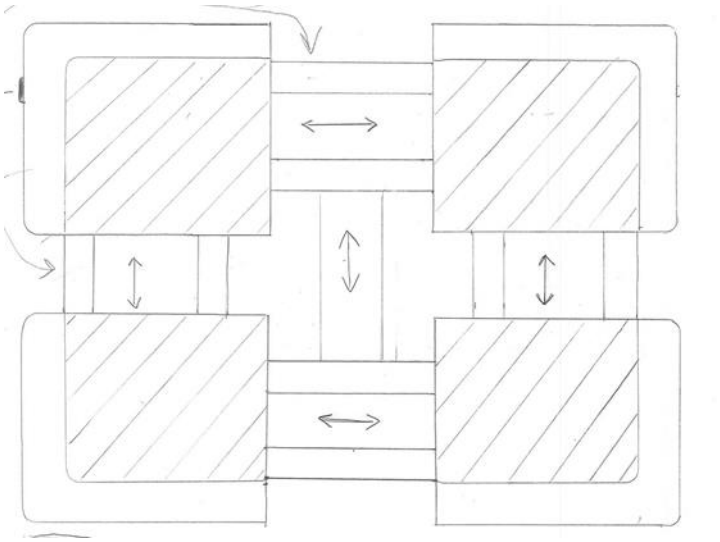
Concept FL14



Concept FL15



Concept FL16



Concept FL18

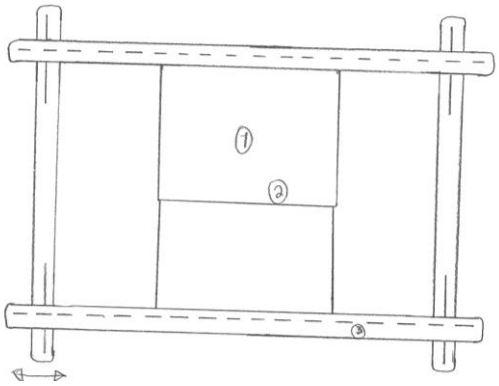
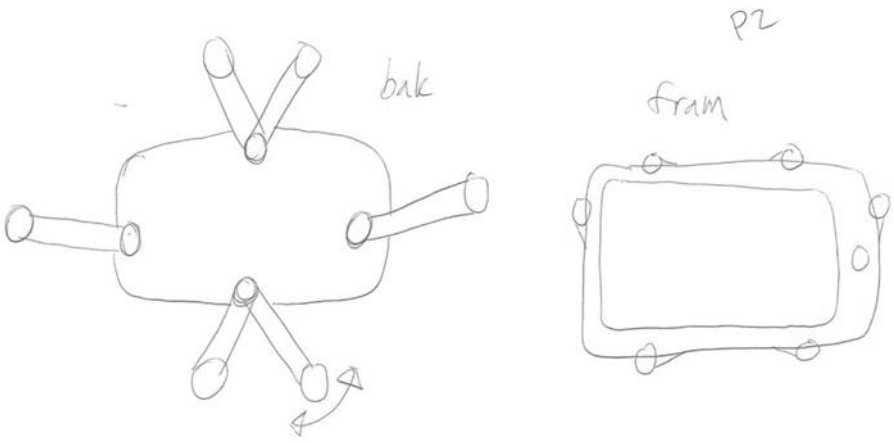
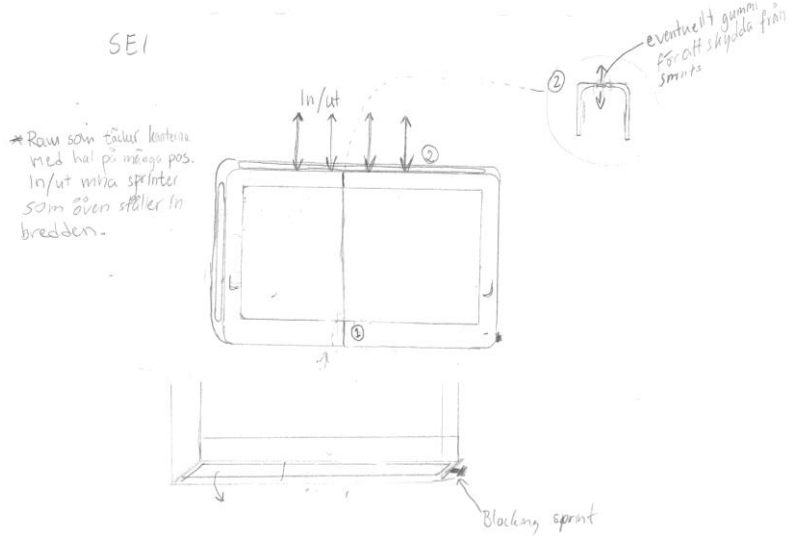


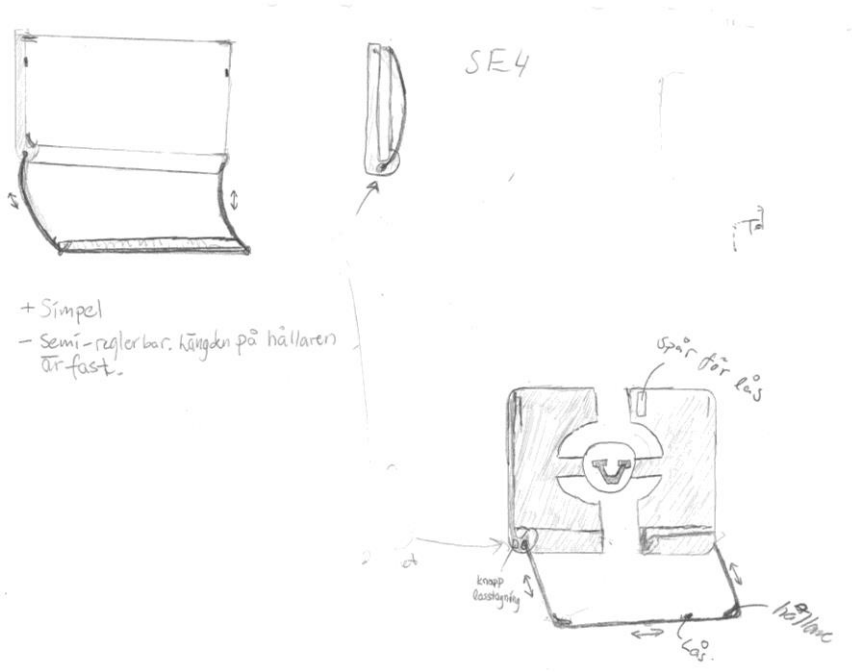
Figure 7- Concept FL19



Concept P2



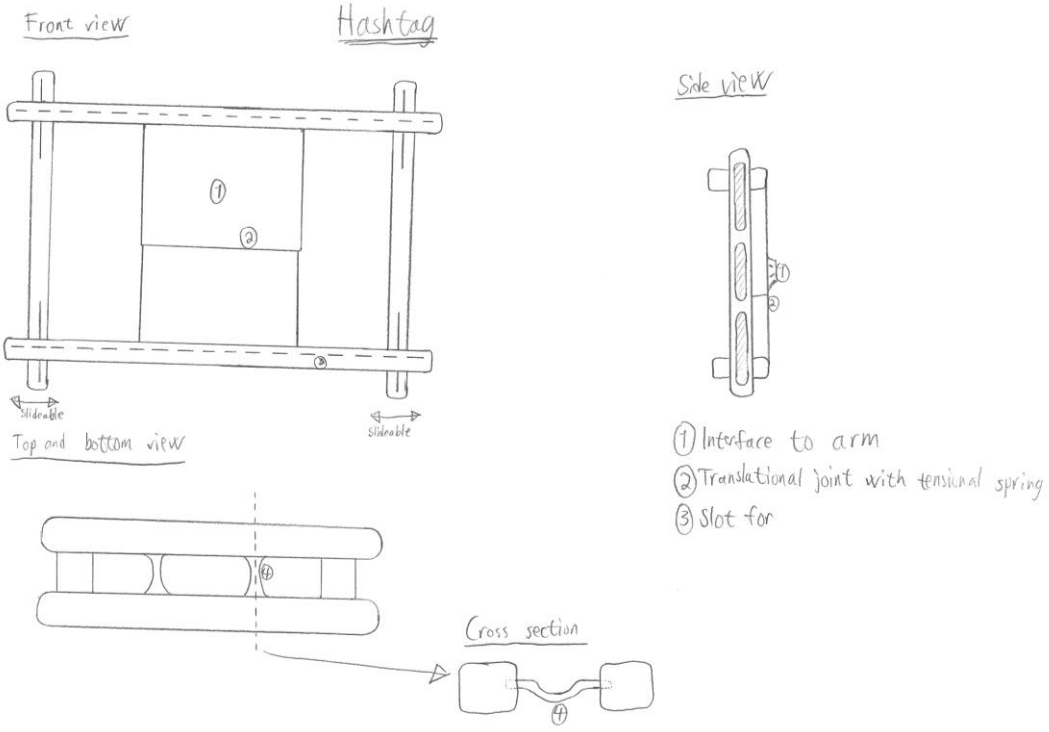
Concept SE1



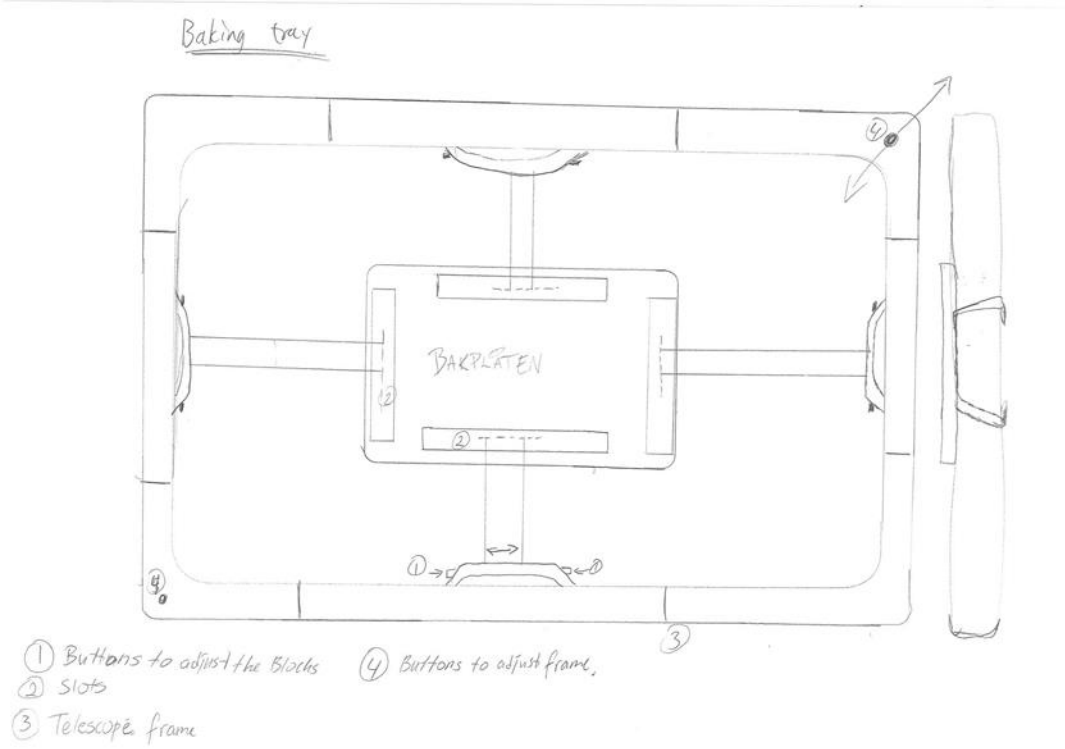
Concept SE4

Appendix K

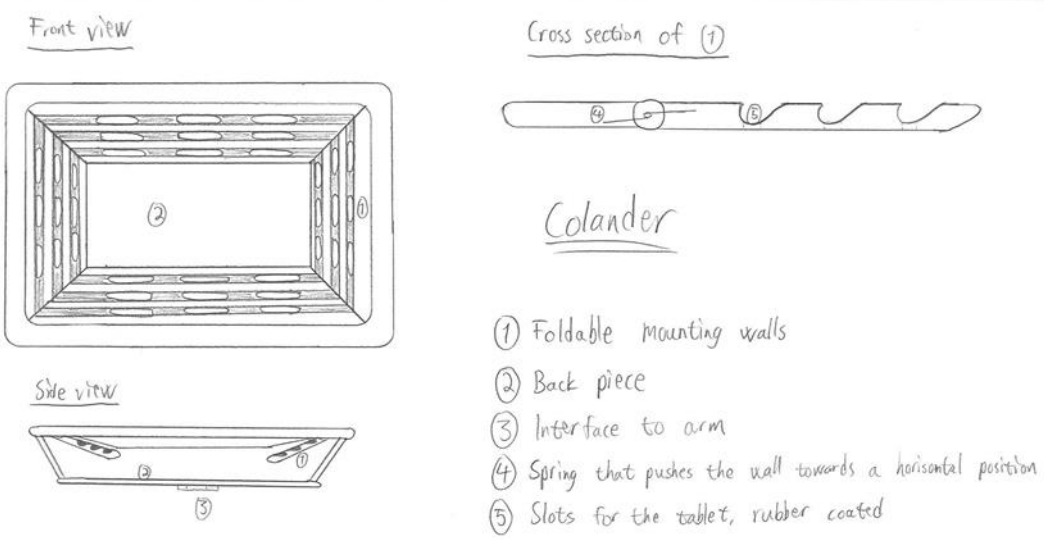
Refined concepts for the second scoring matrix



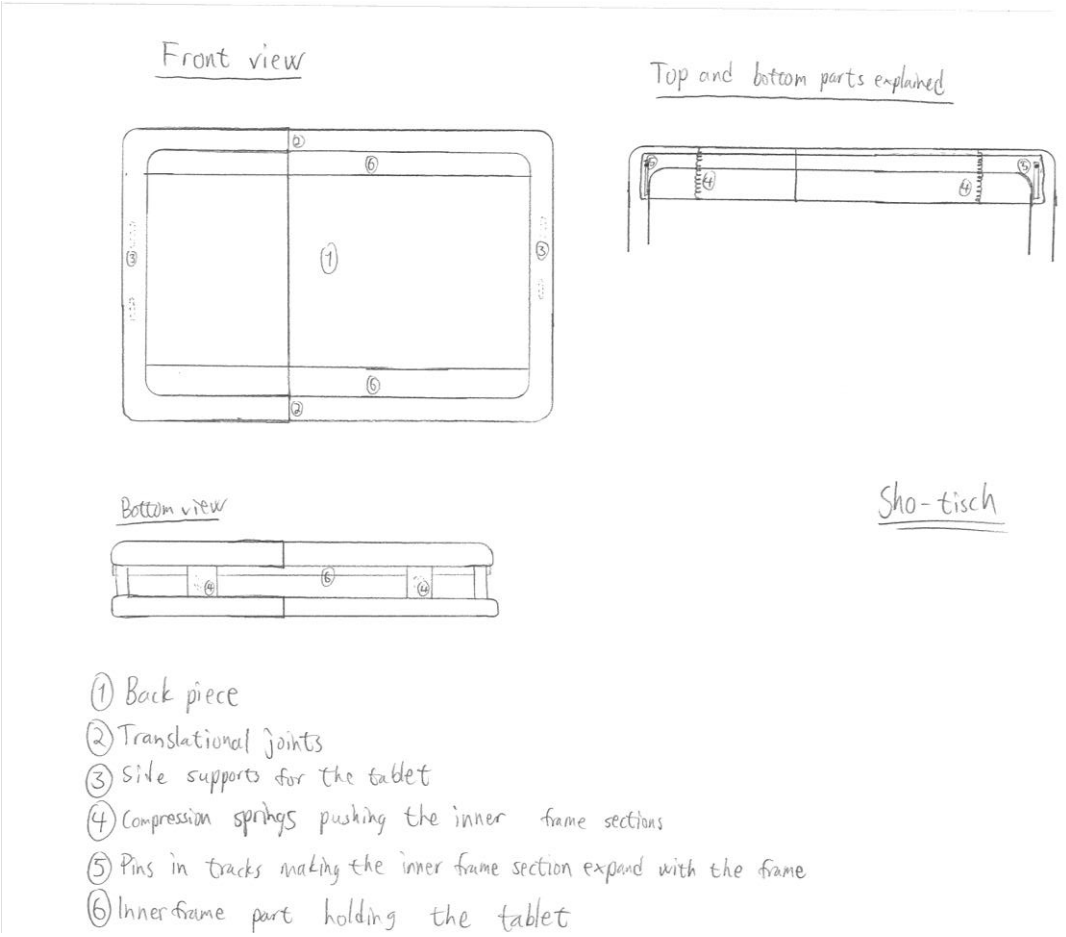
Concept Hashtag



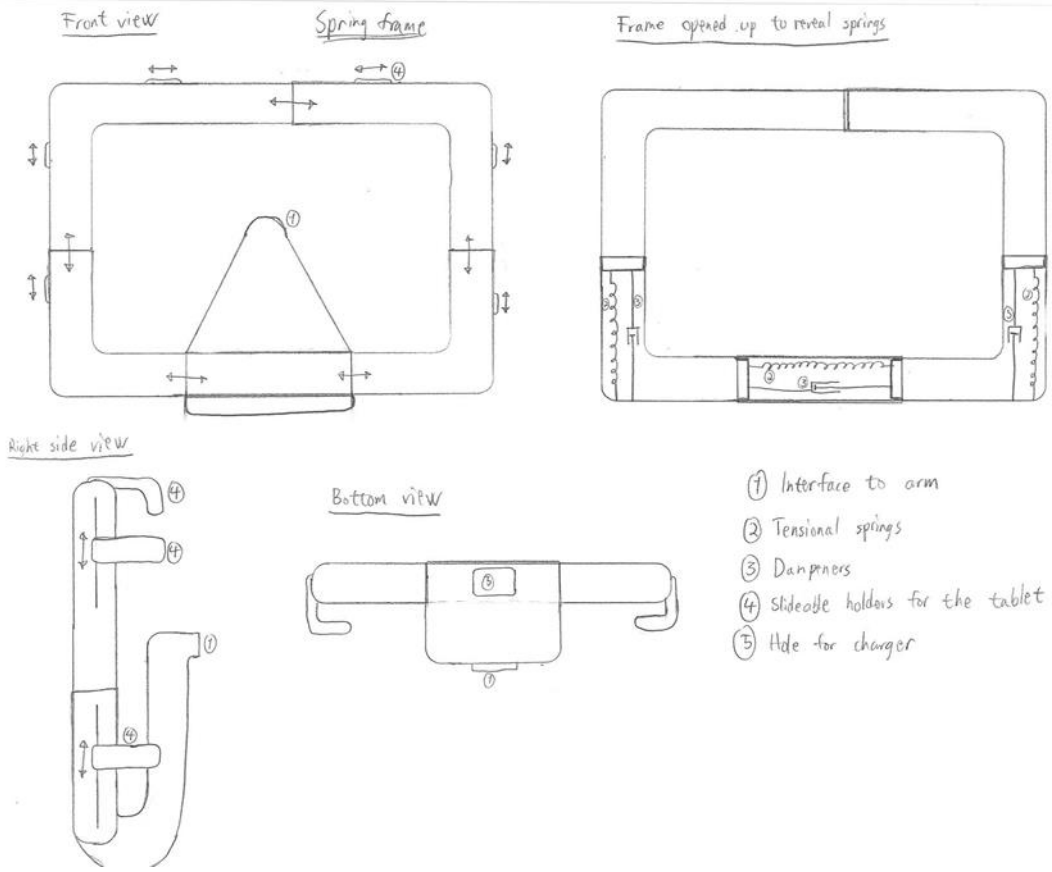
Concept Baking tray



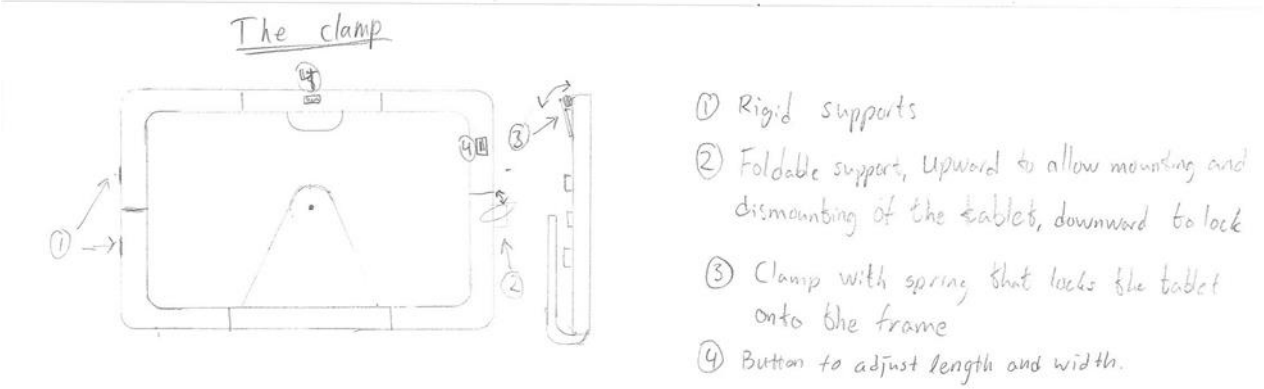
Concept Colander



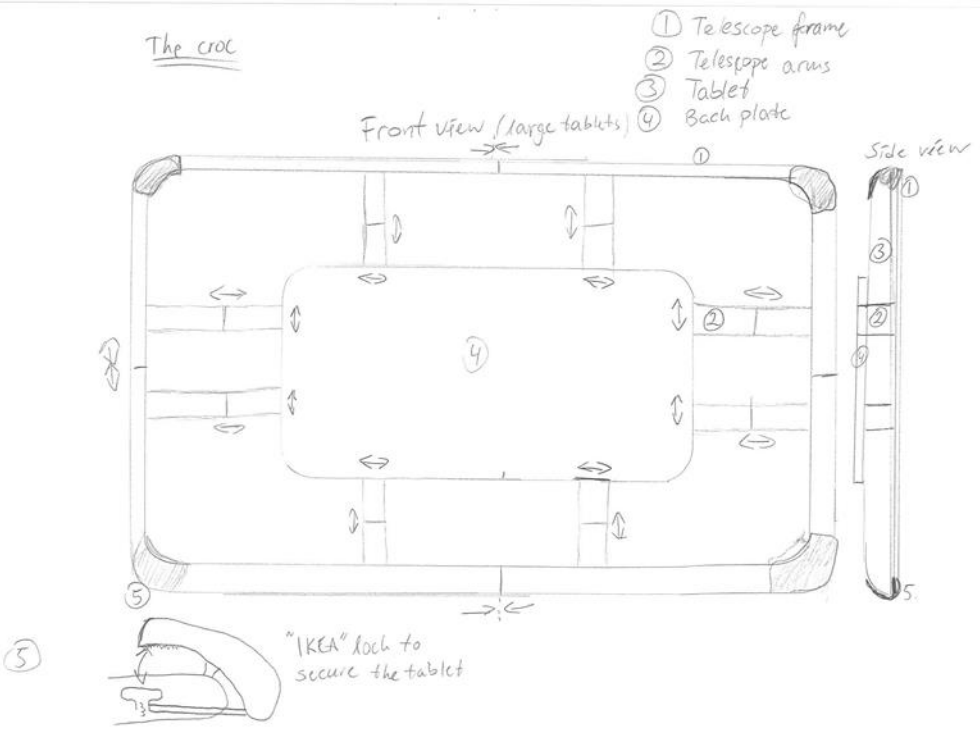
Concept Sho-tish



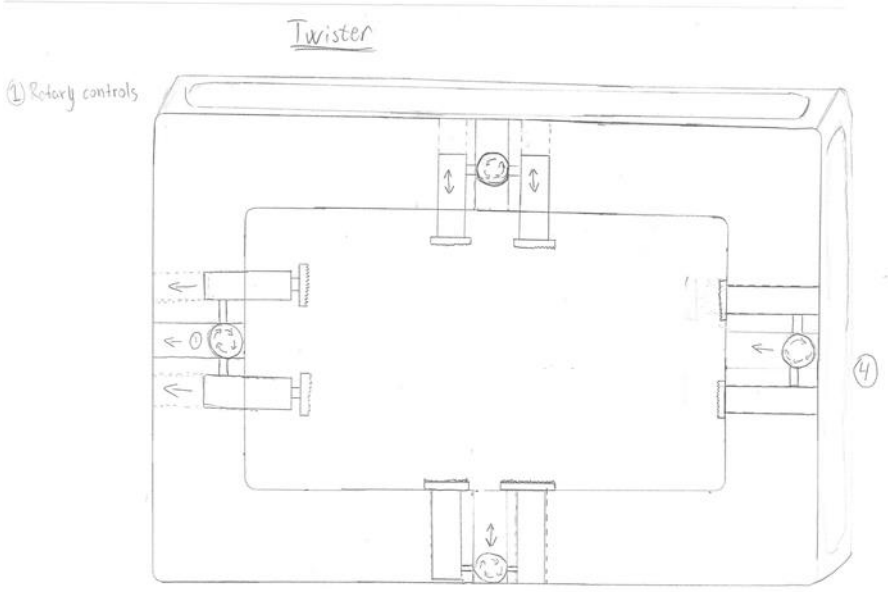
Concept Spring frame



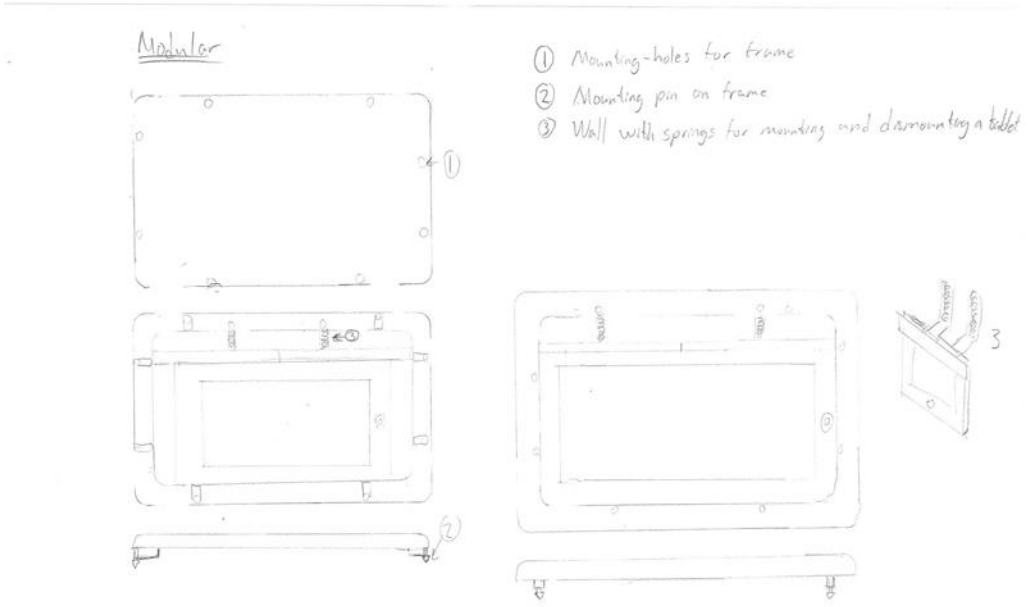
Concept Clamp



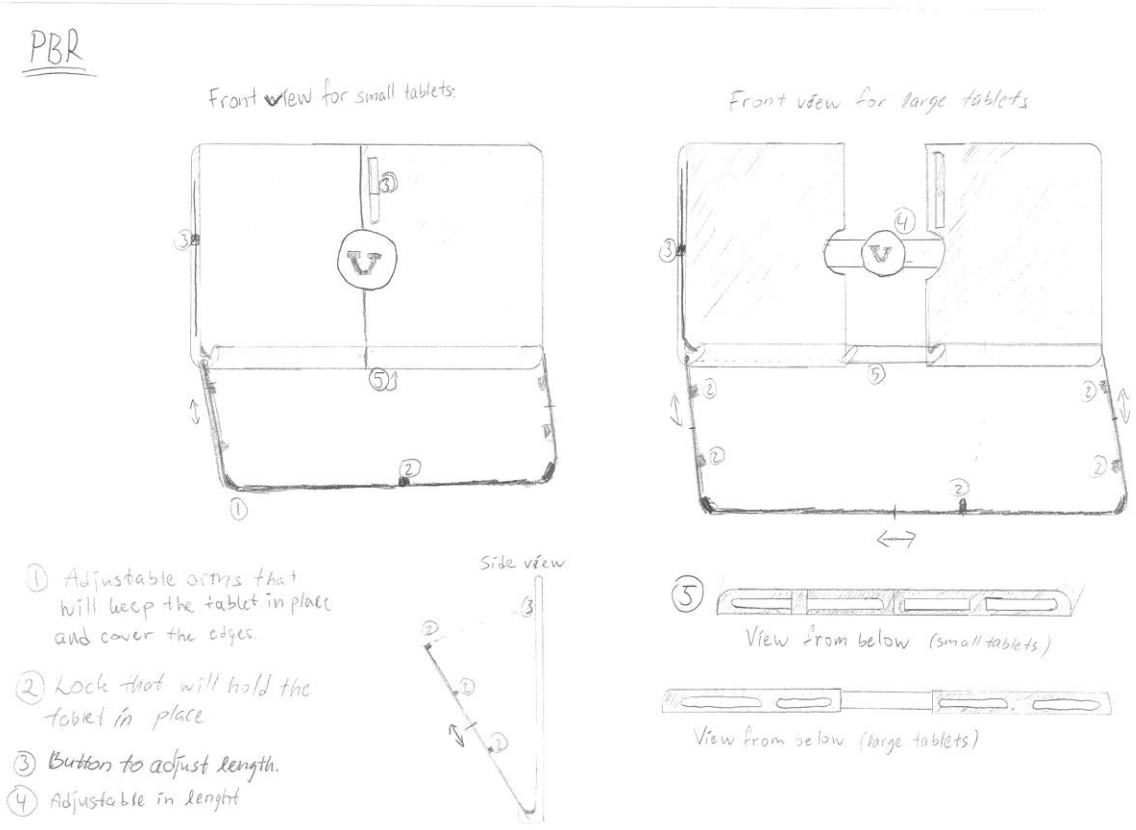
Concept Croc



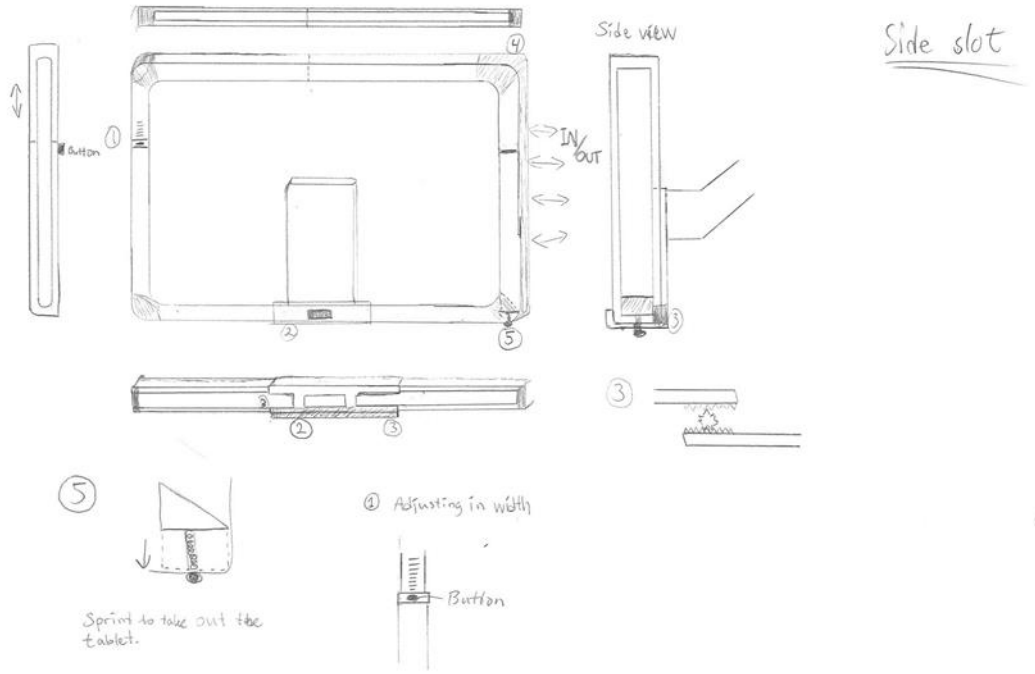
Concept Twister



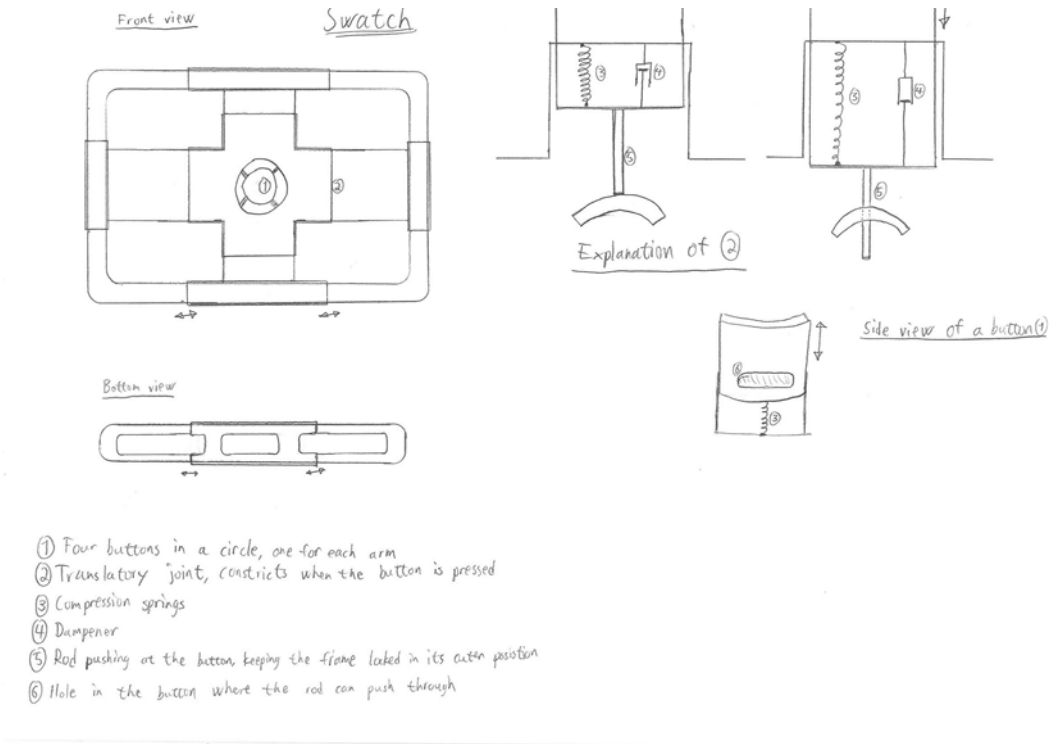
Concept Modular



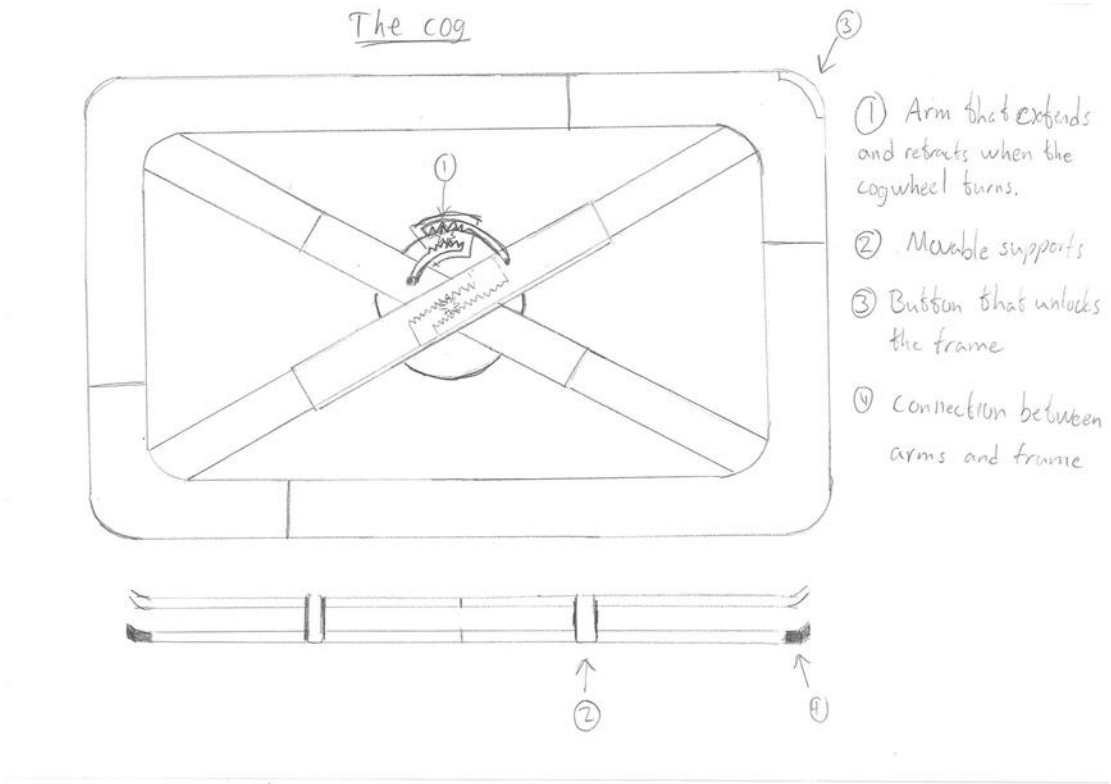
Concept PBR



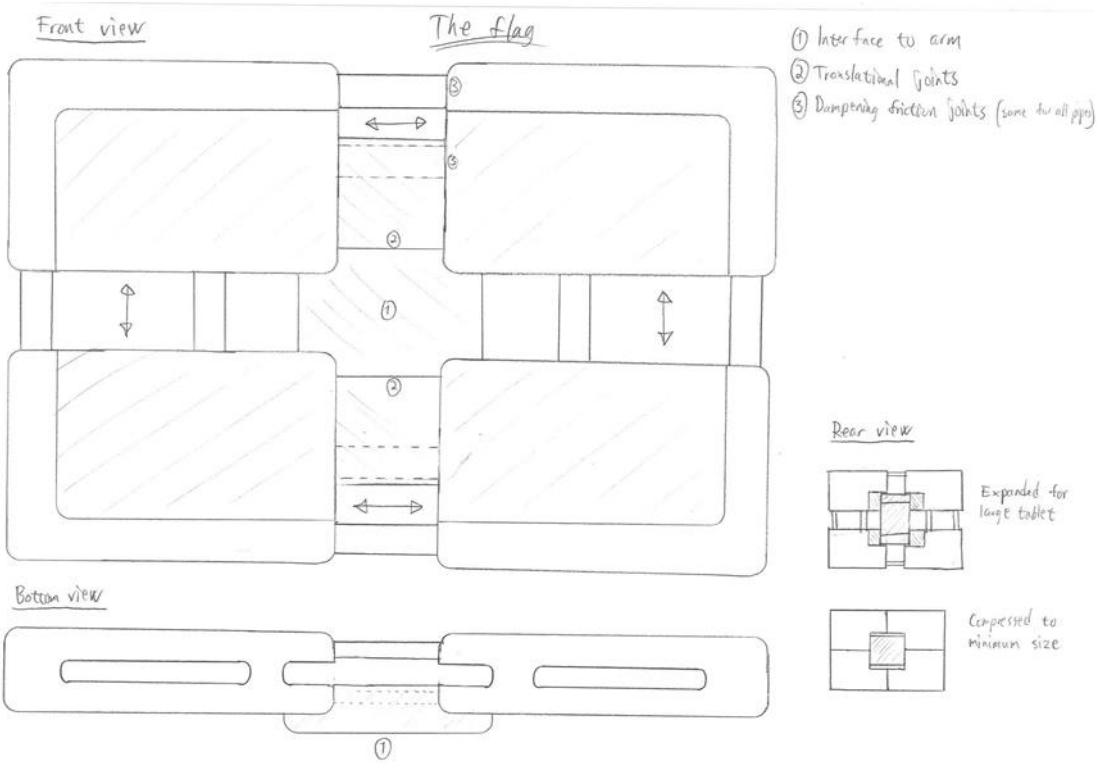
Concept Side slot



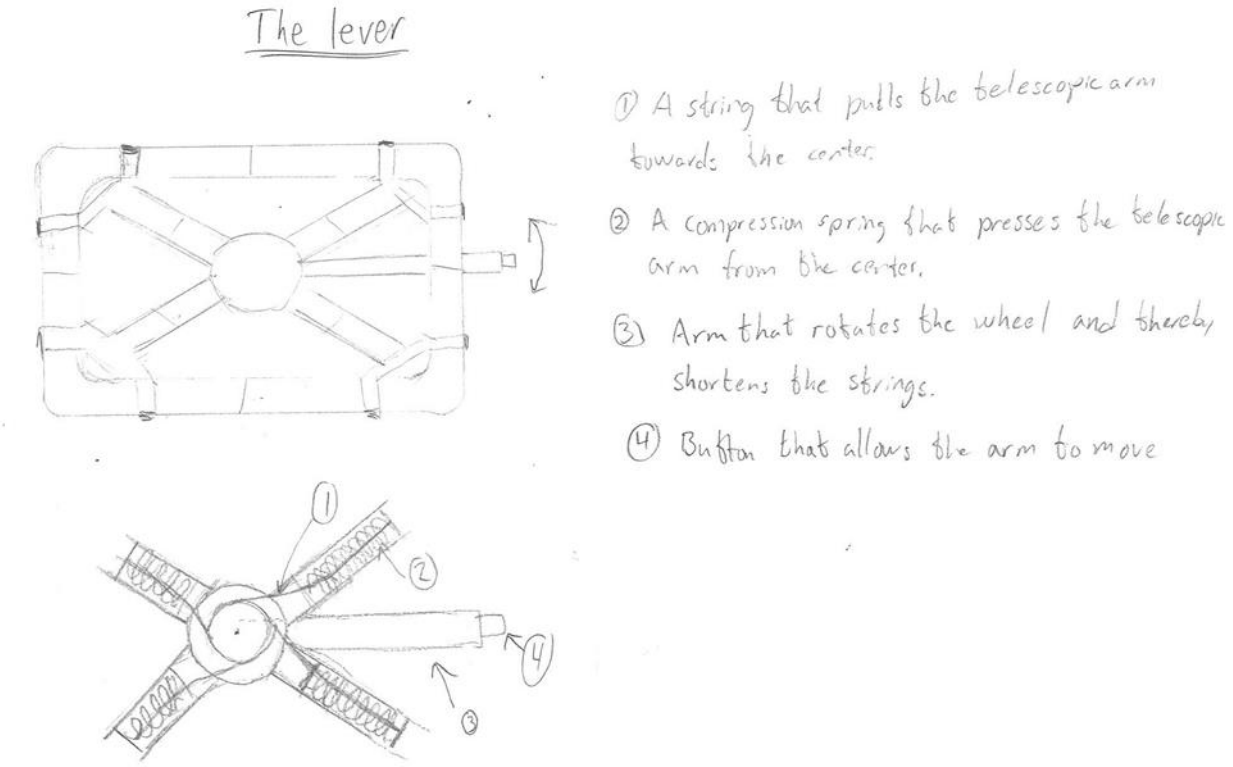
Concept Swatch



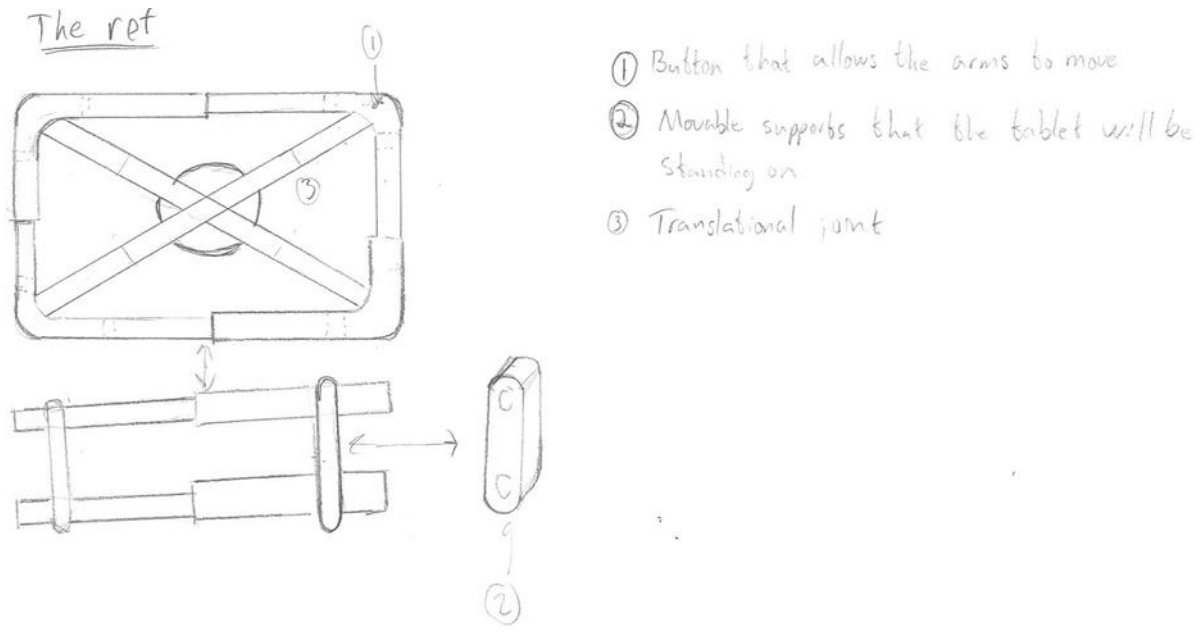
Concept Cog



Concept Flag



Concept Lever



Concept Ref

Appendix L

User verification

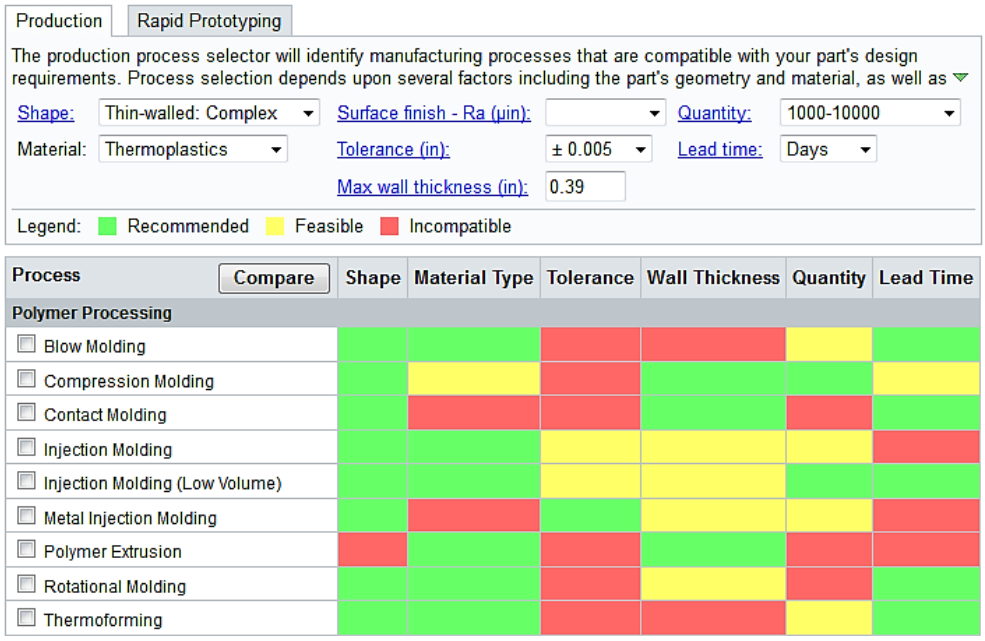
List of the investigated requirements in the verification study

No.	Requirement	Importance	Target value	Units	Verification status
1	Headphone socket accessible	5		Binary	Approved
2	Buttons accessible	5		Binary	Approved
3	Sound distortion	2		Subjective	Approved
4	Volume deviation	2		dB	Approved
5	Wifi performance	4		%	Approved
6	Bluetooth performance	4		%	Approved
7	Charging accessible	4		Binary	Approved
8	Mic and front camera performance	2		Subjective	Approved
9	Prevent reflections on screen	2		Subjective	Not Tested
10	Optimal initial angle for average user	3	57	Degrees	Not Tested
11	Optimal initial position for average user	3	300	mm	Not Tested
12	Design coherent with VCC's interior design	4		Subjective	Approved (user feedback)
13	Aesthetically appealing	4		Subjective	Approved (user feedback)
14	Unit manufacturing cost	5	< 1000	SEK	Approved (only estimation)
15	Tilt adjustment range	4	± 30	Degrees	Not covered
16	Minimum vibration while typing on the tablet	4		Subjective	Not tested
17	Instils safety	4		Subjective	Approved (user feedback)
18	Time to mount and dismount tablet	4	2-8	s	Not Tested
19	Instils quality	4		Subjective	Approved (user feedback)
20	Tablet flexibility range for the mount	4	Height: 180-280 Width: 110-190	mm	Approved
21	Time to adjust mount for different tablet sizes	3		s	(Same time for all tablets, not tested)

Appendix M

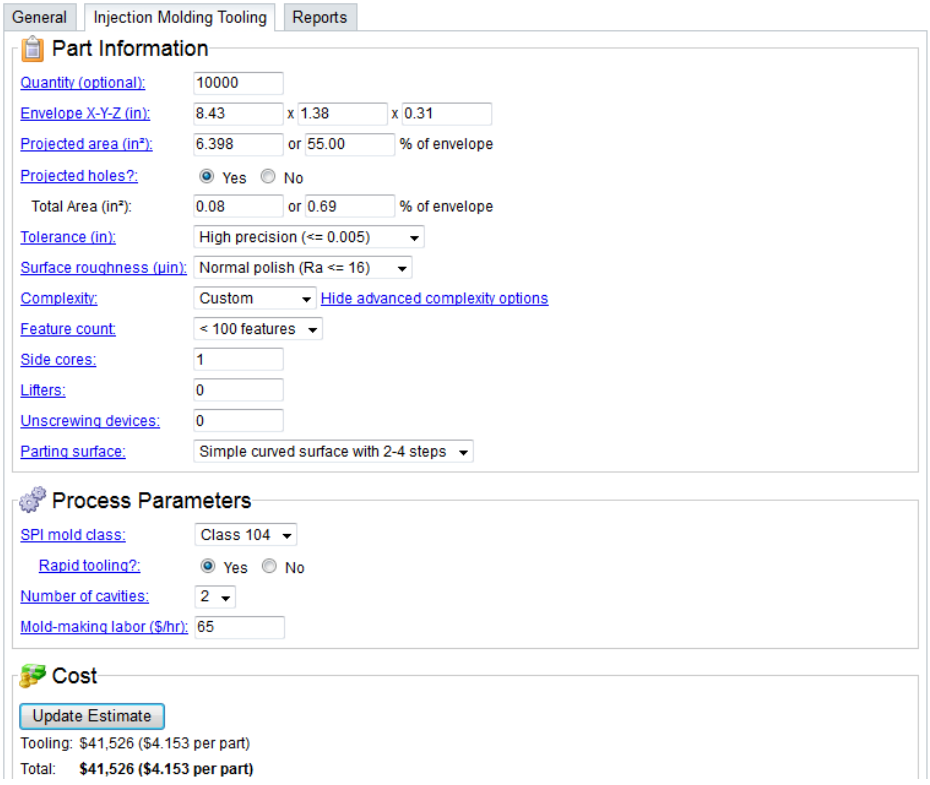
Cost estimation

M.1 Manufacturing process

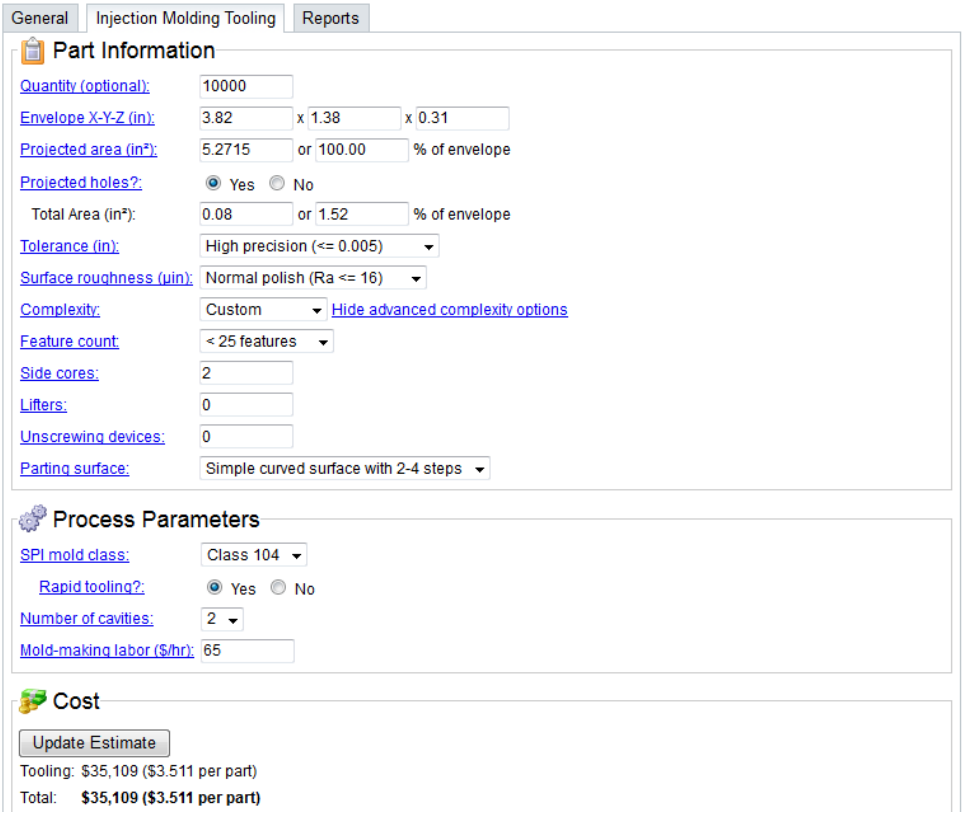


Visualisation of different manufacturing options for thermoplastics

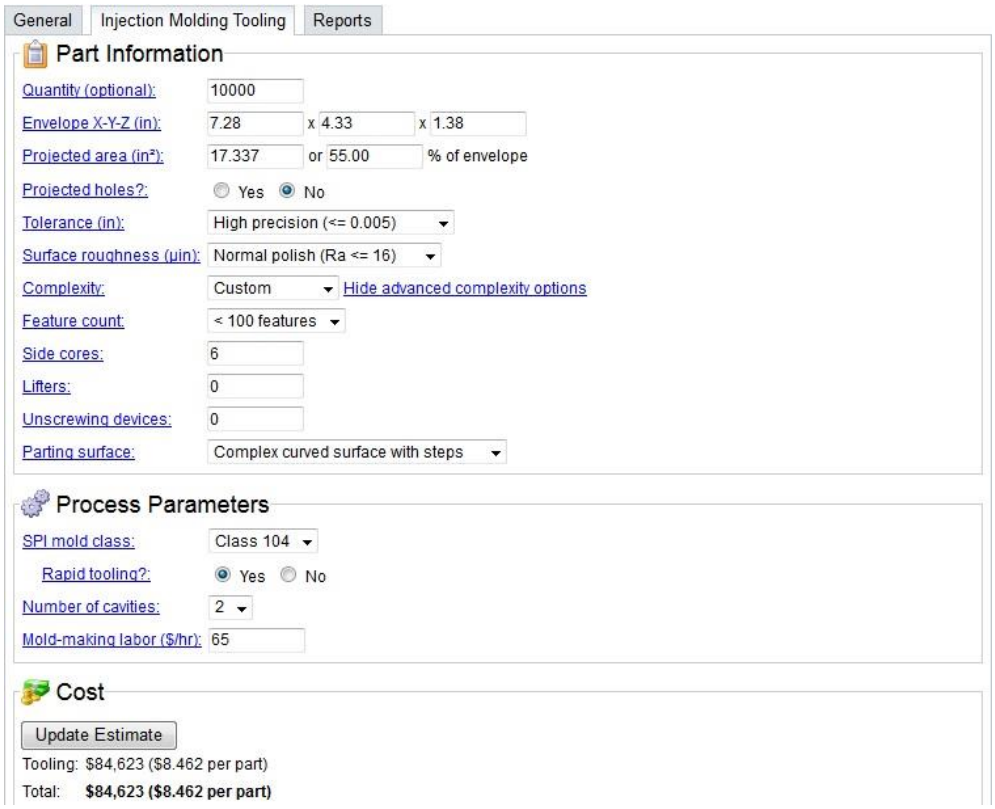
M.2 Configurations of tool cost estimation



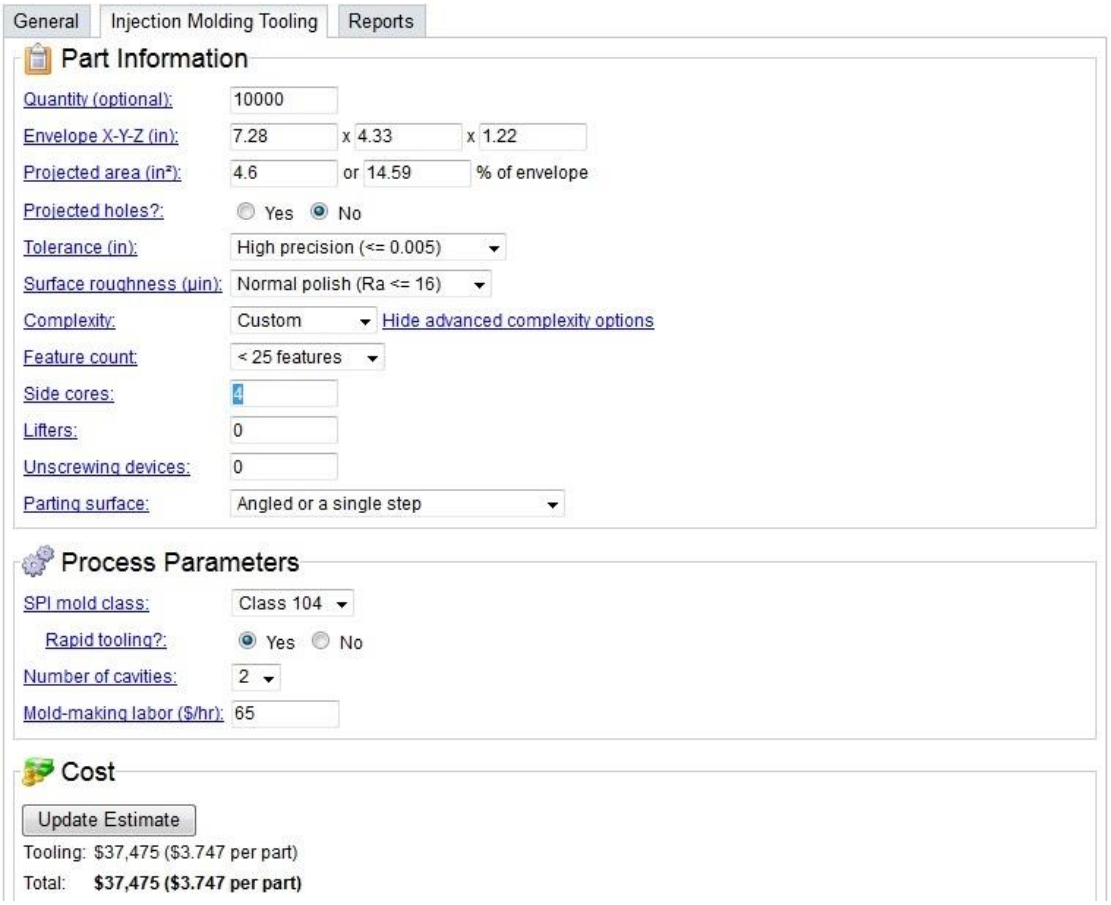
Cost estimation for the Arm cover tool



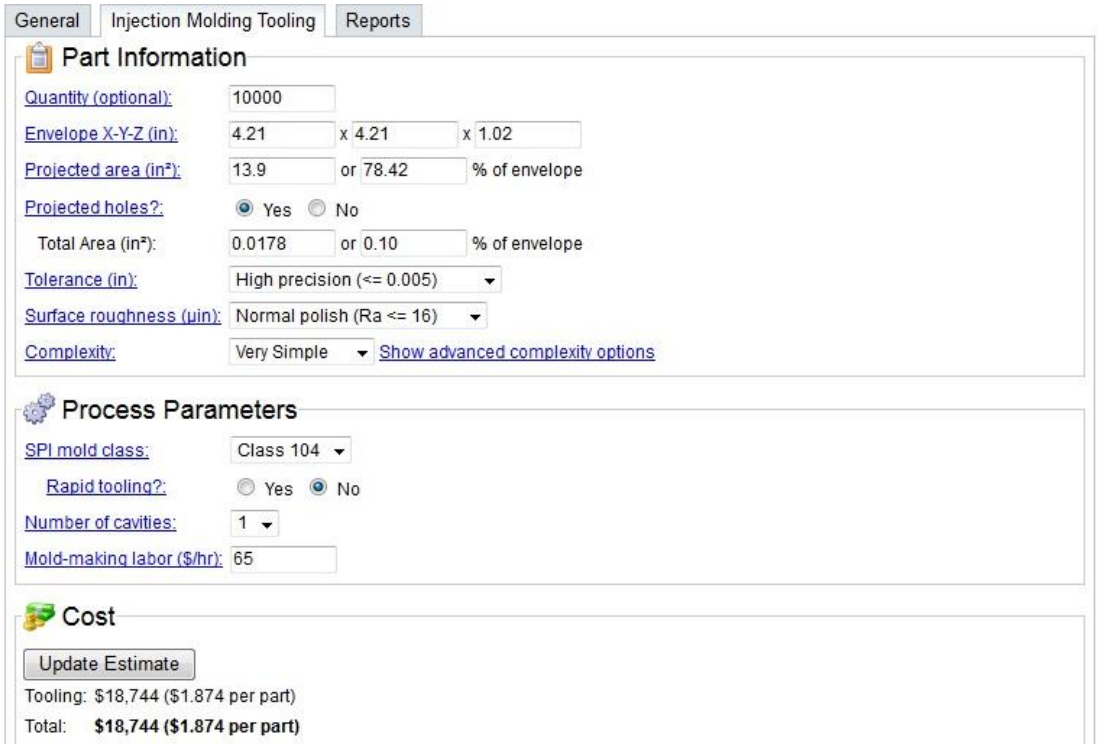
Cost estimation for the arm tool



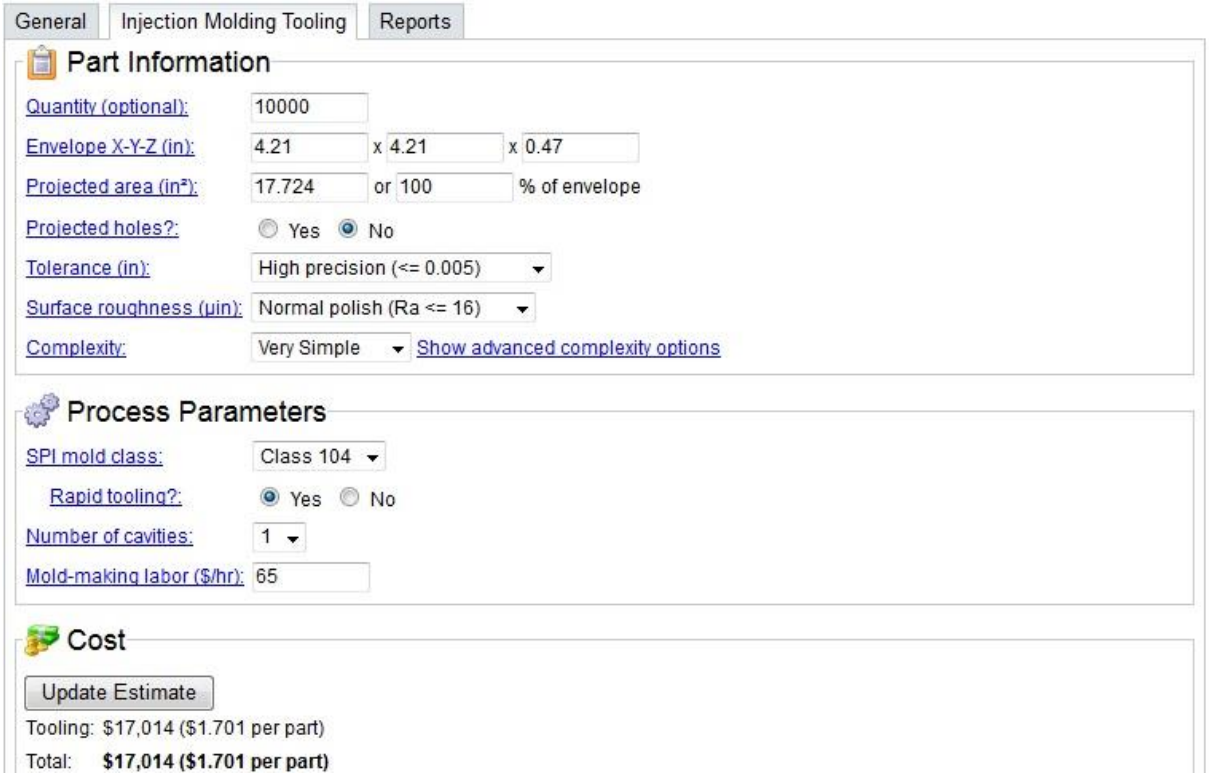
Cost estimation for the Thick Frame tool



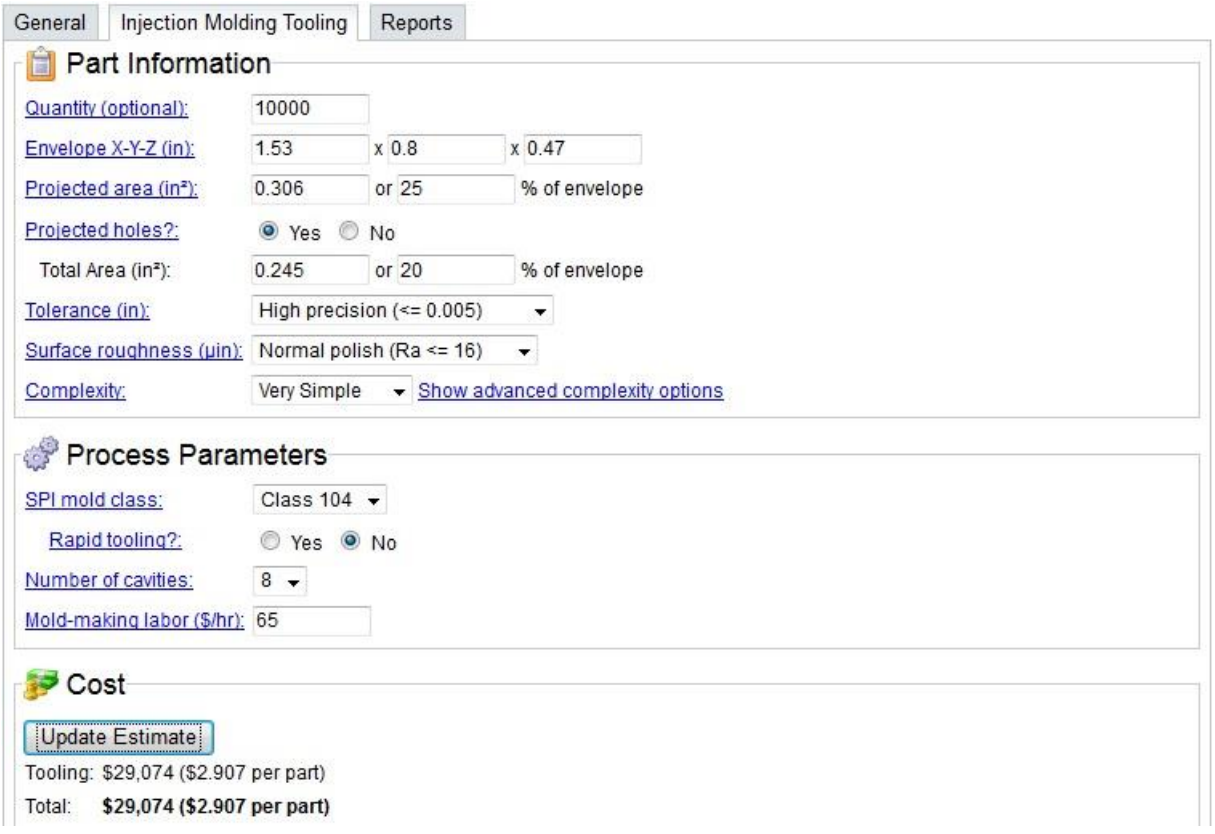
Cost estimation for the Thin Frame tool



Cost estimation for the back plate tool



Cost estimation for the front cover tool



Cost estimation for the side support tool