

Master Thesis

Sport Accessory Design for Narrative Clip 2

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*Division of Machine Design • Department of Design Science
Faculty of Engineering LTH • Lund University • 2015*



LUND UNIVERSITY



Narrative

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ISRN LUTMDN/TMKT 15/5521 SE

Preface

This Master thesis in Mechanical Engineering has been conducted at the Division of Machine Design at Lund University, Faculty of Engineering, commissioned by Narrative.

We would like to thank our mentor at Narrative, Björn Wesén, for being open to our ideas and giving us the opportunity to perform this thesis. We would also like to give a special thank you to Victor Gustafsson, Mechanical Engineer at Narrative - we appreciate the time you have put down in supporting, helping and guiding us through the thesis. Also, we would like to thank everyone at Narrative for always being open, interested in our project and making us feel welcome.

We also want to thank our mentor at LTH, Olaf Diegel, for helping us get past discovered difficulties and delivering valuable input along the process. We also appreciate the opportunity you have given to us to work so freely with the 3D-printers during the implementation of the thesis.

Lastly, we would like to thank Nils Bjerås for giving us the opportunity to discuss our ideas and learn from Semcon's consultants.

Lund, May 2015

Yasser Faraj and Elisabeth Hansson

Abstract

This report describes the development of mounts for the company Narrative's camera Narrative Clip 2, focusing on people with an active lifestyle. The terminal goal of the thesis is to come down to which types of mounts to develop for the active lifestyle user and thereafter, create a couple of 3D-printed mounts for these placements. Moreover, suggestions for optimizing the Clip itself and its user-interaction for the purpose are desirable in the thesis.

The first step of the implementation was to understand the needs of potential customers and get insight in where a placement of the Narrative Clip 2 would be the most suitable for their activity/sport. Hence, surveys were sent out to Swedish and international potential customers. The placements compiled are bicycle handlebars and helmets and the following needs were compiled for the mounts: secure, small size, holds the camera steady and possibility to rotate the camera. Also, the following desires were compiled: pliable and attachable to all handlebars/helmets.

In the second step of the implementation, the concept generation phase, the problem was divided into subproblems making it easier to focus on one problem at a time. The subproblems were solved respectively by internal and external search, whereas various concept ideas were generated and sketched. Subsequently, the concept ideas used in the final prototype were selected by discussions, concept screening, testing of simple prototypes and a workshop.

The result of the thesis are mounts including a ball-joint for rotation, a snap-fit case where to attach the camera and bottom plates that can be varied depending on placement; one for helmets and one for handlebars. The ball-joint and the snap-fit case are assembled with screws, making it possible to adjust the angle of the camera even more than with only the ball-joint. The ball-joint and the snap-fit case can be moved between the two bottom plates as it attaches with magnets - a feature making it easy to vary if you want to switch location of your camera between your helmet and your handlebar.

Keywords:

Mount, Narrative Clip, Narrative, Product Development, Sport accessory

Summary

Detta examensarbete skrevs under våren 2015 för företaget Narrative, vilket är ett svenskt företag som grundades år 2012. Företaget designar, producerar och marknadsför en liten bärbar kamera med namnet Narrative Clip. Idén med Narrative Clip är att använda den som en kamera med livsdokumenterande funktion, då kameran automatiskt tar en bild var trettionde sekund.

I dagsläget finns det endast en infästningsanordning till kameran, ett spänne i metall, vilket går att fästa på kläder med slitsar - något som gör att användningsområdet av kameran begränsas till vardagsklädsel. På Narratives nästkommande produkt är spännet i metall möjligt att ta bort och därmed kan andra infästningsanordningar till kameran fästas. För att bredda användningsområdet av kameran och därmed nå en bredare kundkrets ska i detta examensarbete utveckling av infästningsanordningar till kameran tas fram. Utvecklingen begränsas till kunder med en aktiv livsstil och utvecklingen fokuseras på aktiviteter och sporter som utförs under en längre tidsperiod, då det är det bästa sättet att använda sig av funktionen hos Narrative Clip.

Examensarbetets metod är i den initierade fasen främst inspirerad av Karl T. Ulrich och Steven D. Eppingers bok Product Design and Development. I den slutliga delen av examensarbetet används en egen metod sammanställd för att passa examensarbetets ändamål.

I det första steget av examensarbetet samlades kundbehov in genom att enkäter skickades ut till potentiella användare av Narrative Clip. Detta gjordes i två steg där den första enkäten skickades till svenska potentiella användare. Enkät 1 inriktade sig mot vilken aktivitet/sport som enkätdeltagarna utövar, vart de skulle vilja fästa kameran när de utövar sin aktivitet/sport och vilka parametrar enkätdeltagarna anser är viktiga hos en infästningsanordning till en kamera. En andra enkät skickades ut till potentiella internationella användare, då Narratives största marknad är utanför Sverige. Enkät 2 var mer fokuserad mot vilken parameter som är den viktigaste att fokusera på vid utveckling av en infästningsanordning till kameran samt vilken placering av kameran som de tror är mest passande vid utövning av deras aktivitet/sport. Resultaten av de två enkäterna blev att infästningar till cykelstyren samt hjälmar ska utvecklas, med följande krav och önskemål på infästningen.

Krav

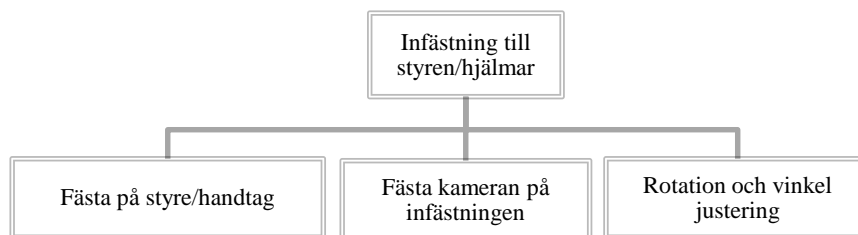
- Säker
- Liten
- Smidig
- Rotering av kameran i flera led

Önskemål

- Kan fästas på alla styren/hjälmar
- Håller kameran stadigt

Med önskemålet att infästningen ska kunna fästas på alla styren/hjälmar gjordes en undersökning som visade att det finns väldigt varierande utseenden på styren, men att de vanligtvis har ett cirkulärt tvärsnitt. Undersökningen visade också att de flesta styrens diametrar faller inom intervallet 22-27 mm, vilket därför valdes som önskat intervall för vilket infästningen ska fungera. Även undersökning av hjälmar gjordes och det visades att det finns tre vanliga varianter av hjälmar på marknaden - hjälmar med hål igenom, ventilationshål samt utan hål. Önskat är därmed att infästningen ska fungera för dessa tre varianter av hjälmar.

I genereringsfasen delades problemet upp i delproblem, för att på så sätt lättare fokusera på ett problem åt gången. Detta gjordes enligt följande problemuppdelning.



Vid en första anblick av delproblemet ”Fästa kameran på infästningen” antogs att en lösning var given, då Narrative redan har utvecklat ett snäppfäste för att kunna byta infästningsanordningen. Vid djupare inblick i delproblemet, visade det sig dock att detta snäppfäste inte var optimalt för de infästningsanordningar som skulle tas fram. Därför togs konceptidéer fram för detta delproblem i ett senare skede av arbetet.

För delproblemen ”Fästa på styre/handtag” samt ”Rotation och vinkel justering” gjordes intern och extern sökning, varpå flera konceptförslag togs fram och skissades.

Koncepten för delproblemet ”Fästa på styre/handtag” rangordnades sedan genom en concept screening. Hur en concept screening görs kan ses i avsnitt 2.2.4.1. Från concept screeningen valdes fem koncept som 3D-modellerades, 3D-printades och därefter testades av utförarna av detta examensarbete samt i en workshop. I testen av koncepten blev det tydligt att en kombination av koncepten Bendy, Cable tie och Watch 1, vilka kan ses i Appendix F, ska fokuseras på för vidare utveckling av infästningar till styren. Dessa koncept har många likheter och fördelar, bland annat är det möjligt att justera diametern på dem genom remmarna och de kan därmed passa flera olika diametrar av styren. För hjälmar valdes konceptet tape/glue att fokuseras på, detta då det var det enda konceptet som skulle kunna fungera för alla hjälmar samt att det är det konceptet som kan tillverkas i minsta storlek.

Koncepten för delproblemet ”Rotation och vinkel justering” diskuterades med flera experter inom området, varpå det blev tydligt att kuller är rotationsmekanismen att fokusera på. Kuller valdes därför då den kan rotera i alla led samt att den går att tillverka i liten storlek.

En insikt om att konceptet för infästningen till styre samt infästning till hjälm skulle gå att kombinera skapade en idé om att tillverka en infästning som fungerar både till styren och till hjälmar. Det bestämdes att följande parametrar ska finnas i slutkonceptet:

- Bottenplatta, vilken kan fästas till hjälm genom dubbelhäftande tejp samt till styren genom ett band som går att justera i längd. Om det inte är möjligt tas två olika bottenplattor fram i stället; en för styren och en för hjälmar.
- En kulle för rotation
- En funktion som gör det möjligt att fästa/ta loss kulleleden från bottenplattan
- En funktion som gör det möjligt att fästa/ta loss kameran från infästningsanordningen

Flera konceptförslag för dessa delproblem togs fram, 3D-modellerades, 3D-printades och testades. Denna process var mycket iterativ då det ständigt uppstod delproblem som löstes allt eftersom. Efter mycket diskussion och tester valdes ett koncept för respektive delproblem, vilka därefter kombinerades och förfinades i detalj tills det resulterade i final prototypen.

Alternativet att göra en gemensam bottenplatta för både styren och hjälmar valdes bort då den blev stor och klumpig och därmed inte skulle uppfylla kraven att vara liten och smidig.

Resultatet blev en infästningsanordning bestående av två olika bottenplattor; en för styren och en för hjälmar, en kulle samt ett skal i vilket kameran kan fästas. Kulleleden består av tre delar; en kula med en pinne, en bottendel och en överdel som skruvas samman i monteringen. Skalet till kameran monterar till pinnen på kulleleden genom att pluggar längst ut på kulleledens pinne pressas in i hållare på baksidan av kamerans skal. Genom friktionen som uppstår mellan ytorna, fungerar denna konstruktion som ett gångjärn. Kulleleden möjliggör rotation i alla led och gångjärnet mellan pinnen och skalet möjliggör vinkeländring. På undersidan av kulleleden samt på översidan på bottenplattorna finns magneter, vilket möjliggör att kulleleden och skalet lätt kan förflyttas mellan bottenplattorna beroende på om infästningsanordningen till styren eller till hjälmar ska användas.

Bottenplattan för styren är anpassningsbar till olika diametrar då den på insidan är belagd med ett skumgummi-material för ökad friktion samt ett elastiskt band vilket fästs och spänns efter diameterstorleken. Då bottenplattan för hjälmar fästs med dubbelhäftande tejp kan den fästas på alla varianter av hjälmar. De slutgiltiga infästningsanordningarna för styren och hjälmar kan ses i Figur 1.



Figur 1 De slutgiltiga infästningsanordningarna för styren och hjälmar

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1 Introduction

This chapter describes the background of the thesis and gives an introduction to Narrative, the commissioner of the thesis. The thesis' aims and purpose as well as the scope and the overall objectives are also explained in this chapter.

1.1 Narrative

Narrative is a Swedish company founded in 2012. Narrative designs, produces and markets a small wearable camera, the Narrative Clip and associated cloud services and mobile applications. The current offering was initially conceived as a Kickstarter project, officially marketed as a “life logging” tool [1]. The Narrative Clip's main purpose is to document experiences and activities perceived during a longer period of time by taking a picture every 30 second by itself. The size of the Narrative Clip is 36 x 36 x 12 millimeters and can be seen in Figure 1.1 and Figure 1.2.



Figure 1.1 The Narrative Clip



Figure 1.2 The Narrative Clip is a small sized camera

1.2 Background

In the current situation there is only one way to attach the Narrative Clip, see Figure 1.3. The metal clip used today limits its scope of use to shirts and other garment with slits. Consequently, the usage of the camera is limited to the workaday life and everyday clothing. Therefore, further research and product development will be done for a new set of accessories to the Narrative Clip to broaden its scope of use and reach a wider customer group.



Figure 1.3 The Narrative Clip attaches with a metal Clip

The next version of the Narrative Clip, The Narrative Clip 2, will have the feasibility to detach the mount and it is therefore possible to attach another. The main focus is laid on activities that are practiced for a longer period of time thus it is the most useful way to use the Narrative Clip. The possibility to remove the metal clip on Narrative Clip 2 can be seen in Figure 1.4.

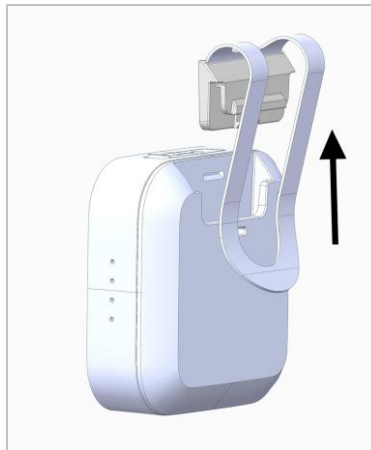


Figure 1.4 Removal of the metal clip on Narrative Clip 2

Hereinafter, Narrative Clip 2 will be mentioned as Narrative Clip even though it is the second version of the camera that is referred to.

1.3 Aims and Purpose

The aim of the thesis is to explore product accessories, mainly focusing on various possibilities to mounts for the camera and possibly product enhancements aimed for the users with an active lifestyle. The thesis will involve interviews with potential customers, analysis of their needs, reasoning and usage scenarios leading up to the design and 3D-print prototyping of a set of proposed accessories to the Narrative Clip as well as possible suggestions for optimizing the clip itself and its user-interaction for the purpose.

1.3.1 Overall Objectives

The terminal goal of the thesis is to create a couple of 3D-printed mounts for the Narrative Clip. The number of various varieties of mounts that will be determinate during the thesis work depends on the numbers of useful concept solutions that is developed.

1.3.2 Scope

A limitation set for the project is the calculations needed. Therefore, calculations managing how the mounts can stabilize bouncing motion are not within the scope of the thesis. Neither are finite element analyses on the external forces of the mounts done. Another limitation set is the impact of weather. It is assumed that the mount and camera is resistant to various weathers, without having to add extra features e.g. rain cover.

Determination of material and manufacturing method is done if time is available.

2 Method

*The product development methodology used in this thesis is substantially according to the book *Product Design and Development* by Karl T. Ulrich and Steven D. Eppinger [2]. In this chapter the steps implemented from Ulrich and Eppinger's product development process will be explained and thereafter, the steps implemented from Bligård's development process. In the last section of the chapter the methodology customized for this thesis will be clarified.*

2.1 Ulrich and Eppinger's Product Development Methodology

Ulrich and Eppinger's product development process is divided into six phases: planning, concept development, system-level design, detail design, testing and refinement and production ramp-up. An illustration of the development process can be seen in Figure 2.1.



Figure 2.1 Ulrich and Eppinger's product development methodology

In this project the most important phase is the concept development phase. Therefore, the concept development phase is explained more thoroughly in the following chapter 2.2 Product Development Methodology - Concept Development. However, the used elements in the other phases of the development process will be explained briefly in this chapter.

2.1.1 Planning

In Ulrich and Eppinger's development process the planning phase only occurs in the beginning of the project where an initial time schedule for the assignment often is compiled. In the planning phase it is also recommended to compile a mission statement. A mission statement consists of the specified market opportunity and a broad direction in which to develop but does generally not specify a precise destination or a particular way to proceed.

2.1.2 Concept Development

In the concept development phase the needs of the target user are identified, alternative product concepts are generated and evaluated and one or more concepts are selected for further refinement and testing. As mentioned earlier, the concept development phase will be explained more detailed in section 2.2.

2.1.3 The Last Steps of U&E Methodology

The last steps of Ulrich and Eppinger's development process are: system-level design, detail design, testing and refinement and production ramp-up. Following is a short description of each step used in this thesis. How well the steps are fully implemented in the thesis depends on the thesis' range and the amount of time available.

2.1.3.1 System-level Design

The system-level design phase includes the definition of the product architecture, decomposition of the product into subsystems and components and preliminary design of key components. The output of this phase usually includes a geometric layout of the product and a functional specification of each of the product's subsystems.

2.1.3.2 Testing and Refinement

In this phase early prototypes, so-called alpha prototypes, are built with parts with the same geometry and material properties as intended for the production version of the product but not necessarily fabricated with the actual process to be used in production.

2.2 Product Development Methodology - Concept Development

As previously mentioned, for this thesis the most important phase in Ulrich and Eppinger's product development methodology is the concept development phase. The concept development phase consists of seven phases: identifying customer needs, establishing target specifications, concept generation, concept selection, concept testing, setting final specifications and planning downstream development. The concept development process can be seen in Figure 2.2. The concept development phase is iterative and therefore, each phase ends with the step "Reflect on the results and the process". The last steps of the concept development: setting final specifications and plan downstream development are only briefly explained as they are not in the range of this thesis. Although, they are the next steps to implement if this thesis' product development would continue.

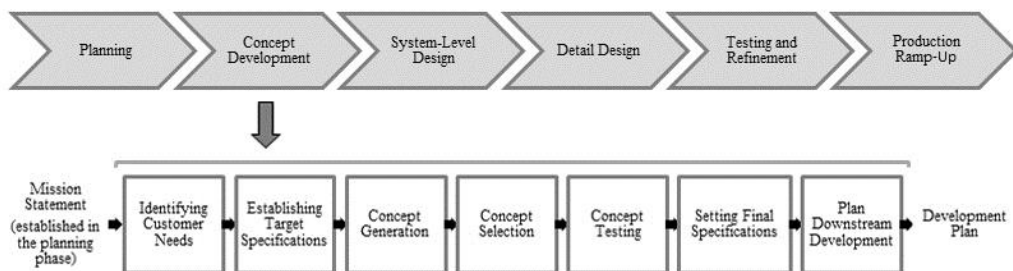


Figure 2.2 Ulrich and Eppinger's concept development process

2.2.1 Identifying Customer Needs

The goal with this phase is to understand the customer's needs. The methodology for doing this is explained in the following three steps: gathering raw data from customers, interpreting raw data in terms of customer need and establishing the relative importance of the needs.

2.2.1.1 Gathering Raw Data from Customers

This step is about gathering high-quality information and data directly from the costumers. This can be done in various ways, but some of the recommended methods are interviews, focus groups and observing the product in use.

2.2.1.2 Interpreting Raw Data in Terms of Customer Needs

After gathering raw data from costumers, the customer needs will be expressed as written statements, which will be done by interpreting the underlying need of the raw data. Each statement will be translated into any number of customer needs.

2.2.1.3 Establishing the Relative Importance of the Needs

This step explains how to establish the relative importance of the customer needs. The outcome of this step is a numerical importance weighting for a subset of the needs. There are two basic approaches to the task. The first approach is relying on the consensus of the team members based on their experience with customers. The second approach is basing the importance assessment on involving customers again through further customer surveys.

2.2.2 Establishing Target Specifications

Target specifications are established to clarify what is needed to achieve in order to satisfy the customer needs. At this stage only the target specifications are set. The final specifications are set at a later stage of the concept development process, based on the limitations of the selected concepts.

2.2.3 Concept Generation

The aim of the concept generation phase is to have a set of concepts from which a final concept selection will be made. The concept generation process contains of the following steps: clarify the problem, search externally and search internally.

2.2.3.1 Clarify the Problem

This step is about developing a general understanding of the problem and breaking it down into subproblems if the design challenge is too complex. This act makes it easier to focus on the subproblems that are the most critical to the success of the product.

2.2.3.2 Search Externally

External search is an information-gathering process, also called benchmarking. The purpose of the external search is to find existing solutions to the problem and/or to the

subproblems. The external search is something that occurs continually throughout the product development process and there are various ways to gather information from external sources examples e.g. interviewing lead users, patent searches, literature searches, competitive benchmarking and expert consultation.

2.2.3.3 Search Internally

Internal search can also be called brainstorming, and it is when personal- and team knowledge and creativity is used to develop various solution concepts. This is the most open-minded and creative step during the development process. Internal search can be done by either working individual in isolation or by a group of people generating concepts together. Guidelines that are useful for improving the internal search process is to generate many ideas and welcome ideas that may seem unfeasible.

2.2.4 Concept Selection

After generating various concepts in the concept generation phase, the concept selection phase is used to narrow the set of concept alternatives under consideration.

2.2.4.1 Concept Screening

The purpose of concept screening is to narrow down the number of concepts quickly and to gain insight in which concepts to improve. The first step is to enter the concepts and selection criteria in a matrix. The selection criteria are chosen based on the customer needs that have been identified, as well as the needs of the company, e.g. low manufacturing cost. The second step is to choose a concept to become the reference concept against which all other concepts are rated. The reference is generally either an industry standard or a straightforward concept with which the development team are very familiar. The third step is to rate the concepts, where a relative score of “better than” (+), “same as” (0) or “worse than” (-). The relative score represents how each concept rates in comparison to the reference concept relative to the particular criterion. At the end of the concept screening a summation and a ranking of the concepts is done giving guidelines of which concepts to develop further.

2.2.5 Concept Testing

When testing concepts the test may be used to select which of two or more concepts which should be pursued, to gather information from potential customers on how to improve a concept and to estimate the sales potential of the product.

The first step of the concept testing is to choose a survey population. This is an important step since if the survey population is either more or less enthusiastic about the product than the eventual target audience for the product will be interferences based on the concept test will be biased. The second step is to collect data through surveys. Common formats for surveys used in concept testing are face-to-face interaction, telephone interviews, postal mail and internet. The third step is to communicate the concept, something that can be done e.g. by verbal description, sketches, photos and renderings and working prototypes or works-like models.

2.2.6 Setting Final Specifications

Setting the final specifications consist of developing a technical model and a cost model of the product. This includes doing trade-offs between technical performance metrics and costs. The output of this phase are the final specifications with marginal and ideal values or the products metrics.

2.2.7 Plan Downstream Development

In this final activity of concept development, a detailed development scheme is compiled, a strategy to minimize development time is devised and the resources required to complete the project are identified.

2.3 Bligård's Development Process

Bligård's development process is similar to Ulrich and Eppinger's development process in many ways [3]. A short explanation of what differs these processes and the steps used in this thesis will be explained in this section. An illustration of Bligård's development process can be seen in Figure 2.3.

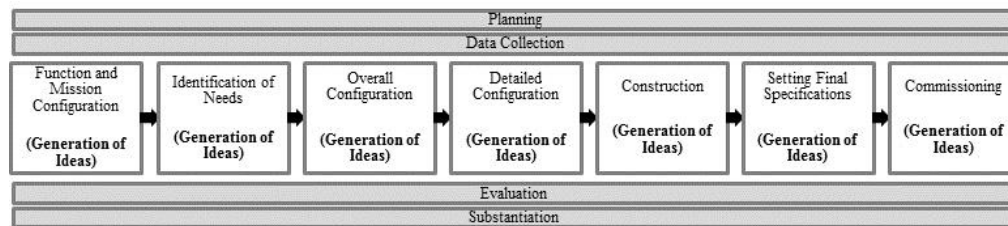


Figure 2.3 Bligård's development process

As seen in Bligård's development process the planning, data collection, evaluation and substantiation phase is done throughout the whole development process. These phases occur during the entire development process and are phases that consequently are updated. The planning and substantiation is done throughout the entire implementation of the thesis and data is constantly updated if there is something forgotten or detected needed. Evaluation of concepts is also done throughout the entire implementation of the thesis and the process is iterative - similar to the methodology of Ulrich and Eppinger.

2.4 Thesis Methodology

The method chosen for the thesis will be explained in this section of the chapter. Overall the method is inspired of Ulrich and Eppinger's concept development phase explained in section 2.2. Moreover, the phases planning and data collection are modified with inspiration from Bligård's development process explained in section 2.3. Also, the concept evaluation steps one and two are modified after discussion with V. Gustafsson [4]. An illustration of the method used for this thesis can be seen in Figure 2.4.

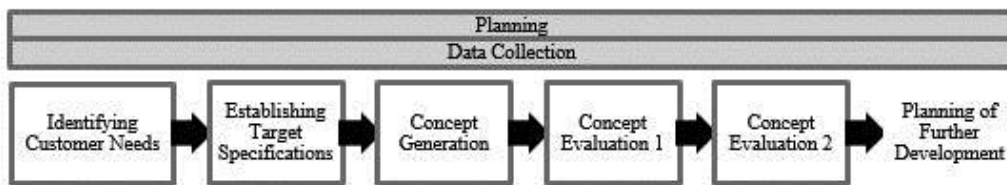


Figure 2.4 The methodology of the thesis

The writers of the thesis were recommended to apply a thesis methodology familiar with since all product development methodologies are more or less alike [5]. Therefore, Ulrich and Eppinger's concept development phase was chosen as the main method in the thesis because the writers of the thesis are very familiar with it. This is also the reason why other product development processes were not discussed and analyzed when choosing method. However, the writers of the thesis saw difficulties in the planning phase of Ulrich and Eppinger as it is only implemented in the beginning of the thesis. Therefore, the writers of the thesis were inspired of Bligård's development process and added the planning and data collection phases to the thesis methodology since these phases are implemented during the entire process and would better suit the work of this thesis.

2.4.1 Planning

The planning phase continues throughout the entire process, inspired of Bligård's development process seen in section 2.3. The phase is starting with setting a primary time schedule for the thesis and as the implementation continues, the time schedule and the planning are constantly updated and tasks are added that are forgotten or detected needed. The major tasks in the planning phase are done in the beginning of the phase e.g. an overall time schedule and compiling general mission statement, see section 2.1.1.

2.4.2 Data Collection

The data collection phase continues throughout the entire process, constantly collecting data from potential users with an active lifestyle and experts within the area. Already existing solutions are also of great importance to the work and will be gathered as inspiration throughout the entire process. The data collection phase is inspired of Bligård's development process seen in section 2.3.

2.4.3 Identifying Customer Needs

The working steps for identifying customer needs can be seen in section 2.2.1.

2.4.4 Establishing Target Specifications

The working steps for establishing target specifications can be seen in section 2.2.2.

2.4.5 Concept Generation

The working steps for concept generations can be seen in section 2.2.3.

2.4.6 Concept Evaluation 1

The concept evaluation 1 phase includes the steps concept selection 1, concept refinement 1 and concept testing 1. The purpose of this steps is to narrow down the concept solutions for the subproblems that were generated during the concept generation phase. Concept solutions will be selected to solve each subproblem by various methods and these concept solutions will thereafter be refined, 3D-printed and tested.

2.4.7 Concept Evaluation 2

The concept evaluation 2 phase includes the steps concept selection 2, concept refinement 2 and concept testing 2. In the second selection, the concepts chosen in concept evaluation 1 narrows down to one concept solution for each subproblem. The choice of the concept solutions will be based on the results from the concept testing 1. Thereafter, further refinement, 3D-printing, assembly of the parts and testing will be done of the whole concept solution.

2.4.8 Planning of Further Development

In the planning of further development phase planning for the continuing work with the thesis will be set. In this phase also determination of material and manufacturing method is done if time is available. Moreover, further testing and prototyping with the chosen manufacturing method will be done.

3 Customer Research

In this chapter the customer research done for the thesis will be explained, from the planning phase to establishing target specifications.

3.1 Planning

The first step in the planning phase was to compile a time schedule over the implementation of the thesis. The time schedule set in the beginning of the planning phase was used as a starting point and was updated as the project proceeded. The set time schedule, with the overtime-added changes, can be seen in Appendix A.

As a second step of the planning phase, a mission statement was formalized. The mission statement was in this step made general due more data was needed to decide in which direction to develop. The general mission statement can be seen as an overall explanation of the problem. It is in this phase not established where the active user wants to attach the Narrative Clip. The general mission statement compiled can be seen in Table 3.1.

Table 3.1 Mission Statement

Mission Statement: Mount for the Narrative Clip	
Product Description	<ul style="list-style-type: none"> • A mount that suits the active user with focus on activities/sports that are exerted for a longer period of time.
Benefit Proposition	<ul style="list-style-type: none"> • More useful placing of the camera (which leads to better pictures) • Lifelogging during physical activity
Key Business Goals	<ul style="list-style-type: none"> • Broaden customer group and field of application • Increase income by selling more products • Interest more retailers
Primary Market	<ul style="list-style-type: none"> • Users with an active lifestyle
Secondary Markets	<ul style="list-style-type: none"> • The everyday user
Assumptions and Constraints	<ul style="list-style-type: none"> • Blurry pictures due to bouncing motion is adopted to the cameras programming • The mount will manage external forces • The mount is resistant to various weathers, without having to add extra features
Stakeholders	<ul style="list-style-type: none"> • Purchasers and users • Manufacturing operations

Mission Statement: Mount for the Narrative Clip	
Stakeholders	<ul style="list-style-type: none"> • Service operations • Sales department • Distributors and resellers

3.2 Data Collection

Data collection was done throughout the entire work of the thesis. Therefore, the data collection done will be explained in each step of the working process respectively.

3.3 Identifying Customer Needs

In this phase the steps implemented to identify customer’s needs will be explained.

3.3.1 *Gathering Raw Data*

To find out what type of mounts potential customers want for the Narrative Clip a survey was sent out to Swedes with an active lifestyle, mainly focusing on activities as biking, hiking, longboarding and alpine sports. These activities were chosen since they are practiced for a longer period of time, which is the best way to use the “lifelogging” feature of the Narrative Clip. The survey sent out can be seen in Appendix A. The questions asked in the survey were compiled by the writers of the thesis to be simple questions giving the most important information of what needs the customers have on the product.

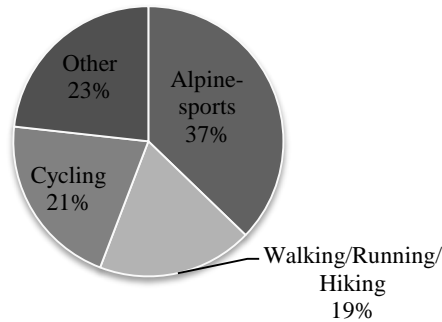
The survey was used as both a customer survey, but partially also as a market survey. This due to various mounts for Narrative Clip do not yet exist on the market and therefore, more information about which focus group to develop for was needed. From the survey information about what activities/sports potential customers exercise, where potential customers want to attach the camera and what parameters people with an active lifestyle see as important was given. Additionally, information about how the potential users want to adjust the settings of the Narrative Clip was given from survey 1. A question about how to adjust the settings was asked to give suggestions for optimizing the clip itself and its user-interaction for the purpose. However, the results do not influence on the development of the product because the majority of the participants of survey 1 wants to adjust the settings of the camera through its app and not through an added button on the camera. Therefore, this information is presented in the final result, see section 5.1.

3.3.2 *Interpret Raw Data in Terms of Customer Needs*

With the information collected from the survey it was clear that the most common activities to practice of the people who answered the survey were cycling, hiking and alpine sports. This information can be seen in Table 3.2.

Table 3.2 An illustration of the most common activities according to Survey 1

What sport/activity are you focusing on when answering this survey?



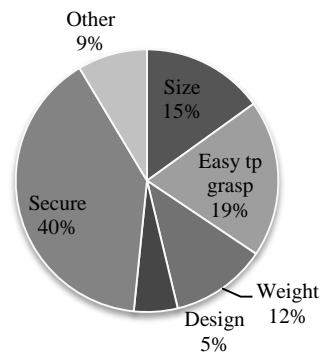
Hence, three separate documents were compiled where raw data was interpreted as customer needs. The documents comprise of customer statements and interpreted needs. These tables can be seen in Appendix C.

3.3.3 Establish the Relative Importance of the Needs

In the sent out survey the participants were asked to choose between six various parameters and answer which one of them they believe is the most important for a mount: secure, design, weight, easy to grasp, size or other. 40% of the participants in the survey believes that the most important parameter for the mount is that it is secure. The parameters weight, size and that the attachment is easy to grasp all approximately share second place as the second most important parameter. A circle diagram illustrating the data collected from the survey can be seen in Table 3.3.

Table 3.3 Illustration of which parameters the participants of survey 1 believes is the most important for a mount

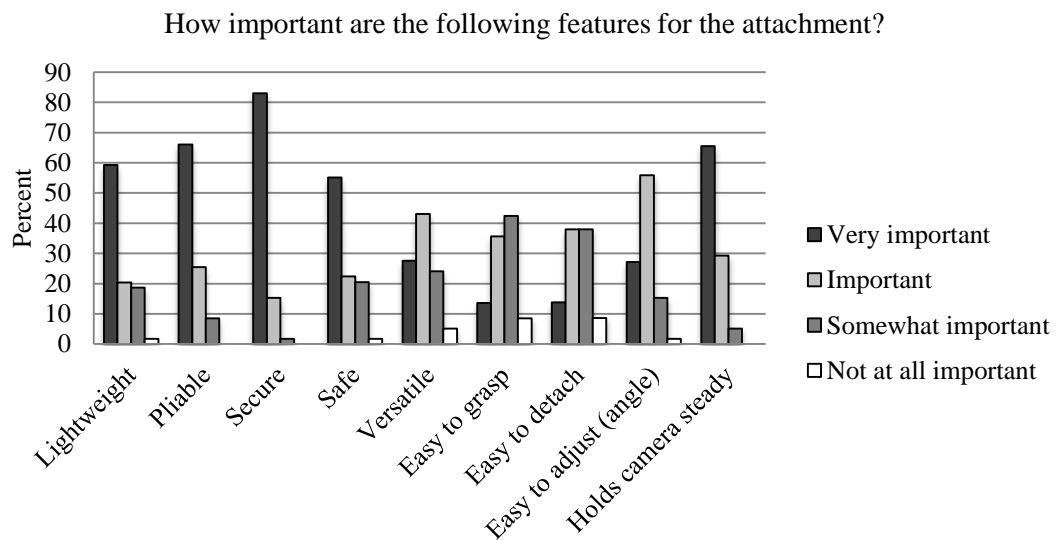
Which parameters do you believe is the most important for an attachment? Maximum of two choices.



With this data, it was given what parameters that are the most important for a mount to meet. However, the parameters given as the second most important were several and therefore, the information of which parameters that are the most important to focus on had to be known. Hence, a second survey was sent out on several activity/sport forums to potential customers; this time focusing on international potential customers since Narrative has its largest market external of Sweden [4]. The aim with survey 2 was to establish the relative importance of the needs. The survey 2 sent out can be seen in Appendix D. The questions asked in survey 2 were compiled by the writers of the thesis as simple questions giving the important information of what customers' needs that are the most important to focus on.

In survey 2, the participants had to rank various parameters with the following options: very important, important, somewhat important and not important. Other parameters were added to survey 2 that occurred while interpreting the data from survey 1 e.g. it was noticed that the parameter secure can have two meanings. Therefore, the parameter safe was added to survey 2. The results of the ranking in survey 2 can be seen in Table 3.4. The weighing of the customer needs were set depending on how high percentage of the participants of the surveys answered for each specific need.

Table 3.4 Chart showing which parameters that are the most important according to the participants of survey 2



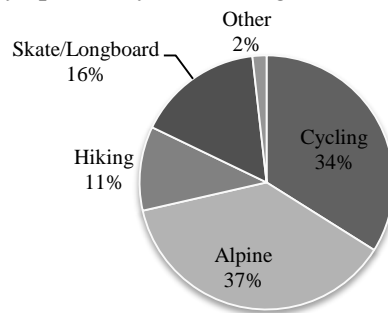
3.4 Establishing Target Specifications

From survey 2, it was given that the most common activities/sports to focus on when answering the survey are alpine sports and cycling, thus 37% of those who answered

the survey answered they exercise alpine-sport and 34% exercise cycling. This can be seen in Table 3.5.

Table 3.5 Illustration of the most common activities/sports to focus on according to survey 2

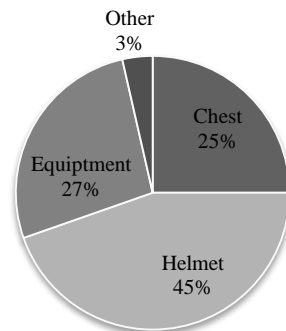
What activity/sport are you focusing on when answering this survey?



45% of the participants of survey 2 believe attaching the camera to the helmet is the best placing for the camera when practicing their activity/sport. The second best placement for the camera, according to the participants of the survey 2, is on the equipment, which 27% of the participants of the survey believe. An illustration of the data can be seen in Table 3.6.

Table 3.6 Illustration of which placement the participants of survey 2 believes is the best for practicing their activity/sport

Which placement do you think is the best for the camera when practicing your activity/sport?



With the data given from survey 1 and 2, it was decided to develop one or more concepts for each of the following:

- Mounts for bicycle handlebars (subsequently mentioned as handlebars)
- Mounts for helmets

3 Customer Research

It was decided to develop a helmet mount since it was the most suitable placing for the camera according to survey 2. Developing a mount for helmets will make the mount usable for many activities/sports since helmets are used in various activities/sports.

It was decided to develop a mount for handlebars because alpine sports and cycling were the most common activities/sports and attaching the camera on the equipment was the second best placement according to survey 2. It was decided to develop a mount for cycling equipment and not for alpine equipment since the helmet mount would be a better choice for alpine sports.

It was decided not to develop a mount attachable to the chest since Narrative's original attachment solution with the metal clip works for that placement.

Also, it was decided to develop two various mounts after consultation with O. Diegel [5], as it was recommended to develop more than one mount when being two writers of the thesis. Moreover, the writers of the thesis saw a need of the both mounts as there is nothing like it on the market and it was clear that there was a need when compiling the customer's needs.

3.4.1 Research of Handlebars and Helmets

Before compiling target specifications and generating concepts for handlebars and helmets, a research about what variations of handlebars and helmets there are on the market was done. Since mounts will be developed for handlebars and helmets, it is important to know the ranges of sizes and shapes of handlebars and helmets there are on the existing market to know for what measurements to develop.

3.4.1.1 Handlebars

Handlebars have a variety of shapes. It is very difficult to say which shape that is the most common because the handlebar pipes can be bent in a lot of various ways, see Figure 3.1. One thing the various handlebars have in common is that their cross-section area is in a circular shape. The range of the diameter size varies depending on the standards in various countries, but is most commonly in the range of 22 – 27 mm [6].

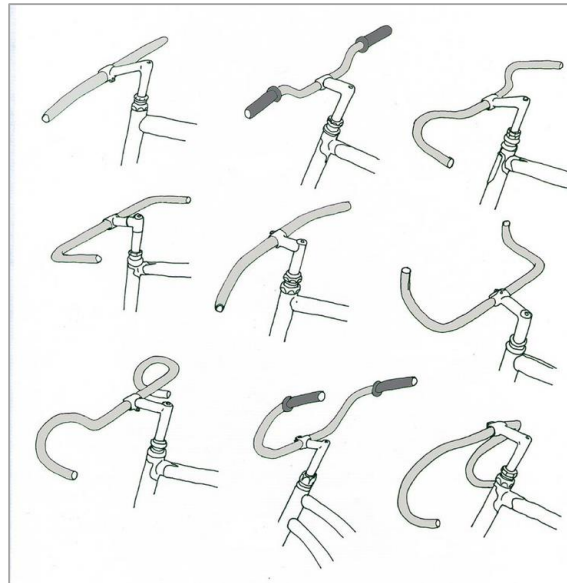


Figure 3.1 Various designs of handlebar shapes

3.4.1.2 Helmets

There are a lot of various shapes and sizes when it comes to helmets, depending on what activity or sport the helmet is used for. After some research, it was obvious that there were three kinds of helmet shapes that are the most common. The most common shapes are helmets with thoroughgoing holes, helmets with vents (holes that do not go through) and helmets without any holes. These shapes of helmets can be seen in Figure 3.2.

If the mount is going to be attachable to all kinds of helmets it is important to have in mind that developing a mount that works on helmets without holes can most likely be attached to a helmet with thoroughgoing holes.



Figure 3.2 The most common helmet shapes: helmets with thoroughgoing holes, helmets with vents and helmets with no holes

3 Customer Research

After having the research done, target specifications for handlebars and helmets were compiled. The lists of needs and their ranked importance can be seen in Appendix E.

The customer needs gave the following specifications to implement when developing the mounts. These specifications are needed in the final concept, making sure to meet the customer's needs.

- Secure
- Small size
- Holds the camera steady
- Rotation possible in the directions seen in Figure 3.3

The following needs are desirable when developing the mounts.

- Pliable
- Attachable to all handlebars/helmets

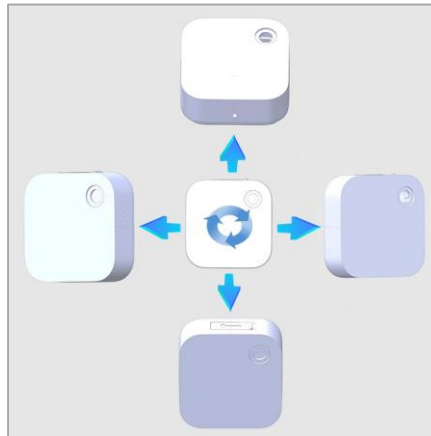


Figure 3.3 The directions it is needed to rotate the camera

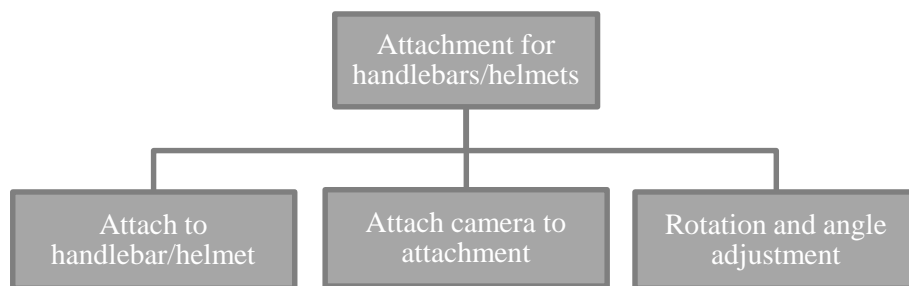
4 Concept Generation

In this chapter the concept generation phase will be explained. It will start with concept evaluation 1 and finish with testing of assembly 2.

4.1 Problem Decomposition

With the customer needs in mind, the concept generation phase was initiated. First, the problem was broken down into subproblems. The decomposition of the problem “attaching to handlebars and helmets” became the same and the problem decomposition compiled can be seen in Table 4.1.

Table 4.1 Figure showing the decomposition of the problem and the subproblems



After discussing the subproblems with V. Gustafsson [4], it was noticed that there already is a solution to the subproblem “Attach camera to attachment”. At Narrative, they already have a snap-fit solution developed for the camera, where various attachments to the Narrative Clip can be attached, see Figure 4.1. The task that now is needed to be solved is where on the mount to use the snap-fit solution and thereby attach the camera. If it is not possible to use the snap-fit as a part of the mount in a good way, another solution will be developed for how the camera will be attached to the mount.

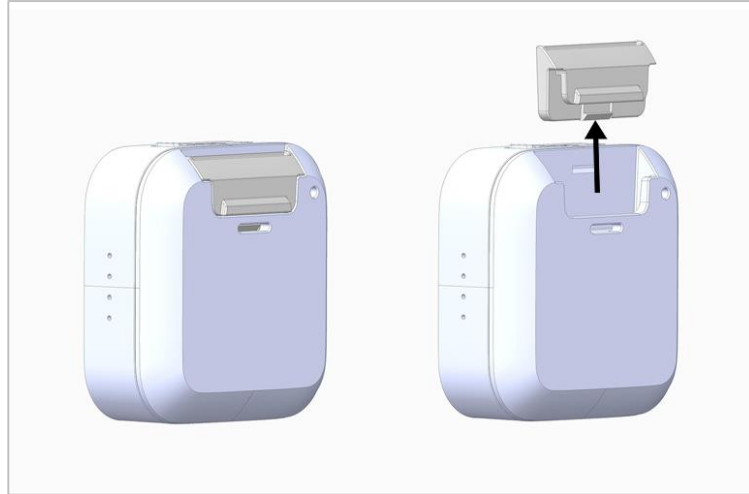


Figure 4.1 The existing snap-fit solution on the Narrative Clip 2

To solve the remaining two subproblems external and internal searches were done for each subproblem respectively. External searches were done by patent searches, expert consultation and searching the internet for existing solutions. Existing solutions that were investigated were other wearable cameras on the market and the versatile camera GoPro and its belonging mounts. Other wearable cameras on the market did not give any inspiration as they do not have any mounts attachable to handlebars nor helmets. However, the GoPro camera have many mounts possible to attach to various equipment in several ways. Although, the GoPro functions differently compared to the Narrative Clip and also the size of it and its mounts is much bigger than the Narrative Clip. Therefore, the existing GoPro solutions only worked as inspiration. External search was also done by being inspired of current solutions in the everyday life e.g. rotation of a doll's arm or adjusting the angle of a table lamp.

Internal searches were done by individual brainstorming and thereafter a collective brainstorming producing several concept ideas. The concepts generated can be seen in Appendix F.

4.2 Concept Evaluation 1

The concept evaluation step includes the steps concept selection 1, concept refinement 1 and concept testing 1 for the subproblems "Attach to handlebar/helmet" and "Rotation and angle adjustment".

4.2.1 Concept Selection 1

The aim of concept selection 1 was to narrow down the number of various concept alternatives for the subproblems "Attach to handlebar/helmet" and "Rotation and angle adjustment".

4.2.1.1 Attach to handlebar/helmet

The aim in concept selection 1 was to narrow down the number of concept alternatives for the subproblem “Attach to handlebar/helmet” to only five concept solutions for handlebars and helmets respectively.

The concept selection was done by a concept screening of the concept alternatives, for handlebars and helmets respectively. The methodology used for concept screening is explained in section 2.2.4.1.

Selected criteria chosen based on the weightings of the customer needs:

- Secure
- Pliable
- Small size
- Holds the camera steady
- Attachable to all diameters/helmets

Selected criteria chosen based on Narrative’s needs:

- Fits into the company’s idiom
- Manufacturing cost
- Simple mechanism

The concept screening for handlebars and helmets can be seen in Appendix G. The concepts decided to continue developing for handlebars were Bendy, Cable tie, 4-velcro, Watch 1 and Buckle. The concepts decided to continue developing for helmets were Side Belt, Tape/Glue, The Hook, Suction Cup and Brads. The sketches of the concepts can be seen in Appendix F.

4.2.1.2 Rotation and Angle Adjustment

Research and brainstorming were done and thereafter sketching of various rotation concepts. The rotation concepts evaluated were e.g. ball-joint, bayonet coupling, hinge and the feature to adjust the height of crutches.

After consultation with V. Gustafsson, O. Diegel, and M. Blixt [4, 5, 11] it was decided to focus on ball-joints as the feature for rotation and angle adjustment. This because it can be designed small and it allows rotation in all directions. Refinement and testing of ball-joints is done in the step Concept Refinement 2. However, the ball-joint do not solve the angle adjustment problem but it was decided to add a solution for angle adjustment on the end of the ball-joint stick e.g. a hinge making it possible to both rotate and adjust the angle of the camera. The hinge will be explained more clearly in the final results.

4.2.2 Concept Refinement 1

The five concepts for handlebars and helmets respectively were 3D-modelled in Creo Parametric. Thereafter, they were partly 3D-printed and built in various materials to give an idea of which concepts that have potential and how well they attach on handlebars or helmets.

At the stage concept refinement 1 only simple designs were compiled and further refinement will be done in concept refinement 2.

4.2.2.1 3D-Printing

3D-printing, or additive manufacturing as it also can be called, is the process of creating three dimensional solid parts from a virtual design. The virtual design is constructed by using a 3D-modelling software or using a 3D-scanner to copy the dimensions of an existing object.

In an additive manufacturing process, the object is created by adding layer by layer of material until the entire object is created. There are several various ways to 3D-print and not all 3D-printers use the same technology. However, all of the various 3D-printing methods use the additive process. The difference between the additive processes is the way the layers are built to create the object e.g. some methods heat up the material until it melts to create the layers and some methods melt the material by using laser.

All the concepts developed were 3D-printed to physical parts to test before deciding which parts that will be included in the final concept. All the concept were 3D-modelled by using the software Creo Parametric 2.0 [7].

Two various kinds of 3D-printers were used to print the various parts during the thesis. The first printer was the Up Plus printer, see Figure 4.2. The Up Plus printer uses the fused deposition modelling method which is when a part is produced by extruding small beads of thermoplastics material to form the layers after extrusion from the nozzle of the 3D-printer. The plastic used to print various parts in the Up Plus printer was ABS plastic [8].



Figure 4.2 The Up Plus 3D-printer

The second 3D-printer that was used during the thesis was the Form1+ printer, see Figure 4.3. The Form1+ printer uses a method called stereolithography, also known as resin printing. With this method the printer creates one layer at a time by hardening a photo-reactive resin with an UV-laser. This method gives a finer surface and a more accurate prototype compared to the Up Plus 3D-printer [9].



Figure 4.3 The Form1+ 3D-printer

4.2.3 Concept Testing 1

In concept testing 1, the simplified prototypes were tested to give an idea of which are functional solutions and what needs to be improved. To test the built prototypes they were attached to handlebars and helmets respectively. Figures showing when they are being tested can be seen in Appendix H. From the testing an idea of which concepts that can be possible solutions were given.

To get further ideas of what concepts to develop further a workshop was compiled. A variety of students from Lund's Tekniska Högskola were participating in the workshop, with the aim to get more insight of which concepts to keep developing. The workshop was initiated with a brainstorming session to see if any other concept ideas than the concepts developed in the concept generation came up. Thereafter, the built prototypes were shown and a session was held where the students were asked to rank and discuss further development of the concepts.

4.3 Concept Evaluation 2

4.3.1 Concept Selection 2

From concept testing 1 it was clear what concepts to develop further.

For handlebars it was decided to develop the features of the concepts Bendy, Cable tie and Watch 1 further. These concepts functions similarly and therefore, a combination of these concepts will be developed further. There are many benefits with these concepts as they are adjustable and can therefore be attached to all diameters of handlebars. The concepts bendy, cable tie and watch 1 can be seen in Figure 4.4.



Figure 4.4 The concepts Bendy, Cable tie and Watch 1

For helmets it was clear that the concept to develop further was the tape/glue concept, see Figure 4.5. The tape/glue concept is the only concept that can work for all helmets and it is also one of the smallest concepts. Double sided tape was chosen as the adhesive method to use since it is the method which have the least possibility to destroy the contact surface when removing the mount. Thus, the aim with the tape concept is to develop it in such design that you want to have it taped to your helmet all the time regardless if you are using the camera or not. It was also mentioned during concept testing that a flat tape-plate is not the optimal design since the helmet is curved. With a flat tape-plate there are many sections of the plate that stick out from the surface and is not in contact with the helmet.



Figure 4.5 The tape/glue concept in a diamond shape and with three legs

4.3.2 Concept Refinement 2

During the Concept selection 2 it was noticed that the concept ideas for helmets and handlebars are possible to combine. Therefore, an idea of only developing one mount possible to attach both on handlebars and helmets came up.

In Concept refinement 2 the concepts chosen in Concept selection 2 were developed more detailed into concepts that were 3D-modelled and thereafter 3D-printed.

The following features are wanted in the final concept:

- One bottom plate that can be attached to both helmets with double sided tape and to handlebars by attaching a strap. If that is not possible, two various bottom plates will be developed; one for helmets and one for handlebars.
- Ball-joint for rotation and angle adjustment.
- A feature making it possible to attach/detach the ball-joint to/from the bottom plate, making it possible to detach the ball-joint and the camera without removing the whole mount from the helmet or handlebar.
- A feature making it possible to attach/detach the camera to/from the mount.

4.3.2.1 Bottom Plate

The concepts for bottom plates were refined in three groups and they will therefore be explained in three separate sections. The sections are called: Bottom plate for both helmets and handlebars, Bottom plate for helmets and Bottom plate for handlebars.

4.3.2.1.1 Bottom Plate for Both Helmets and Handlebars

In this section the concept ideas for bottom plates for both helmets and handlebars will be explained. The concepts Bendy, Cable tie and Watch 1 for handlebars and the tape concept for helmets were combined into a couple of various bottom plate ideas.

▪ **Bottom plate with magnets**

A bottom plate concept with magnets was developed to work for both helmets and handlebars, see Figure 4.6. The idea is that there are two small plates with magnets that sticks on to the helmet with double sided tape. The main bottom plate will also have magnets on its flat sections. The main bottom plate will be attached to the two plates on the helmet with the magnets. To attach the bottom plate to handlebars, the bottom plate can be detached from the helmet and placed on a handlebar then attached securely with a strap, which is attached to the mount through the hole.

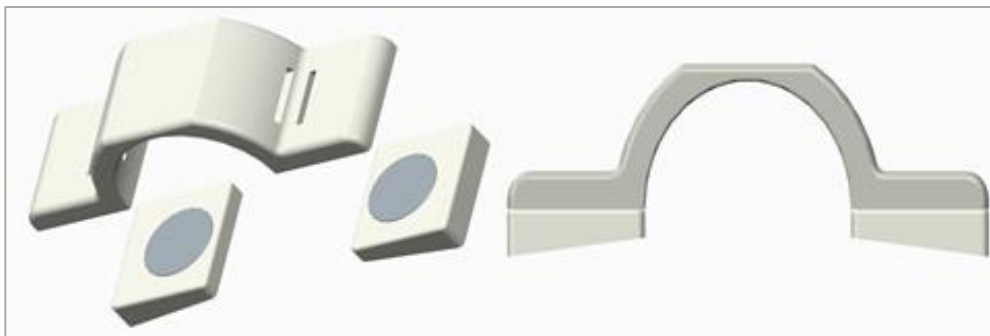


Figure 4.6 Bottom plate with magnets

▪ **Bottom plate with slots**

A bottom plate concept with slots were developed to work for both helmets and handlebars, see Figure 4.7. This concept is very similar to the concept with magnets.

The difference is that the main bottom plate attaches to two small plates on the helmet with two slots. The small plates are attached to the helmet with double sided tape. The plate gets detached from the helmet by pulling it out from the slots. The same bottom plate is attached to handlebars with a strap.

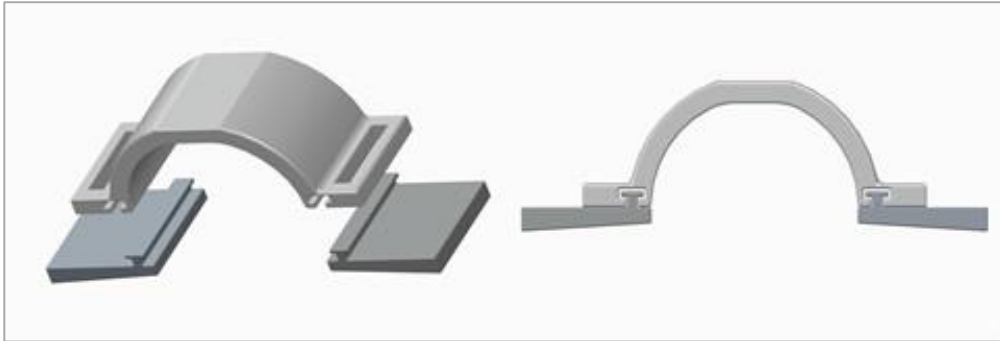


Figure 4.7 Bottom plate with slots

- **Bottom plate with tape**

A bottom plate concept was developed to work for both helmets and handlebars that consist of only one part, see Figure 4.8. The bottom plate have two flat sections where it will be attached to helmets with double sided tape. The plate will get attached to handlebars by removing the whole plate from the helmet and removing the tape and then placing it on the handlebar and attaching it with a strap.

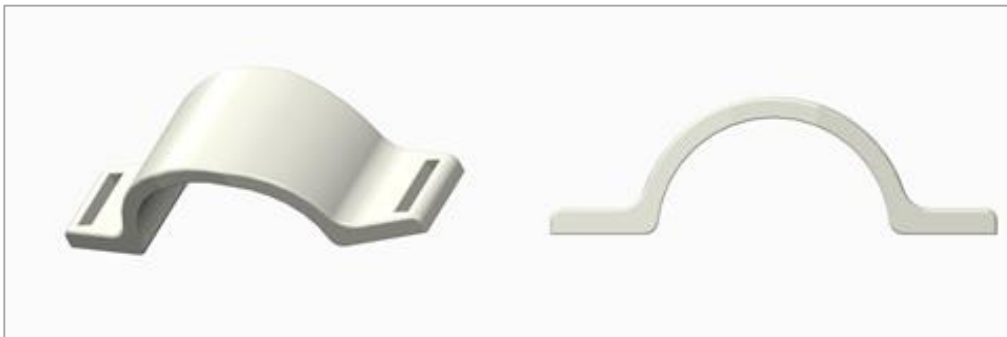
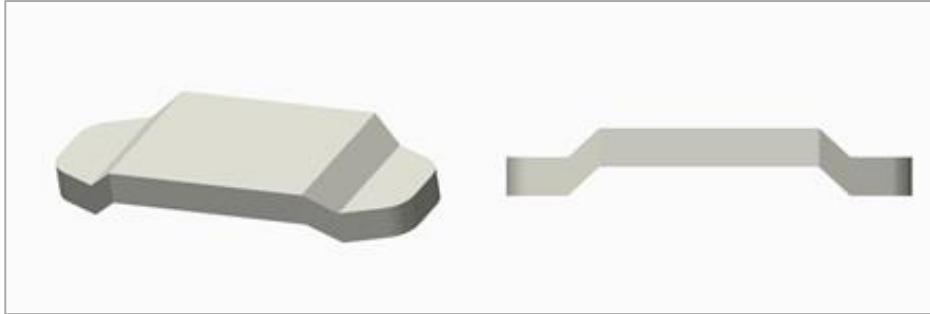


Figure 4.8 Bottom plate with tape

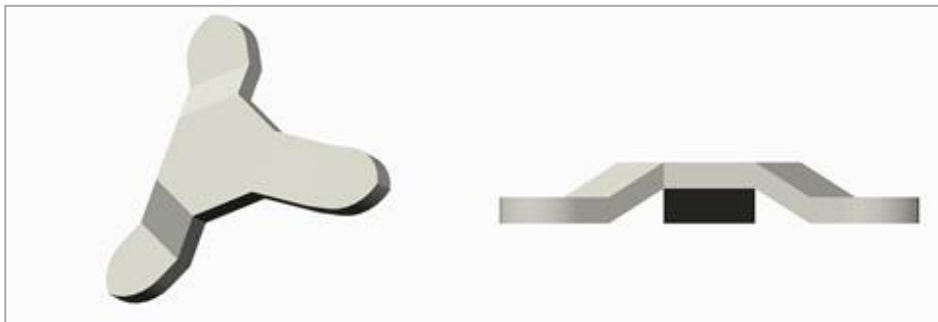
4.3.2.1.2 Bottom Plate for Helmets

Various kinds of bottom plates for only helmets were developed, see Figure 4.9. This was done in case the concepts that were developed to work for both helmets and handlebars are chosen not to proceed with. All the bottom plates for helmets will be attached to helmets with double sided tape since that is the method chosen in concept selection 2. As mentioned in concept selection 2, the plates are chosen to have some elevation making it easier to attach to a curved contact surface.

1. Bottom plate with two legs



2. Bottom plate with three legs



3. Bent bottom plate with two legs



4. Bottom plate with angled legs



Figure 4.9 Various bottom plates numbered 1-4

4.3.2.1.3 Bottom Plate for Handlebars

Various types of bottom plates for handlebars were developed, see Figure 4.10. This was done in case the concepts that were developed to work for both helmets and handlebars are chosen not to proceed with. All of the concept for handlebars will be attached to handlebars with some kind of strap since that is what was chosen to proceed with from the concept selection 2. The difference between the bottom plates for handlebars is the way the strap will be attached to the bottom plate, how to fasten the strap and the diameter of the bottom plate.

1. Circular bottom plate



2. Circular bottom plate with spikes



3. Circular bottom plate with hooks

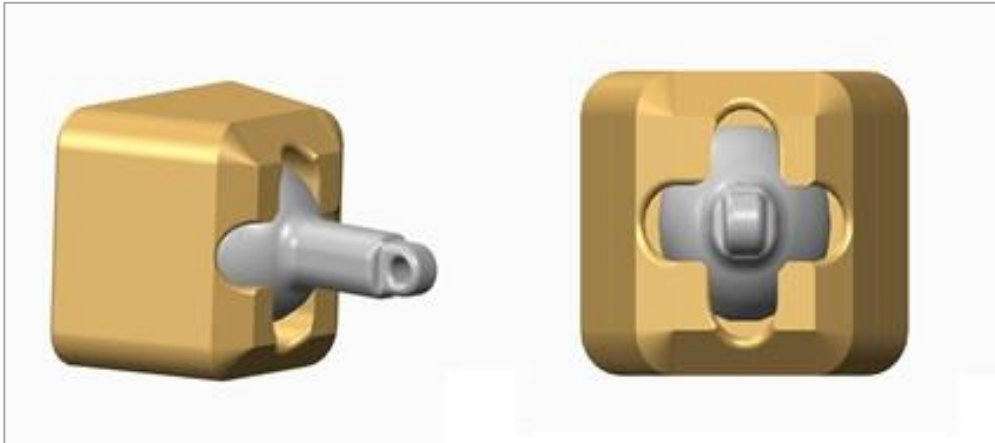


Figure 4.10 Various circular bottom plates numbered 1-3

4.3.2.2 Ball-joint

As mentioned, ball-joints became the chosen feature for rotation and angle adjustment. Various concepts of ball-joints were developed, with the main difference on the top section of the ball-joint where the hole is. Various concepts of ball-joint designs can be seen in Figure 4.11.

1. Ball-joint with two slits



2. Ball-joint with a circular crater



Figure 4.11 Various designs of ball-joints numbered 1-2

4.3.2.3 Attachment of Ball-joint

During the Concept Evaluation 1 it was decided to focus on ball-joints as the feature for rotation and angle adjustment. Various concepts were developed to make it possible to detach the ball-joint from the bottom plate.

- **Snap-fit solutions**

Various kinds of snap-fit concepts were developed as solutions for detaching the ball-joint from the bottom plate, see Figure 4.12. The bottom parts of the snap-fits will be a part of the bottom plate and the top parts of the snap-fits will be a part of the ball-joint. That will make it possible to attach the ball-joint to the bottom plate.

1. Inner snap-fit solution



2. Outer snap-fit solution

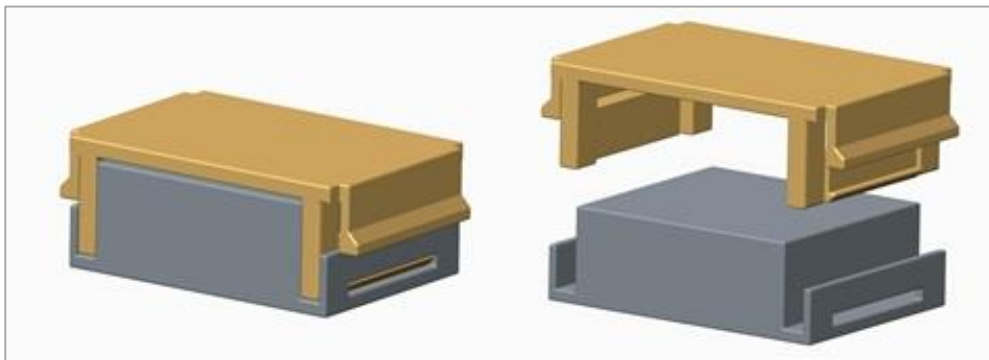


Figure 4.12 Various designs of snap-fit solutions numbered 1-2

- **Magnet solution**

A magnet concept was developed as a solution for detaching the ball-joint, see Figure 4.13. The bottom plate will have magnets on the top surface and the ball-joint will have magnets on the bottom surface. In that way the ball-joint can be attached and detached from the bottom plate.

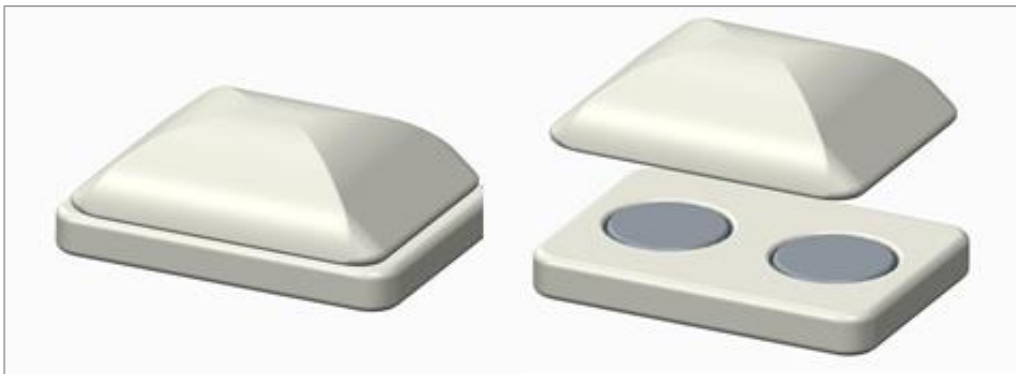


Figure 4.13 Magnet solution

4.3.2.4 Attachment of the Narrative Clip Camera

Various concepts for the attachment of the camera to the mount were compiled. As mentioned, Narrative have already developed a snap-fit solution, see Figure 4.1 in section 4.1, to attach various attachments to the Narrative Clip. However, it is uncertain if the snap-fit that Narrative has developed will be safe enough to hold the camera without dropping it when it is used during an activity where the user is attaching the camera to a helmet or to a handlebar. Some of the solutions for this problem take advantage of the snap-fit that Narrative has developed while some concepts uses a different way to attach the camera to mount.

- **Narrative snap-fit case**

A camera case was developed using the snap-fit that is developed by Narrative, see Figure 4.14. The case is a plate with the snap-fit assembled on it and the camera is attached to the case by using the snap-fit. The plate has a hole in the back for detaching the camera from the case.



Figure 4.14 Narrative snap-fit case

- **Snap-fit case**

A camera case was developed, taking advantage of the snap-fit of the camera, see Figure 4.15. A support is added on the underside of the camera securing that the camera do not fall out of the case. The case is attached by putting the support towards the bottom of the camera and thereafter clipping in the snap-fit. The snap-fit can be untucked by pressing the protruding end of the case.



Figure 4.15 Snap-fit case

- **Camera case with two legs**

A camera case with two legs was developed for the attachment of the camera to the mount, see Figure 4.16. The camera slides into the case from the sides and the case holds the camera from the top and the bottom.



Figure 4.16 Camera case with two legs

- **Camera case with three legs**

A camera case with three legs was developed, see Figure 4.17. The camera can slide into the case from the side or be pushed into the case. The case will hold the camera with the top section and the two bottom corners of the camera. It is important for this case that it is made of a material with a little bit of flexibility otherwise the legs of the case will break when trying to slide or push in the camera.

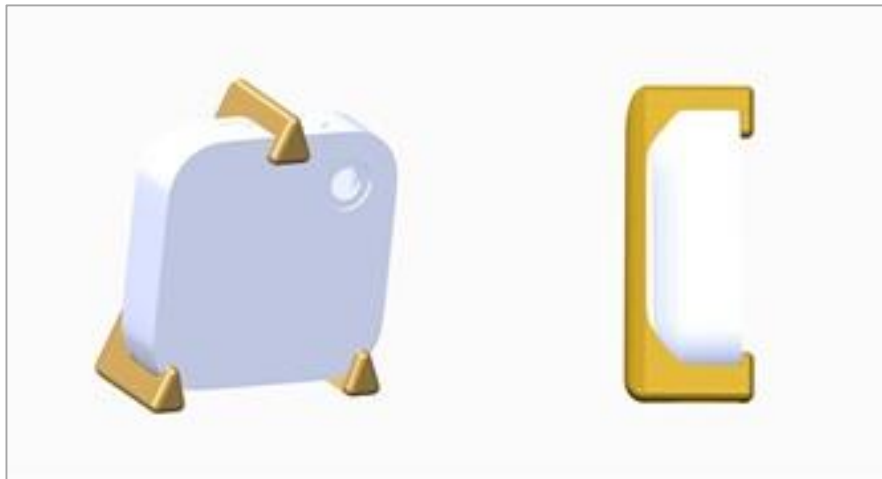


Figure 4.17 Camera case with three legs

- **Camera case with four legs**

A camera case with four legs was developed, see Figure 4.18. The case will hold the camera from every corner. It is also important for this case that it is made of a material with some flexibility so the legs of the case do not break while pushing in the camera.



Figure 4.18 Camera case with four legs

- **Box case with a lid**

A box case with a lid was developed, see Figure 4.19. The camera will be placed inside the box. To make sure that the camera do not fall out a lid will be attached to the box with plugs in every corner, attaching the lid tight to the box case.

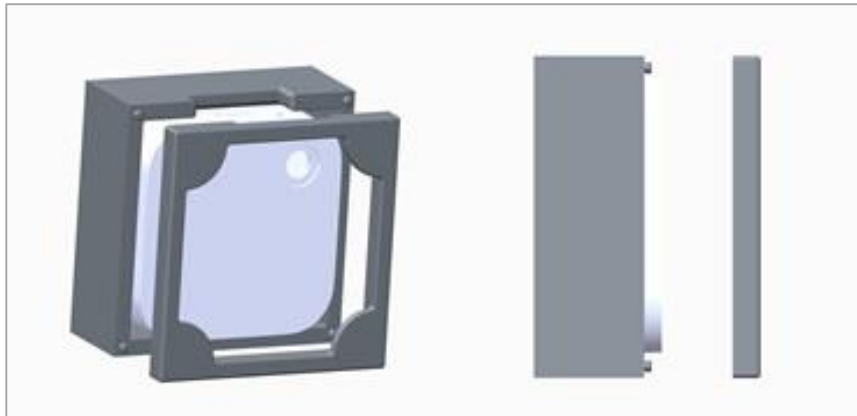


Figure 4.19 Box case with a lid

4.3.3 Concept Testing 2

The concepts from Concept refinement 2 were, after being 3D-printed, tested with varying results. After a lot of discussion about how well the concepts meet the set needs and desires, the following concepts were chosen to apply in the final prototype.

Bottom plate

After the concepts being 3D-printed and tested, it was decided to develop two separate solutions; one bottom plate for handlebars and one for helmets. The combined concepts did not meet the need of being small sized, nor the desire pliable. Consequently, the combined solutions were too clunky. Hence, the solutions chosen were (3) Bent bottom plate with two legs for helmets and (3) Circular bottom plate with hooks for handlebars.

- **Bent bottom plate with two legs for helmets**

This solutions was chosen as it is designed to follow the outer surface of a helmet and is therefore possible to attach firmly with double sided tape. The design of the bottom plate makes it possible to attach it close to the helmet, which also gives an impression of being small size and pliable. The concept did also meet the desire of being attachable to all helmets as it attachable with double sided tape and the geometry follows a common surface of a helmet.

- **Circular bottom plate with hooks for handlebars**

This solution was chosen as the hooks made the elastic strap attach more safely than with e.g. spikes. Although, the hooks makes the solution have a larger size than the other solutions, but the fact that the bottom plate can be attached tight and safe was after discussion prioritized.

Ball-joint

The solution chosen for the ball-joint was (2) Ball-joint with circular crater. Hence, it met the need “Rotation possible in the directions seen in Figure 3.3. The solution (1) Ball-joint with two slits also met the rotation-need, but it was not chosen as the other solution allowed rotation in all angles which was found as even better than just allowing rotation in four directions.

Attachment of Ball-joint

The solution chosen for attachment of ball-joint was the magnet solution. It was chosen as it was presumed to be the solution with the longest lifespan. This was presumed as the size of the snap-fit were made so small that they would break easily when being used during long term use. The solution with magnets can perceive as not being secure enough, but was chosen anyway as it was considered to be innovative.

Attachment of the Narrative Clip Camera

The solution chosen for attachment of the Narrative Clip camera is the snap-fit case. It was chosen as it met the need “secure”. It was noticed during the testing that the camera wobbles a little in the case and therefore, do not meet the need of holding the camera steady. However, adding foam rubber material can level up the dimension variations and reduce the wobbling.

4.3.3.1 Testing of Assembly 1

The assembled solution for helmets can be seen in Figure 4.20 and the assembled solution for handlebars can be seen in Figure 4.21. Assembly 1 was 3D-printed with the Up Plus printer mentioned in section 4.2.2.1.

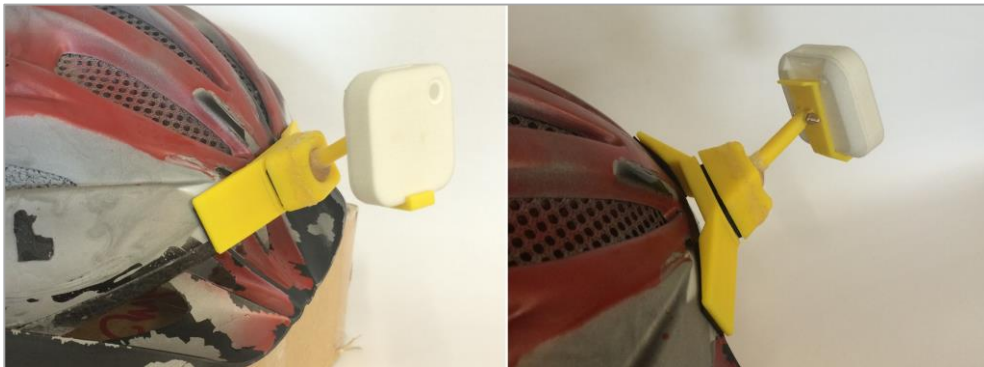


Figure 4.20 The assembled solution for helmets

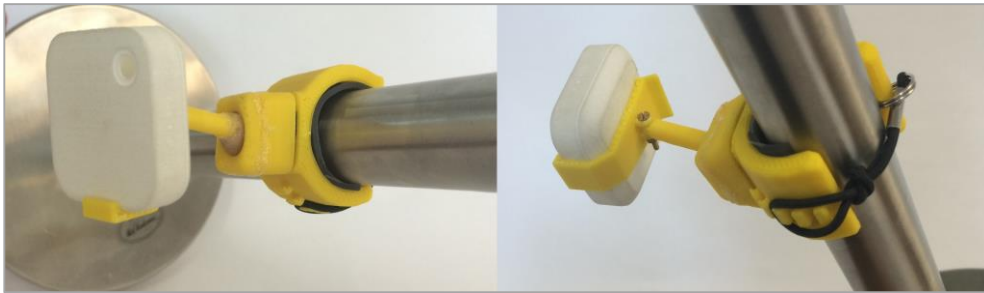


Figure 4.21 The assembled solution for handlebars

The two mounts were tested on various helmets and handlebars. The helmet mount was also tested by placing it on various locations on the helmet. It was placed on the front surface of the helmet, on the top surface of the helmet and on the sides of the helmet. It was also tested on helmets with thoroughgoing holes, with vents and without holes. The handlebar mount was tested on various handlebars with various diameter sizes. It was also placed on various locations on handlebars, some of the locations were curved while some of the locations were straight.

In the testing of the ball-joint, it was assembled with glue. However, it was mentioned that glue is a difficult assembly method and it was also problematic to tighten it enough. It was therefore decided to assemble the parts with screws instead. During the testing it also became clear that the stick on the ball-joint is too long and therefore, will be produced shorter in the final concept.

4.3.3.2 Testing of Assembly 2

After testing of assembled concepts 1 the parts were 3D-printed in a more accurate and better 3D-printer named Form1+ mentioned in section 4.2.2.1. This was done to get better insight of how well the dimensions of the parts are set. The discovered difficulties with the parts in the testing of assembly 1 were fixed before the print. Assembly 2 attached to a helmet can be seen in Figure 4.22 and attached to a handlebar in Figure 4.23. Now the ball-joint is assembled with screws, screwed in from the bottom of the ball-joint. Moreover, the stick is shorter and a logotype is added on both bottom plates, see Figure 4.24 and Figure 4.25. As the resin used for this print is transparent, the logotype will be more noticeable on the final prototype where the plastic will not be see-through.

In the testing of the assembled concepts 2, it became clear that the final mount concepts will have to be constructed in plastics with better elasticity than the plastic used in assembly 2. Plastic with better elastic properties would attach more easily to various ranges of handlebar diameters and various curved helmets.

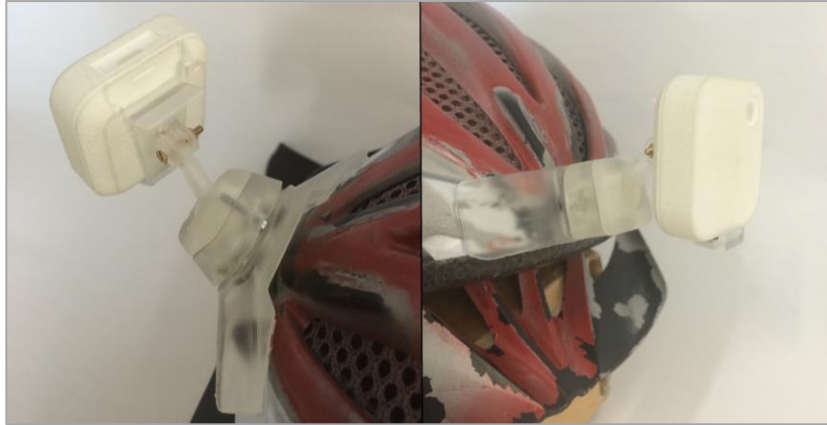


Figure 4.22 Assembly 2 tested on helmets



Figure 4.23 Assembly 2 tested on handlebars



Figure 4.24 The logotype on the bottom part for helmets



Figure 4.25 The logotype on the bottom part for handlebars

5 Final Result

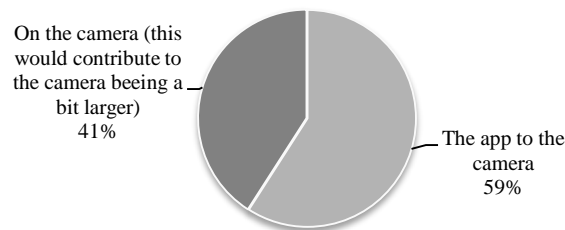
In this chapter the result of the thesis will be explained; starting with suggestions for optimizing the Clip itself for the active user, to an explanation of the various parts and features of the final prototype.

5.1 Optimization of Narrative Clip for the Active User

In Survey 1, a question investigating how potential future users would like to adjust the settings of Narrative Clip was asked, see Table 5.1.

Table 5.1 A question investigating how potential future users would like to adjust the settings of Narrative Clip

If the camera would have a "normal mode" and a "activity mode" (which takes better pictures in fast moving motion). Where would you like to adjust this setting?



As seen in the circle diagram, the majority of the participants in Survey 1 would like to change the settings of which mode to use through the app to the Narrative Clip. Therefore, no extra button where to activate the activity mode is added to the final prototype.

5.2 Presentation of the Final Concept

The final result includes the following features:

1. A bottom plate that is attachable on handlebars by friction and an elastic strap
2. A bottom plate that is attachable on helmets with double sided tape
3. A ball-joint that is attachable/detachable to the bottom plates with magnets
4. A snap-fit case for the camera that is attachable to the ball-joint with plugs

5 Final Result

The final prototype for helmets and the final prototype for handlebars can be seen in Figure 5.1. An extracted version of the final prototypes can be seen in Figure 5.2.

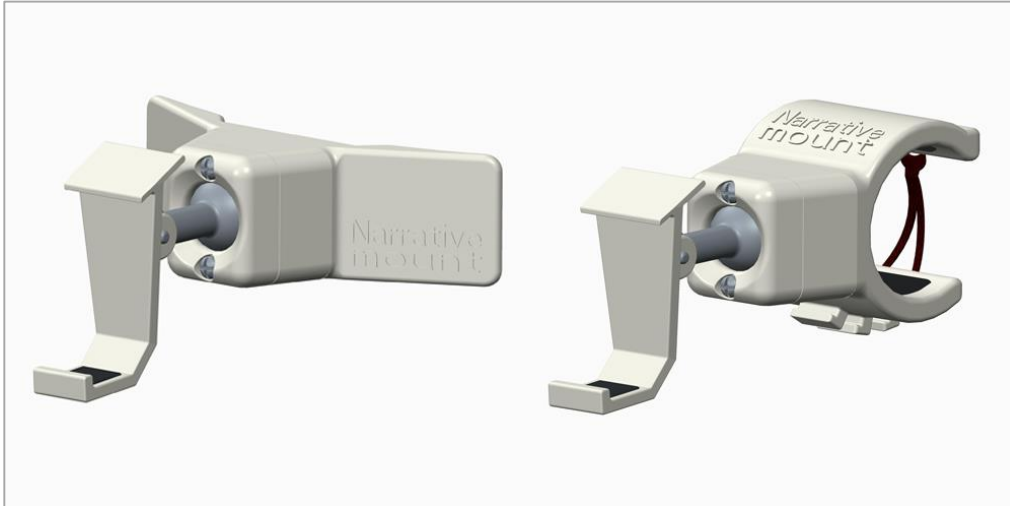


Figure 5.1 The final prototype for helmets to the left and for handlebars to the right



Figure 5.2 An extracted version of the final prototypes

5.2.1 Bottom Plate for Handlebars

The bottom plate chosen as the final concept for handlebars was the circular bottom plate with hooks. The bottom plate will have a circular shape with an inner diameter of 24 millimeters and an outer diameter of 32 millimeters. The bottom plate attaches by snapping it on to handlebars and an elastic strap is used to tighten it, see Figure 5.3.

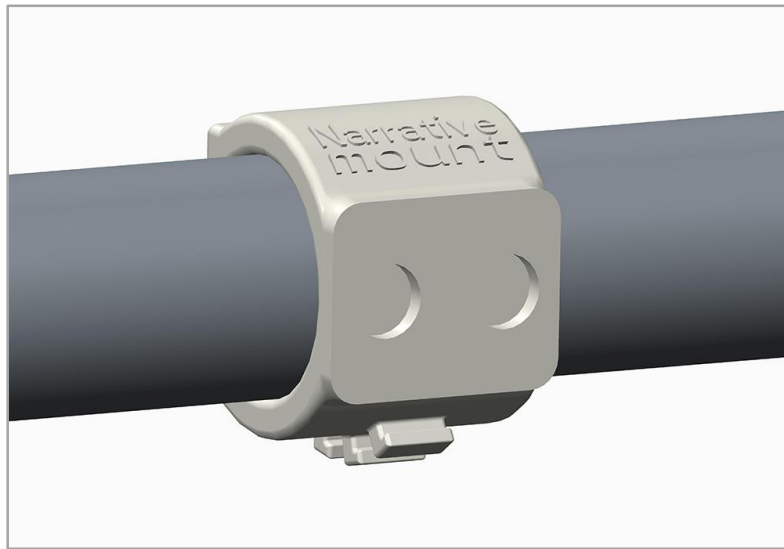


Figure 5.3 The bottom plate for handlebars attached to a handlebar

The bottom plate is equipped with three hooks on one of the curved sides. When attaching the bottom plate to a handlebar, the elastic strap latches on to one of the hooks. Which hook that the elastic strap latches on to depends on the diameter of the handlebar and should be chosen so the bottom plate is attached firmly. By having three hooks the bottom plate can be adjusted to fit various handlebar diameters, see Figure 5.4. Even a thin elastic strap will function properly in securing the bottom plate and therefore, it was decided to use a thin elastic strap instead of a thick elastic strap as it is less visible.



Figure 5.4 The bottom plate for handlebars is equipped with hooks, making it adjustable to various handlebar diameters

On top of the bottom plate there is a flat surface with two holes, where magnets are assembled, see Figure 5.5. It is towards this flat surface where the ball-joint and

consequently, also the camera case will be attached with magnets. This feature will be explained more thoroughly in section 5.2.3.



Figure 5.5 Two magnets on the flat surface of the bottom plate, where the ball-joint and the camera case will be attached

The bottom plate will have a cut-out on the inner surface where foam rubber will be added, see Figure 5.6. The foam rubber will increase the friction between the bottom plate and the handlebar, preventing the bottom plate losing from the handlebar. Moreover, it will be possible to adjust the bottom plate by adding an extra layer of foam rubber, making it attach better to handlebars with small diameters.

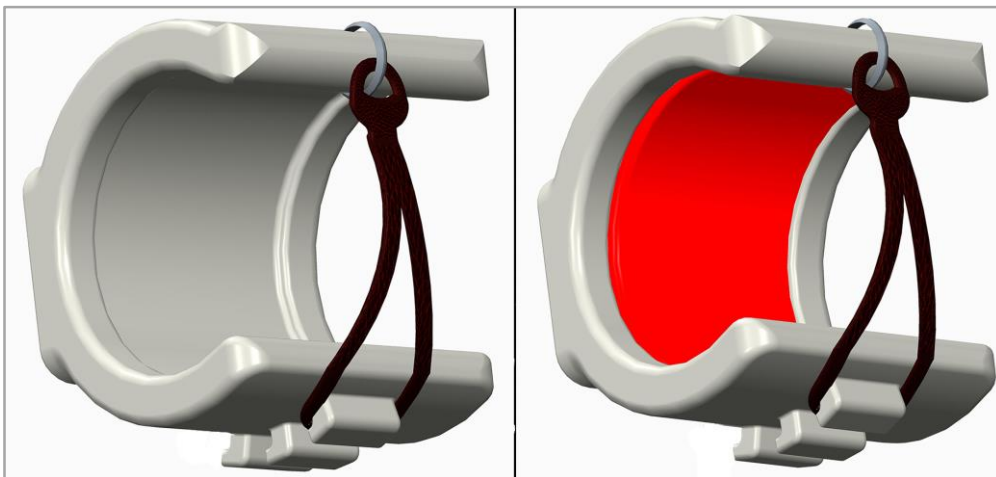


Figure 5.6 Foam rubber is added on the inner surface of the bottom plate for handlebars

The rubber strap is attached to a thin metal ring, which in turn is attached to the bottom plate, see Figure 5.7.

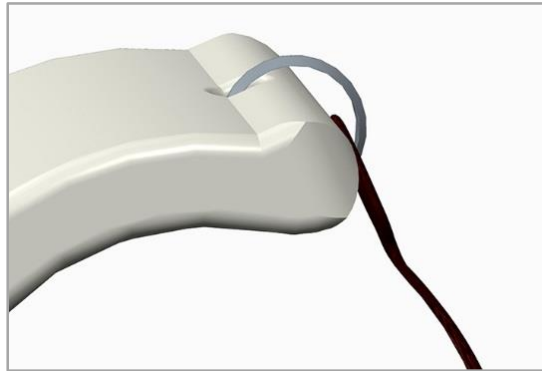


Figure 5.7 The metal ring attached to the bottom plate for handlebars

The curved side of the bottom plate where the metal ring is attached is designed to be five millimeters longer than the opposite side, avoiding the metal ring being jammed between the handlebar and the bottom plate when attached, see Figure 5.8.

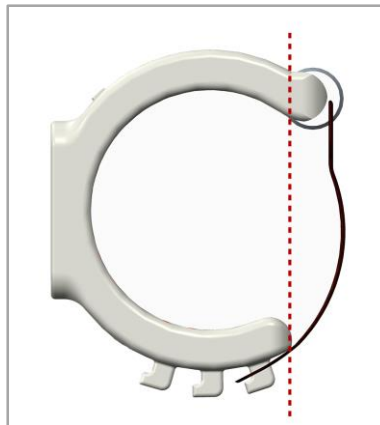


Figure 5.8 The curved side where the metal ring is attached is five millimeters longer

A logotype is added to one of the curved sides of the bottom plate, showing the company's and the product's branding, see Figure 5.9 .



Figure 5.9 Logotype on the bottom plate for handlebars

5.2.2 Bottom Plate for Helmets

The bottom plate chosen as the final concept for helmets was the bottom plate with two angled legs, see Figure 5.10. The bottom plate is angled so that it follows the outer surface of an average helmet, see Figure 5.11. This makes the helmet mount attachable to various locations of various helmets, making it easy to place the mount on the most suitable location depending on the activity/sport.

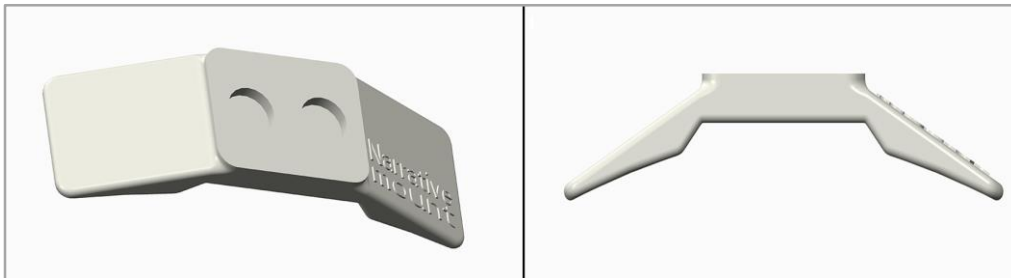


Figure 5.10 The bottom plate for helmets



Figure 5.11 The bottom plate for helmets attached to the surface of a helmet

The bottom plate will be attached to helmets with double sided tape. On the bottom side of the plate there are two flat surfaces where double sided tape is placed, see Figure 5.12.

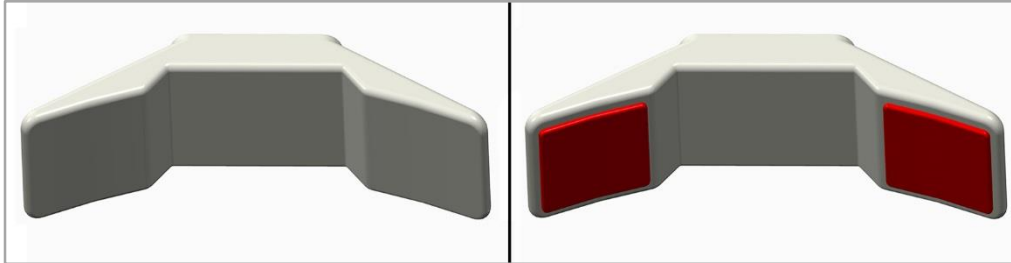


Figure 5.12 The bottom plate for helmets is attachable with double sided tape

On top of the bottom plate there is a flat surface with two holes, where magnets are assembled, see Figure 5.13. It is towards this flat surface where the ball-joint and consequently, also the camera case will be attached with magnets. This feature will be explained more thoroughly in section 5.2.3.



Figure 5.13 Two magnets on the flat surface of the bottom plate, where the ball-joint and the camera case will be attached

Since the bottom plate is attached to helmets with double sided tape it will be taped to the helmet even when the camera is not used. Therefore, the bottom plate chosen have a simple design making the bottom plate as discreet as possible.

A logotype is added to the bottom plate, showing the company's and the product's branding, see Figure 5.14.



Figure 5.14 Logotype on the bottom plate for helmets

5.2.3 Ball-joint

The feature of a ball-joint makes it possible to rotate the camera in all directions. The ball-joint consists of three parts: a ball with a protruding stick, a bottom section and a top section. The ball is placed in the crater of the bottom section before the top section is placed above it, see Figure 5.15. The ball have a diameter of 12 millimeters.



Figure 5.15 How the ball is placed in the ball-joint

The top section and the bottom section are assembled by two M2 screws from the top surface into the bottom section, see Figure 5.16. The top section have two holes on the top surface, avoiding having the screws sticking up above the top surface of the ball-joint.

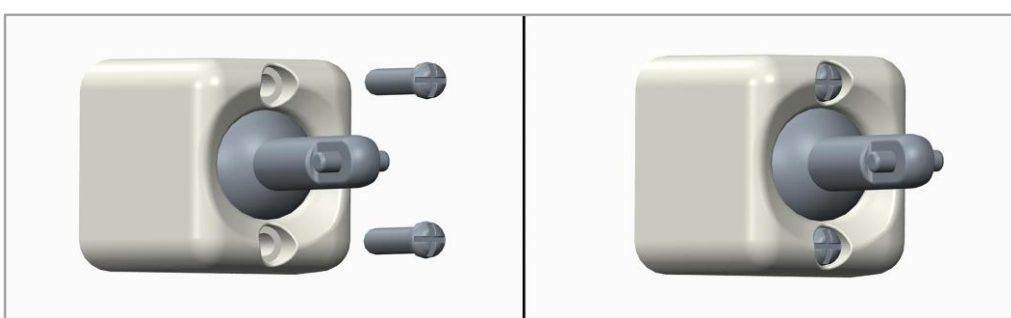


Figure 5.16 The ball-joint is assembled with two M2 screws

Under the bottom section of the ball-joint, there is a flat surface with two holes where magnets are assembled, see Figure 5.17. It is towards this flat surface the ball-joint can be attached to the bottom plates.



Figure 5.17 Magnets on the underside of the ball-joint

The feature of a ball-joint makes it possible to adjust the position of the camera in all directions. The ball-joint also allows rotation of the camera, making it possible to choose between portrait and landscape orientation when taking pictures, see Figure 5.18.



Figure 5.18 The rotation possible with a ball-joint

5.2.4 Snap-fit Case

The solution for attaching the camera to the mount chosen for the final concept was the snap-fit case, see Figure 5.19.

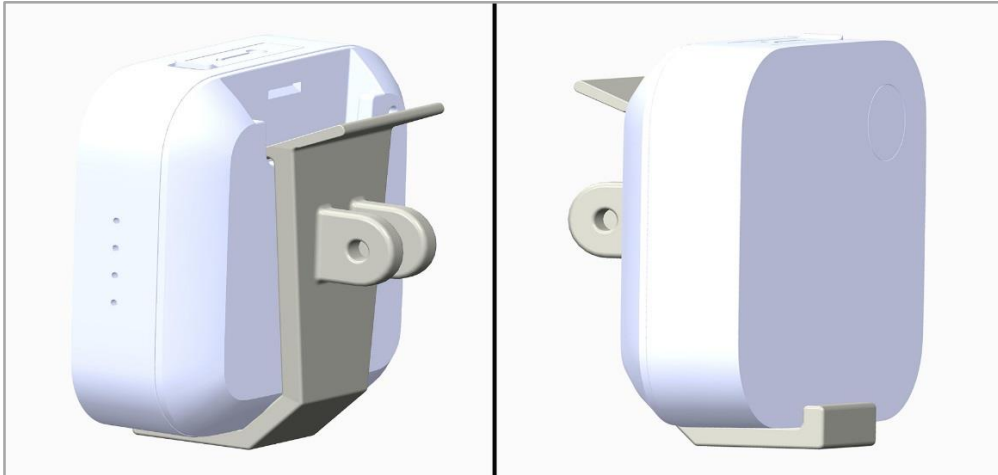


Figure 5.19 The snap-fit case

The snap-fit case is taking advantage of the snap-fit of the camera, with a supporting shelf added on the underside of the camera securing that the camera do not fall out of the case.

Foam rubber is added on the top section of the shelf to hold the camera firmly. The foam rubber will increase the friction between the camera and the case, preventing it from wobbling in the case. With this case the mount holds the camera steady and the camera will not fall out during use, see Figure 5.20.

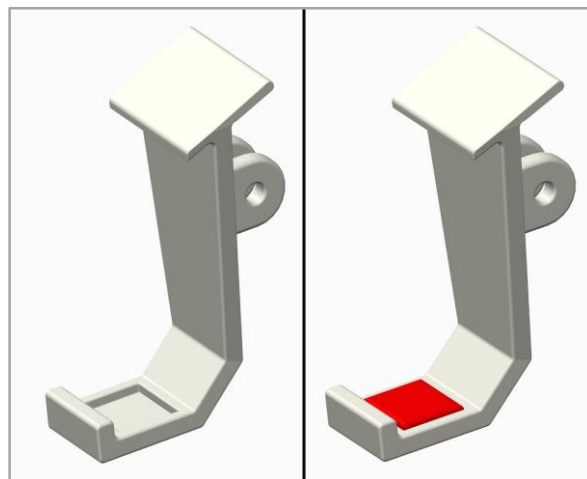


Figure 5.20 Foam rubber added to the snap-fit case, preventing the camera from wobbling

The snap-fit case is attached by pushing the shelf towards the bottom of the camera and thereafter pressing the protruding material up until clipping into the snap-fit. The snap-fit can be untucked by pressing the shelf up towards the camera so the rubber is pressed together, see Figure 5.21.

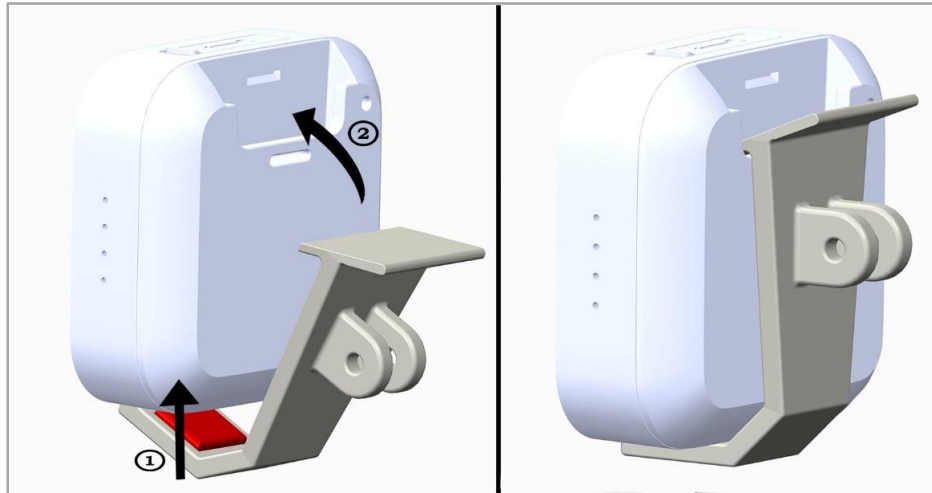


Figure 5.21 How to attach the snap-fit case

The Narrative Clip has a unique design on its back section with the back section a little angled. The case is designed to fit the geometry of the camera, making it easy to attach the camera to the case, see Figure 5.22. The case has the shape for aesthetic reasons too, as it follows the camera's shape and design.

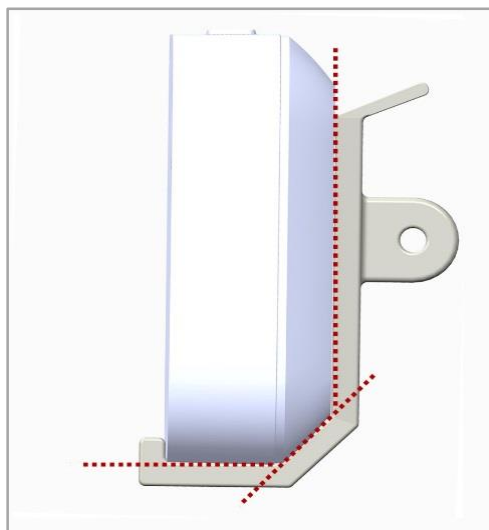


Figure 5.22 The geometry of the case is following the geometry of the camera

The case has two anchors on its back where the ball-joint will be attached, see Figure 5.23.

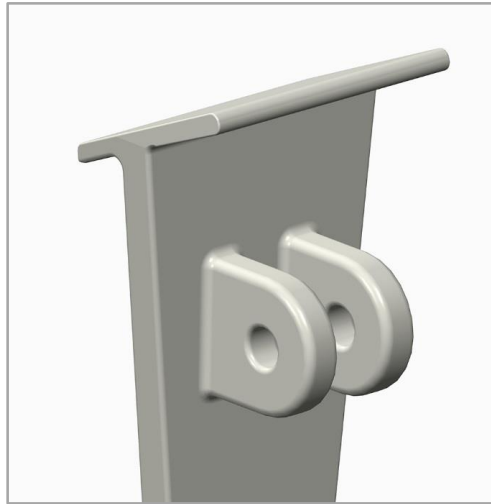


Figure 5.23 The anchors on the back of the case

The case is attached to the ball-joint by pressing the plugs on the ball-joint stick between the anchors. The plastic's elasticity will let the anchors be pressed sideways until the ball-stick is pressed through to the holes. The plugs will keep the case in place by friction against the anchors, see Figure 5.24. The anchors will function as a hinge, making it possible to angle the camera to the desirable position. Adjusting the camera's angle will be needed after as the ball-joint only adjusts the camera's direction, see Figure 5.25.

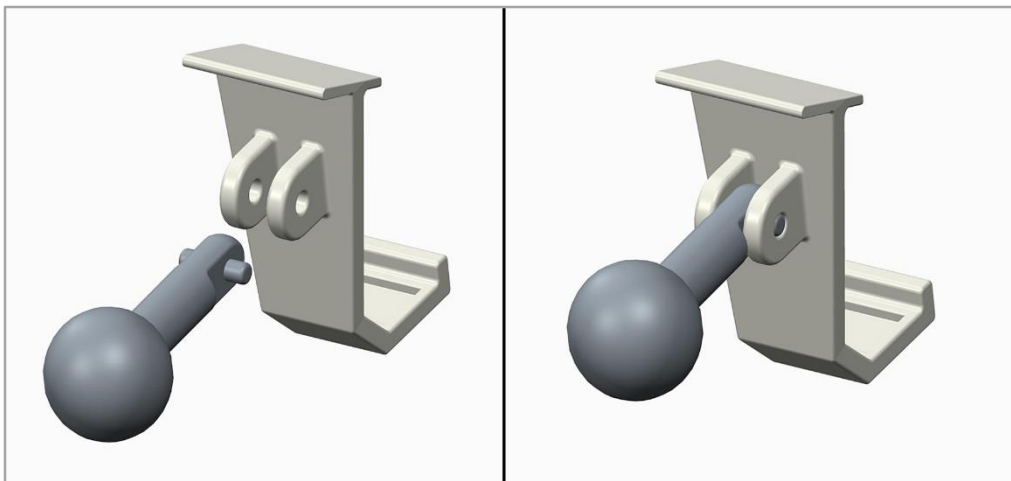


Figure 5.24 The ball-joint attaches to the case with plugs

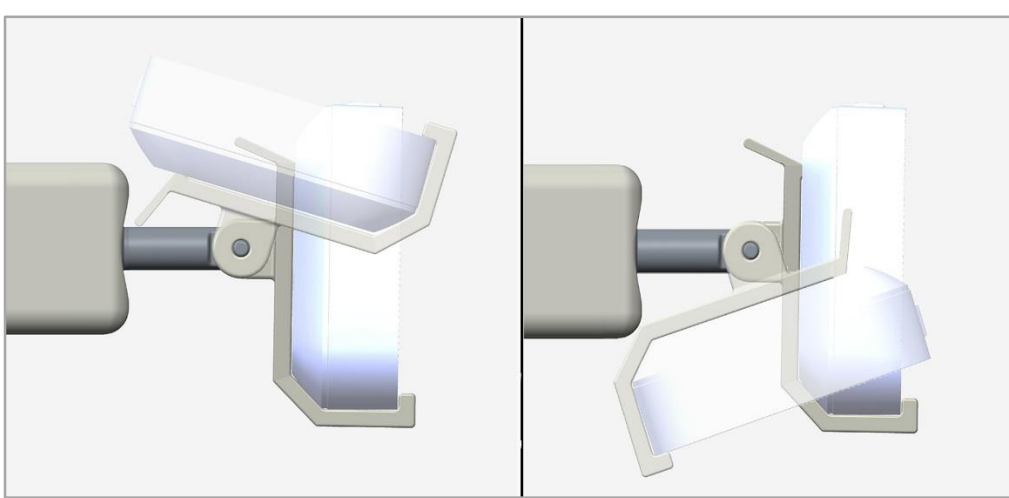


Figure 5.25 Angle adjustment of the camera

5.2.5 The Final Concepts in its Correct Environment

Pictures of the final concepts used on helmets and handlebars can be seen in Figure 5.26 and Figure 5.27.



Figure 5.26 The final concept for helmets used on a helmet

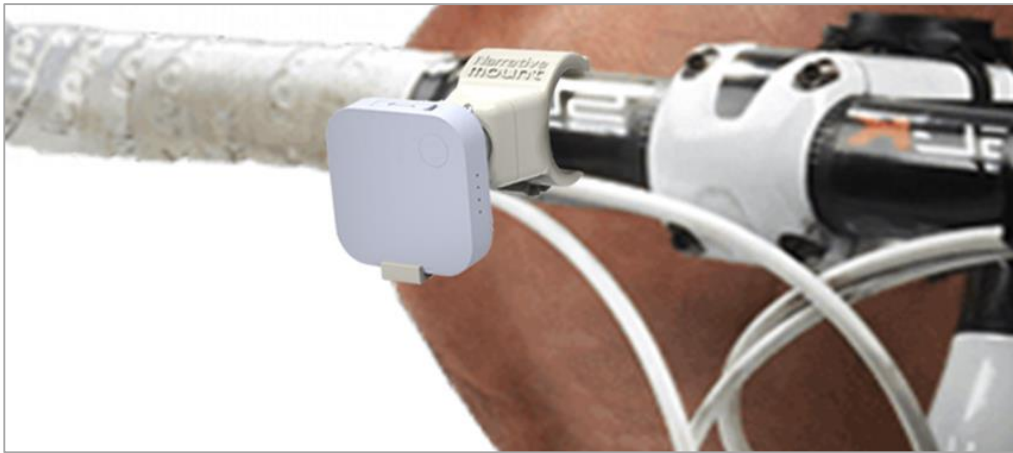


Figure 5.27 The final concept for handlebars used on a handlebar

5.3 Final Concept Evaluation

The following specifications were compiled as needed from the customer needs when developing the mounts: secure, small size, holds the camera steady, rotation possible in the directions seen in Figure 3.3. It is very important that these specifications are met so the product answer for the needs of the end-user. Following is a review of how well each need is met.

✓ **Secure**

The added shelf on the underside of the snap-fit case shelf along with the snap-fit makes the case secure. The camera cannot fall out of the case during use, unless the case breaks. The added shelf also give an impression to be secure because of having something holding the camera from the underside. Consequently, the specification of the mounts being secure is met.

✓ **Small-size**

It is difficult to determine if the mounts are small-sized or not as it is relative. In this case the size of the mounts will be compared to the size of the Narrative Clip. As the mounts are in the same size-range as the Narrative Clip, it can be determined that they are small-sized. Consequently, the specification of the mounts being small-sized is met.

✓ **Holds the camera steady**

The added foam rubber on the shelf of the snap-fit case holds the camera steady, preventing it from wobbling. Consequently, the specification of the mounts holding the camera steady is met.

✓ **Rotation possible in the directions seen in Figure 3.3**

The mounts contain of a ball-joint equipped with a crater, making it possible to rotate the camera in the directions seen in Figure 3.3. Consequently, the specification of the mounts being possible to rotate is met.

The following needs were compiled as desirable when developing the mounts: pliable and attachable to all handlebars/helmets. It is important that these specifications are met. However, the desires are not as important to be met as the needs. Following is a review of how well each desire is met.

✓ **Pliable**

The mounts are developed to be withy and not contain accumulations of material. Since the mounts are not considered to be clunky, the desire of the mounts being pliable is met.

✓ **Attachable to all handlebars/helmets**

On the mount for handlebars the diameter size can be adjusted depending on how tight you attach the strap. Also, when producing the handlebar mount in another manufacturing method than 3D-printing, the plastic used will have better elastic properties and therefore, be more flexible and manage a larger range of diameter sizes. If the mount do not attach tight enough, it is always possible to add an extra layer of rubber material by the inner surface of the mount holding it firmly.

As the mount developed for helmets is attachable with double sided tape it can be attached to any helmet; with or without thoroughgoing holes. Although, because of the geometry of the bottom plate the mount will attach better to helmets with an arched shape without holes. Consequently, the specification of the mounts being attachable to all handlebars/helmets is met.

Since the ball-joint and the camera case can be removed from the bottom plates with the uniting magnets, the ball-joint and the snap-fit case can be re-used for other bottom plates developed for other purposes and/or locations. Narrative can therefore develop new products by only developing new bottom plates. For this reason, and also because of the need of having the products small sized and pliable, the ball-joint and the snap-fit case are developed to be a small, wieldy solution that can be used in other fields of application as well.

The hinge used for adjusting the angle of the camera and attaching the snap-fit case to the ball-joint was not 3D-printed since it is very difficult to print with such accuracy. Also, the material used for the 3D-printer did not have the properties that is required to make the hinge work with plugs. However, it was still decided to develop a hinge with plugs instead of a screw and a nut after consultation with O. Diegel [5], as it will function properly when constructed in a proper material.

As mentioned, using magnets as the assembly method between the bottom plates and the ball-joint is an innovative solution which makes it possible to change the field of

application for the camera by changing the bottom plate. However, there are difficulties with having magnets in an assembly. When assembling the magnets to the bottom plates and the ball-joint, the magnets gravitate towards each other making it difficult to glue the magnets in place. Furthermore, when assembling the screws they will also gravitate towards the magnets making it difficult to keep them in place. This problem can be minimized when choosing assembly-setup. Further discussion for solving this problem can be read in section 5.4.

Screws was the chosen method to assembly the ball-joint as it is a simple assembly method, where the tension can be adjusted depending on how firmly you tighten the screws. This makes it easy to adjust the tension to get the ball-joint to work perfectly. As mentioned in Section 4.3.1, earlier in the development process, the ball-joint was assembled with glue; an assembly method that is more difficult to handle and to attach tight enough. Another way to assemble the ball-joint could be to develop the ball-joint in only two parts; with the bottom section and the top section united as one part. Hence, the ball-joint would be produced in a flexible material and the ball-stick would be pushed through the hole on the top section until it attaches as a snap-fit. However, this is not fully tested and is only explained as a concept modification.

5.4 Further Development

There are several areas that need to be researched further to transfer the concept into a product. Because of the time limit for the thesis the final concept has only been developed conceptually.

During Concept testing 1 and 2, a 3D-printed version of the Narrative Clip was used to test the mounts. Thereafter, the mounts were further developed and minor changes were made so that the camera could be attached firmly. The next version of Narrative Clip, which the mounts are developed for, is not yet released on the market and the final design of it is not completely set. Hence, minor adjustment of the measurements of the mounts might have to be done after testing it with the fully developed Narrative Clip 2, and not with the 3D-printed version of it. The changes between the 3D-printed version of the camera and the fully developed camera will probably be few and minor, so there will not be any major changes that will have to be made.

Calculations managing how the mounts can stabilize bouncing motion and finite element analyses on the external forces of the mounts were not done in this project because of the time limit. However, these areas require additional effort and are of great importance for the concepts to become products. Information that will be provided by executing these calculations and simulations is for example how the mounts will handle collisions as it is important that the mount do not hurt the user in an accident. There are possibly simple solutions to reduce the risks of the external forces, e.g. by adding edges to the magnet sections of the bottom plates and adding a cut-out slit on the magnet section of the ball-joint, which can reduce the effect of horizontal and vertical forces on the magnets. However, how well this solution works is either needed to be analyzed with finite elements or tested.

Choosing an appropriate method for manufacturing is an important step in the development process. However, the time limit set for the thesis was not enough to decide a manufacturing method. Following is a recommendation of what manufacturing method to use for this project. However, this is only a recommendation and what manufacturing method to use for this project needs to be investigated further before a decision of what method to use for the mounts is set.

When discussing manufacturing method with M. Nielsen, a senior specialist in plastic at Semcon [10], he recommended injection molding. He recommended that if the product will be mass-produced, meaning manufacturing over 1000 products, it is almost always good to invest in molds for the products. When injection molding it is the molds that are the largest investment. However, in this case it is good to use injection molding as many molds can be re-used since all the parts in the ball-joint and the snap-fit case are the same for the handlebar mount and the helmet mount. It is the same situation if Narrative develops other bottom plates for mounts used in other fields of application. Therefore, the costs for the molds for the ball-joint and the mold for the snap-fit can be divided over the costs for various mounts leading to a low total cost for each mount.

M. Nielsen also mentioned that when injection molding products, the range of plastic to choose from is much larger than when 3D-printing. Therefore, it will be much easier to find a material with the wanted properties, as good elasticity and with high strength.

When assembling these mounts, there will be difficulties because of how the magnets and the screws will gravitate towards each other. This problem can be minimized by choosing the assembly set up. Following is one recommendation of how to minimize this problem. Begin the assembly with the screws, as it will be easier to place them correctly without having any magnets in the assembly to which the screws will gravitate towards. After the screws, glue one pair of magnets at a time. Meaning one magnet on the bottom plate and one magnet on the ball-joint. This will reduce the risk of having the magnets gravitate towards each other as the parts can be left to dry with distance between them. Thereafter, glue the last pair of magnets. This assembly-setup will minimize the problem with magnets and screws gravitating towards each other when not yet fully assembled.

Before sending the mounts to mass-production, it is also important to think of advertisement and promotion of the product. It can also be of advantage to come up with a slogan that can increase the customer's interest of the product and therefore increase the selling. An example of an advertisement for the mounts can be seen in Appendix I.

6 Discussion

This chapter consists of discussion and reflections on various topics related to the thesis, starting with the time schedule and finishing with the final concept.

Time schedule

The intended time schedule and the actual time schedule can be seen in Appendix A. The steps in the time schedule turned out to be different as it was noticed during the thesis that some steps had to be added to accomplish the best result. In concept selection it was planned that one solution for each subproblem would be chosen and consequently, have a final solution when adding all the various parts. The final solution would thereafter be 3D-modelled, 3D-printed and assembled into the first prototype. Although, it turned out to be too difficult to choose what solutions that are the most appropriate so early in the project without testing them. Hence, five various concepts were chosen, 3D-printed and tested. Subsequently, the various parts of the chosen concepts were further developed until a final concept was decided.

Another thing noticed to differ from the intended time schedule was when the deciding of target group was done. Early in the project it was noticed that starting the development with deciding the target group was not possible – first more information about the target group was needed. Therefore, the deciding of target group turned out to be later in the project while the beginning of the project was initialized by researching of where the most suitable placements for Narrative Clip is to the active lifestyle user.

Method

The most observed difficulty when writing the method of the thesis was to understand which steps of Ulrich and Eppinger's product development methodology that were reasonable steps to implement in the thesis. Ulrich and Eppinger's methodology is very detailed and contains of many steps. It was noticed early in the project that there were not enough time to follow the method completely and a decision on what steps that were significant to implement in the thesis had to be made.

The method established for the thesis did not proceed exactly as believed from the start. Hence, it has been interesting to see what changes that have had to be made in the methodology according to the problems and twists discovered during the work of the thesis.

Customer Research

Since the aim of the thesis was compiled by Narrative and the writers of the thesis, there can be a deficiency in the demand of the product on the market. A complete market research would have needed to be made before starting with the thesis, making sure there is a need of the product on the market and that the customers are willing to buy it. The customer surveys sent out in the thesis is not trustworthy enough to make sure there is a demand of the product on the market. There can also be insufficiency in the customer surveys sent out since there is lack of reliability in customer surveys and also because the writers are lacking knowledge of how to compile a customer survey to reach the most credible results possible. Another method for collection of data would have been used if there was capital for it.

Concept Generation

To use 3D-prototyping as the method to evaluate and test concepts is a good way as it quickly gives you an actual prototype to test. However, as the writers of the thesis had lack of experience in 3D-printing prototypes it was time consuming. Many attempts to 3D-print parts were unsuccessful of various reasons. Firstly, the measurements in the models were made too small and therefore, the some parts of did not get 3D-printed completely. Secondly, because of too small measurements the prototypes sometimes broke when removing them from the plate of the 3D-printer. Thirdly, not knowing enough of the properties of the plastic used it was difficult to know what features that would work properly if produced with some other manufacturing method than 3D-printing. Sometimes, this led to reduced confidence in some concepts.

A difficulty observed in the concept generation phase was the fact that it was difficult to 3D-print a ball for the ball-joint. This obstructed the testing sizes of the ball-joint concepts since the size of the ball in the ball-joint was limited to what was found on the market.

Final Concept

The overall evaluation of the mounts are that they have a clean, nice and innovative design. Some of the features could be discussed more thoroughly to make sure there are not better, simpler ways to solve the problems but it is also some of the more uncommon features chosen e.g. attaching by magnets that makes the mounts innovative. The clean and simple design of the mounts fit into Narrative's idiom, and the mounts could have been products in Narrative's product range. The mounts are functional and have the features needed, but still give an impression of being a luxurious, trendy product just as the Narrative Clip.

References

- [1] B. Wesén, Interviewee, *Chief Technology Officer at Narrative AB*. [Interview]. 26 November 2014.
- [2] K. T. U. & S. D. Eppinger, *Product design and development, international edition*, New York: McGraw-Hill companies, 2012.
- [3] B. Lars-Ola, "Utvecklingsprocessen ur ett människa-maskinperspektiv," *Institutionen för produkt- och produktionsutveckling, avdelning Design and Human Factors*, Göteborg, 2011.
- [4] V. Gustafsson, Interviewee, *Head of Mechanical Engineering and Industrial Design at Narrative AB*. [Interview]. 3 March 2015.
- [5] O. Diegel, Interviewee, *Professor at Lund's Tekniska Högskola*. [Interview]. 24 April 2015.
- [6] "Mått och gängor på cykeldelar," *Cykelhobby*, [Online]. Available: <http://www.cykelhobby.com/matt.html>. [Accessed 20 March 2015].
- [7] "3Dprinting.com," [Online]. Available: <http://3dprinting.com/what-is-3d-printing/#processesandtechnologies>. [Accessed 08 June 2015].
- [8] "UP3D," [Online]. Available: <http://pp3dp.com/>. [Accessed 08 June 2015].
- [9] "Formlabs.com," *Formlabs*, [Online]. Available: <http://formlabs.com/>. [Accessed 08 June 2015].
- [10] M. Nielsen, Interviewee, *Senior Specialist at Semcon*. [Interview]. 20 May 2015.
- [11] M. Blixt, Interviewee, *Consultant at Semcon*. [Interview]. 25 April 2015.

Image References

Figure 1.1, Narrative, Narrative Clip Memoto Camera. 8 May 2015.
<http://www.peoplepeople.se/wp-content/uploads/2013/12/Narrative-Clip-Memoto-Camera.jpg>

Figure 1.2 Narrative, Holding the Narrative Clip. 8 May 2015.
<http://ecx.images-amazon.com/images/I/21yiARePQbL.jpg>

Figure 1.3 Mashable, The Narrative Clip. 8 May 2015.
http://rack.0.mshcdn.com/media/ZgkyMDE0LzAyLzIwLzdlL05hcnJhdG12ZV9DLjY0MzA1LmpwZwpwCXRodW1iCTEyMDB4OTYwMD4/145af52e/53e/Narrative_Clip-2.jpg

Figure 3.1 Pinterest, Various handlebars. 15 April 2015.
<https://s-media-cache-ak0.pinimg.com/736x/e4/fd/55/e4fd55059fe2dcf315f5e15af5132b7d.jpg>

Figure 3.2 Tumblr, Helmet with holes. 8 April 2015.
http://33.media.tumblr.com/3b3d7156dd8b74eb697b0274fbd199d2/tumblr_inline_mu65u7KNO1sn782w.jpg

Figure 3.2 Sportsdirect, Helmet with vents. 8 April 2015.
http://images.sportsdirect.com/images/imgzoom/40/40731703_xxl.jpg

Figure 3.2 Gearist, Bern-helmet. 8 April 2015.
<http://gearist.com/wp-content/uploads/2013/01/Bern-helmet.jpg>

Figure 4.2 Resins-online, Up printer JB cut out small. 8 June 2015.
http://www.resins-online.com/UserFiles/Images/Learning%20Zone%20Images/UP_printer_JB_cut_out_small.jpg

Figure 4.3 3D hubs, s3fs-public. 8 June 2015.
<https://3dhubs.s3-eu-west-1.amazonaws.com/s3fs-public/Form%201.png>

Figure 5.11 3Dcadbrowser, Bike Helmet Mount. 21 May 2015
<http://www.3dcadbrowser.com/th/1/96/96033.jpg>

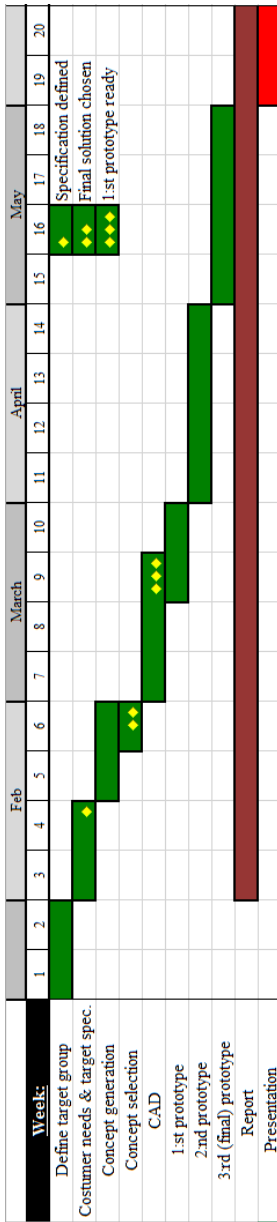
Appendix G Reference MyTrendyPhone, GoPro Hero Bike Mount. 2 April 2015.
<http://www.mytrendyphone.eu/images/Arkon-GP132-Bike-Mount-for-GoPro-HERO3-GoPro-HERO3-HERO2-19062014-01.jpg>

Appendix G Reference Bivouac, GoPro Vented Helmet Strap. 2 April 2015.
http://www.bivouac.co.nz/media/catalog/product/cache/1/thumbnail/9df78eab33525d08d6e5fb8d27136e95/g/o/gopro_vented-helmet-strap-on-helmet.jpg

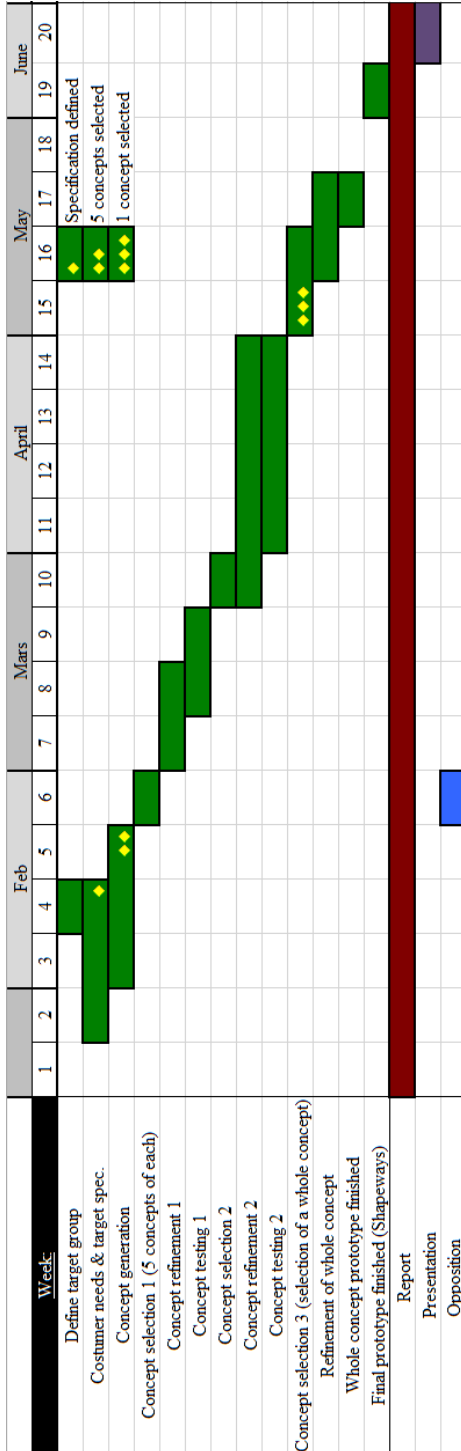
Appendix I Onefitlenses, Active eyewear. 27 May 2015.
<http://www.onefitlenses.com/images/cyclist.png>

Appendix A: Time Schedule

A.1 Intended Time Schedule



A.2 Actual Time Schedule



Appendix B: Survey 1



Kameraprojekt behöver din hjälp!

Vi är två Maskinteknik-studenter som gör vårt examensarbete för företaget Narrative AB som designar, tillverkar och säljer en liten kamera, en sk. "wearable". Kameran heter Narrative Clip (se bild) och är en "lifelogging tool" då idén med kameran är att man kan fästa den på sina kläder varpå kameran tar två bilder i minuten och därmed förevisar din vardag. Kamerans storlek är 3,5 x 3,5 x 1 cm.

Examensarbetet går ut på att utveckla nya typer av infästningar till Narratives nästkommande kamera Narrative Clip 2, för att bredda kamerans användningsområden. Vi har valt att fokusera på "den aktiva människan" då vi tror att det kan finnas glädje av att använda produkten Narrative Clip 2 som en lifelogging tool vid aktiviteter man gör under en längre tid.

För att kunna ta fram bästa möjliga infästningsanordning behöver vi Er hjälp och input. Det skulle betyda mycket för oss om ni tog er tiden och hjälpte oss genom att fylla i denna enkät, det tar inte mer än några minuter!

* Required

Vilken sport/aktivitet syftar du på när du fyller i denna enkät? *

Med aktivitet menas exempelvis under cykelturen, när man åker longboard, på skidsemester, vid vandring, ridning, bergsklättring etc.

Finns det tillfällen eller ögonblick när du utövar din sport/aktivitet som du känner är svåra att

Appendix B: Survey 1

dokumentera? Motivera gärna varför.

Vilken är den bästa placeringen av kameran för att kunna dokumentera din sport/aktivitet på bästa sätt och med rätt vinkel? Motivera.

Ex. på byxorna, på hjälmen, på longboarden, fram på cykeln, på grimman på hästen osv.

Om kameran hade haft ett "normalt läge" och ett "aktivitets läge" (som tar bättre bilder vid hastiga rörelser). Vart skulle du vilja ställa in den inställningen?

- Genom appen till kameran
 På själva kameran (detta alternativ bidrar till att kameran blir något större)

Kameran The Narrative Clip funkar bra för att göra sk. "time-lapse". Finns det något tillfälle (ex. vid åkning genom ett vackert landskap) när du utövar din sport/aktivitet som du hade sett glädje i att kunna göra detta?

Time-lapse = när flera bilder tas under en period och spelas sedan upp i ordning och bildar då en filmliknande sekvens

Är det viktigt för dig att kunna byta placering på kameran under användning? Och på så sätt få bilder från olika vinklar i samma "time-lapse".

Ex. först ha kameran riktad mot vägen när du åker longboard och sedan byta placering så du får bilder på ditt ansikte i samma sekvens.

- Ja
 Nej
 Vet ej

Vad anser du är viktigast hos en infästningsanordning? Välj maximalt två alternativ. *

- Storlek (att infästningen tar lite plats)
 Användarvänlig (att infästningen är lättförståelig)
 Vikt (att infästningen väger lite)
 Design (har en simpel och snygg design)
 Säker (att kameran inte ramlar loss vid användning)
 Other:

Har du några övriga tips eller idéer som kan hjälpa oss med vårt arbete att ta fram nya infästningar till din sport/aktivitet?

Din input är värd guld för oss!

Never submit passwords through Google Forms.

Appendix C: Customer Statements and Interpreted Needs

This appendix includes the customer statements and interpreted needs compiled with the data from survey 1. The activities/activities that were chosen to focus on are alpine sports, hiking and cycling.

C.1 Alpine Sports

Customer Statement - Alpine	Interpreted Need - Alpine
Many attachment solutions for cameras today has a lot of various parts	The attachment consist of few parts
A lot of attachments for cameras are clunky	The attachment of the camera is flexible
I do not want the attachment to be heavy	The attachment is lightweight
I do not want my camera to be in contact with the snow	The attachment is positioned so the camera is not in contact with snow
I do not want my camera to move during the time I use it	The attachment holds the camera steady during use
I would like to be able to attach two cameras at the same time so I could record myself and the surrounding at the same time	It is possible to attach more than one camera to the attachment
I would like to be able to adjust the height placement of the camera	It is possible to adjust the height of the camera placement
It is important that my camera doesn't fall off while I am using it	The attachment is safe
I would like if I could attach the camera wherever I want	It is possible to attach the camera in various places
Sometimes I think it is difficult to understand the attachment	The attachment is easy to grasp
I do not want the attachment to take a lot of space	The attachment is small
I would like it if it was easy to reach the camera during use.	The attachment is close to the user
I want the camera to capture my entire ride	The attachment is developed so the camera is facing forward
I want to be able to record and photograph myself too during the ride	The attachment is developed so the camera can be rotated facing the user
I do not want the camera to disturb me while I am skiing	The attachment has a good placement

Appendix C: Customer Statements and Interpreted Needs

Customer Statement - Alpine	Interpreted Need - Alpine
I want to be able to attach and direct my camera while wearing my ski gloves	The attachment is easy to attach even while wearing gloves
I want to know when the camera is attached safely	The attachment lets you know when it's attached firmly and safe
I would like to be able to easily attach the camera to my ski sticks	The attachment can be attached to sticks
I want to be able to rotate the camera so I can take pictures forward and backward	The attachment can be rotated
I want to attach the camera to my helmet	The attachment can be attached to helmets
I do not want my attachment to be ugly	The attachment has a good looking design

C.2 Cycling

Customer Statement - Cycling	Interpreted Need - Cycling
I wish to have the camera close to me	The attachment is developed to be attached close to the cyclist
I wish to place the camera so I can capture my route	The attachment is developed so the camera is facing forward
I am scared that the camera will be pressed through my head if there I am in an accident	The attachment is safe and will not hurt you in an accident
I do not like that it is difficult to detach the camera	The attachment is easy to detach
I have dropped my camera many times when biking	The attachment is secure
Attachments are clunky	The attachment is pliable
I do not want to add something heavy on my bike	The attachment is lightweight
I wish I did not have to bring so many attachments	The attachment is versatile
I wish I could take pictures both in front of me and behind me with the same attachment	The attachment's angle is easy to adjust
I cannot attach my camera to my bike because it has different diameter on the bicycle frame	The attachment is possible to attach on different diameters of bicycle frames
I wish I could attach my camera to the handlebar	The attachment can be attached on handlebars
I wish the camera was not disturbing me when I am cycling	The attachment has a good placement
Sometimes I think it is difficult to understand the attachment	The attachment is easy to grasp
I do not want the attachment to take a lot of space	The attachment is small
I am having problems when trying to attach the camera	The attachment is easy to attach
I wish I could rotate the camera	The attachment can be rotated

Appendix C: Customer Statements and Interpreted Needs

Customer Statement - Cycling	Interpreted Need - Cycling
I do not want the camera to move while I am using it	The attachment holds the camera steady during use

C.3 Hiking

Customer Statement - Hiking	Interpreted Need - Hiking
I wish my camera to show what's right in front of me	The attachment is attached centered to the walker/hikers body
I wish to capture what I see	The attachment is developed so the camera is facing forward
I wish the pictures were not blurry from when I walk	The attachment is making the pictures come out with good sharpness
I cannot carry any more weight	The attachment is lightweight
Attachments are clunky	The attachment is pliable
I am scared to drop my camera when hiking	The attachment is safe
I wish to attach the camera close to my body	The attachment is developed to be attached close to the user's body
I cannot take pictures easily when hiking because I have to stop	The attachment (and the camera) is in reaching-distance
I cannot take spontaneous pictures	The camera is easy to detach from the attachment
When I am hiking and walking it is difficult to take pictures because of the bouncing motion	The attachment can neutralize the bouncing motion
I like to take pictures in chest-height	The attachment is able to attach in breast-height
I wish to take pictures in various angles	The angle of the attachment is easy to adjust
I want my camera to be easy to attach regardless situation	The attachment is versatile
I wish to have the camera attached from my head's position	The attachment can be attached on headgear
I wish to attach the camera to my backpack	The attachment can be attached to backpacks
I miss not being able to aim with my camera	The angle of the attachment is possible to adjust so aiming is possible
I wish to attach my camera to my necklace	The attachment is possible to attach to a necklace
Attachments are ugly	The attachment has a good looking design

Appendix D: Survey 2

Camera project needs your help!

The Narrative Clip (see picture) have the size 3.5 x 3.5 x 1 cm.

The Narrative Clip



* 1. What activity/sport are you focusing on when answering this survey?

- Biking
- Hiking
- Skate/Longboarding
- Alpint
- Other (please specify)

* 2. Which placement do you think is the best for the camera when practicing your activity/sport?

- On your chest
- On your helmet
- On your equipment
- Other (please specify)

* 3. How important are the following features for the attachment?

Appendix D: Survey 2

	Very important	Important	Somewhat important	Not at all important	No Opinion
Lightweight	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pliable/small (is not in the way during your activity/sport)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Secure (the attachment will not lose the camera)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Safe (will not hurt you if in an accident)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Versatile (many fields of application)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Easy to grasp	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Easy to detach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Easy to adjust (angle)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Holds the camera steady during use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Appendix E: Target Specifications

In this appendix the needs and their ranked importance for handlebars and helmets respectively can be seen.

E.1 Handlebars

No.		Need - Handlebars	Importance
1	The attachment	is easy to reach	2
2	The attachment	makes the camera face forward	2
3	The attachment	is safe and will not hurt you in an accident	3
4	The attachment	is easy to attach/detach	1
5	The attachment	is secure	5
6	The attachment	is pliable	4
7	The attachment	is lightweight	3
8	The attachment	is versatile	2
9	The attachment	s angle is easy to adjust	2
10	The attachment	is attachable to all diameters of handlebars	5
11	The attachment	has a good placement	3
12	The attachment	is easy to grasp	1
13	The attachment	is small	4
14	The attachment	can be rotated	2
15	The attachment	holds the camera steady during use	4

E.2 Helmets

No.		Need - Helmets	Importance
1	The attachment	can be attached to helmets	5
2	The attachment	consist of few parts	2
3	The attachment	is pliable	4
4	The attachment	is lightweight	3
5	The attachment	is steady during use	4
6	The attachment	can attach more than one camera	1
7	The attachment	is secure	5

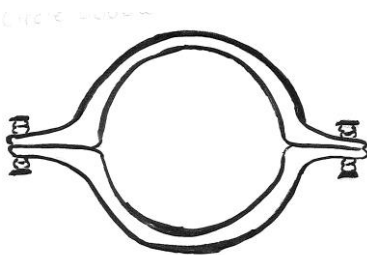
Appendix E: Target Specifications

No.		Need - Helmets	Importance
8	The attachment	is versatile	2
9	The attachment	is easy to grasp	1
10	The attachment	is small	4
11	The attachment	is easy to reach	2
12	The attachment	has a good placement	3
13	The attachment	is easy to attach	1
14	The attachment	is explicit	1
15	The attachment	has a good looking design	4
16	The attachment	can be rotated	2
17	The attachment	is safe	3
18	The attachment	is easy to detach	1

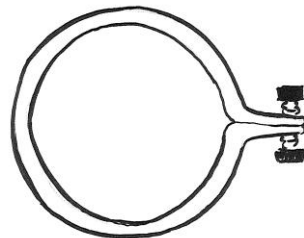
Appendix F: Concept Sketches

F.1 Handlebars

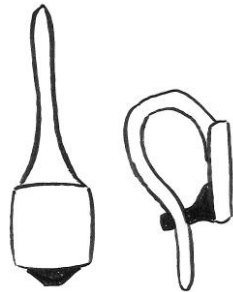
A – Circle Double



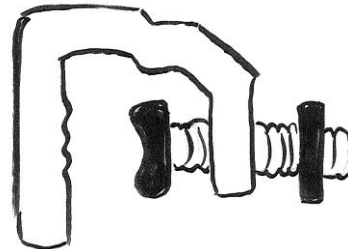
B – Circle Single



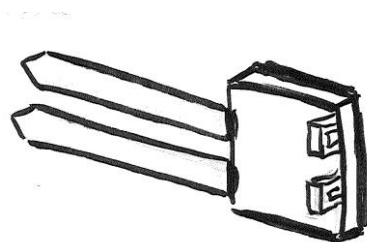
C – Bendy



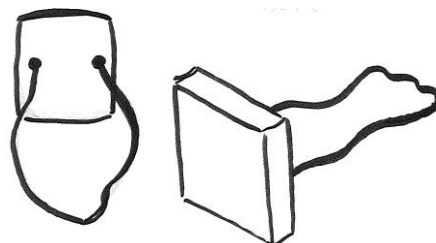
D – Screw



E – Cable tie

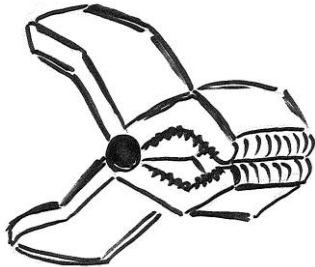


F – Rubber band

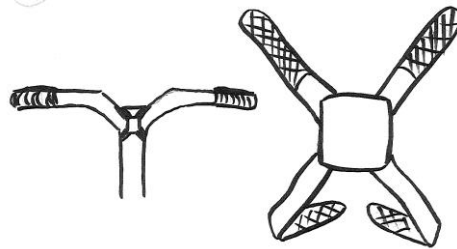


Appendix F: Concept Sketches

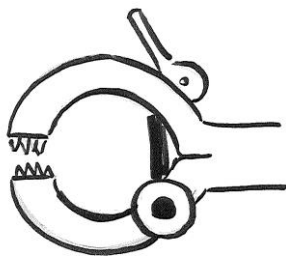
G - Nippers



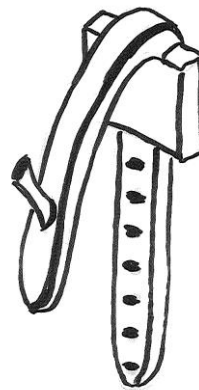
H - 4 Velcro



I - Pincers



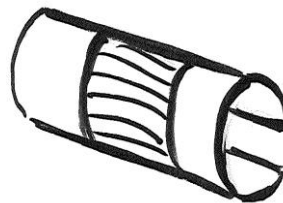
J - Watch 1



K- Watch 2



L - Buckle



F.2 Helmets

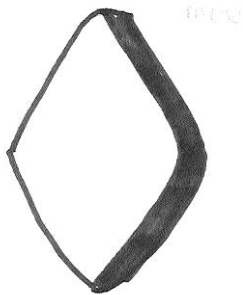
A - Sidebelt



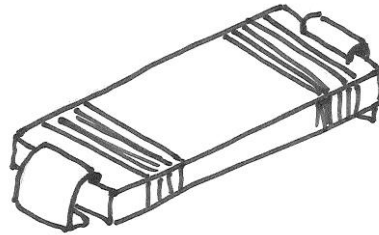
B - 2 belt mount



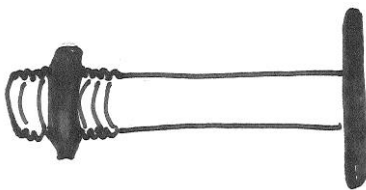
C - Tape/Glue



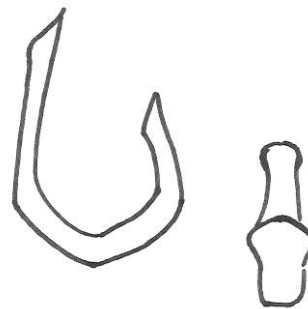
D - Clip



E - Inside Screw

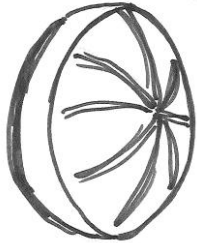


F - The Hook

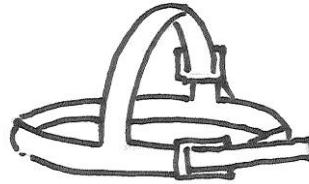


Appendix F: Concept Sketches

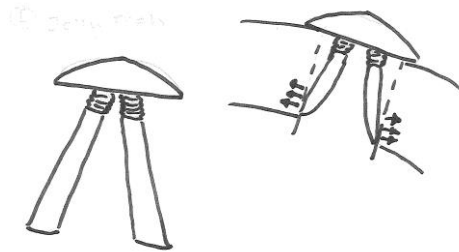
G – Suction Cup



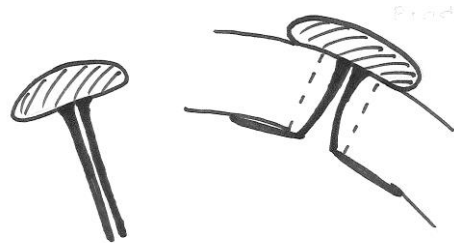
H – Helmet Strap



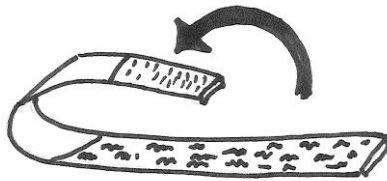
I – Jellyfish



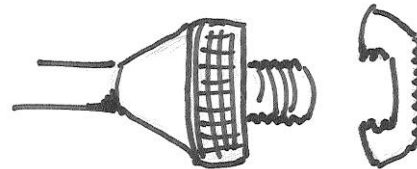
J - Brads



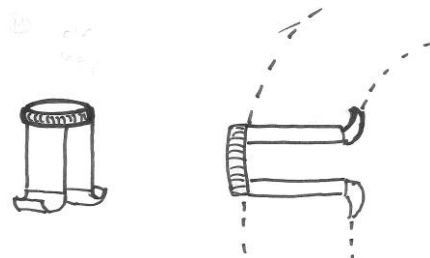
K - Velcro



L - Outside Screw



M - Elf Feet



Appendix G: Concept Screening

G.1 Handlebars

Concept Screening Table - Handlebars

Selection Criteria	Handlebar Attachment Concepts											M (Reference) GoPro HERO Bike Mount	
	A Circle double	B Circle single	C Bendy	D Screw	E Cable tie	F Rubber band	G Nippers	H 4-Velcro	I Pincers	J Watch 1	K Watch 2		L Buckle
Secure	0	0	0	-	0	-	-	0	0	0	0	-	0
Pliable	0	+	+	-	+	+	+	0	0	+	+	+	0
Small size	0	0	+	0	+	-	+	0	0	0	0	+	0
Holds the camera steady	0	0	0	-	-	-	0	-	0	0	-	0	0
Attachable to all diameters	0	0	0	0	0	-	0	0	0	0	0	-	0
Fits into the company's idiom	0	0	+	-	+	0	0	0	0	0	0	+	0
Manufacturing cost	0	+	+	-	+	-	+	-	+	+	+	+	0
Simple mechanism	0	0	+	0	0	+	0	-	+	+	+	+	0
Sums + 's	0	2	5	0	4	4	0	4	0	3	3	5	0
Sums 0 's	8	6	3	3	3	2	1	4	5	5	4	1	8
Sums - 's	0	0	0	5	1	2	7	0	3	0	1	2	0
Net Score	0	2	5	-5	3	2	-7	4	-3	3	2	3	0
Rank	5	4	1	7	3	4	8	2	6	3	4	3	5
Continue?	No	No	Yes	No	Yes	No	No	Yes	No	Yes	No	Yes	No

G.2 Helmets

Concept Screening Table - Helmets

		Helmet Attachment Concepts													
Selection Criteria		A	B	C	D	E	F	G	H	I	J	K	L	M	N (Reference)
		Side Belt	2 Belt Strap	Tape/ Glue	Clip	Inside Screw	The Hook	Suction Cup	Helmet Strap	Jellyfish	Brads	Velcro	Outside Screw	Elf Feet	GoPro Vented Helmet Strap
Pliable		+	0	+	0	+	+	+	-	+	+	+	+	+	0
Holds the camera steady		0	0	+	0	+	0	+	+	-	0	-	+	-	0
Secure		0	0	0	0	+	-	0	+	-	0	-	+	0	0
Small		+	0	+	+	+	+	+	-	+	+	+	+	+	0
Attachable on all helmets		0	0	+	-	-	+	+	+	0	-	0	-	-	0
Fits into the company's idiom		0	0	+	+	-	+	+	-	+	+	0	-	+	0
Manufacturing cost		+	0	+	0	+	+	+	-	-	+	+	+	+	0
Simple mechanism		0	0	+	0	-	+	+	-	0	+	+	-	0	0
Sum +'s		3	0	7	2	5	6	7	3	3	5	4	5	4	0
Sum 0's		5	8	1	5	0	1	1	0	2	2	2	0	2	8
Sum -'s		0	0	0	1	3	1	0	5	3	1	2	3	2	0
Net Score		3	0	7	1	2	5	7	-2	0	4	2	2	2	0
Rank		4	7	1	6	5	2	1	8	7	3	5	5	5	7
Continue?		Yes	No	Yes	No	No	Yes	Yes	No	No	Yes	No	No	No	No

References

Handlebars

M - Go Pro Hero
Bike Mount



Helmets

N-GoPro Vented
Helmet Strap



Appendix H: Concept Testing 1

H.1 Handlebars

Bendy



Cable Tie



Buckle



Watch 1



4-Velcro



H.2 Helmets

Side belt



Tape/Glue



The Hook



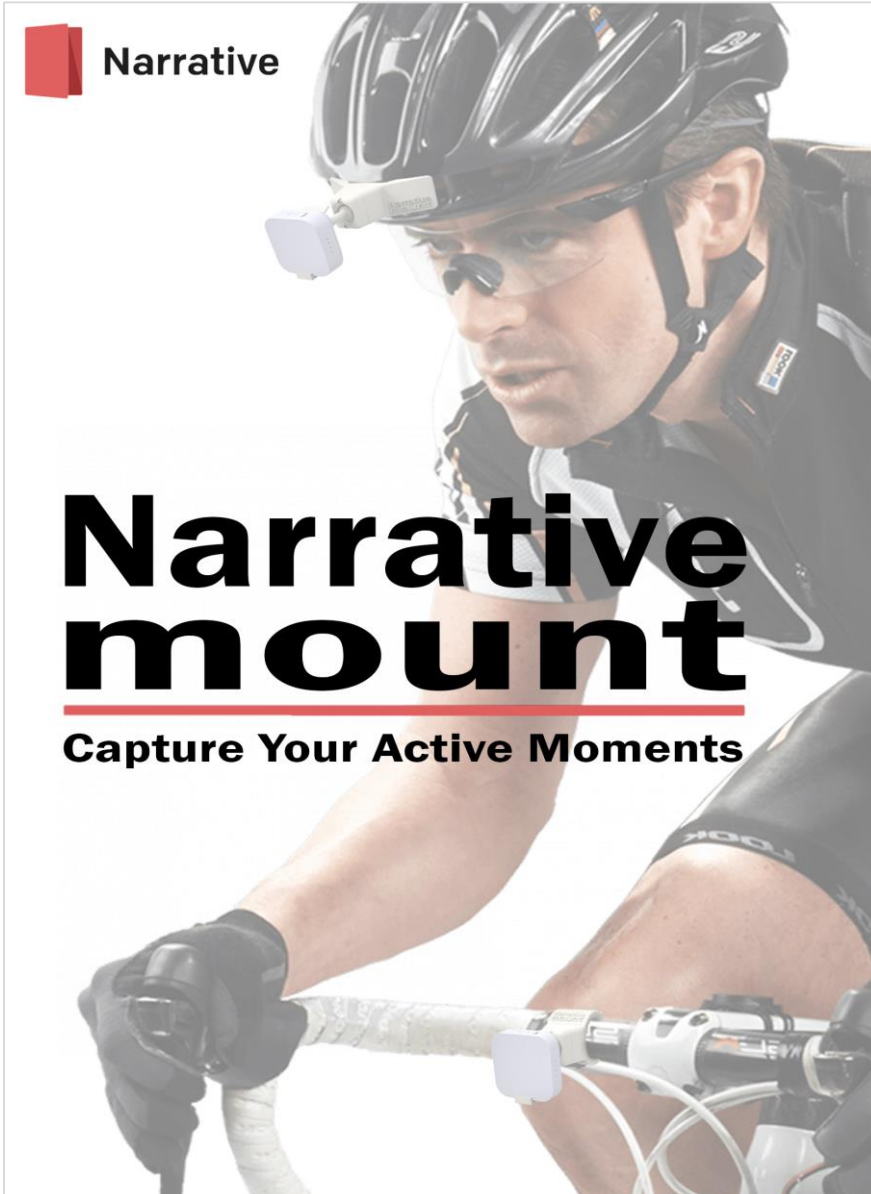
Brads




Suction Cup



Appendix I: Advertisement



 Narrative

Narrative mount

Capture Your Active Moments

The advertisement features a cyclist in a black and white jersey, wearing a black helmet with a camera mounted on the front. The cyclist is looking down and to the left, focused on the road. The background is a plain, light color. The text 'Narrative' is in a sans-serif font, and 'mount' is in a larger, bold, sans-serif font. A red horizontal line is positioned below 'mount'. The tagline 'Capture Your Active Moments' is in a smaller, bold, sans-serif font. The cyclist's hands are on the handlebars, and a camera is also visible on the handlebars.

Appendix J: Work Distribution

	Elisabeth	Yasser
Report	70%	30%
Survey 1	50%	50%
Identify customer needs, Survey 1	50%	50%
Survey 2	50%	50%
Analyzing results, Survey 2	50%	50%
Benchmarking	50%	50%
Sketching	40%	60%
Compilation of customer statements and needs	50%	50%
Concept Scoring	50%	50%
Workshop	50%	50%
CAD	40%	60%
3D-print	50%	50%
Mean value	50,00%	50,00%