CHALMERS


# Mobile 3D Traffic Measurement

*Stakeholder mapping and design of a new housing solution*

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

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Gothenborg, Sweden 2014

Department of Product- and Production Development
Division of Design & Human Factors

Master of Science Thesis

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# ABSTRACT

Urbanization together with the need for sustainable travel put new demands on modern city planning. Bicycles, pedestrians and public transportation are essential elements that require smart methods for measurement and analysis. The technique of 3D vision video analysis gives new possibilities for measuring traffic.

The aim of the project was to explore the opportunities for this new technique and to develop a mobile housing and mounting solution for the equipment. Through stakeholder mapping and interviews, competitor analyses and literature studies, a framework for the design work was created. Possible situations for 3D video analysis were identified and important aspects for use and mobility were defined. The visual expression of traffic measuring equipment using video technology was evaluated and the aspects of integrity analyzed. Ergonomic and semantic aspects of the product were other key issues in the development process.

The final concept is a flexible, robust and professional housing with a modular mounting solution. The product combines form and function with the appropriate expression from different stakeholder views. It fulfills the requirements for the shorter mobile measurements that were identified in the project.

Keywords: *3D video analysis, product development, traffic measurement*.

Master of Science Thesis PPUX05

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Cover photo: Alexander Larsson
Print: Repro Service Chalmers

# ACKNOWLEDGMENTS

To make a project like this successful, a large amount of people are involved. It has been very inspiring with the positive attitude and valuable feedback we have received from all participants.

First of all we would like to thank two of the pioneers within the field of 3D traffic measuring; Amritpal Singh and Ulf Erlandsson at Viscando AB, who launched the project and supported it all the way.

Many thanks to all municipalities and consultancies that supported the project by providing us time for interviews and visits. The thoughts and insights of the people at the City of Gothenburg, Eskilstuna, Varberg, City of Mölndal, Falkenberg, Infracontrol, Sweco and VTI, who all contributed to our research.

Thanks to all our friends and classmates that have given us inspiration, input and ideas.

Finally we would like to thank our supervisor Viktor Hjort af Ornäs and examiner Johan Heinerud who have given us constructive feedback and advice throughout the whole project.

Thank you!

Alexander Larsson

Hans Iverlund

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# 01 INTRODUCTION

This chapter describes the background of the project, aim, goals and questions posted.

## 1.1 BACKGROUND

Since the use of cars increased significantly in the 1950's, the urban environment has been designed to facilitate motorized vehicles. With reduced efforts to stimulate alternative transportation like walking or biking, this change affected the way people lived their lives in the cities (Gehl, et. al. 2006). In 2009 approximately 3.4 billion people lived in cities, year 2050 that number is estimated to 6.4 billion (WHO, 2014). This increasing number of urban citizens requires better possibilities for sustainable travel and the city planning must therefore follow this development.

Measurements of traffic are done to facilitate city planning and to maintain a well-functioning infrastructure by using statistics and analyses. Cars have been measured and analyzed in large scale for a long time, while bicycle measurements has only been conducted for the last decades and pedestrian measurements only for a few years. As a result, the techniques for measuring especially pedestrians but also bicycles (figure 1.1) are less developed compared to the measurement systems for cars. To be able to build and develop sustainable urban areas where people want to live, new and effective measuring techniques are needed to facilitate true and accurate data.

Viscando has developed a system for automatic traffic monitoring which utilizes state-of-art 3D computer vision technology. It is the only automatic system in the world that can detect and classify all traffic types in a single system. Although the system is based on cameras, it preserves the personal integrity of the road users. No images are stored or transmitted, only high quality traffic data is sent to traffic authorities. The traffic authorities use the collected data to better understand the traffic trends as well as plan and follow up on actions to improve traffic flow and traffic safety. Viscando Otus 3D simplifies and enhance this work by providing automation and high quality data. A more detailed description of the existing Otus 3D system is found in Appendix I.

Today, Viscando is using existing housing solutions for their traffic monitoring system, the same that is used for common surveillance cameras, which might bring associations to personal monitoring and have an impact on personal integrity. Viscando wants to further develop their product in terms of visual expression in the public environment, ease of installation, mobility, maintenance and branding.

*Figure 1.1. Pedestrians and bicycles in the city*

## 1.2 AIM

Viscando is developing a unique product for a yet vague market, to be successful they need to know the demands of the market and what will be expected from such a product. The aim was to learn which stakeholder needs that were important and how these needs could be materialized through a new product design.

## 1.3 GOALS AND DELIVERABLES

The goal was to develop a housing solution for the ingoing components of the Viscando Otus 3D system that satisfied all important stakeholder needs. The result was to be presented as renderings and a physical model. Suggestions was to be made for material choice and suitable manufacturing processes. The specifications for the housing solution was based on the result of a thorough analysis of stakeholder needs. To create a brand identity, the core values of Viscando was to be reflected in the final concept. The main deliverable was a written report, which described the academic approach of the work.

## 1.4 QUESTIONS POSTED

· Who are the important stakeholders and how do they relate to the product?
· How should the product be designed in order to satisfy all important stakeholder needs?
· How should the product be designed to integrate properly into the public environment?
· How should the product be designed to simplify installation and maintenance of the product?
· How to connect product design and brand identity?

## 1.5 DELIMITATIONS

Choices of camera modules, batteries and computer hardware are done by Viscando and not investigated by the project group. Development of the Viscando Otus 3D software was not considered in the project. When affected by laws and regulations, the product will be designed to satisfy laws and regulations for a Scandinavian market. During product development more delimitations and choices are made and presented throughout the report.



# 02 DESIGN APPROACH AND METHODS

This chapter describes the design process outline, the methods and theories used and how these methods were implemented.

## 2.1 FOCUS AND STARTING POINTS

The master's program in Industrial Design Engineering is a multi-disciplinary education that integrates engineering and industrial design. This master's thesis project included a variety of questions, which made it suitable for someone with both engineering and design competence. As a base for the product development, a number of frameworks and design theories were used to structure the work.

The model by Monö (1997) describes a product as a trinity consisting of three cornerstones: technical whole, ergonomic whole and communicating whole (figure 2.1). This trinity is surrounded by the limits of ecology and economy. The technical whole includes the product´s construction, technical function and production. The ergonomic whole concerns attributes of the product design to fit the human physical and psychological abilities. The communicating whole can represent the product's communicative abilities with human intellect and perception.

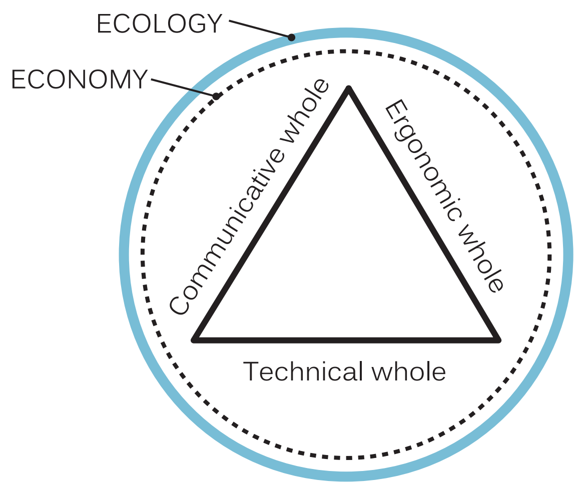



*Figure 2.1. Product design according to Monö (1997)*

### 2.1.1 Product experience

People always use their senses when perceiving and interacting with products. The way people experience products is subjective and is very much depending on who you are, the role you have and the environment you are in. A product can have several properties in terms of e.g. materials, composition or technology that can lead to functionality, possibilities for behavior or sensory properties. Humans have abilities like motor skills, cognitive skills and sensitivity (Schifferstein & Hekkert, 2008). One view of the human-product interaction, is that the product characteristics are perceived for the human mind to think and evaluate before actions are taken (Figure 2.2).

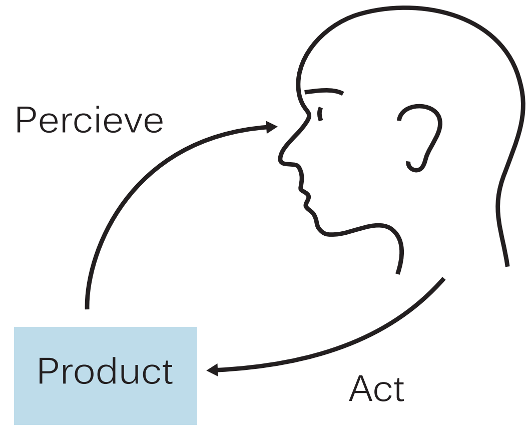



*Figure 2.2. Product experience according to Schifferstein & Hekkert (2008)*

### 2.1.2 Product semantics

The semantic memory is the part of the human memory that stores information, knowledge and facts. It includes the relations between concepts, meaning that you can recognize certain prototypical traits in things and know what they are or what they are for (Bohgard, et. al., 2011). Product semantics is derived from semiotics (the study of signs), which describes the use of e.g. symbols, graphic elements or labels to convey symbolic messages and information to the users. Product semantics on the other hand looks at how the product itself can communicate its functions and purpose through e.g. form, shape or texture. Often semantics is about making products self-explaining, easy to understand and perceived in the right way by the intended user. The designer can be the communicator that sends these messages about a product´s symbolic qualities to the users (Krippendorff and Butter, 1984).

### 2.1.3 Ergonomics

Ergonomics concern interactions between humans and products, from both a physical and cognitive perspective. It applies theory, data, principles and methods to design products that optimize human well-being and system performance (IEA, 2014). One important tool in ergonomics is anthropometrics, which is about using statistics of human measurements to set dimensions for products. Anthropometric data often follows a normal distribution and a common example could be to make the product fit 90% of the population by using data between the 5th and 95th percentile. To study users and building mockups, are other important tools to verify that the design is correctly adapted to the user (Österlin 2010).

### 2.1.4 Brand identity

Visual recognition of brands is a central competitive factor when working with various products. Visual brand identity is about understanding the semantic transformation of brand characteristics to more concrete design cues. Products must not only appear attractive, but also carry references to the company brand and values. These value-based design features could be both explicit and implicit references to the brand and be used constantly or flexible in the product portfolio (Karjalainen, 2007).
Early in the design process a strategy for the product is created, deciding the role the product should play in the company. Values for the product are defined and form the basis of the design work. The product is an important part in the brand experience, and a part of this is to find a product DNA. The DNA is then used to create a coherent product portfolio within the brand. Other important aspects when building a strong brand could be to have a brand story and a heritage (Hestad, 2013).

### 2.1.5 Manufacturing and material selection

When developing a physical product the choices of materials and manufacturing processes become important. Manufacturing process selections depend on the material that is chosen and how the material is shaped. Also the amount of products or parts that are to be produced will determine what processes and materials that is most suitable. The choices that are made should preferably not affect the desired functions and properties of the product in a negative way. These above mentioned circumstances create a network of prerequisites (Figure 2.3) that can be seen as a framework choosing materials and processes. Some areas that are affected by material and process choices are costs, aesthetics and environmental issues (Ashby, 2011).

One approach for producing usable, sustainable and cost efficient products is design for assembly (DFA). DFA aims to minimize the time for assembly by e.g. reducing the number of parts in the product, making parts easier to place, orient and grasp. By considering assembly aspects during the whole design process, problems might be avoided in the construction work. Another side of this approach is the design for disassembly (DFD), which is important from a sustainability and recycling perspective. If the product easily can be disassembled the ingoing materials can more easily be separated and recycled or reused (Boothroyd & Alting, 1992).

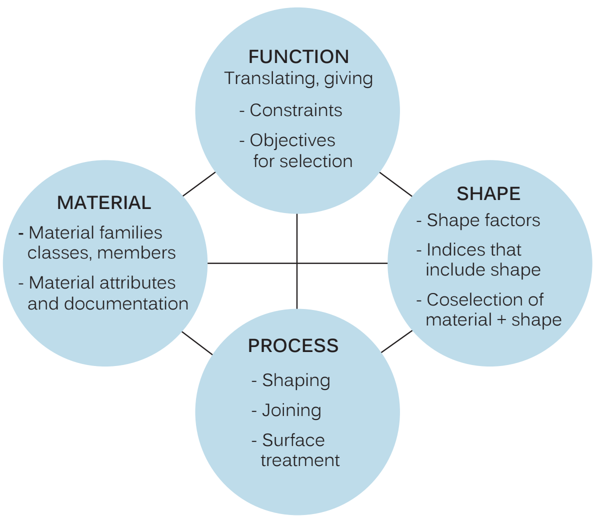



*Figure 2.3. Material and process selection according to Ashby (2011)*

## 2.2 OUTLINE OF DESIGN PROCESS

The design process is based on the horizontal model of the product development process, described by Ulrich & Eppinger (2004). This model has seven main phases described in a linear sequence. The model includes iterative cycles that is performed within each phase of the horizontal process. To support the report structure, the process is here described as consisting of five phases: Introduction, Research, Ideation, Concept development and Final result (figure 2.4).

The introduction and final result are merely the input and output of the project, which places them outside the actual design process. The three middle phases were of a more iterative art, and constituted the major part of the design process. In the research phase, stakeholder needs were identified by using various methods and tools for collecting and analyzing data. In the ideation phase, ideas and possible solutions were developed through idea generation and structuring models. In the concept development phase, chosen ideas and solutions were further developed, in order to bring one concept closer to realization. This was done through prototyping, testing and evaluation.

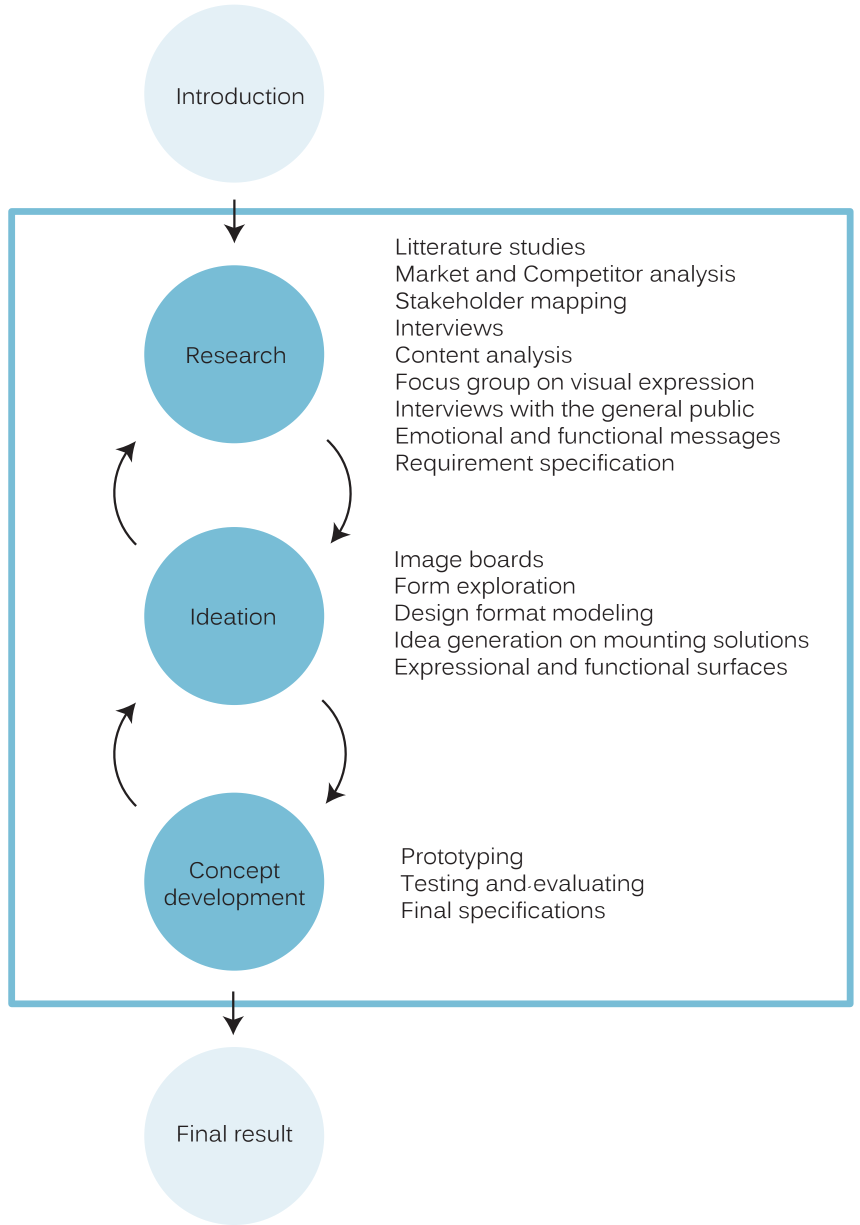



*Figure 2.4. The process outline for the project, based on the horizontal product development process by Ulrich & Eppinger (2004)*

## 2.3 RESEARCH

In this chapter research was made to collect data regarding users, environments and technologies that were of importance for the product development. Methods used for gathering and analyzing this information is presented in the following sections.

### 2.3.1 Literature studies

The initial step in this project was to get an understanding of the aspects that could be related to the problems posted in the brief. Therefore, books, journal articles and reports relating to traffic measuring or the consequences of video analysis were studied. The findings from the literature studies served as a base for deciding which stakeholders interviewed and what kind of questions to ask.

### 2.3.2 Market and competitor analysis

It is important to investigate the market where a product is to be launched. Important areas to investigate are the customer categories, market potential, market penetration and market share (Johannesson, 2004). Based on the literature studies, methods for traffic measurement were compiled. Different existing products and technologies were compared and summarized. The summary of different competitor products enabled an overview of where a new mobile traffic measuring system best would fit in, regarding questions like market share, uniqueness and unfulfilled needs.

### 2.3.3 Stakeholder mapping

Using stakeholder mapping (BSR, 2011), the interests of the identified stakeholders were arranged (figure 2.5) in a cross-plot with two ingoing parameters. The method was used to identify, analyze, visualize and prioritize the interests and concerns of the different stakeholders. The first parameters was *why*, and referred to why certain stakeholders conduct measurements of traffic, what the objectives are and what kind of outcome they were expecting. The second parameter was *how*, and referred to how the actual measurement are performed and which methods that are preferred. The stakeholder map was later used as a guide to understand which specific interests, different stakeholder could have in the product.

*Figure 2.5. Sorting out stakeholders at Viscando's office*

### 2.3.4 Interviews

To get a deeper understanding of important stakeholder needs, interviews were conducted with 7 municipality traffic planners, 2 traffic consultants and 1 traffic researcher. In total 5 municipalities and 2 traffic consultancies were visited. These interviewees were chosen due to their involvement in actual traffic measuring as well as interest in using the measuring data to perform their work. Many of these stakeholders also functioned as installation personnel of the measuring equipment, questions concerning installation and product use were therefore also addressed.

The traffic planners and traffic consultants were interviewed at their respective workplaces, during approximately one hour. The traffic researcher was interviewed over phone for approximately 40 minutes. The interviews had a semi-structured approach, meaning that relatively open questions were formulated and used as a guide during the interviews. The purpose for using this approach was to generate more of an open discussion, rather than to strictly follow predetermined and specific questions for the interviewee to answer (Bohgard, et. al., 2011). The qualitative data from the interviews were recorded and transcribed in preparation for analysis.

### 2.3.5 Content analysis

Content analysis is a tool that is used for making conclusions from communicative and verbal data, such as interviews or observations. By first studying the communicative texts thoroughly, they can gradually be condensed into short descriptive sentences that can be categorized by creating different themes or topics (Graneheim & Lundman, 2004).

To analyze the data from the interviews, the transcribed material was printed. The next step was to cut the printed papers apart and divide the data under different headings depending on subject (figure 2.6). Examples of this being, everything found about what the product could communicate being put under the heading communication. Everything was pinned to a big board, which was divided into two main categories, *why* and *how*. The *why* section incorporated all the topics about the need of the product e.g. difficult situations and goals for measuring. In the *how* category included answers relating to use and mobility e.g. installation, power supply and also visual expression. This method was used to structure the large amount of data collected from the interviews and turn it into manageable information.

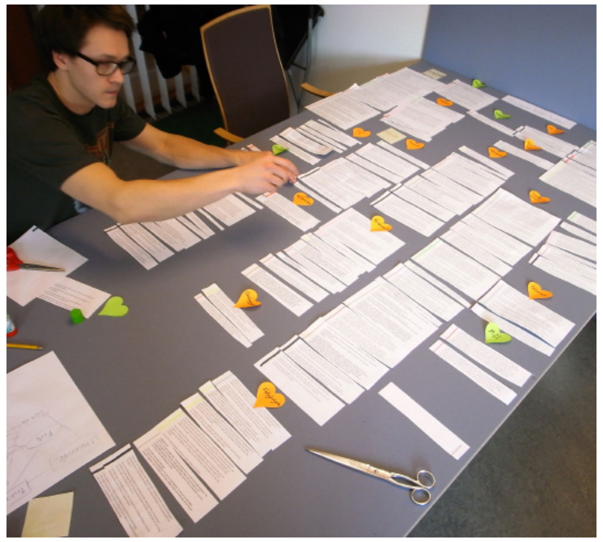


*Figure 2.6. Structuring verbal data with a content analysis*

### 2.3.6 Focus group on visual expression

A focus group (figure 2.7) with 8 students from the masters program in Industrial Design Engineering at Chalmers University, was carried out in order to discuss the use of a mobile traffic measurement system. The purpose of this session was to gain new insights on how the Otus 3D system could be used and how the product's visual expression could affect the appearance, influence on integrity issues, communication and the risk of vandalism. The discussion lasted for approximately two hours and mainly concerned the impact of the product's visual expression concerning video analysis and surveillance. The focus group was structured as described by Jordan (1998), where questions were posed by the moderator for the group to discuss.

*Figure 2.7. Focus group on visual expression*

### 2.3.7 Interviews with the general public

Short interviews were held with people of the general public in Eskilstuna, on a normal workday afternoon for approximately two hours. This was done at the location of one of Viscando's stationary measurement systems. The interviews had a structured approach, with questions that were easy for the interviewees to answer quickly. According to Bohgard (2011), a structured approach is suitable for short interviews in public places. Fifteen persons of mixed gender and age were interviewed as they were passing by the location. The procedure was the same for all participants, after introducing ourselves, they were asked to answer five questions regarding Viscando's measuring system that is in use at the location. This study was done to get an idea of how the function of the system itself and the existing housing solutions was perceived by the general public and if there they had any suggestions for improvements. A similar approach was used as a way of verifying the final result, however this time in the city of Gothenburg.

### 2.3.8 Emotional and functional messages

As an extension of the company's current core values, new lead words for the Otus 3D mobile system were developed. For this, the method of the message, the physical object and the interpretation (Hestad, 2013) was used. The method aims to generate different emotional and functional messages, which should be reflected as signs in the physical object. These signs are interpreted in different ways by the observers or users, which in this project are the stakeholders.

The emotional and functional messages were generated from the existing core values of Viscando and from the research findings. The outcome of the method was four clusters of words. All four clusters were represented by one chosen lead word that formed the product as a sign. The words were chosen in consideration with the different stakeholder's interests and needs as well as with Viscando.

### 2.3.9 Requirement specification

As the final step of the research phase, a requirement specification was created. The structure of the requirement specification was based on Olsson's matrix of criterions (Johannesson et. al, 2004). The method was modified in the way that the aspects of stakeholders and life cycle phase were integrated directly into the requirement specification table. The aim of the requirement specification is to be a complete list of the requirements for the construction and production of the product. However this is seldom possible in the early stages of the development process, since the specifications are continuously evolving and changed and does not become complete until late in the process (Pahl & Beitz, 1995).

## 2.4 IDEATION

The ideation phase was carried out based on the findings from the research. Methods for stimulating creativity and idea creation as well as for structuring were used. The aim was to produce several concepts for both housing the components and mounting the product, which in the end was to be narrowed down into one combined concept to be further developed in detail.

### 2.4.1 Image boards

Image boards can be used to visualize needs and requirements or serve as inspiration during the creative development process (Österlin, 2010). To visualize and structure the research findings, three different image boards were made. They served as inspiration to the form exploration work and to visualize possible situations where the product might used or located.

*Products with Similar Shape and Function:* When investigating if there were other products that had a similar design language as the product that was to be developed, some interesting findings were made. The market of 3D scanners was one of these findings. 3D scanners are mainly used for scanning machines and machine parts to create digital models. The construction is similar to the Otus 3D system, in the way that it uses two cameras mounted at a fixed distance from each other to generate a 3D image. A selection of these products was compiled into an image board that served as an inspiration for the concept generation.

*Measurement equipment:* Since the Otus 3D mobile system is a measurement system and possibly should look as like one, different types of measurement equipment were compiled on an image board to serve as inspiration. Equipment like calculators, weather stations and radars were used on the image board.

*Situations:* The situations that were chosen in the research findings chapter were all visualized on image boards. This was done to get further inspiration and references to how the environment for a future product might look and how other products are integrated into these environments.

### 2.4.2 Form Exploration

Early in the process, the form generation had a more open approach, meaning that focus was on creating a large variety of concepts. The aim at this stage is to find possible solutions and to explore different forms and shapes. One theory that explains a form exploration is Transformations by Knauer (2008), where basic form elements are successively transformed to more complex structures. Another theory is the one by Muller (2001), where the form creation process is described in three steps. Topological variants are the basic structure. Typological are more structural variants creating a formal concept. Morphological variants are the last step where the concepts become materialized. These different levels also to reflect the different tools used for concept visualization, from basic sketches via miniature models and cad models to full size models.

Later in the process the form exploration adopted a more detailed approach, meaning smaller variations of more defined concepts. Stebbing (2004) identifies a universal grammar for visual composition. It consists of four fundamental organizational principles; Contrast, Rhythm, Balance and Proportion. These principles are ultimately about relating components of a composition or design to each other. Exploration of smaller variations was done to define the final form of the product. Theories of forces and curves by Akner-Koler (1994) were used when evaluating expressions of movements and directions of concepts.

Different types of visualization were used throughout the ideation and concept development phases. *Sketching* (figure 2.7) is a very useful tool when creating more basic structures in a fast way. However there are some limitations with sketching and it starts to be more time consuming when more advanced 3 dimensional shapes are needed. To get a better feeling for more complex typological geometries *physical models* could be used. Depending on visualization type different materials and tools are used, e.g foam and cardboard. *CAD* modeling is useful at a morphological level to create concepts with materials and textures. Other strengths with CAD models are the abilities to present complicated forms and relations between details (Österlin, 2010).

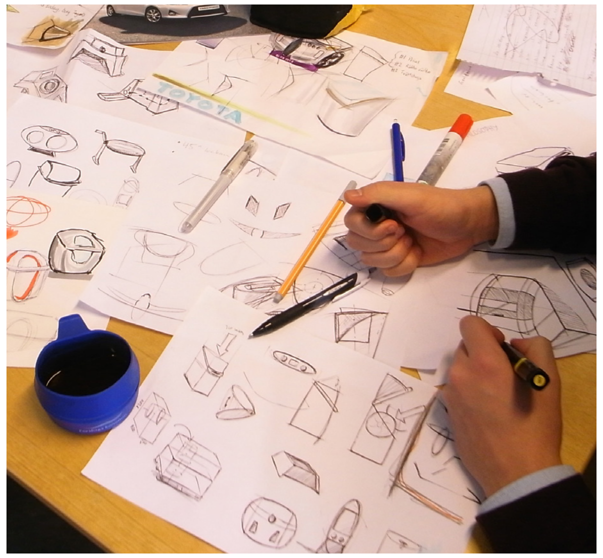


*Figure 2.7. Sketching as a tool of the design work*

### 2.4.3 Design format modeling

To understand which design cues that make cameras look like cameras, a design format analysis (Warell & Nåbo, 2002) was done on typical surveillance cameras. This analysis was done in order to know which specific design cues that should be avoided to minimize the expression of surveillance cameras. The method was used as a line analysis of contours of various surveillance cameras. By comparing the lines, shapes and patterns that were present in these product, specific design cues for surveillance cameras could be identified.

### 2.4.4 Idea generation on mounting solutions

To generate ideas for the mounting solution of the product, an idea generation session with design students was arranged. Questions about how to elevate, attach/detach the product to posts, adjust and move the product was posted. This session was based on two methods for stimulating creative thinking, called brain writing and six thinking hats. The participants of the idea generation started off by individually sketching their wildest ideas for how these issues could be solved. After one session the participants presented their ideas to the group. This was follow by one iteration and a final group discussion. The outcome from this session was a number of ideas and suggestions for how the product could be mounted, which served as inspiration for the ongoing development work.

*Brain writing:* This method allows the participants to initially explore and sketch their ideas for a stated problem individually. After a while of individual idea generation, the participants can start looking at each other's ideas and get inspiration for their own ideas (Österlin, 2010).

*Six thinking hats:* The brain writing was followed by the method Six thinking hats (De Bono, 1985), in order to increase the thinking productivity during the idea generation. The method divides a stated problem by ways of thinking, giving the participants the opportunity to focus on a specific direction of the problem. This is done to minimize confusion due to handling to many issues, or too much information at the same time. The aim is to achieve parallel thinking, meaning that every participant focus on the same problem and try to solve this issues with an equal mindset. This method was used to further explore the ideas from the brain writing session.

### 2.4.5 Expressional and Functional Surfaces

In order to get some structure in the form development work, the method of functional surfaces (Tjalve, 1979) was used. The method aims to identify certain surfaces or areas of products, as areas of function. These areas are to be designed to a specific purpose, and therefore becomes a limitation to the overall design. However, these surfaces could also clarify and guide the design work and unnecessary solutions can be rejected due to intrusion on such a surface.

For this project the method was modified in the way that also visual expression of the product was included and could be labeled to specific surfaces. The method generated useful guidelines and a simple model of what the different surfaces of the product should express and which specific functions were important. The model also included how the different stakeholders interacted with the surfaces of the product. How the product was to be placed and angled were other key aspects for how this model should be used.

### 2.4.6 Kesselring

To rank different concepts a Kesselring matrix could be used. Predefined criteria are weighted from 1 to 5. The concepts are then evaluated how well they fulfill a criterion and multiplied with the weight to get a total score. In the end the concepts are ranked (Johannesson et al., 2004). In this project the kesselring matrix was used as a way of visualizing the thoughts behind concept evaluation and concept selection.

## 2.5 CONCEPT DEVELOPMENT

The concept was in this phase further developed to meet the demands stated in the requirements list. Further, testing and evaluation of the product was conducted in order to develop the concept and verify the result.

### 2.5.1 Prototyping

It is possible to manufacture different types of physical prototypes. Simple mock-ups to represent form, shapes and materials or functional models to test the product's functions. The last stage of prototyping could be a test run which demonstrates the products complete functionality and design, using the right materials and manufacturing process (Johannesson, 2004). Various functional models were manufactured in order to experience how different technical solutions would work in reality and simple mock-ups were made to show possible alternatives for form, shape and textures. The functional models and mock-ups were tested and evaluated to achieve the best possible result. The final prototype was a functional model with roughly the intended appearance, to the most part made out of the intended material but with the use of different manufacturing processes.

### 2.5.2 Testing and evaluating

To see if the intended functions of the product worked, tests were conducted by the project group together with representatives from Viscando, (figure 2.8) and with industrial design engineering students. As a part of the iterative approach of the design process, tests were made of an intended function and rapidly evaluated and modified for further testing. Evaluations of functions were made as unstructured discussion during tests and verified against the requirement specification. Mock-ups made to show form, shapes and textures were also evaluated by the project group and together with representatives from Viscando, as well as verified against the requirement specification. The final concept prototype was also evaluated by asking the general public how they experienced the design.

*Figure 2.8. Testing and evaluating concepts*

### 2.5.3 Final specifications

Decisions for the product design, material choices, manufacturing processes and product expression were set and formed a base for dimensioning of the final concept. Decisions were verified against the requirement specification.



# 03 RESEARCH FINDINGS

This chapter summarizes competitors, defines stakeholders of interest for this project and describes the stakeholder needs.

## 3.1 MARKET AND COMPETITOR ANALYSIS

There are two main alternatives to estimate people's traveling behavior, either to make a travel survey, which normally is done by sending a questionnaire to a group of people, or to do physical traffic measurement (Niska 2010). Viscando is developing equipment for physical traffic measurement and therefore travel surveys are not covered in this project.

Today there are several methods for measuring traffic. Some methods are more suitable for cars and some for bicycles. All methods have their pros and cons and are therefore suitable for different applications. Table 3.1 shows a compilation of common methods used today. There are problems with all existing solutions when it comes to more complicated situations, where there is dense traffic or a mix of pedestrians, vehicles and bicycles. Here the method of video analysis has many possibilities. Video analysis also opens up opportunities for more advanced analyses of traffic behavior.

### 3.1.1 Video analysis market today

Video analysis could be done using one or more cameras connected to each other. This method makes it possible to identify and measure more complicated situations than other methods, e.g. patterns of movement or analyses of incidents and conflicts. Video cameras are easy to mount and requires no machining of the street. Video analysis is a rather new method and there are not that many actors on the market today.

*Table 3.1. Compilation of common methods for measuring traffic, based on the summary of mehods by Trafikverket (2012)*

| Method | Description | Benefits | Disadvantages |
|---|---|---|---|
| **Radar** | Emmits radiation that is reflected on objects | Easy installation, durable, maintanence, independent of weather/light | Difficult to separate pedestrians, bicycles and cars, weak signal for pedestrians |
| **Infrared radiation (IR)** | Emmits radiation that is reflected on objects | Easy installation, durable, small amount of maintanence | Difficult to separate pedestrians, bicycles and cars |
| **Pneumatic tube** | Two tubes placed over street, detects changes in air pressurie in tubes | Good detection rate | Unsuitable in winter, problems with vandalism and wear |
| **Inductive loops** | Machined into street, detects metal by induction | Durable, small amount of maintanence | Needs machine work when installed, could miss aluminium bikes, detects prams. Problems with high flow |
| **Fiberoptical cable** | Machined into street, detects objects optical | Good detection rate | Needs machine work when installed, dont work with snow |
| **Data from traffic signals** | Data from existing traffic signals are recorded | Existing sensors availiable all year around | Suitable for cars, not for bikes and pedestrians |
| **Manual counting** | Field workers counts and records | Can record use of helmet, no need for advanced technical equipment | Resource demanding, difficult to record longer periods and night time |
| **Video anlysis** | Videoanalysis software combined with video camera(s) | Can separate pedestrians and bicycles | Permission for video surveillance required, problems in bad view eg. heavy snowfall and mist |
| **Wifi** | Tracking wifi or bluetooth adresses from mobile phones | Can see peoples travelling routes | Needs many nodes, only counts people with wifi devices |

## 3.1.2 Viscando's current product

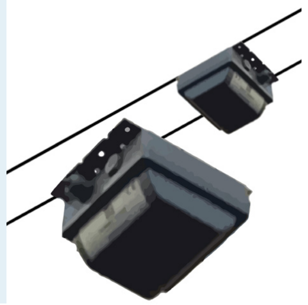
Viscando uses two cameras, which gives a 3D view of the environment. This solves the challenge of double counting shadows of people, which is a problem with single camera systems. It also makes it possible to see smaller objects in front of bigger objects, for example a bicycle in front of a bus that will be hard to detect with one camera. Another key concept with Viscando's technology is integrity. The video image is processed directly in the computer of the measuring device and there is only video data in 20 milliseconds. This is then directly translated into statistics, such as number of pedestrians and bicycles. No video is sent from the station and therefore the hope is to not need permission for video surveillance in the future. The product that Viscando can offer today is sold as a stationary product. It uses standard surveillance camera housings that are mounted on a post or similar. Power supply is facilitated either by separate power cords, or by accumulating power from a light post. Today the software is available for counting pedestrians and bicycles and for analyzing sideway distribution. But software updates, for more advanced analyzes will probably be available in the future.

*Figure 3.1 The current Otus 3D system*

## 3.1.3 Competitors

Below follows some information about five different traffic measuring systems currently on the market. These five systems were identified as the main competitors of the mobile Otus 3D system.

**Competitor 1** uses infrared cameras that are mounted on a wire above a street. The product is designed to count pedestrians. It is stationary systems that sends data via GSM. The data is available through an online analysis tool. This product does not need surveillance permission as it uses IR cameras, which generates a picture that makes it impossible to identify individuals. The IR technology do put some constraints to the system i.e. differentiating between pedestrians, bicycles and cars. The mounting facing straight down might be a limitation in some environments.



**Competitor 2** has a product that can count bicycles and pedestrians as well as directions of these. The solution uses standard Axis surveillance network cameras with the company's software. The camera has to be positioned high up pointing straight down on the spot where measuring is done. There is a maximum width of 6 meters that can be measured and the camera needs to be mounted minimum 4 meters above the ground. Data can be monitored real time through an online solution.



**Competitor 3** offers their video analysis software which is sold as a semi-automatic solution. In this software movements and interactions between cars can be analyzed. They also have a solution for collecting video with a camera house with built in hard drive storage. This unit can pick up film for one week with built in battery or longer periods with external power supply. This camera is then mounted on a post, balcony or mobile post. They also offer a database solution where data from different measurements can be collected and analyzed.

**Competitor 4** offer their product as a mobile device that attaches to a light post or similar. The video collection unit can be used for analyzing intersection turn share, road volume, vehicle gap data and license plate data. It is used for vehicle analysis only. The camera unit is placed next to an existing post, then the camera is elevated on a telescopic pole to a height of 7,6 meters. On the bottom of the telescopic pole a computer and battery pack is placed. The unit collects data as a video recording of e.g. an intersection, which is later uploaded to a server and analyzed. After a couple of days a turn share analysis can be obtained. With the integrated battery up to 72 hours of filming time is available and with extra battery pack up to one week. The product could be transported in a normal car when folded, and be deployed by one person.

**Competitor 5** is like Viscando using dual cameras to gain the benefits of 3D technology. The product is not used for collecting traffic statistics. It is used in road crossings for controlling and optimization of traffic signals. Main applications are to detect pedestrians crossing the road, detecting pedestrians waiting to cross the road and for activation of warning signals. Not being a competitor on traffic measuring the product is still interesting as the dual camera 3D technology and setup is similar to Viscondo's product. It is mounted on post and the tuning is done by predefine a detection zone on a real time video screen. Another interesting aspect with the product is that the housing is designed by a design agency. The design brief stated that it should not look like a camera; it should look like a pedestrian detector (Seth 2010).

### 3.1.4 Design of existing systems

Most competitor systems do not stand out when looking at the design. Almost all of them are placed in some kind of standard housing and using standard components for mounting. This could for example be a square plastic electrical equipment housing, mounted to a post with threaded clamps. Competitor 5 and competitor 4 have put efforts to design their own special casings and mounting solutions. The camera unit of competitor 4 has a design reminding of a loudspeaker with its cone shape. Competitor 4 has also solved the problem of getting the equipment up to the needed height by working from ground using a telescopic pole. Other competitors mainly use an existing post as base for their products. The camera unit is rather small and light making it possible to use a light and simple telescoping rod to get it up. There are also trailer based posts, used with various traffic equipments that could be used, but these are big and not very mobile. Competitor 5 is designed to look like a pedestrian detector instead of a camera. It has rather round and organic shape compared to many competitors on the market, which are mostly using boxy shapes. It also has a post clamp that is neatly integrated in the product housing.

> **Implications 3.1**
>
> All systems on the market have problems when it comes to more complex traffic situations, mixed traffic and pedestrians. Here video analysis opens up new possibilities. Most competitors use standard casings and mounting solutions. Not many competitors are working with facilitating easy use of their equipment and the visual expression. To have an own design with thought out solutions would be a way to differentiate on the market. This will help positioning Viscando Otus 3D as a high end product.

## 3.2 STAKEHOLDER MAPPING

From literature studies and discussions with Viscando, seven different stakeholders were identified. It was investigated how much the different stakeholder interacted in the actual measuring situation and how much interest the stakeholder had of the results of the measuring e.g. which situations in traffic to analyze. With this as a starting point, different stakeholders were chosen for interviews, with the intention of covering as many aspects as possible. Besides the interests from Viscando, focus was put on traffic planners, as these interact both with the product and have interest in the data gathered.

For mounting equipment used for measuring traffic, there is some kind of installation personnel. Often this is done by the traffic planners themselves, otherwise by personnel at the municipalities or consultancies.

There are also consultants working with traffic measurements and analyses. These consultants often do jobs on behalf of municipalities or the transport department, putting them in a similar position as the traffic planners and the installation personnel, or somewhere in between.

There is research being conducted within the field of traffic safety and infrastructure. They have interest in both new technologies for making analyses as well as for what kind of situations to analyze.

Regarding the expression and interaction with the product, the general public is of course in focus. Since the people being exposed and analyzed are regular people, their opinion on both appearance and function of the product becomes very important.

Politicians were recognized as being the top decision makers, in terms of what kind of outcome traffic analyses should produce. However, politicians were deemed to have too little interest in the actual measurement product and because of that, not investigated any further. In reality, it seems like the traffic planners can work rather freely and decide for themselves how to carry out their work and perform analyses. The influence from politicians seemed to mostly concern budgeting and allocation of resources.

The result from investigating the possible stakeholders was compiled in a stakeholder map (Figure 3.2), showing how the different stakeholder relate to; *how* and *why* measurements and analyses are done.

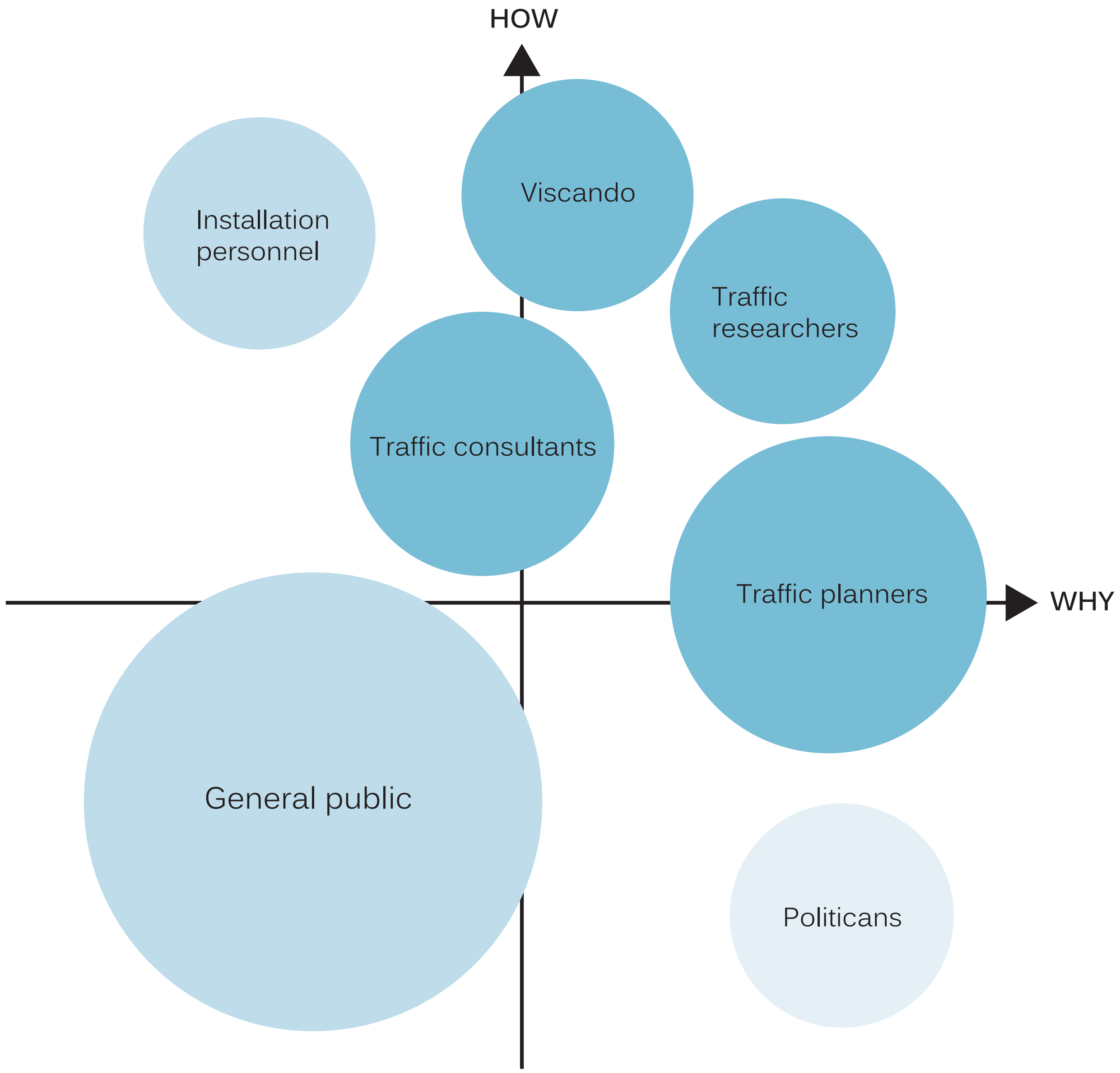



*Figure 3.2. Stakeholder map showing the different interests in why and how traffic measurements are done*

> **Implications 3.2**
>
> The stakeholder mapping resulted in seven identified stakeholder groups, including Viscando as a stakeholder as well. The major stakeholders that were chosen for interviews in the initial phase was traffic planners, traffic consultants and research institutions. These three stakeholder groups were believed to cover questions regarding both why and how measurements are carried out. The stakeholder group of installation personnel was found to be included in the groups of traffic planners and traffic consultants, since these often operate and install the equipment as well. The opinions of the general public was further investigated with interviews and a focus group.

## 3.3 CONTENT ANALYSIS

When summarizing and structuring the transcribed material from the interviews, the content analysis was divided in the two categories; *why* and *how,* which were identified as seperate areas of interest for the stakeholders. The excerpts from the interviews were sorted into these two categories and within these, new topics were found. *Measuring traffic* was the main heading for *why* measurements are done and included nine topics. The *how* category was divided into two headings: *use and mobility* that included five topics and *visual expression* that included four topics. The complete content analysis (figure 3.3) was the framework for the continuing work and each topic is presented in the following three chapters *measuring traffic, use and mobility* and *visual expression.*

> **Implications 3.3**
>
> The content analysis helped to structure the verbal data in order to draw conclusions, by visually displaying the relations between the different topics. It also highlighted the two main problem areas for the upcoming product development work. It displayed how the product is *used* in practise, important aspects of the visual *expression* as well as giving valuable information about different situations and contexts.

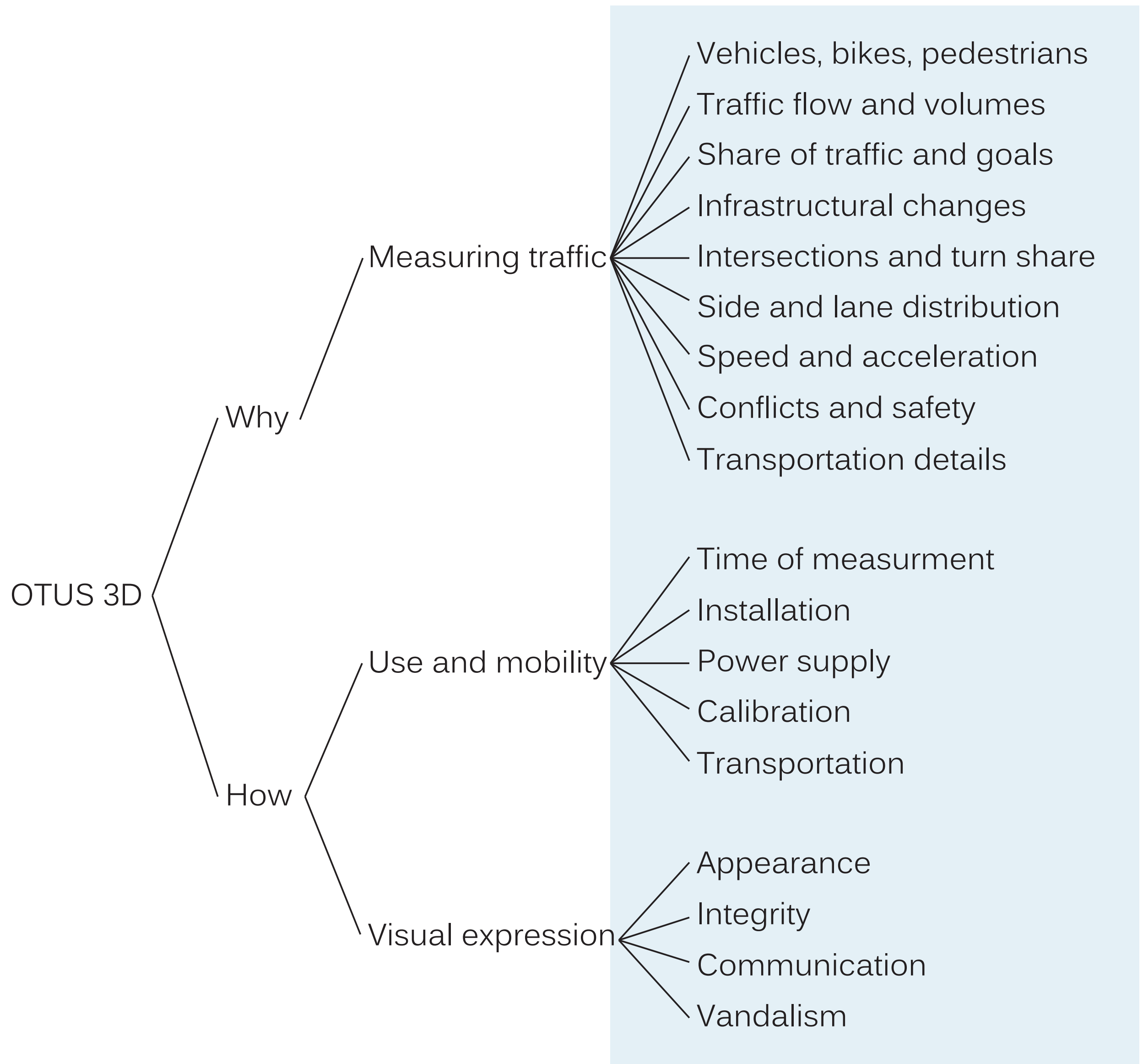



*Figure 3.3. Result from the content analysis, which defined the headlines for the continuing work.*



## 3.4 MEASURING TRAFFIC

The interviews with traffic planners, traffic consultants and traffic researcher showed a number of reasons for why measurements and analyses of traffic are done today, what kind of analyses that are desired and problems that might occur. The nine identified topics; *Vehicles, bicycles and Pedestrians, Traffic Flow- and Volumes, Share of Traffic and Goals, Infrastructural changes, Intersections and Turn Share, Side- and Lane Distribution, Speed and Acceleration, Conflicts and Safety* and *Transportation Details,* which explained why measurements of traffic are done is presented in this chapter.

### 3.4.1 Vehicles, bicycles and Pedestrians

There were differences between traffic types (vehicles, bicycles and pedestrian), in terms of how far developed measurement techniques were and how frequently measurements were made. Vehicles, mainly cars, are measured in large scale and with well developed techniques that have been used for a long time. Bicycles have been measured for quite some time, but are still relatively new for most municipalities. Whereas pedestrian measurement, is something new to most traffic planners, either it is something recently initiated or something planned to be initiated within a few years time. It is obvious that the size of the municipality affects this progression of measuring different types of traffic, where smaller municipality generally are a few years behind medium sized or large ones.

### 3.4.2 Traffic Flow- and Volumes

The single most common reason among the municipalities was that continuous measurements of the traffic flow of cars, trucks and bicycles i.e. the quantity of traffic on the main roads and streets. This data gives an understanding of the traffic density, which affect the wear of the road and therefore also indicates if dimensional changes are needed. These measurements give the traffic planners control over the current quantitative traffic volumes. This data is most commonly gathered with methods such as pneumatic tubes, inductive loops or radar, in some cases manual counting's are also made. The inductive loop is used for stationary installations and the pneumatic tube is generally used for more temporary measurements, whereas radar is used both for permanent and temporary installations. Overall, the use of these techniques for measuring traffic flow seemed to be appreciated by the traffic planners, since they gave good data relatively easy. However, some shortcomings were also discovered, for instance that the quality of the collected data could decrease when dealing with slow moving traffic (radar, inductive loop, pneumatic tube), bad weather conditions (inductive loop, pneumatic tube), vandalism (radar, pneumatic tubes) or environmental limitations such as background noise (radar). Manual counting's are seen as rather primitive, time consuming and expensive.

### 3.4.3 Share of Traffic and Goals

Municipalities often have goals regarding traffic. These goals are set by the local politicians and could often be derived from national goals for infrastructure. With the increased awareness for environmental issues, the goals are set to increase sustainable travel, meaning that the use of public transportation, bicycles or even walking is encouraged. This of course means that the use of cars should decrease. These goals are mentioned by the traffic planners as a guide for their work in analyzing traffic situations. However, these goals demand a measurement of the share of the different types of traffic. This is problematic since measurements today often are only collecting data of the quantity of the different types of traffic. Different measuring techniques are often used for the different traffic types, at different locations, making it hard or almost impossible to compare the data, even for measuring the share of traffic in a certain point. This makes it extremely hard to follow up the effects of infrastructural changes, in terms of measuring the share of traffic types. Typically, transportation surveys are made every five or ten years, asking people of their transportation habits, in order to get this information. These surveys are however time consuming and expensive. The measurement techniques for measuring the share of traffic are basically the same as for measuring flow or volumes. However, all traffic planners that were interviewed agreed to that it would be a benefit to have one measuring system that could gather data from all traffic types at the same time.

### 3.4.4 Infrastructural changes

When making reconstructions or changes in infrastructure, there is a need to find out if these changes had any impact on the situation. When asking traffic planners if they strived for enabling this possibility of comparing by measuring both before and after reconstruction, the traffic planners agreed that it would be the most rational thing to do, but that it was not always the case. In many cases it seems as changes are made, then evaluated by for instance measuring the traffic flow or similar afterwards. This approach will give any indications of improvements, rather indicating that it is working or not. The interviewees agreed on that measuring before and after changes are made can give important knowledge and input for future changes, you can e.g. learn from your mistakes or continue with successful methods.

### 3.4.5 Intersections and Turn Share

A common wish among the traffic planners was to identify routes and movement of traffic, mainly within or around cities. They are interested in knowing where people are going, where they are coming from and why they are choosing certain routes. This is said to best be discovered by logging turn shares for vehicles, bicycles or pedestrians at intersections or roundabouts, since these are natural route dividers. For instance, one of the interviewed traffic planners was interested in knowing whether the traffic was only passing by the city, going through it or staying.

### 3.4.6 Side- and Lane Distribution

The placement and distribution of traffic across a street or side walk, was something that seemed interesting to know for the traffic planners. They saw benefits of mapping where traffic was most intense, which lanes that were used, if the right lanes were used by the intended traffic type, if streets divided with painted lines had any effect on the behavior. The traffic researcher also had interest in knowing how close to the roadside traffic was going. Information about the distribution could help in planning new road constructions in terms of width, lanes, dimensioning, obstacles or maintenance.

### 3.4.7 Speed and Acceleration

Detailed information about speed and acceleration was something mentioned a lot during the interviews. Such information would be valuable when constructing solutions for increased safety in traffic. Speed bumps and shared spaces were typical topics up for discussion. If speed and accelerations could be logged for different traffic types in a shared space or at crossing, typically vehicle-bicycle or vehicle-pedestrian situations, these spaces could be evaluated. Other areas where different traffic types are present simultaneously could also be evaluated and actions could be taken to improve safety for that location. There was also interest in knowing the speed differences between bicyclists, as well as how often they need to brake or accelerate going through a city center with many obstacles, both for improving accessibility and flow, but also to keep the speed down for safety reasons.

### 3.4.8 Conflicts and Safety

As an extension of the speed and acceleration section, other types of safety reasons were mentioned during the interviews. Since accidents in traffic luckily are quite rare, it is difficult to evaluate if a certain location is to be considered safe or not, based on gathered data. If there was a way to measure conflicts or incidents and analyze these, actions could be taken to prevent accidents. For instance, analyses of how close cars and unprotected road users get at an intersection could indicate the risk for accidents. A conflict indicating system was seen as desirable from most of the interviewees. Today, these kinds of analyses are done manually, with people watching a certain location, registering possible conflicts or incidents.

### 3.4.9 Transportation Details

Municipalities seem to have a great interest in analyzing specific details among road users. For bicyclists, the use of helmets, proper lighting and type of bike are some examples of desirable data. At the research institution there was an interest in knowing how different type of bike users interact in traffic, e.g. comparing the behavior of people with racing bikes with people using regular bikes or electrical bikes. Even information about people using their cell phone or listens to music, in a traffic situation could be of interest.

### 3.4.10 Ordering of situations

Out of the results from the investigation on why traffic measurements are made, some situations were rejected, and not chosen for further investigations. Still, some of these situations and analyses could be worth developing for the future. The situations, which were not chosen for further development in this project, is a matter of software development and could be possible to realize in the future. Figure 3.4 shows which type of measurements or situations that were deemed reasonable for the mobile product to manage. The colors indicate how much software development that is needed to manage the situation. Where the darkest color means that it is possible today, the middle color that some development is needed and the lightest color that substantial development is needed. This visualization also shows the situations, which were considered within the project boundaries.

Together with representatives from Viscando three situations or contexts were developed to symbolize typical areas of use for the Otus 3D system. By doing this the environment where the product is meant to be used became clearer. These contexts served as representations of the operative environment for the product and are presented in Appendix II.

### Implications 3.4

Categorization of traffic situations answered to why traffic measuring is conducted. The situations and contexts defined the environments where the product is to be used. These environments were used for creating imageboards as guidelines for the product's visual expression. The categorization enabled guidelines for the traffic measuring situations that will give the best business opportunities.

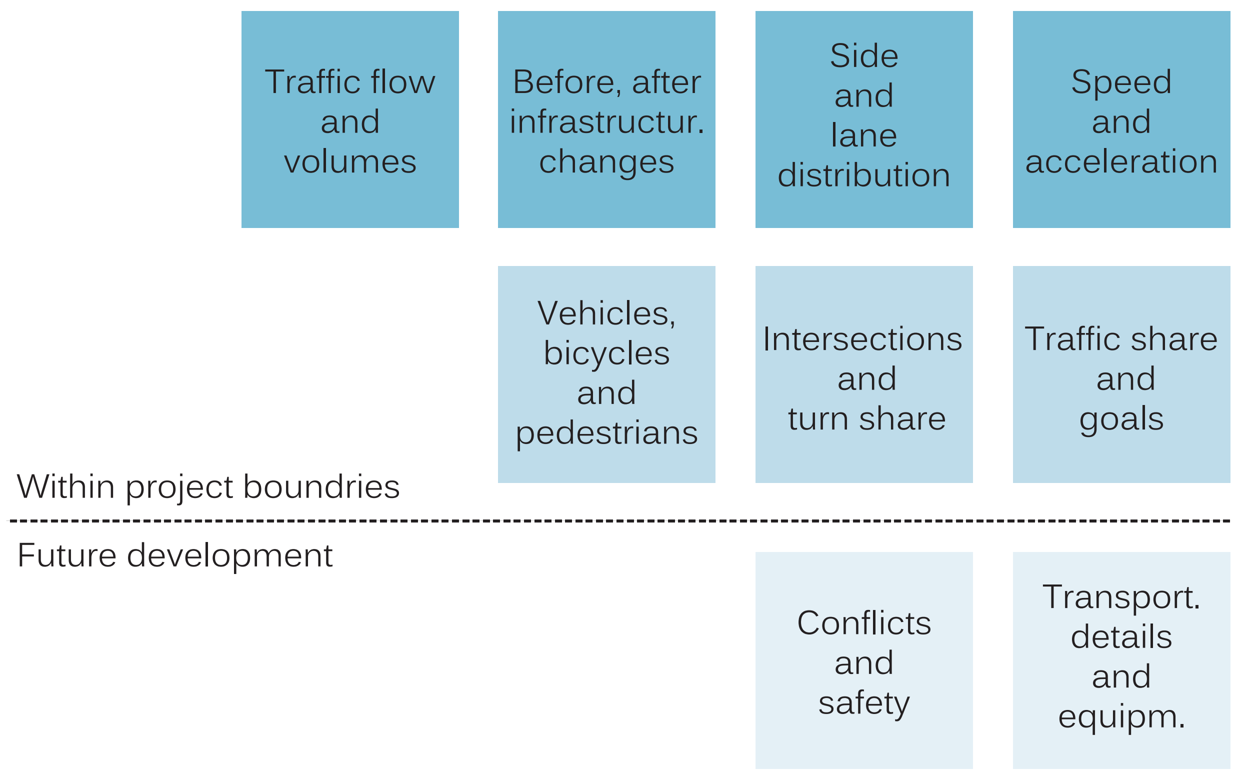



*Figure 3.4. Ordering of situations for traffic measurement*

## 3.5 USE AND MOBILITY

To produce a mobile and user-friendly product the term mobility had to be further defined. From the interviews important aspects of mobility and usability were identified. These were categorized and concluded under the five topics; *time of measurement, installation, power supply, calibration and transportation.*

### 3.5.1 Time of measurement

Depending on situation and desired data different time lengths of the measurements are requested. One traffic planner was interested in the maximum intensity for morning and afternoon traffic, which could be gathered from 2-4 hours of measurement. A traffic engineer in another municipality stated that one week is the minimum, at least from Monday to Friday. Two interviewees thought that they could measure up to two weeks with their existing mobile radar and tube stations. Another stated one week as the longest with existing equipment and two weeks as a wish. One of whom thought they could measure for two weeks only did one week measurement even if their battery would last for longer periods. The overall impression when discussing time of measurements was of course that the longer time possible to measure, the better. However, it seemed as shorter measurements often would give enough information to reach the intended objective.

### 3.5.2 Installation

One traffic planner stated that it is desired that only one person is needed for installation. Another thought it was handy to be two persons, as then one could drive by and the other could stand by the station and check that speed and direction was properly registered in their radar. If a sky-lift is needed for installation, there might be need to close the road or put up some kind of protection. The same problem was occuring when installing pneumatic tubes. This was seen as an issue, since there are more regulations today regarding protection than there were a few years ago. Sky-lifts were also claimed to be expensive. "To be able to work on the side of the road is very good" was a typical quote when talking about installation. Equipment that only requires to be mounted on a rather low height (2-3 meters), for example mobile radar units, are commonly installed with the help of a small ladder or from the loading surface of a pick-up truck. Installation time for a mobile radar system was claimed to be as fast as 5-10 minutes installation time when used to it, but for a inexperienced person it would take about one hour. Another traffic engineer stated one hour as maximum installation time for a mobile system. One suggestion was to make handles and a good installation sequence to make it more ergonomically, as this was something lacking on the equipment used today. Talking about the possibility to use existing posts as a base for the installation. One traffic planner stated that "Post are to be found everywhere, it is no barrier for mobility to use existing posts".

### 3.5.3 Power supply

Everybody that was interviewed agreed that to be a mobile product, it has to run on batteries or some other mobile power supply. The alternative to connect to the power grid, as there often is power available at the light posts was dismissed. Reason for this being that special education is needed, permission is hard to get, it is expensive and to drill holes into posts might generate corrosion problems. If the power from a lighting post was to be used it was regarded as some kind of temporary system instead of mobile, as stated by one of the traffic planners: "It has to be battery power; if we need to make connections to electricity from a post we can call it semi-stationary, more of a planned system". Another aspect was that a mobile system is used in situations that look completely different every time, and therefore battery was concerned as the only reasonable alternative.

### 3.5.4 Calibration

One of the traffic consultants had experience of using the Miovision mobile video analysis equipment. He was satisfied with the solution and time it took to calibrate it. The only thing he thought was missing was to be able to adjust the camera from the ground, as it is now it has to be folded down, adjusted and folded up again when adjusting field of view. One municipality had difficulties calibrating their mobile radar stations to get satisfied results, and another said: "It has to be easy to calibrate, otherwise you will just skip it in the end!". One suggestion was to put some kind of "green lamp" that indicates when the equipment is properly tuned.

### 3.5.5 Transportation

To be mobile, the device has to be easy to transport between the different measuring locations. One of the municipalities discussed their trailer with radar and a speed sign on it, as a good way of transporting, but limiting in use as it is hard to find a spot next to the road where it fits. One traffic measuring consultant had an idea of a cargo bike with a mast and equipment on it for easy transportation between locations.

### Implication 3.5

When summarizing the results regarding use and mobility, a timeline (fixure 3.5) of measurement was used for visualization. The mobile product should be optimized for shorter measurements of up to one week. There is a market for shorter and more advanced measurements, which puts demand on easy use and quick installation. A well thought out and installation procedure and ergonomic product is desired. For a shorter time of measurements no advanced tools should be needed to qualify as a mobile solution. Ladders and sky lifts were considered the best alternatives for mounting the and will be the techniques used for the new product. To achieve a quick and safe installation preocedure in this context, weight, balance and handling is of the essence. This can be achieved by dividing the product into modules for better installation procedures and by enabling good gripping possibilities.

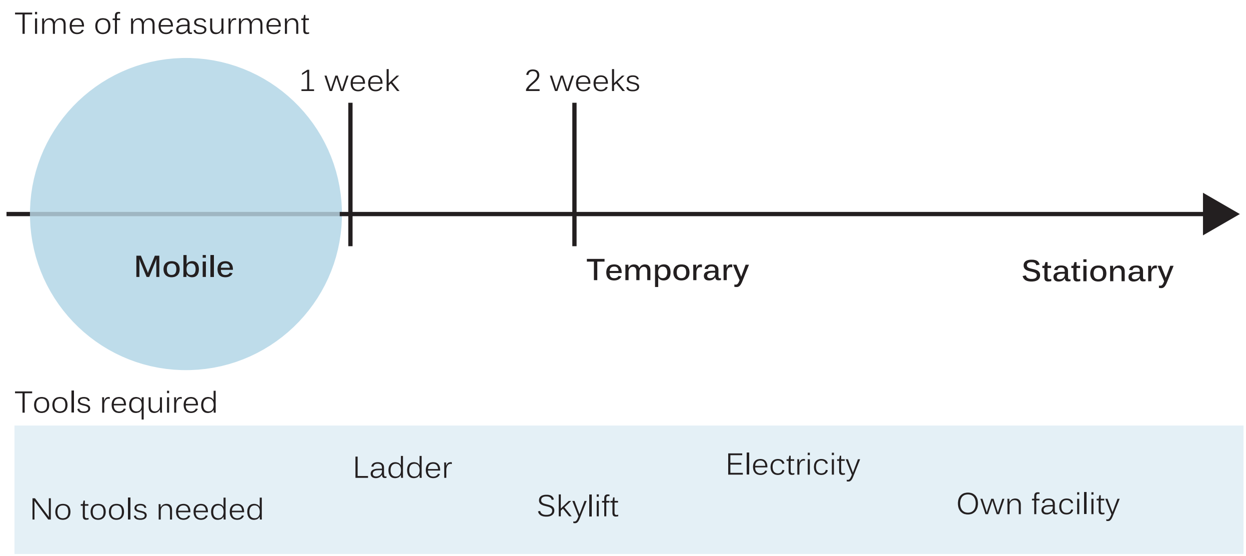



*Figure 3.5. Timeline for defining mobility*

## 3.6 VISUAL EXPRESSION

This chapter addresses the impact that the visual expression could have on the perception and experience of the product. The four topics *appearance*, *integrity and camera permission*, *communication* and *vandalism* that were identified in the content analysis are described in this chapter. The product is viewed from different perspectives, in terms of how this expression could affect people, depending on which stakeholder that is considered. The potential buyer, which probably is a traffic- planner or consultant, has one view, while the installation personnel and general public have their respective views of the product. The installation personnel have the most physical interaction with the product and might treasure more functional values, but is also the one that can view details on the product. The general public is merely the observer in this case, with no ability to affect the product. For this stakeholder the most important issue is that the product blend into the environment in the best way possible. Detailed explanations and compilation of quotes on visual expression from the interviews with traffic planners, traffic consultants and traffic researcher, as well as the focus group on visual expression is found in Appendix IV.

### 3.6.1 Appearance

The most common suggestions from the interviewees was that the measuring device should have a neutral or anonymous look, so that it is less disturbing to both the environment and the people laying eyes on it. There were several reason mentioned why a discreet look was wanted. One was to be less threatening to people, which a more expressive look might be. One suggestion to minimize a threatening look was to put the two cameras in the same housing. This request was however certain to be met, since the project brief states that the product should be enclosed in one singular casing. A discreet look was also motivated by the fact that the product should not affect people's behavior. A too expressive product was said to increase the risk of people not acting as they normally would. A change of people's behavior might affect the measurement accuracy and not reflect the reality, this was the underlying reason mentioned in the interviews.

One look that was suggested by some of the interviewees was the traffic equipment look, referring to other types of equipment that are present in the traffic environment, such as traffic lights or traffic signs (figure 3.6). This was seen as a good alternative for blending in and being discreet, since it is a familiar look in the urban environment.

In contrast to the discreet look, an attractive and aesthetic appearance was also desired. One reason mentioned for why this was important, was that people are more likely accept attractive things in their surroundings.

During the interviews the question of familiarity became evident. It was believed that the mobility of the product could affect people's attitude towards it, since they might not get used to the product if it is being moved to different locations.

According to Carl Sagan (1995) the human is hardwired to recognize faces. The human brain tries to find patterns that are similar to faces. A big part in this is the pattern of two eyes. The housing of the product will need to have two openings for camera lenses, and this could make people recognize it as a face. If people associate the housing with a face they might also associate it with somebody watching them, which is not desired.

*Figure 3.6. Traffic equipment*



### 3.6.2 Integrity

The opinions on whether a system like the Otus 3D, should look like a camera or cameras, was more or less unanimous. Almost all participants in the focus group and all of the professionals that were interviewed agreed on that such a system should probably not look like cameras, since the system's main purpose was to collect- and analyze data, and not to record video material. Interestingly enough, much of what is being mentioned about the ambivalent feelings towards video surveillance in the paper 'The gaze without eyes' by Hille Koskela (2000), becomes evident in the interviews and especially during the focus group. In her paper, Koskela discuss the mixed emotions of feeling safe or sensing danger at the same time, when being under surveillance. This paradox of contradictory emotions was obvious when the focus group participants discussed whether they liked or disliked the presence of surveillance cameras (figure 3.7). Ellis Et.al. (2013) state that space under surveillance could be both complex and ambiguous, facilitating safe and secure environments but also facilitating distrust. The statements about of how spaces under surveillance affects people's emotions, strongly indicates that a visual expression that has any resemblance with surveillance cameras should be avoided, if the intention is to produce a product that does not affect people's behavior. Similar to the discussion about camera surveillance, other authorities monitoring methods were addressed. Mainly this discussion concerned the police and the use of speed cameras. These cameras are made to affect people's behavior and should not be resembled in the product, in the same sense as surveillance cameras. In the interviews it was mentioned that a lot of people generalize municipalities and authorities and see them as the same organization.


*Figure 3.7. Integrity*

### 3.6.3 Communication

Regarding the communication and information about traffic measuring activities to the general public, there were split opinions among the interviewees and focus group participants on how this should be done. There were those who doubted the need of showing either what they were doing or who they were. There were also those who pointed out the benefits of enabling more information to the residents about ongoing activities.

One reason for not communicating any messages to the general public was that it was claimed that the police and municipalities often are seen as the same organization by people, which might lead to confusion for people if e.g. a municipality logotypes was placed on the product. Another simple explanation was it did not seem to be of importance that people knew what kind of measurements the municipality was doing.


*Figure 3.8. Bicycle barometer communicating statistics*

Those who meant that the communication with the general public might be a good thing, also had several reasons for this. One being that it was of importance that the municipality showed people that they were active in the work for improvements of traffic safety. Another reason was to simply encourage people by being visible, much like the purpose of bicycle barometers (figure 3.8), which counts the number of bikes passing by a certain location. It was also mentioned that labeling of the product could be a way of communicating with e.g. the police, so that they know it is a legitimate piece of equipment that is in place. It was mentioned at several occasions that the integrity preservance of the system had to be certain. By this they meant, if doubts or questions regarding integrity issues of the system would be posted by the general public, they must be able to ensure that the system respects personal integrity. Homepage information was mentioned as another possible channel for communicating information to the general public.

The result shows an uncertainty towards communicating information about the system, which makes it hard to draw any conclusions. However, this might be something that the buyer of the system can decide for himself, meaning that some parts of the communicative aspects of the product should be customized. As an addition to the results from the interviews and the focus group, the communicative attributes of the product must also convey the Viscando Traffic Systems brand identity and the Otus 3D product signs.

### 3.6.4 Vandalism

When discussing the expression of traffic measuring systems with the interviewees, the subject of vandalism (figure 3.9) or sabotage were always brought up. Almost everyone that was interviewed had some kind of experience with equipment being stolen, tampered with or even destroyed. Vandalism, in terms of traffic equipment in a public environment, seems to be an unwanted result if the expression or integrity issues fail to communicate the right message to people. The risk of vandalism is closely connected to the three prior topics concerning appearance, integrity and communication. The interviewees express their experiences from several perspectives. For instance, it was believed that people tend to attack things they do not recognize, things that resembles with police equipment and things that simply are possible to destroy, due to vulnerable

*Figure 3.9 Vandalism*

appearance or accessibility. Another issue that was brought up was theft of equipment. It appeared to be quite common that people try to steal equipment that is believed to have some kind of value. It was mentioned that the camera look might show that it is a valuable product, and therefore should be avoided.

One definition of vandalism is “the willful or malicious destruction, injury, disfigurement, or defacement of any public or private property” (FBI, 1978). Cohen (1973) lists five categories of vandalism; acquisitive vandalism (looting, petty theft), tactical/ideological vandalism (to draw attention to oneself or to an issue), vindictive vandalism (for revenge), play vandalism (to combat boredom), and malicious vandalism (to diffuse the frustration and rage often occurring in public settings, wherein the target is depersonalized). The Otus 3D system was considered most likely to be exposed to more spontaneous act such as acquisitive or play vandalism. However, more ideological intentions concerning integrity issues could of course occur, especially if the product has resemblance to cameras.



**Implications 3.6**

When discussing the visual expression for this type of product, several suggestions and insights were presented by the interviewees and the participants of the focus group. This resulted in a number of requirements that were taken into consideration for the further development of the product. The following requirements/recommendations were identified as important: To have a discreet look so that it to some extent blends into the environment. Preferably have similar design traits as common traffic equipment to increase familiarity. To not be considered as threatening and have no resemblance of the human face, in particular the eyes. To have little or no resemblance with surveillance cameras or speed cameras. To communicate honest information about the system, possibly by customizing the message after the users own intentions and wishes. Communicate the Viscando brand identity and the Otus 3D product signs. To have a robust look, so that vandalism might not be as inviting. To not look too expensive or technological, in order to minimize the risk of thefts.

## 3.7 INTERVIEWS WITH GENERAL PUBLIC

To get an understanding for the general public’s view on Viscandos existing equipment, field interviews were performed. In Eskilstuna, Viscando has installed a stationary measuring station for bicycles and pedestrians. The equipment looks like two surveillance cameras mounted on the top of a 6 meter high post about 2-3 meters away from the sidewalk. These cameras are pointing down at the road, which consists of a motor road with sidewalks for bicycles and pedestrians on both sides. The five questions and answers that each of the 15 interviewees answered are summarized below. The first question was, after pointing at the camera, to ask if they knew what the equipment was for. Nobody knew for sure what it was, about half of the people thought it had something to do with surveillance and the other half thought it was something with traffic monitoring. One person thought it was a speed camera.

The second question was if they had noticed the equipment before, which nobody had. Many of the people were also commenting that they lived close by and passed the location almost every day. The third question was about who they thought was the owner of the equipment. Here it was more mixed answers. Three persons had no idea at all and the one guessing speed camera in the previous question thought it belonged to the police. Seven people thought it belonged to the municipality and the remaining four guessed on transport administration departments. The fouth question was about how they felt about the equipment, based on what they thought it was. Here nine persons agreed that they did not care about it, five were positive and one was totally against any kind of surveillance cameras.
Now it was explained for the interviewees what the equipment was, what it did, who owned it and that they got counted every time they passed by. Then they were asked one more time how they felt about the equipment, now when they knew what it was doing. Twelve persons agreed that it was positive, two were unsure and the person who was against all camera surveillance was a little more positive but still did not like them.

Other comments occurring during the interviews were that three interviewees would have liked there to be some kind of sign saying what it was and who it belonged to. One of the persons who thought it was a surveillance camera thought it would have been good if it was filming, as the area was considered messy and unsafe. One person thought it should be more discreet.

**Implications 3.7**

From the interviews with the general public it was concluded that there was a overall acceptance of cameras in the urban environment. About half of the interviewees thought it was a surveillance camera. This further points out that a honest traffic measuring device that is not recording any film should not look like a surveillance camera. This became a reason for further investigating relevant design cues of surveillance cameras, which is described in chapter 4.4 *Line analysis of surveillance cameras.*

## 3.8 CORE VALUES AND MESSAGES

Viscando had previously formulated three words as core values for the company. The words were innovation, knowledge and simplicity. Innovation symbolized the creativeness and continuous development of the their products and offerings. Knowledge came from the competence and experience of the staff. Simplicity referred to how they pictured their systems to be experienced, in terms of usability and semantics.

In an attempt to further develop these core values and incorporate appropriate messages in the new product, thoughts and findings from both Viscando and the entire research phase were compiled and categorized (Figure 3.10). Four categories were recognized that could help clarify and summarize these messages. The categories were displayed as word clouds that were analyzed in order to find representative words for each category. The words advantage, professional, honest and simplicity were selected representative words.

Advantage - Represented what Viscando could offer the customers in terms of e.g. their knowledge, unique offering and service. This category covered the services and promises that are given to customers, with the aim to signal the advantage that a mobile traffic measurement system from Viscando provides.

Professional - Viscando is a very technological driven company and also need to show this in the right way. Since the people buying this system are professionals, professionality in performance, technology and innovation needs to be present in the product.

Honest - This category highlights to how the product should be looked upon in the public space. There are many uncertainties to what might be the correct expression, still the product needs to be honest.

Simplicity - The more hands on use of the product was represented by the word simplicity. This word was taken from Viscando's own core values, since it seemed give a fair picture of what kind of benefits the mobile system provides.

These functional and expressional messages were set as signs for the product, to later in the process help form the physical product. The stakeholders were then put into the model as the interpreters.

The stakeholders different interests in the functional and emotional messages were then elaborated.

Traffic planners - Have interest in all stated messages, since they are usually involved in several stages of the measurement process. For the procurement process, advantage will probably be the most important message. Later on, professionalism and simplicity will probably be valued and honesty seen as a benefit.

Traffic consultants - Have a similar role to traffic planners and therefore the values the same aspects of the product. Possibly more attention is put on the simplicity of the product, since their main expense is the employment costs and man hours.

Installations personnel - The more operative role will make this stakeholder value the simplicity and professionalism of the product the highest.

Researchers - A quite small group in terms of sales, but could constitute a promotional benefit if they were to become interested of using the product in their research. The technology of the system and the advantages it might bring would probably be the most significant drivers.

General public - The observing role of the general public makes the honesty aspect the most important one. To some extent, the professional message could also affect the impression of the product for this stakeholder.

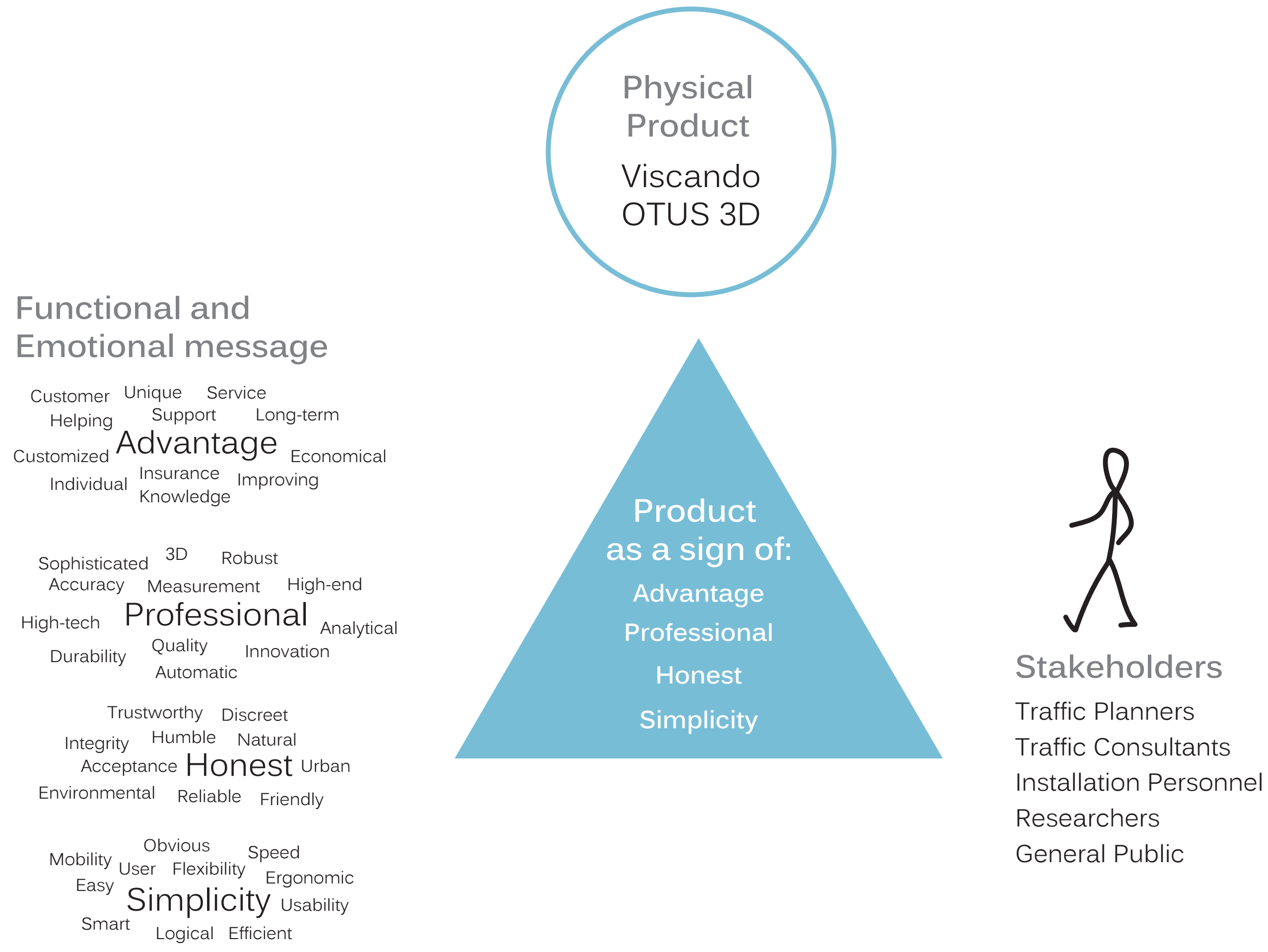



*Figure 3.10 The Otus 3D mobile system as a sign of advantage, proffessionality, honesty and simplicity*

### Implications 3.8

Analysis of the different core values and stakeholders highlights that there is a need to create a model describing how the product could be seen from different angles by different stakeholders. For example installation personnel interact with the handle and mounting solution, therefore these should express professional and simplicity. On the contrary side is the general public that mainly interacts with the front and sides of the product, where the expression of honesty is most important. These implications formed the base of the development of the functional and expressional surface model in chapter 4.

## 3.9 REQUIREMENT SPECIFICATION

The combined results from the research identifying stakeholder needs and technical considerations for developing a mobile traffic measuring system was discussed in a meeting with representatives from Viscando. From this discussion a requirement specification (table 3.2) was established, to serve as a framework and checklist for the continuing product development. To further visualize the different stakeholder's different interactions with the product, a stakeholder column was added. The requirements are grouped into the three groups construction, expression and use. Construction is the group where the technological specifications are placed and are mainly input from Viscando. Expression and use are based on the findings from the research findings.

*Table 3.2. Requirement specification*

| Nr. | Group | Criterion | Type | Explanation | Stakeholder |
|---|---|---|---|---|---|
| 1 | **Construction** | Mounting height minimum 3,5 m | Demand | Be able to mount to minimum 3,5 meter without skylift | IP, GP |
| 2 | | Distance between cameras 500 mm | Demand | Fixed distance | V |
| 3 | | Camera angle | Demand | 2-5 degrees inward pointing, adjustable | V |
| 4 | | Cameras adjustable tilting horizontal and vertical | Demand | To adjust angle of view when calibrating | V,IP |
| 5 | | Sunscreen | Demand | No sun light on lenses, no reflections on lenses | V |
| 6 | | Glass parallell to camera lens | Request | If not, evaluate distortion | V |
| 7 | | Rigid | Demand | Handle tough use and misuse | V,IP,TP,TC |
| 8 | | Stability | Demand | Tight mounting, no vibrations that affect analysis performance | V,TP,TC |
| 9 | | Fit post | Demand | 60 - 120 mm round and square pole | V, IP |
| 10 | | Sustainable material selection | Request | Sustainability aspects considered in material selection | V,TP,TC |
| 11 | | Lifetime | Demand | Last for X years of continuos outdoor use | V,TP,TC |
| 12 | | IP 65 | Demand | SS EN 60529 | V,TP,TC |
| 13 | | Cost optimized for small scale production | Request | Between 10-20 units per year, future larger scale in consideratior | V |
| 14 | | Prevent corrosion and sun bleach | Demand | Surface treatment | TC,TP |
| | | | | | |
| 15 | **Expression** | Aesthetic | Request | Right expression for considered enviroment | GP,TC,TP |
| 16 | | Not look like surveillance camera | Request | Avoid camera design cues | GP,TC,TP |
| 17 | | Not look like police equipment | Request | Avoid association to speed cameras, radars etc. | GP,TC,TP |
| 18 | | Honest | Request | Right expression to right stakeholder | GP |
| 19 | | Prevent vandalism to device | Request | Discourage vandalism | GP,V,TC,TP |
| 20 | | Communication | Request | Express traffic and/or measurement thorugh design cues | GP |
| | | | | | |
| 21 | **Use** | Be installed by 1 person | Request | Preferable only 1 person needed for installation and calibratior | IP,TP,TC |
| 22 | | Be installed by 2 persons | Demand | Maximum 2 persons needed for installation and calibratior | IP,TP,TC |
| 23 | | Low weight | Request | Facilitate mounting and transportation | IP |
| 24 | | Ergonomical mounting procedure | Demand | No harmful mounting postures | IP |
| 25 | | Gripable | Demand | For carrying and installing | IP |
| 26 | | Internal battery for shorter measurments | Request | 3-4 hours use with internal battery | IP,TP,TC |
| 27 | | External optional battery placed on ground | Demand | Up to one week continuos use | IP,TP,TC |

Stakeholder shortenings: General Public: GP, Viscando: V, Installation Personel: IP Traffic Planner: TP , Traffic Consultant: T(

## 3.10 CONCLUSION OF REASERCH FINDINGS

The research formed a framework for the ideation and concept development. The number of design issues and the time limitation of the project made it reasonable to prioritize the development of some modules of the product. When approaching the ideation and concept development a priority list was established:

The development work focused on developing, firstly the housing, secondly the adjustment solution and lastly the post mounting solution. The prioritization did not mean that one module was to be fully developed before the work with the next module would start. Rather determining how far developed the module was to be in the final result. Further development of the external power source for longer measurements was not considered at this stage. The goal for the upcoming design work was to find a solution that fulfilled the criteria of the requirement specification. Parts of the research findings concerning time of measurements and mobility were verified by a meeting with potential users of the product. The details from this meeting are described in appendix V.

| | |
|---|---|
| Housing | Construction |
| Adjusting | Conceptual |
| Mounting solution | Conceptual |
| External battery | Future development |

*Figure 3.11. Priority list for the development work*



# 04 IDEATION

Based on the research findings, this chapter handles the ideation phase of the process. The ideation aims to produce ideas and concept suggestions as well as theoretical models that would help the development work.

## 4.1 IMAGE BOARD

Image boards were used to visualize and categorize design alternatives from the research findings. The purpose was to display both existing product designs as inspiration and framework but also to show completely different products that had the traits and features desired in the design for the Otus 3D system. The visualization of typical traffic equipment was one of the image boards that was used (figure 4.1). The three scenarios or locations selected as the area of use for the product were also visualized on image boards (figure 4.2).

*Figure 4.1. Image board displaying typical traffic equipment*

*Figure 4.2. Image board displaying different contexts where the Otus 3D mobile system is meant to operate*

## 4.2 OPEN FORM EXPLORATION

First step in the concept development was to generate a great variety of ideas and concepts on how the housing could be designed. This was done with the help of different ideation techniques and tools. Sketching (figure 4.3) was used to rapidly explore possible looks and features and models (figure 4.4) were built to get a better feeling for 3D geometries. To get a feeling for materials and to put concepts in realistic environment, simple and fast Cad surface models were made. In this phase the concepts were very open and some not even realistic. But in this phase all ideas are considered good ideas. Focus was put to create many different concepts. For inspiration different parts from the research findings were brought up at different sessions. This could for example be an image board with measuring equipment, in order to generate concepts from this theme. It could also be a more shape driven session, for example starting with a triangle and continue transformation of this shape to different concepts.

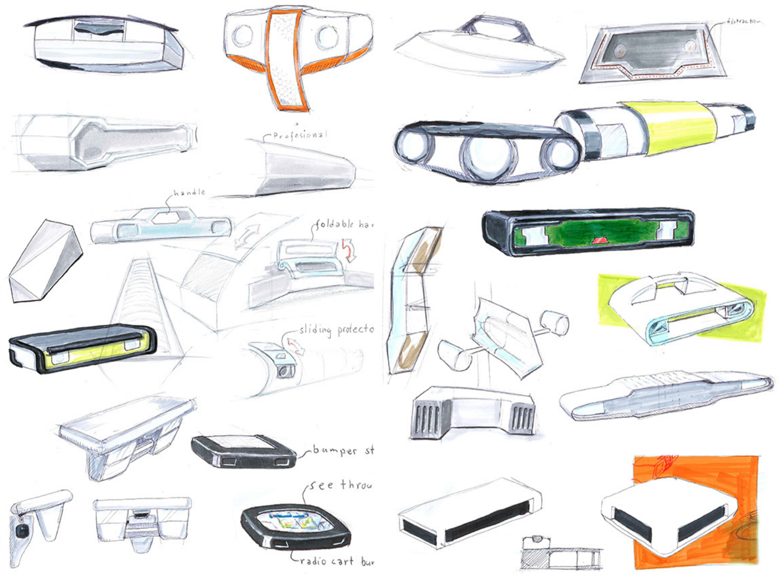


*Figure 4.3. Compilation of sketches from lateral form the exploration*

*Figure 4.4. Compilation of models from lateral form the exploration*



## 4.3 FUNCTIONAL AND EXPRESSIONAL SURFACES MODEL

The functions and expressions of the product were, as understood during this process both widely spread and sometimes contradictory. In the research findings it was suggested by some that the product should blend in and by others to be visual and informative. Parallel to this the product should also have functions that ease the use of the product and convey a feeling of quality. The product was to be a sign of advantage, professionalism, honesty and simplicity. These respective attributes addressed specific stakeholders and it therefore became important to place them in the right area of the product, since it is viewed and used differently depending on which stakeholder you are. The model was constructed as a simple cuboid (figure 4.5), where the surfaces represented the top, bottom, front, rear and sides of the product. Different functions and expressions were assigned to the surfaces according to how they are perceived by the intended stakeholders.

*Front - Expression*

This side is seen when a person gets counted and registered by the system. Hence, it became important to reflect the intended honesty through this surface and also to communicate any necessary information. This side is mostly viewed by the general public.

*Top - Function and expression*

The top surface of the product will mostly be viewed by installation personnel up close or by the general public from a distance, due to the down angle of the product. This suggested that both of these attributes should be present. Up close the top surface must contain functional value as well as giving the right impression to the installer. Hence, details and haptic attributes could be used. For the general public, details are not as visual and a bolder formal language is needed to convey an expression. The top is also the surface where weather protection becomes most important.

*Bottom - Blend in and function*

The bottom of the product will be hidden from most angles. The general public can only see the bottom when being close to the post or when seeing the product from behind. This is a functional surface and should include functional attributes such as distinctive indication that this is the bottom, when for instance being placed on the ground. It must therefore also be durable enough to perform this task. Expressive wise, it should probably have a discreet look, and more or less blend in with the environment. This is done to reduce the risk of affecting people's behavior. The bottom is also a possible surface for the mounting solution.

*Back - Blend in and function*

Also the back surface is a possible placement of the mounting solution, which gives it functional attributes. Furthermore, this surface is most of the time facing slightly upwards, which makes it the less visible surface from the ground, meaning that no particular expression of this surface is needed, besides from blending in.

*Sides - Blend in*

The sides of the product should mainly blend in, to reduce the risk of affecting people's behavior. They also become important in terms of avoiding the camera look, since they shape the profile of the product.

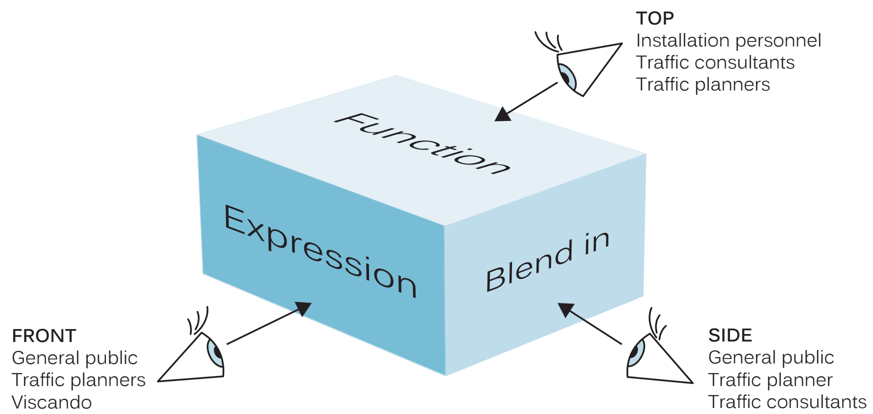



*Figure 4.5. The functional and expressional surfaces model*

## 4.4 LINE ANALYSIS OF SURVEILLANCE CAMERAS

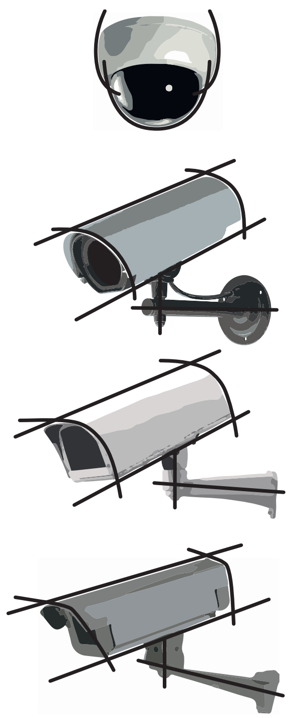
When the existing surveillance cameras were analyzed, it became clear that there are certain design cues that are typical for this kind of product. There are of course models of surveillance cameras that has a completely different design, for instance the hemisphere shaped camera housing. However, the majority of models that can be seen out in public spaces follow a rather coherent design language.

Seen from the side, the surveillance cameras often have two parallel lines as the top and bottom. The front- and back end form often follow the same style, e.g. if one is curved, the other is as well. This is probably because the material used to create this surface is an extruded uniform shape. To create a sunscreen, the front typically has a sharper angle where the front and top surface meet. This angle really points out the direction of the product.

Almost all surveillance cameras that were studied had a black area where the camera is located. In most this becomes cases inevitable, since they are constructed in the way that a transparent or semi transparent glass or plastic sheet is placed in front of the lens. Since the housing itself is completely enclosed, it becomes dark inside, and therefore black. This becomes a color contrast to the rest of the housing, which in most cases has a lighter color or even is plain white.

The mounting solutions for common surveillance cameras are often shaped as bent arm, fastened in the center of the bottom surface of the product. There is of course a functional reason to why the arm is fastened in the center, since the camera should be adjustable; this placement enables the most movement with the less force. The placement with the camera balancing on its center creates a feeling of instability and by that also anticipated movement.

The analysis showed that there are at least five different design features that determines the prototypicality of surveillance cameras (figure 4.6). These were features that were to be avoided in the final design.



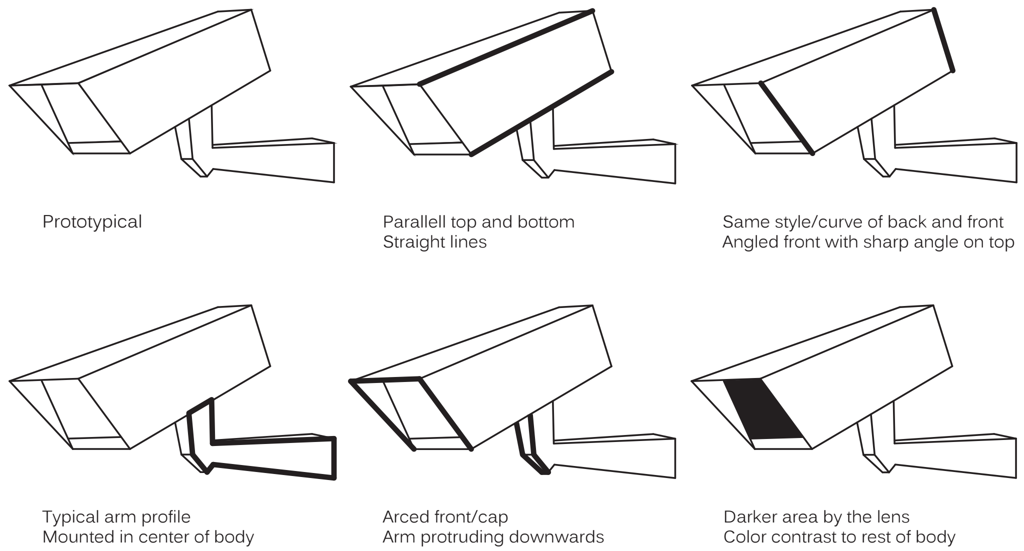



*Figure 4.6. Prototypicality of surveillance cameras*



## 4.5 DESIGN AND SYSTEM GUIDELINES

At this stage of the process it became important to establish the framework of the system and its modules (figure 4.7). The housing that was prioritized as most important could be roughly estimated in size, when considering the components (figure 4.8) that were to fit inside. After discussions with Viscando and own investigations the components were decided to be the two cameras, the computer hardware box, a one terrabyte hard drive, a dc/dc-converter to allow external battery supply and eight battery cells corresponding to approximately four hours of measuring time. The approximate measurements for the housing was set to 600x150x70 [mm] inside. Since the product was meant to be as light, mobile and easy to use as possible, these measurements became the target image for the housing.

To make the equipment easy to handle and install the product was divided into three main modules: housing, adjusting and mount-to-post. With this structure the lightweight and handy mount can be installed first. With the mount safely installed on the post, the camera housing can be attached to the mount, which is further described in *4.5.6 Click-to-mount*. In this chapter the ideation and conceptual choices of different solutions for both housing, adjusting and mounting to post is presented.

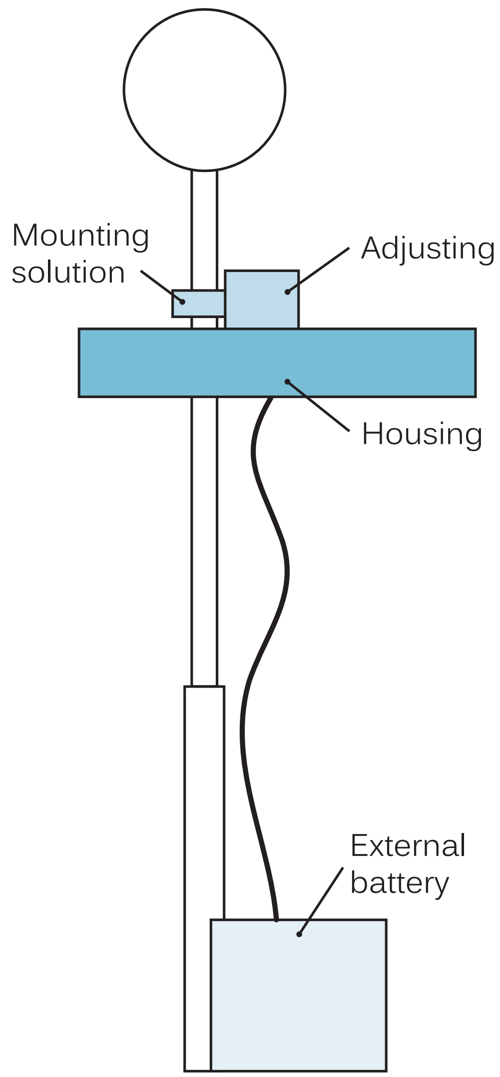



*Figure 4.7. Prototypicality of the Otus 3D mobile system*

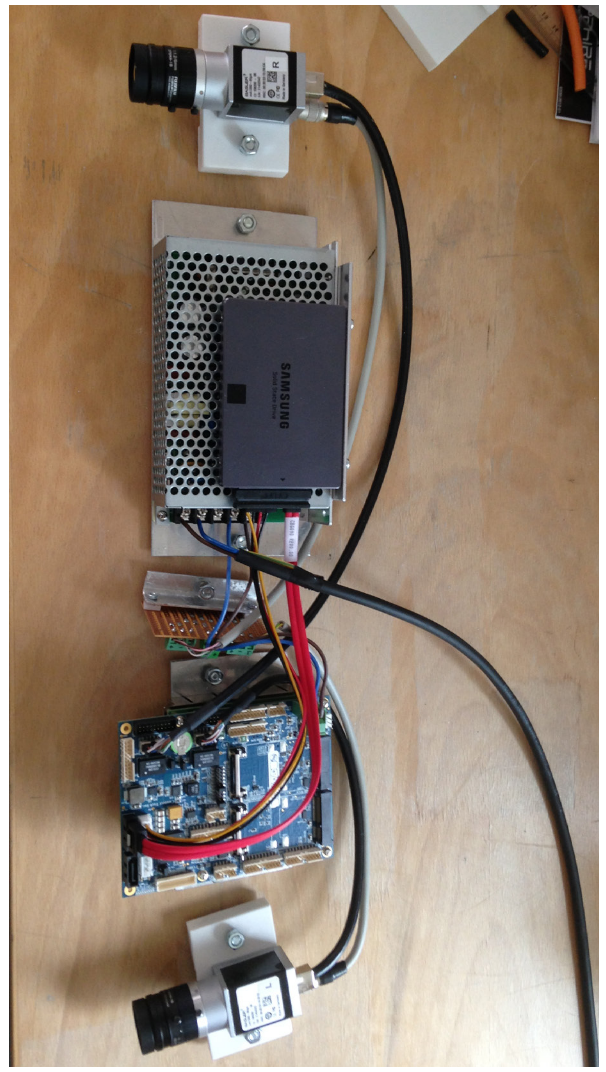


*Figure 4.8. Components that was to fit inside the housing*

### 4.5.1 Vertical vs. horizontal mounting

With a great number of ideas and concepts it was time to narrow it down. One of the early decisions that was made was however the casing should be mounted vertically or horizontally. The distance between the cameras are given and gives the main proportions of the casing. It was not considered to affect the video analysis performance of the product if it is mounted horizontal or vertical.

Horizontal position is considered preferred. The product is desired to blend in from a side view, which a horizontally mounted product does not. When horizontally mounted it also has to be mounted off center of the pole to not obstruct the view of the camera (figure 4.9). This will give a rather large side view of a product that is mounted off center at a angle, which not will blend in very easily. It is also a larger area for the wind to affect the product when mounted vertically.

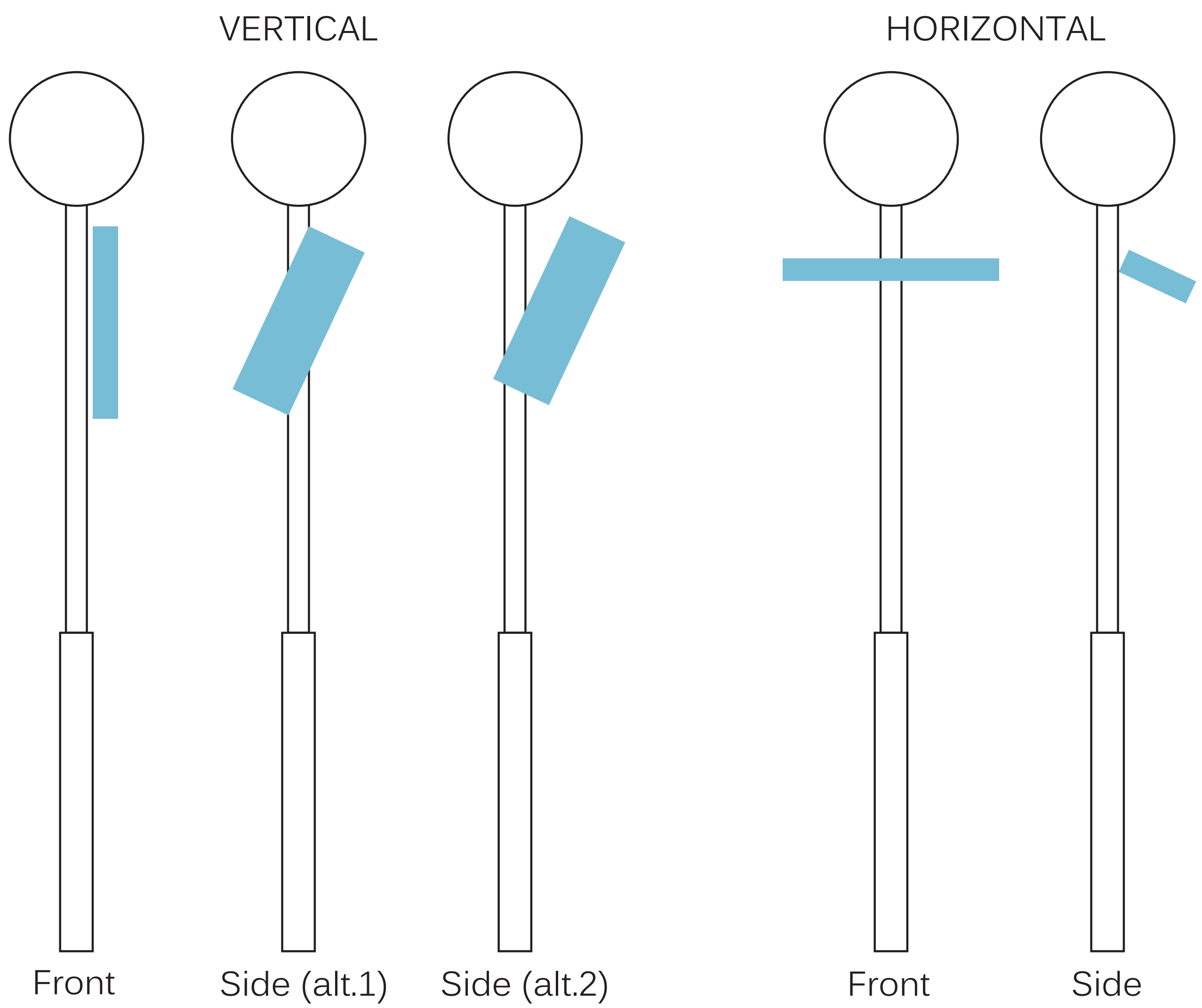



*Figure 4.9. Alternatives for mounting vertically or horizontally. Horizontal mounting was chosen*

### 4.5.2 Housing

Given from the technology used is that the two cameras has to be mounted 500 mm apart. This distance is to be fixed and should be rigid. Therefore some kind of frame could be used as a base of the construction. In this chassis the cameras and computer could be mounted. To save material and weight, it would be a benefit if the chassis also was a part of the housing for the product. Several shapes and concepts that could fulfill this purpose was investigated. Four of these were chosen for a more detailed evaluation (figure 4.10).

*U Profile* - Easy to manufacture and easy to install cameras. Becomes quite stiff and also rather lightweight with opportunities for lighter materials on open sides.

*Tube* - Very stiff but difficult to install cameras and computer inside. A lot material adds weight and gives little freedom for shaping.

*Frame* - Easy to manufacture and easy to access equipment. Lightweight construction but will need additional shelfs or similar to fix components. Not very stiff

*Bar* - Simple and stiff. Needs casing all around that will add material to the construction. Can be bought as standard component. Enables freedom for shaping.

*Evaluation* - U profile was chosen, as it is rather stiff but still gives easy access to equipment. The three sides could house both cameras, mounting solution and camera lenses and give easy access when adjusting cameras. It also gives some freedom for the shaping of the product.

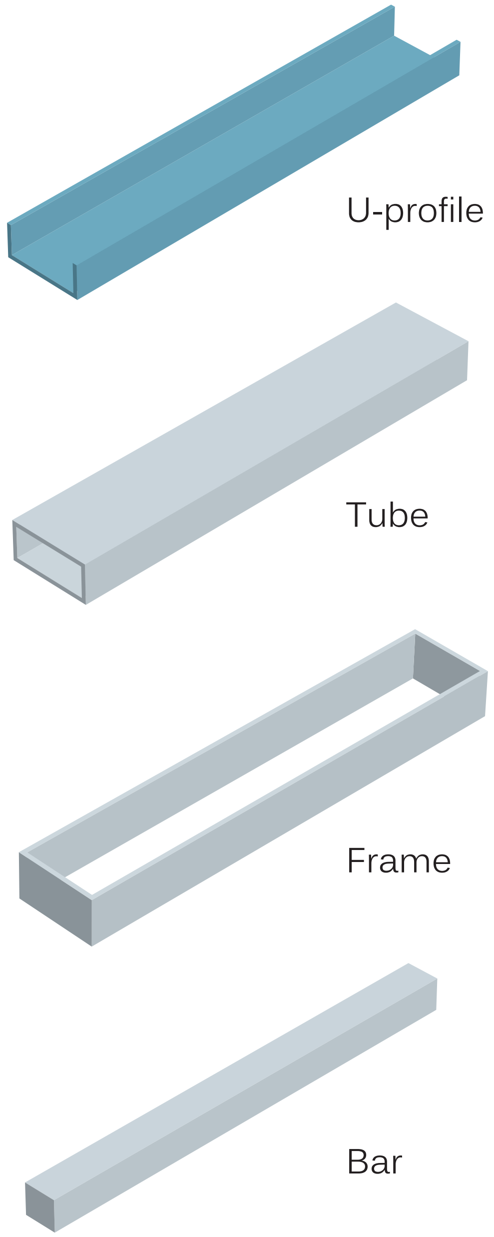



*Figure 4.10. Housing chassis concepts. U-profile was chosen*

### 4.5.3 Adjusting cameras

The equipment has to be adjustable both horizontally and vertically to target the cameras. Preferably the targeting should be performed with only one hand. It has to be rigid enough to handle the weight of the equipment and stay in the same place for the measuring period. As almost all posts are made of round tube, the horizontal adjustment is done in the post mount. If mounted on a square post or wall, a simple post-adapter piece can be used.

After investigating different methods for adjusting the housing with the cameras, four concepts were studied more in detail (figure 4.11).

*Pivot pin* - Simple construction. Needs two hands and can slip when not properly tightened. Needs extra tools.

*Fixed steps* - Adjustable in fixed steps, rigid and cannot slip. Needs two hands for adjustment. Loose and can fall when safety is released

*Ball joint* - Allows adjustment in all directions. Needs two hands and can slip when not properly tightened. Risk of not being secure enough to carry hanging loads. Needs extra tools.

*Worm drive* - Gives a precise adjustment of the angle and allows no slipping. Easily adjusted with one hand. Suitable for a hanging load. Require more space than most other solutions. Quite advanced solution.

*Evaluation* - As only adjustment in one direction is needed and preferably only one hand should be needed the worm drive style adjuster was chosen. It is a solution suitable for hanging load, which is a benefit. It is a quite advanced solution, but since it is a high-tech product it is justified.

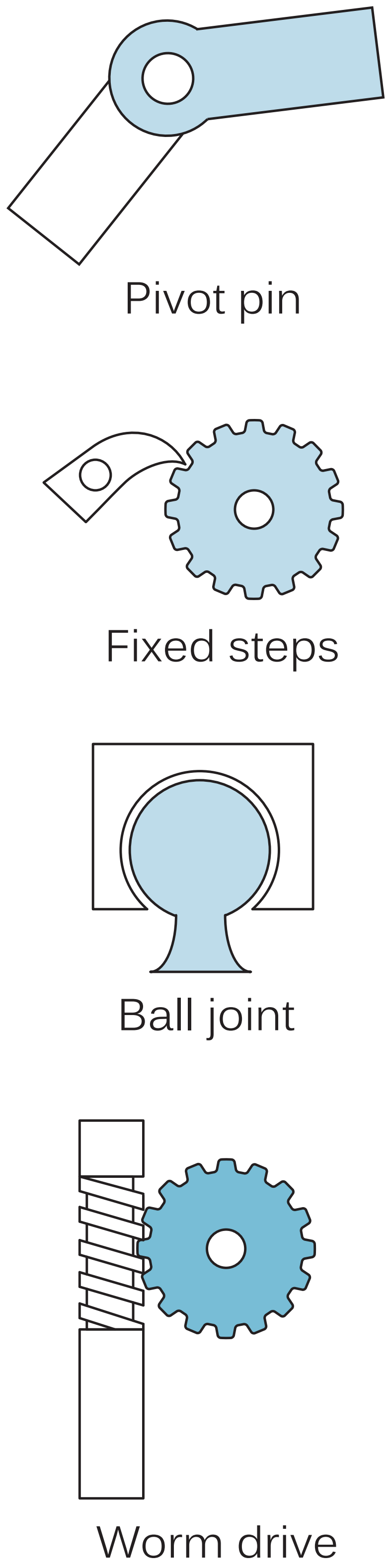



*Figure 4.11. Adjustment concepts. Worm drive was chosen*

### 4.5.4 Mounting to post

One of the key issues with the video technology is that it needs to be mounted rather high up, approximately 3,5-6 meters. An idea generation session created some concepts on how the equipment could be mounted (see appendix III). Due to the complexity of other tasks to solve and time limit the development of these concepts was put for future work. Decision was made for this project to go with the today existing solutions. It was also decided to use tools like ladder or sky lift to get the equipment up to the needed height.

The mounting solution has to be adjustable to different post diameters, from 60 to 120 mm diameter. It has to be easy and quick to install and take down by the installation personnel. It also has to be resistant against vandalism and prevent thefts from happening. Four alternatives that were evaluated in detail (figure 4.12).

*Exhaust clamp* - Made of metal and reusable. Clamps are made for specific post sizes and has to be changed when mounting on different diameters. Very secure but also quite large and heavy. Commonly used for traffic equipment.

*Hose clamp* - Made of metal and can be reused, needs only a screwdriver for installation and dismantling. Could be difficult to mount when one hand is needed to hold equipment.

*Zip ties* - Made of plastic, cheap and easy to install. UV resistant models are available. Needs special tool for proper tensioning and wire cutter for dismantling. Cannot be reused.

*Steel ties* - Similar to plastic zip ties but more durable. Also need special tool for tensioning and wire cutter for dismantling. Not reusable but secure and commonly used for traffic equipment.

*Evaluation* - There are many varieties on the market of the four principles described above. For a mobile application, plastic zip ties or steel ties were considered cheap, easy and durable alternatives. Hose clamp and exhaust clamp are rejected because the lack of flexibility to adjust to post diameter and because they are difficult to assemble in the situation when holding the rest of the equipment. There were also a possibility to develop a custom clamp that would need no tools, but this is left for further work. The final decision for mounting solution was to enable space were plastic zip ties and steel ties could be placed and fixed when mounting to a post. By doing this, it becomes one less thing to keep in place while mounting, which will make the procedure more secure.

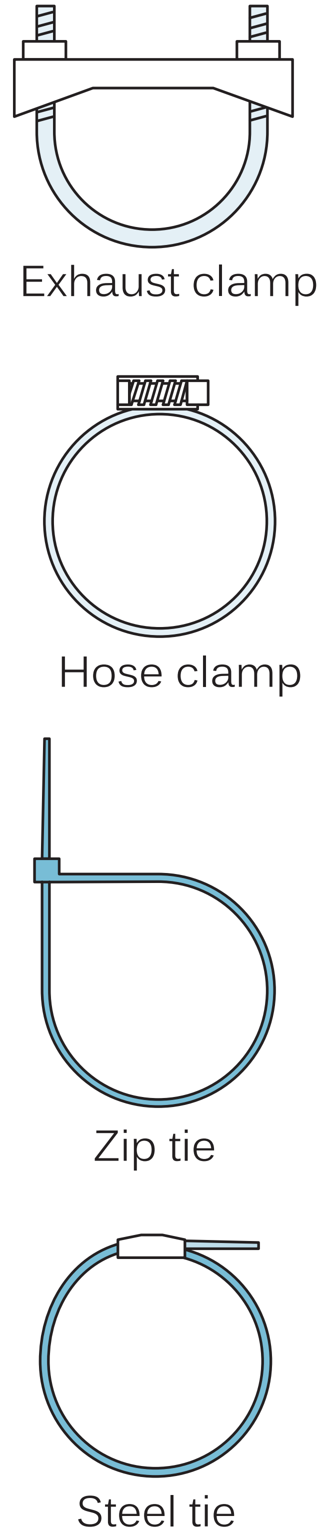



*Figure 4.12. Mount-to-post concepts. Facilitating the use of zip ties and steel ties was the chosen concept*

### 4.5.5 Click-to-mount

To fasten the housing module to the adjusting and mounting solution some kind of attachment was needed. This should be very easy to operate but still hold the equipment in place in a secure way. Some kind of blocking device was needed to make sure that the equipment could not fall down. It would also be a benefit if this blocking device could be locked to prevent thefts.

The attachment was made with a wedge shape to make it fix solidly. Similar wedge shape is used on some camera pods to attach the camera but in a smaller scale. The intended wedge was to be made wider to gain stability. In one of the functional models a locking device from a car glove department was used to lock the housing to the mounting solution. This gave a nice 'click' sound when properly attached (figure 4.13). This gave a good feedback to the installer that everything was secure and in place.

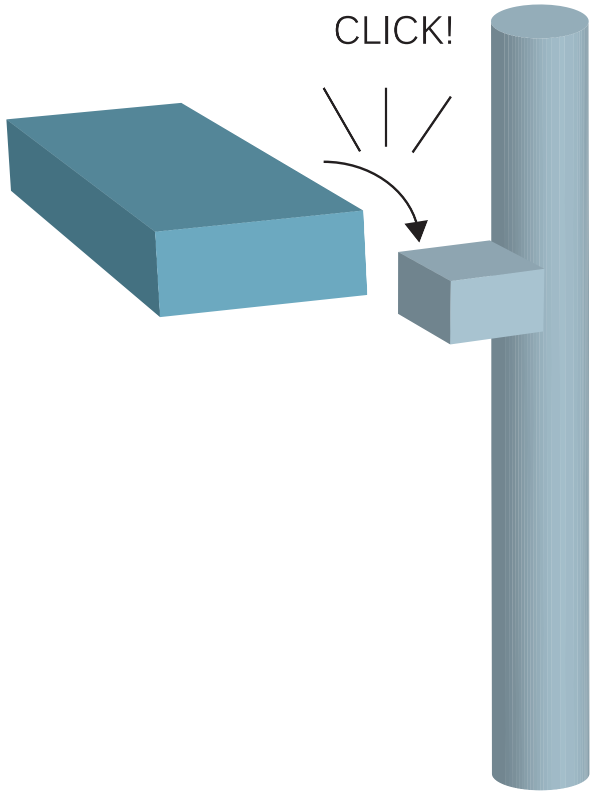



*Figure 4.13. Click-to-mount*

### 4.5.6 Grip design

There are plenty of rules for how you are allowed to work from ladders and sky lifts. For ladders it is extra important that the product is easy to install and handle, since it is an exposed position. The Swedish ladder use regulations (AFS, 2004:3) gives some guidelines for what aspects to consider for the handling of the product on a ladder. Below follows some important points from the regulation.

- Only short time work from ladders
- Stand steady, be able to support body in a secure way, extra important if something is carried
- Only handle light and manageable load
- Tools should be able to be used in a secure way

To ease the mounting procedure of the camera housing onto the adjusting and mounting solution, some kind of gripping area was needed. Different types of griping possibilities were tested in order to find the most appropriate solution for the intended use.

There were basically two different areas of use for the grip, for mounting the product (figure 4.14) and for carrying the product (figure 4.15). The product should be able to be carried with one hand, in a relaxed manner. The weight of the product was at this point estimated to 3-4 kg, which becomes the load to carry and mount.

Mounting takes place on either a ladder, for lower heights (3,5-4,5 meters) or in a sky lift, when mounted high (4,5-6 meters). Both these situations cause instability for the person executing the job, which results in increased demands on precision and maintained coordination. Concerning the possible instability if where this product is to be installed, it is likely a necessary to have one hand free for body support, which suggests that it would be beneficial to be able to mount the product with one hand.

*Evaluation* - To fulfill a preferable mounting posture, both a 'pistol' handle or the cross mounted top handle were OK. The length mounted handle gives a bad mounting posture with very high elbow position. The pistol grip is not good when carrying the equipment. Both the Length and cross mounted top handle gives an acceptable carrying posture. The cross mounted top handle was chosen as it solves both carrying and mounting with only one handle.

A 70° angle is the one suggested for a regular saw handle (Bohgard, 2010). If the product is to be mounted onto the adjustment module from the front, which is likely the case from a skylift, the movement of the products becomes similar to the movement done with a saw. For a relaxed carrying handle, the gripping surface should preferably be horizontal. It was decided to compromise the saw handle angle, towards a smaller angle to facilitate carrying while still enabling acceptable mounting posture. Instead of having sharp angles within the handle a more rounded grip profile for alternate hand positions was chosen. It was extra also identified that generous space under the handle would be desirable, to fit big hands or gloves.

*Figure 4.14. Testing mounting postures*

*Figure 4.15. Testing carrying postures*

## 4.6 FORM DEVELOPMENT OF HOUSING

With the housing U-profile concept available, form development of the housing was continued. Main elements that was considered at this stage was:

*Sun Screen* - To protect the camera lenses from direct sunlight some kind of cap is needed on the top and preferably on the sides of the camera lenses.

*Expression* - The product should have the appropriate expression and communicate the right message from the right surface, to the right stakeholder as described in functional/expressional surfaces model.

*Not look like surveillance camera* - Product should look like a traffic equipment and not a surveillance camera.

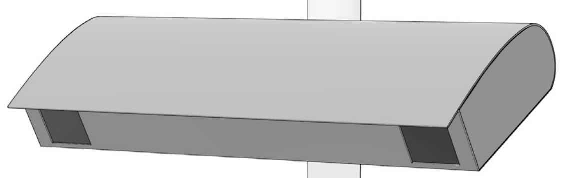
*Not look like eyes* - Try to avoid that the product has a human-like look, especially hiding the camera lenses, which might become ‘eyes’.

*Manufacturability* - Consider the possibilities and complications if the concept was to be manufactured.

The ideas and design features was summarized in six concepts further described below.

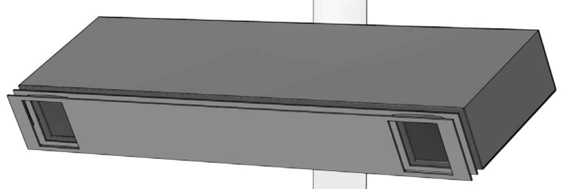
### SWOSH

This concept is based on a curved surface that is going all the way from the back bottom of the housing to the front. In the front this surface creates a sunscreen. When looking at this concept from the side view it has a rather organic, but still stable expression with its curved top and flat bottom. From the front it is rectangular and rather anonymous. Even if the sunscreen is sticking out similar to most surveillance cameras, it does not give a direct association to surveillance camera sunscreen, since the side profile is different. The wide sunscreen and flat expression surface might also hide the fact that there are two lenses, which could associate with eyes. Manufacturing should not be any problems, however the U-profile would be distorted and possibly rotated.



### LAYER

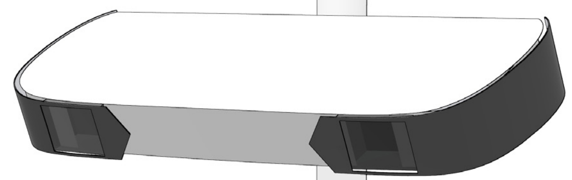
Different layers are used to create a sunscreen for the cameras. Similar construction is sometimes used on lamps to avoid exposing light bulb to the user. This gives a sunscreen not resembled with a surveillance camera sunscreen. It also gives a rectangular side view that does not point in a clear direction. This solution might give the product an exclusive feel but being rather weak at the sharp corners. The side view might also reassemble an old style camera. Even if this old style camera does not have the same idiom as a modern surveillance camera, it is sometimes used for signs informing about surveillance and therefore might lead associations to this. The layers of sunscreen would hopefully draw the attention from the two holes for the cameras, minimizing the ‘eyes’ look. The construction is simple and easy to manufacture. The thin ‘layers’ will however be quite vulnerable and not very robust.





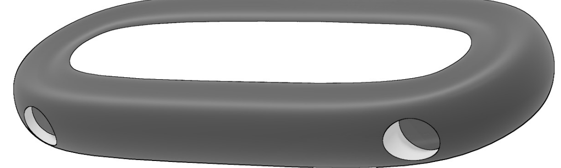
### CORNER

By making a sweeping surface from the sides covering the camera focus could be moved away from the lenses. The radius of the front surface might give the expression of a wider angle view of the camera. A more holistic product that indicates that it measures a larger area. This design will not enable very good sunscreen from the sides, due to the rounded corners. A rather complex shape and parts that might be difficult to manufacture, still not impossible.



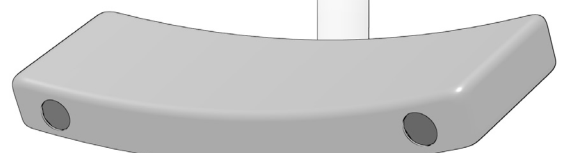
### BUMPER

This concept consists of a rubber bumper extending all the way around the housing. The original idea was that the rubber bumper then also could serve as a handle when mounting the product. But testing with a mock-up showed that this was not an ergonomic solution and a separate handle is preferred. The rubber would give a very robust and professional expression of the product and protect it well. If the rubber is to be black it might also hide the lenses in a good way. The sunscreen capability of this concept is however unclear. An all-around covering rubber bumper and rounded base will be complicated to manufacture.



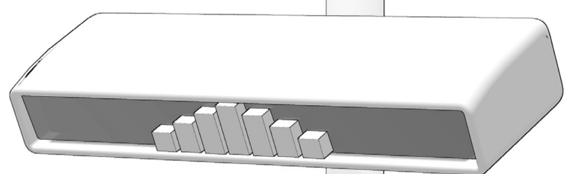
### CURVE

With its bent front view, this concept gives associations to a smiling mouth. This more playful expansive shape gives a movement but still not a direction pointing at the person being measured, making it less threatening. However, this might lead associations to a head and human-like attributes, which is unwanted. The bent shape also causes problems for the decided U-profile base, since it will require additional processing. The shape is beneficial for the cross-mounted grip, since it allows extra space for the hand. Complex shape that requires a lot of processing.



### BARS

With this concept focus is put on communication. To have something on the front/expression surface that gives associations to traffic measurement. In this case a form resembling a bar chart. If made more abstract these bars could also be used as sunscreens for the lenses. Using a pattern or symbol in the middle between the cameras could take focus away from the camera lenses. Simple shape, which is easy to manufacture. Details might require more processing.



## 4.7 SYNTHESIS

Several concepts had elements that were desirable to include in the final concept. These elements were combined in a synthesis. To make the decision explicit and to check strengths of the different concepts, a Kesselring matrix was used. This evaluation gave an indication on what features or functions that might be combined in the final concept design.

### 4.7.1 Kesselring matrix

A weighing of the different criteria in the Kesselring matrix was done in order to get a score that reflected the importance. The weights were estimated by the project group and derived from the combined insights of the research findings and technical requirements from Viscando. The ideal score after weighing the criteria became 105. The result was that the concept Swosh got the highest score (74), followed by Bars (63), Corner (62), Layer (60), Bumper (48) and Curve (46) (table 4.1). The result was used as a base for the concept choice and as a way of making a complicated selection procedure explicit.

### 4.7.2 Concept choice

After evaluating the six concepts it was decided that the main shape of the *Swosh* concept was to be chosen for further development. As shown in the kesselring evaluation there were other concept that contained strong features that could be used in the final concept as well. For the final concept it was decided to take features from the *Corner, Bumper* and *Bars* concepts. From the *Corner* concept the idea of smoothening the transition from the sides to the front surface was chosen. This feature was seen as possible to combine with the *Bumper* concepts rugged style to enhance professionalism and robustness. From the *Bars* concept the idea of using the front surface as the obvious place for communication was chosen. As previously identified in the research findings, the message to convey from this surface should mainly be up to the user to decide.

The final concept is combination of four concepts, which all had features that were seen as beneficial for the product's design. Based on these decision an illustration (figure 4.16) of the combined concept was generated and taken into further concept development.

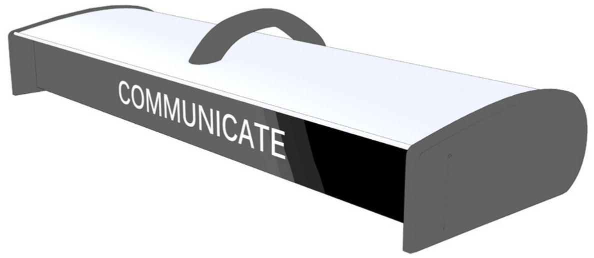



*Figure 4.16. Concept taken into further development*

*Table 4.1. Kesselring matrix of the six concepts*

| Criteria description | W | Ideal | Swosh | Layer | Corner | Bumper | Curve | Bars |
|---|---|---|---|---|---|---|---|---|
| Enable sun screen | 5 | 25 | 15 | 25 | 10 | 5 | 10 | 15 |
| Expression/function surfaces | 3 | 15 | 12 | 12 | 15 | 9 | 12 | 12 |
| Not look like surveillance camera | 4 | 20 | 16 | 4 | 12 | 16 | 12 | 8 |
| Resemblance with traffic equipment | 3 | 15 | 9 | 9 | 9 | 6 | 6 | 12 |
| Not look like eyes | 2 | 10 | 6 | 2 | 8 | 8 | 2 | 4 |
| Manufacturabliity | 4 | 20 | 16 | 8 | 8 | 4 | 4 | 12 |
| **Total** | | **105** | **74** | **60** | **62** | **48** | **46** | **63** |
| **Rank** | | | **1** | **4** | **3** | **5** | **6** | **2** |



# 05 CONCEPT DEVELOPMENT

This chapter includes detailed design of ingoing parts, material selection, manufacturing processes, testing and evaluation.

## 5.1 DETAILED DESIGN

When the concept choices of both housing and mounting concepts were made, these concepts were further developed in detail. The development continued as a combined concept to become one coherent product of form and function. Choices of suitable materials and manufacturing methods, both for small and larger scale production is also discussed in this chapter.

### 5.1.1 Design of ingoing parts

The chosen concept for the housing basically consisted five main parts, the main body (U-profile), side bumpers, front surface (communication surface), the handle and the button function for the click-to-mount solution.

*Body* - The curved shape of the body almost hides the fact that it was based on a U-profile. Still it is, since it has merely been rotated 90 degrees, from the original idea with an open top. This part now has the opening in the front instead. This part is the main structure of the product and will be the part that contains all the vital components. Therefore, the inside of this part has to contain options for mounting of the components. The development of the inside mounting solutions is found in the chapter *5.2.3 Components function test*. Since the body becomes the biggest part of the product, it is important to keep the size down to a minimum. The profile was therefore optimized to precisely fit the ingoing components (figure 5.1), without intruding too much on the main shape. The part is to be made out of extruded aluminum. The idea of using aluminum for the main part of the housing had been thought to be the best alternative, since it is stiff and light. It will also enhance the expression of traffic equipment, since it is a very common material for such equipment. Detailed descriptions concerning material selection and manufacturing is found in chapter *5.1.2 Material selection and manufacturing processes*. The bottom surface of the body is flat, since this can be a semantic element that informs the user that this is down and of course makes it easier to place on the ground. The profile's shape with its curved top and back, and flat bottom, is in many ways contradictory to the prototypical surveillance camera look.

*Figure 5.1. The extruded aluminum body part*

*Side bumpers* - The side bumpers are the end pieces that encloses the body part. These parts should be both functional and have the appropriate look. The functional aspects are to be bumpers that protects the body from impact and also to be the feet or distances when placed on the ground. The expressional aspects of the side bumpers are that they should enhance the robust and professional feeling of the product. Furthermore, the side bumpers have an impact on what expression to give to people on the ground, since they constitute the side profile of the product. I line with the features of the *Corner* concept, the side were to have a smooth transition to the front surface. This suggested that a darker color should be used for the side bumpers, since the glass area of the lenses will be dark, and so also the main part of the front surface. The side bumpers is preferably made out of some kind of plastic or rubber material, which is presented in detail in chapter *5.1.2 Material selection and manufacturing processes.*

An exploration of form variations was conducted in order to find the best possible design for the side bumpers (figure 5.2). The chosen design (dark color box) was considered to be the best alternative of both functionality and expression. The second best alternative (light color box) is quite similar to the chosen design, except for a sharper edge in the front bottom corner. This sharp edge was considered as it literally moves the sharp angle corner of the prototypical surveillance camera housing, from the top to the bottom, generating less resemblance. However, this design was considered to be too aggressive, due to the sharp corner and therefore not chosen. The third option (white background) that was considered, has an irregular base shaped as two feet. This could improve the semantic function of the product, by emphasizing that tis is down. The feet also has functional value as the improve stability when placed on a rough surface. This design was not chosen, since the irregular shape became to 'messy' when places in a diagonal position, which is the most common position for the product. The side view is supposed to blend in and be anonymous, which this design does not live up to.

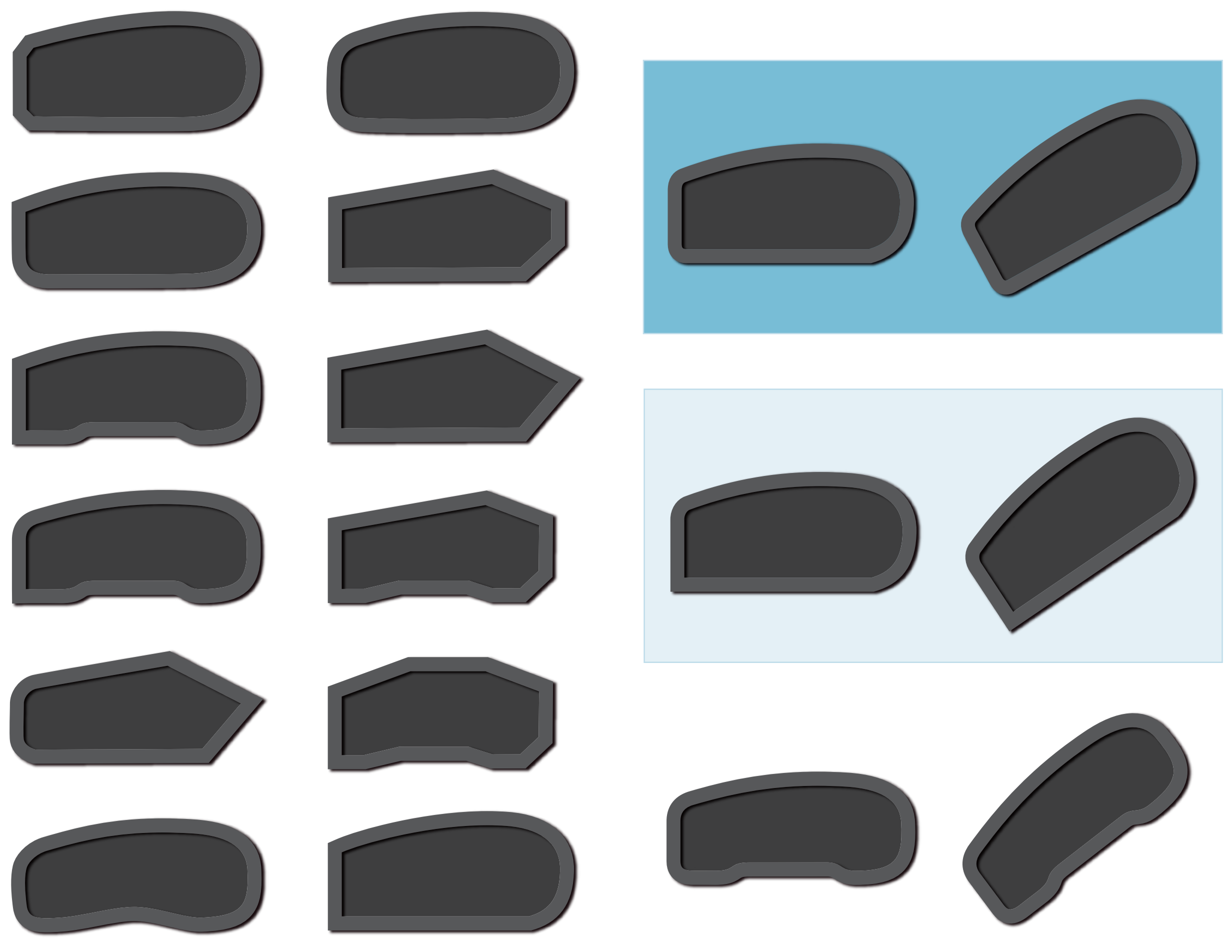


*Figure 5.2. Form variations of side bumpers*

*Front surface* - This is the surface that is intended to communicate the message decided by the users and also display Viscando's brand. This was a suitable location for communicating, since this is the place where the cameras are located and it would be the most honest place to convey a message. The part is a simple plate that needs to be transparent in the end sections, for the cameras to look through. It was decided that the whole surface was to be made out of a transparent material e.g. glass or plexiglass. The logotype or graphics used for communication is then simply attached as sticker on the inside. The sticker has a black base to cover the components inside. The glass plate is mounted in tracks located in the top and bottom of the aluminum body. Seals are used to make the construction weather proof. Different suggestions for how the graphics could be placed and look was made (figure 5.3).


*Figure 5.3. Close-up on possible graphic and examples of how the front surface could be used*

*Handle* - One major part of the housing is the handle. The handle has to be rigid and stable enough to resist the weight of the equipment, so it can be mounted and carried safely. Aspects like stability, flexibility for hand positions and space under the handle bar are considered to be important. The angle towards the front is one of the previously identified features for the handle. By exploring different alternatives for the shape, a decision was made (figure 5.4). The chosen design (dark color box) is a long handle with smooth angles, tilting slightly towards the front. The long grip area enables various hand positions and generates a slim profile from the side view that follows the main shape of the body in a pleasing way. The main shape of the cross-section (figure 5.5) for the handle was decided to be a horizontally oriented rectangle (dark color box). After testing different alternatives, this shape was found to give good stability and little risk of slipping compared to the other alternatives. The cross-section of the handle can be either constant or variable over the length. From a manufacturing perspective it is probably best to keep it constant. This issue was however not elaborated in detail at this stage. Overall the chosen handle shape was found enable good gripping possibilities for various hand positions.

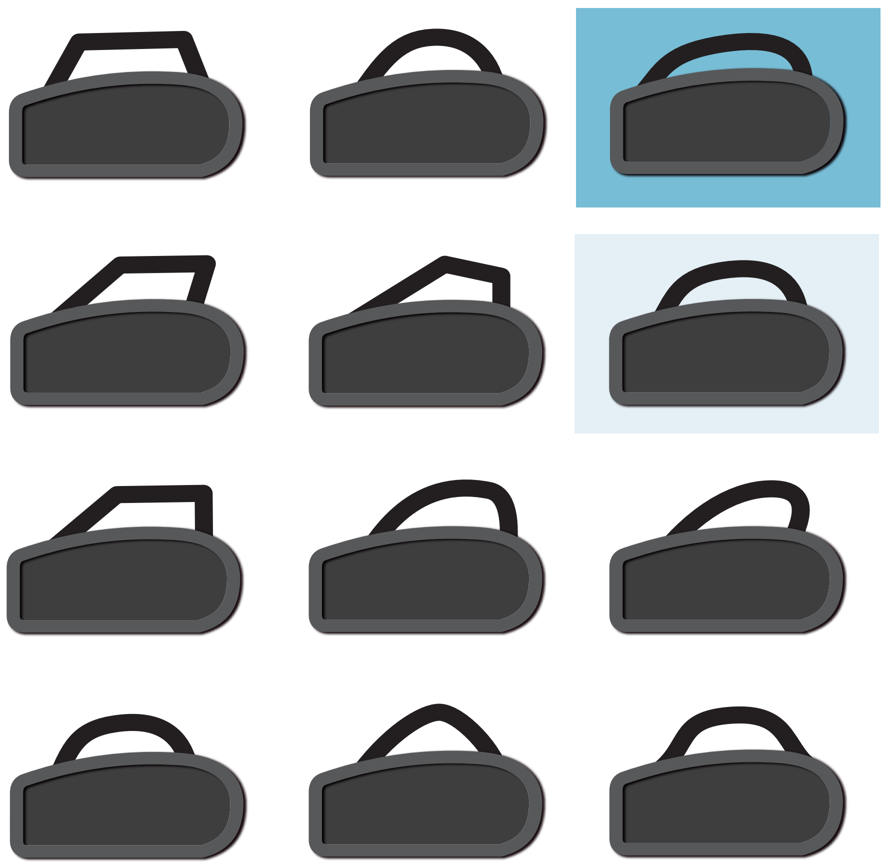


*Figure 5.4. Form variations of handles*

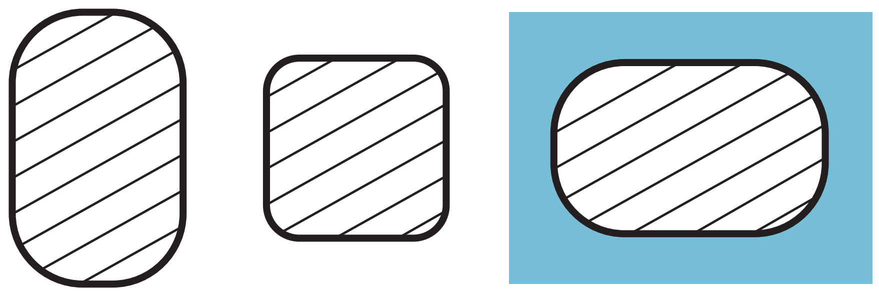


*Figure 5.5. Cross-section alternatives for the handle*



*Button function* - For the intended click-to-mount solution a release button and latch was needed. Different ways of constructing this function was made and tested. The first being a regular push-down button, since this was an available solution that could be tested on a functional model (figure 5.6). It was a well-functioning solution but the push-down motion did not feel natural when pulling the other direction with the equipment. New tests showed that a push-forward button felt more natural and allowed less stress on the finger used for releasing the housing (figure 5.7). This solution also allowed a simpler construction of the latch. The final design of the release button solution was mounted on the outside of the aluminum body to simplify construction. It was incorporated with the handle for easy access with the hand.

*Figure 5.6. Push-down release button on functional model*

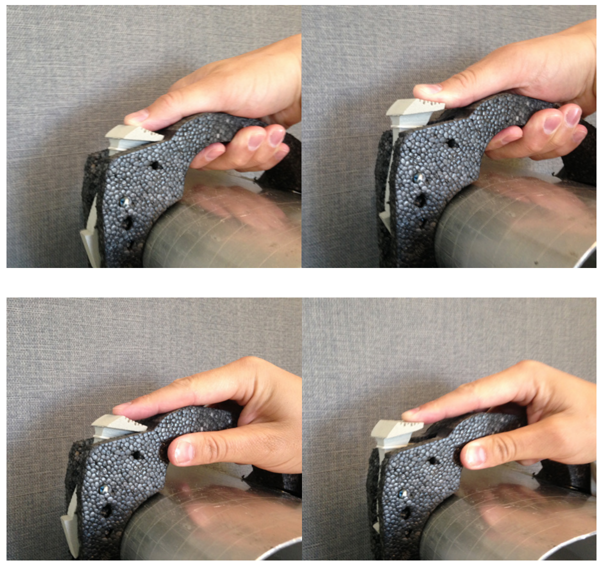


*Figure 5.7. Testing push-forward release button on functional model with different gripping techniques*

## 5.1.2 Material selection and manufacturing processes

The *body* is the core of the product and made of extruded aluminum. With this method the aluminum could be shaped to almost any shape desired. It is a suitable method for medium and larger scale production. A tool has to been produced which makes for an initial cost, but as the series grow it is a rather inexpensive method. For very small series or prototypes the body could be made of sheet aluminum that is folded to the approximate shape. On the sheet metal some details for fastening etc. has to be added by welding or gluing. To use extruded aluminum profile together with the other design features also gives the advantage of free scalability (figure 5.8). This will allow for other computer hardware setups and camera distances.

The window could be made of plexi-glass. This will be cut to fit and the cost of this will not vary a lot depending on series size.

*Side bumpers* and *Handle* with button are to be made of plastics. On a larger scale production injection molded plastics are suitable, but the tooling costs will make it expensive in smaller series. For a prototype or a few units 3D printing could be used for these parts. When producing smaller series a silicone mold could be used. It is also possible that the handle could be bought "off the shelf" and thereby reducing the number of specific parts needed. If adjusting the design of the side bumpers, it could be possible to produce them with vacuum formed plastic, which has a lower tooling cost.

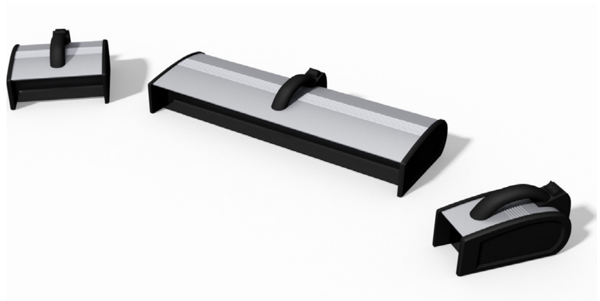


*Figure 5.8. Scalability of the product*

The construction of the product consists of five main parts, which is rather few, in order to be designed for assembly and dis-assembly. It was important to keep the housing structure as simple as possible due to the rather complicated network of components and functions inside. When reducing the number of parts in the outer housing it became important to consider the accessibility of the components inside. This is thought of in the sense that the stationary parts, intended to be moved, are placed in the middle, which is the most difficult place to reach, but possible when removing the front glass surface. The cameras that could occasionally need to be adjusted are placed in the end of the aluminum profile making the easy to reach and adjust, by only removing the side bumpers. The track developed for mounting the components gives a freedom for placement, to achieve balance of weight or when switching to new hardware, and is described more in detail in chapter *5.2.3 Component function test.*

## 5.2 TESTING AND EVALUATING

Through out the process several models have been built to test various functions and appearances. In this chapter three test will be described. First an installation test performed by the project group, second an installation test together with Viscando and last a test where the real components where mounted in the intended way, in a functional model.

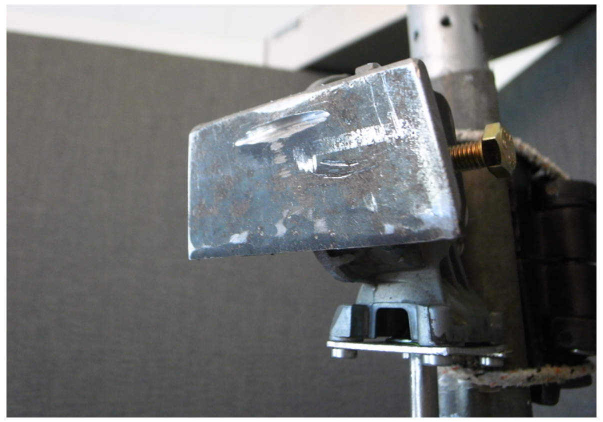
### 5.2.1 Installation Test

Functional models of the housing and adjustment module was tested by installing it from a ladder on a lighting post outside Chalmers University. The technical functionalities of both the worm drive, wedge shaped click-to-mount solution and handle was tested. The practical and ergonomic aspects could then be evaluated and discussed.

The prototype was mounted at a height of approximately 3,5 meters, but could easily have been mounted at 4 meters with the ordinary stepladders, measuring 1,7 meters to the platform, that was used. The lighting post had a diameter of 60 millimeters where the prototype was mounted. The housing module was loaded with extra weight, meaning a total weight of approximately 3,2 kg, to represent what a final product might weigh.

The mounting module was first put in place, using dual zip ties. This procedure went rather good, the relatively small size and compact format of the adjustment module enabled the installer to keep it in place and at the same time gain support from the post with that same hand. One problem that occurred was that the zip ties were quite tricky to keep in place while tighten them and at the same time

*Figure 5.9. Testing the click-to-mount solution*



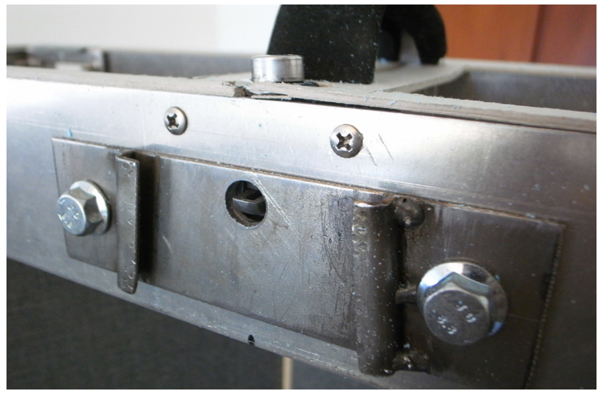


*Figure 5.10. Male wedge connector on the adjustment module (top) and female connector on the housing module (bottom)*

*Figure 5.11. Functional model mounted on light post*

remain balanced with your body. The mounting was done slightly above the head of the installer, which is not optimal from an ergonomic perspective, but still necessary if the product is to be mounted as high as possible. The strain from working above the head is mainly a concern if the procedure becomes a static load during a longer period, and should not be a problem if the system could be mounted rather quick and easy.

Once the mounting module was in place, the housing module was put in place by using the click-to-mount connection (figure 5.9). The angle of the male wedge connector (figure 5.10) on the adjustment module affected the effort to mount the housing module. When placed vertically, the arm of the installer was put in an uncomfortable angle, and the bending of the wrist reduced the arm strength. When the male connector was angled more towards a horizontal placement, the arm became more relaxed and the wrist suffered less bending, which generated a radical improvement for the connection procedure. The prototype construction prevented the male connector to be placed in a strict horizontal position, which would be optimal for this solution. However, it was recognized that this would be possible to modify for a final product, by either extending the pivot from the worm drive or by placing the female connector underneath the housing module. The wheel used for adjusting the worm drive worked without any trouble.

The placement and direction of the handle was perceived as satisfactory for this type of installation, as previous tests of different grips also suggested. The product was experienced as balanced during the whole installation even when only using the handle in the middle. The slight angle of the handle, towards the installer was perceived as beneficial when mounting above the head, since this prevented some unsatisfactory bending of the wrist. The button's placement in front of and integrated with the handle made it clear how to grip and use the handle. Some uncertainties was however experienced, on which finger that was best to use for pushing the button. Both the thumb and forefinger were possible to use.

Keeping zip ties or other clamps in place or fixed to mounting module, to enhance balance and limit the amount of procedures while on the ladder, was seen as a great advantage. The push-down motion of the existing button was not satisfactory. A push-forward button would probably generate a better product experience and also be more ergonomic. Overall the test went well and most functions seemed to work out as intended (figure 5.11).

### 5.2.2 Test with Installation Personnel

During a shorter measurement conducted by Ulf Erlandsson at Viscando, using their existing equipment the second test was done. The functional model used in the previous test, at this stage covered with a temporary cardboard casing, was brought out for a comparative test. The situation that was to be measured was a lane distribution of bicycles and pedestrians at a bike and pedestrian walkway. The equipment was installed at about 3,5 meter height using a portable stepladder.

The first thing that was compared was the installation sequence of the two systems. The existing solution uses four steps for installation. First a post clamp is attached to the post by tensioning two threaded rods. Second step was according to Ulf the most bothersome; this is when the rather heavy crossbar had to be attached to the post clamp (figure 5.12). This crossbar attaches with two screws, and therefore screw, screwdriver and the bar has to be operated at

*Figure 5.12. Complicated step in the mounting procedure*

*Figure 5.13. Existing system mounted on light post.*

the same time, trying to target the hole in the clamp. Step 3 was to attach the two camera houses to the crossbar which is done with click mounts. Four cables from the cameras were then connected to the computer and external battery pack placed at the ground, as the final step (figure 5.13).

The feedback from mounting the new housing concept was positive. Only two steps were needed to mount the whole equipment. The mounting sequence was significantly faster and simpler (figure 5.14). For a shorter measurement like this the built in batteries would be enough and therefore no cables or equipment on ground would be needed. One thing that was pointed out by Ulf was that it might be of importance from which direction the ladder is put when mounting the camera housing. The click-to mount solution was regarded as very pleasing, since it made the handling of the equipment much easier. The angle of the handle was perceived as good for both carrying and mounting. The conclusion from the test was that the major functions of the new mounting solution was appreciated also by professionals (figure 5.15).

*Figure 5.14. Installation with new mounting solution*

*Figure 5.15. Functional model properly mounted.*

### 5.2.3 Component function test

A test of the concept with ingoing components like cameras, computer, hard drive and DC/DC-converter was executed. The batteries that were chosen for the product were however not available at the time for the test. Instead an external power source was used, which also is a possible option and therefore interesting to test. The components were mounted on a functional representation of the intended mounting track. The track is meant to be made of aluminum but was out of plastic for this test, since it allowed a faster manufacturing of the model. The function of this track is however the same, except from the heat conductive properties that are found in aluminum that will be important for the finalized product. The same material substitute was used for the mounting distances that are used to connect the components with the track (figure 5.16). All parts were assembled in the functional model, which has similar measurements as the final product should have. After mounting the components it was made sure that there was enough space left for the batteries that were not available for the test. The system was tested by Viscando and the components worked out as intended.

The next step of the process was now to combine all the functional and expressional decisions into one final result, which is presented in chapter 6 *Final result.*

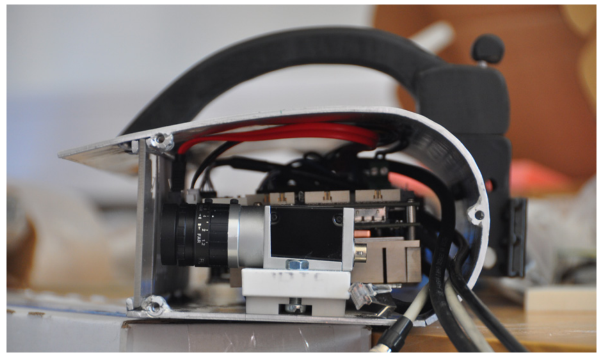


*Figure 5.16. Track and distance for mounting the equipment made out of white plastic.*



# 06 FINAL RESULT

This chapter presents the final result based on the decisions and detailed explorations made in the concept development

## 6.1 OTUS 3D MOBILE

The market offers business opportunities for measurement systems that can handle complex traffic situations, mixed traffic and pedestrians. This was stated by both the competitor analysis and interviews with numerous traffic planners. The shorter types of measurements was something that was identified as common and well suited for an mobile traffic measurement system. The new Otus 3D Mobile system (figure 6.1) is a product that aims to fill this gap in the traffic measurement market.

Equipment like this is rarely developed from a user-centered or user-experience perspective. This new product has been thoroughly worked out with these aspects in mind making it unique, not only by the technology used inside. These properties will hopefully generate the high-end feeling of advantage, professionalism, honesty and simplicity of the product, which was the target. The product has been designed not only to meet the identified requirements and wishes of how and why measurements are to be conducted, but also specifically to who these different aspects are important.

The Otus 3D Mobile has been developed out of two main perspectives; *use and mobility* and *visual expression.* Use and mobility has included ergonomic and semantic studies in order to design an easy-to-use product. By testing and evaluating different alternatives the final design has features like few other of the market. The visual expression has been developed with all involed stakeholders in mind, which in some cases has lead to compromises. Still, the expression is designed to satisfy all stakeholders in the best way possible. The main issues that have been elaborated is the overall appearance, the aspects of integrity, how to communicate through form and information and how to avoid vandalism.

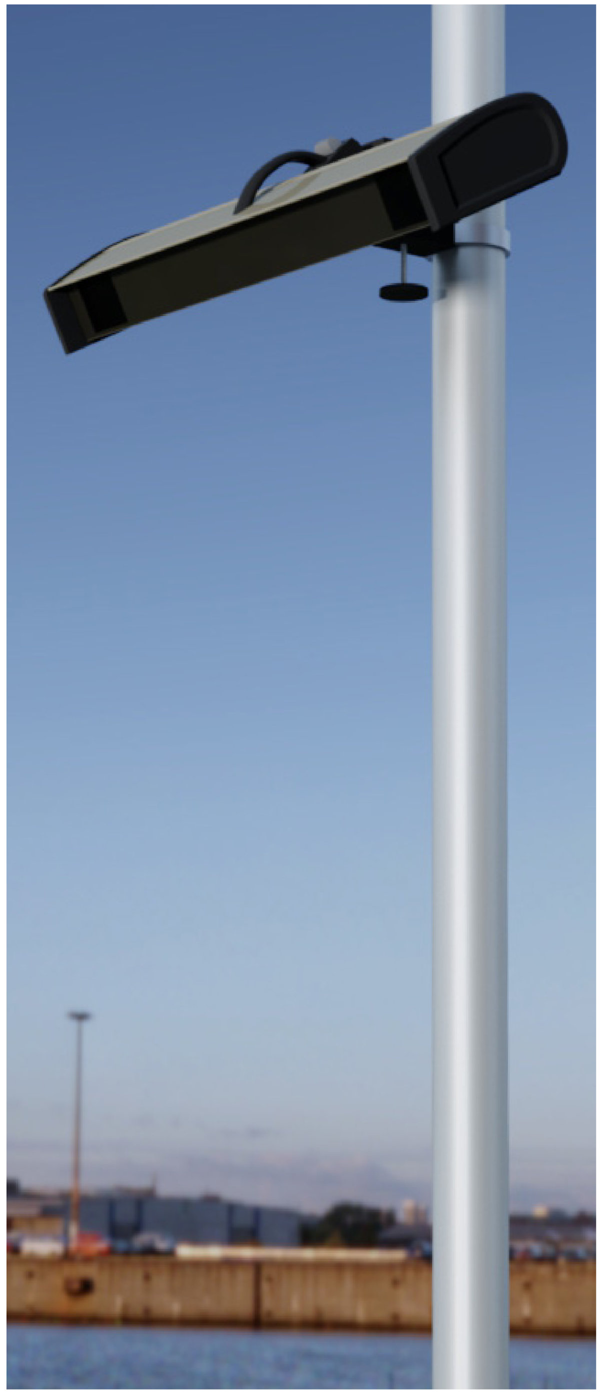


*Figure 6.1. Otus 3D Mobile System*

## 6.2 DESCRIPTION OF USE AND MOBILITY

Figure 6.2 and 6.3 highlights the features that are designed to ease the use and mobility of the product. The product is installed by a simplified and ergonomically mounting procedure described below.

The installation sequence starts by mounting the adjustment module (1.). This is attached to the post with the help of two ties (2.) that are attached to the mount. These two ties could be either zip ties or metal ties depending on situation and what the installer is used to work with. At this stage the installer holds one hand at the adjustment module close to the post, and secures the ties with the other hand.

Next step the housing (3.) is lift up by using the balanced handle (4.). The handle makes it possible to lift and mount the unit by using only one hand. The other hand could hold on to the post or ladder/sky lift for stability. When the housing is in correct position the latch mechanism locks it in place. To remove housing the release button (5.) is pressed down and the latch is disengaged.

To tune the cameras field of view a hand-held device, e.g. a smart phone is connected to the computer inside the housing via wi-fi. Now the housing is targeted by using the adjustment wheel (6.) for vertical direction and by sliding it on the post for horizontal direction. When the cameras are correctly targeted the ties are finally fully tensioned, either by hand or by using a tensioning tool. The hand-held device is also used for defining the area and type of measurement.


*Figure 6.2. Step 1, 2 and 6 of the mounting procedure*


*Figure 6.3. Step 3, 4 and 5 of the mounting procedure*

## 6.3 DESCRIPTION OF VISUAL EXPRESSION

The visual design of the product is based on the functional and expressional surface model developed in the project. This means that the product is designed with the intention to express the appropriate expression from different stakeholder views (figure 6.4).

The sides of the product have a more rounded and discreet form that don´t cause to much attention (figure 6.5). This is done to let the product blend in into the environment when viewed by the general public passing by. On the other hand, the sides of the product also act as bumpers to protect the computer hardware and cameras. When viewed in detail (figure 6.6) the ribs on the edge and the rugged material helps enhance this feel of solidity and expression of professionalism for the installer. The side profile has a shape that is designed to not resemble the side profile of a surveillance camera. This is achieved by not having an angled front surface and by putting a curvature on the top and back surface.

An anodized aluminum body, combined with plastic end pieces or side bumpers is commonly seen in other types traffic equipment, which helps the housing to further blend in into the traffic environment. The front surface where the glass sweeps over the whole length of the housing, avoids the face like expression achieved when having two separate camera openings in the housing (figure 6.7) This is done to not get a feeling of somebody watching down on the street when passing by.

The front glass surface can also be used to communicate a more explicit message. The area between the camera lenses can be customized with e.g. a brand logo or a symbol. The lengthwise trim on the top and bottom of the product help protect the surface when storing and transporting the product.

The final concept was briefly evaluated by asking people on Avenyn in Gothenburg, what they thought of the product. The procedure was similar to the one used in Eskilstuna but the answers were a bit different. This time, the majority thought the product looked like a measuring system, rather that a surveillance system. Indicating that the design efforts might have affected the visual expression as intended.

*Figure 6.4. Final concept model*


*Figure 6.5. Final concept model in environment*


*Figure 6.6. Final concept modules in detail*

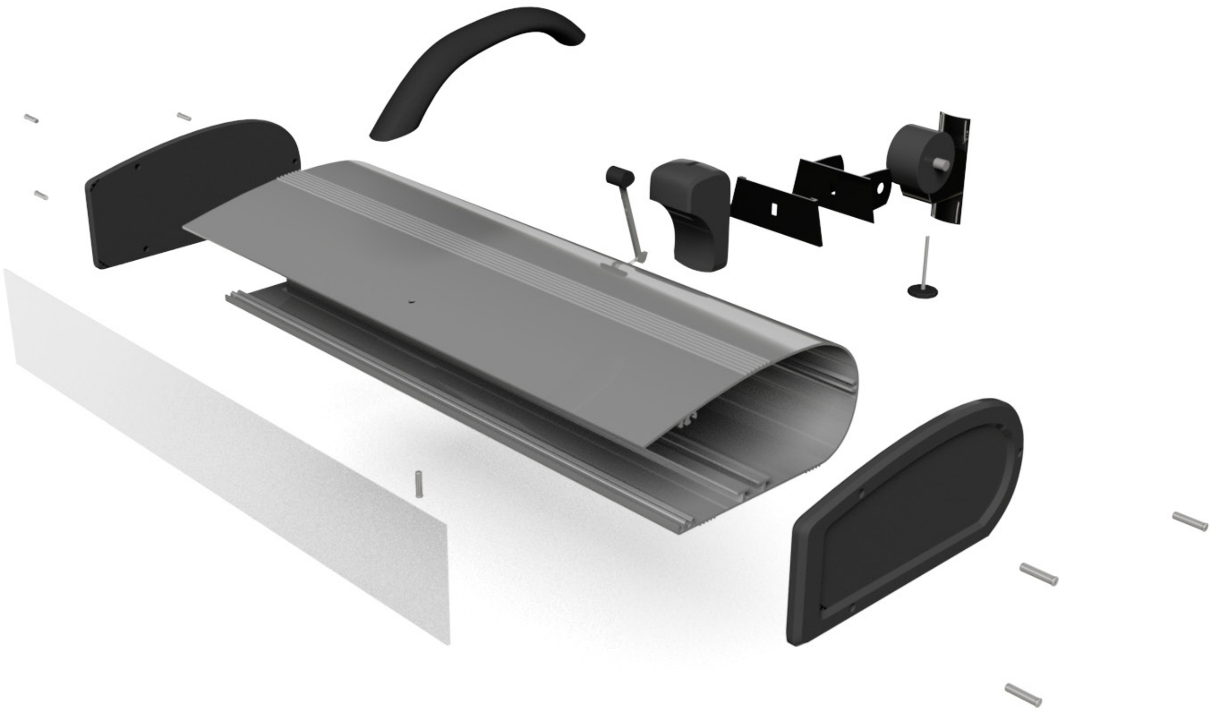


*Figure 6.7. Explosion view of  the final concept, displaying the different parts*

# 07 DISCUSSION

This chapter is a discussion about the outcome and execution of the project. It covers the process, design approach and methods, the final result and the downstream development for future work.

## 7.1 PROCESS

The design process approach for this project was, as described in the second chapter of this report both a linear and iterative process. The main focus has been on making qualitative iterative work and continuously testing and evaluating the results.

This project has been about New Product Development, meaning that a completely new product with no similar products on the market, was being developed. This precondition did put extra demands on the research phase. It became important to get an in-depth understanding of not only how traffic measuring is done today, but also why it is done and who are involved. 3D vision technology offers new possibilities that might get lost if only imitating what the competitors can do today.

Research and ideation often ran parallel during the project which sometimes made it difficult to know if the time schedule was followed. But in the end it was concluded that the estimations made in the project upstart conformed rather well with the work being performed. The process for the actual design of the product followed the priority list stated in the research findings. This was a necessary intervention in order to focus the development work on the most important and interesting aspects of the product. This lead to some differences in the level of development as some modules became developed in detail, while some to a more conceptual level.

## 7.2 THEORETICAL APPROACH AND METHODS

Emphasis for this project has been on identifying how different stakeholders perceive products depending on their interest, position or location, which will affect their product experience. Schifferstein and Hekkert (2008) describe the product experience in human-product interaction as a matter of perceiving a product and acting after that impression. As an attempt to systematically approach the product experience from an individual point of view, the model of functional and expressional surfaces was developed. With the starting point in Tjalve's method of functional surfaces, the dimension of surface expression was added. This made it possible to cover a wide spectra of possible interactions with the product, from several stakeholder views. As a second phase of the product experience development, branding theory was incorporated as a part of the perception of the product. After elaboration of company core values and identified aspects of the research findings, lead words were labeled to the different surfaces, in an attempt to find balance between company goals and stakeholder needs. As a third phase in of the product experience work, it would have been interesting to further investigate expressions or semantic functions as a part of the model, in a more systematic way. This would have been possible to explore by using the approach by Monö, which defines four semantic functions of products; to describe, to express, to signal and to identify. This would be something to further explore in future development project with similar focus.

To systematically identify stakeholder needs, qualitative data collection methods were used. Evaluation of the findings was done with methods like stakeholder mapping and content analysis. Like most methods used, these were also modified in order to best suit the project objectives and to generate useful results.

The product development had its starting point in the model for product design presented by Monö (1997). This approach describes the product as a trinity that includes; the technical whole, ergonomic whole and communicative whole. The three aspects each represented requirements that was needed for the product to be a success. The technical whole required the technology used inside to work in the best way possible; the why aspect of traffic measurements and physical requirements for the technology to work; the ergonomic whole, which was represented by the exploration of use and mobility; the communicative whole that included the visual expression of the product.

## 7.3 FINAL RESULT

The simplified installation procedure with the need of no or very few tools provides a fast and ergonomic use of the product. This is a requirement when working with shorter mobile measurements. The aspects of easy use mobility was important for creating a unique product for the market. The use and location of the product demands that ergonomic aspects are considered, in order to have a safe product for both users and people in the surrounding. Various regulations for how work is to be conducted on ladders and in sky lifts has been elaborated in this project. It can be discussed whether using ladders or sky lifts are good alternatives for mounting equipments like the Otus 3D, since they constitute limitations for both safety, time and cost.

The visual expression of the product is designed with the different stakeholders in mind. Evaluation showed some changes in people's perception of the product, in the way intended with the design. It would be interesting to thoroughly evaluate the expressions of the different surfaces, according to the model that was used and the different stakeholders.

## 7.4 SUSTAINABILITY

The modular construction of the housing consists of few parts and simple assembly and disassembly generates a sustainable product. The usage of the product helps traffic planners and consultancies to gain a better understanding of peoples traveling behaviors to support a sustainable development of the urban environment.

## 7.5 DOWNSTREAM DEVELOPMENT

Due to limitations in time and the starting point of the project the product needs further development before it can be fully realized. All solutions are there at a conceptual level, but needs refinement with respect to drawings, manufacturing methods and material selection. As prioritized in the project the focus has been put on the housing and therefore this part of the product is the most developed. The attachment and adjusting module is left at a more conceptual level.

Dimensions and proportions of the ingoing parts have to be further evaluated before production drawings can be made. This evaluation could be done by field tests of functional models and digital CAD modeling.

The attachment of the adjusting module could be further developed. The concept presented in the report needs some tools for tensioning and disassembling the ties used. An ideal solution would need no tools at all, but still prevent thefts and facilitate mobility. There is a principal concept for this available, but due to future intellectual property rights it is not presented in the report. This solution will make it possible to install the housing completely without tools on a large variety of post diameters and lock it securely in place with a key.

The functional model built during the project houses no internal batteries; instead it relies completely on external battery or other power sources. The final product should house internal batteries for shorter measurements, and the attachment of these has to be developed. The dimensioning of the housing might also be in need of adjustment to fit the batteries depending on which batteries that are chosen.

Seals and IP classification has to be further developed to make the product resist weather and wind. The product consists of rather few parts, which should simplify this task. The only connector to the housing is a port for external power supply, which is available sealed as standard component.

To send the data from the measuring device to its intended destination, the computer needs wi-fi and 3G connection. How well the antennas for this purpose works inside the aluminum housing has to be evaluated. If the aluminum is shielding the signal, it could be possible to place the antennas close to the glass or to integrate them in the plastic handle.

The adjustment module uses a worm drive, how this is assembled and manufactured needs further development. The precision needed for the adjusting makes it critical when developing a manufacturing method. It might be possible to simplify the adjustment solution to make it cheaper but still reliable.



# CONCLUSION

The goal of the project was to develop a mobile housing and mounting solution that satisfied all stakeholder needs. Through stakeholder mapping and interviews, competitor analyses and literature studies, a framework for the design work was created. Possible scenarios for 3D video analysis were identified and important aspects for use and mobility were defined. The visual expression of traffic measuring equipment using video technology was evaluated and the aspects of integrity analyzed to design a product that integrates in the public environment. Ergonomic and semantic aspects of the product were other key issues in the development of the product.

The final concept is a flexible, robust and professional housing solution with a modular structure. The product combines form and function with the appropriate expression from different stakeholder views. It fulfills the requirements for the shorter mobile measurements that were identified in the project. The design of the product will help Viscando AB to position themselves in the high end segment of the market by offering a unique solution. Further testing, evaluation and development within the fields of mechanical construction and manufacturing is needed before realization of the product is possible.

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# APPENDICES

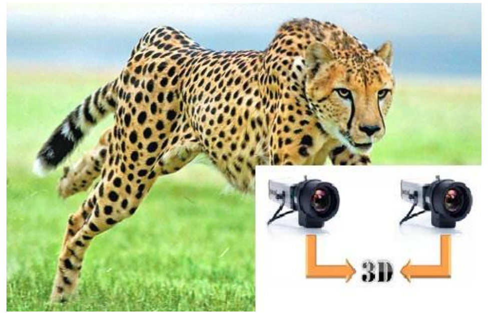
# APPENDIX I

# Viscando OTUS 3D

*new generation of automatic traffic monitoring and statistics*

## Overview

Based on the same principles as the human vision and building on a military heritage, Viscando OTUS 3D is a unique system for automatic traffic monitoring and statistics.

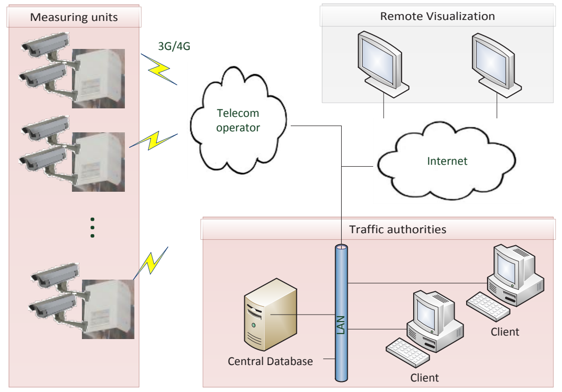



OTUS 3D is a camera based system that provides an unprecedented versatility, in function, installation and maintenance. The high quality traffic data is collected in a centralized SQL database, offering easy access and export to Microsoft Excel for further analysis.

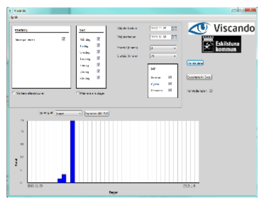
## Key Advantages

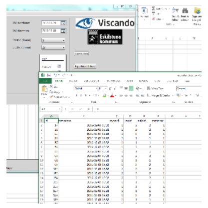
- High degree of automation
- Detection rate exceeding 95%
- Installation outside the road – no need for milling or traffic stops
- Counts all passing traffic – pedestrians, cyclists and vehicles – keeps track of traffic type
- Covers an area rather than just a line
- Multiple detection zones with a single system
- Virtual "coils" for speed and direction
- Preserves personal integrity – no images are stored nor transmitted
- Optional: Battery powered operation

## Architecture




- One to several hundred measurement stations
- Communication over 3G/4G, WLAN or cable
- Real-time output to visual counters
- Centralized data collection in a SQL database
- Easy to integrate in existing IT-infrastructure
- User authorization to data
- Easy to export data to Excel, web pages, remote sites etc.





## About VISCANDO

Viscando specializes in products and services based on advanced analysis of images and video. With a technological background from military development, Viscando knows how to build robust and user friendly products.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# APPENDIX II

Three Scenarios for the Otus 3D System

Based on the findings from interviews with traffic planners, traffic consultants and traffic researcher along with the market analysis and benchmarking and discussions with the supervisors from Viscando, three possible scenarios were presented. The scenarios represented situations where different stakeholder needs could be fulfilled. The situations were also chosen with influence of criterias like; feasibility, time to market and market positioning.

## Scenario 1: Bridge with mixed traffic

The first scenario represents more or less what a common traffic measurement situations looks like today, whether video analysis or other techniques are used. Bridges are natural bottlenecks in the urban environment, and are therefore interesting when measuring flow or share, since you can easily recognize how traffic is moving from one part of the city to another, with relatively few measurement locations. It is a limited area or cross section that can be covered with most systems. This of course makes this situation kind of crowded in terms of market positioning, since there are many actors doing this kind of measurements. However, this is such an obvious market and common spot for municipalities to measure, it is almost prerequisite for the Otus 3D system to manage. To monitor a bridge with a video analysis system might even be the best alternative, since it can cover the actual bridge without tampering with the bridge itself, this becomes a limitation for some techniques e.g. inductive loops and pneumatic tubes. The Otus 3D system's ability to measure different traffic types, in combination with the bridge scenario gives a good opportunity to gather and analyse traffic share in an accurate way.

## Scenario 2: Intersection analysis

The second scenario represents a situation that should be interesting to analyse among traffic planners at the municipalities. In contrast to a bridge, the intersection splits traffic and create different routes. Hence, measuring at intersections or roundabouts enables analyses of turn share, which could be used for studying route choices within a city. The intersection is also a good spot for measuring flow and traffic volumes, since traffic often becomes dense in the intersection. This increased density often leads to slow moving traffic, which most of the existing systems have trouble handling today. The Otus 3D system does well in handling dense and slow moving traffic, which becomes a strength for this kind of situation. This creates a unique market position for Viscando. One problem that most systems, including Otus 3D suffers from, is the limited coverage area. This become a limitation especially for intersections and roundabouts, which often are quite large.

## Scenario 3: Pedestrian walkway with bicycles

The final scenario covers a pedestrian walkway, where both pedestrians and bicycles are to be counted. Analyses and counting of pedestrian is a relatively new market, with quite few actors and a lack of well functioning techniques. This makes room for a good market position for Viscando and the Otus 3D system, since pedestrian counting and analyses is a well developed part of the system. The combination of both pedestrian and bicycle counting creates an even more favorable position in terms of competition, since there are very few available systems that manages this. Even if pedestrian analyses is a new thing, not done by too many municipalities or consultancies, it is claimed to be the next step to take in consideration when building well functioning infrastructure. This hypothesis stresses the fact that pedestrian analyses could be growing market for the future.

# APPENDIX III

## Idea Generation on mounting solutions

8 students gathered to solve the problem of how to mount the camera up. The questions posted was:

How to get the equipment up about 6 meters, get it to stay there and get it down again? Conditions where equipment weight of approx. 3 kilos and a light post available. When summarizing the workshop the idas were clustered into different groups:

**Clamping solutions**

- **Rope**
- **Tube clamp**
- **“Tool Hanger”, “Guitar Hanger”**
- **Click, like reflective wrist stripe**
- Rubber balloon that is blown up to get tight
- Pad lock
- Magnet
- Compressed spring diameter change

Ideas was also generated for how to get the equipment up without a ladder or skylift. These ideas were categorized as variants of three basic concepts: own post, self sliding on existing post and to slide it up with some kind of stick.

**Own Post**

In this category the ideas were placed that used an own separate post. Different concepts in this category were:

- Inflatable post
- Scissor lift
- Foldable post
- Post with integrated line for pulling up the equipmen
- Telescopic post

**Self sliding on existing post**

- Threaded post where the equipment could spin up
- Jacking device to push equipment up
- Pulling rope that drives wheel dolly that climbs post
- Clamp with crawlers
- Clamp with skewed wheels that climb the post when rotating
- “pull back” engine
- Radio Controlled dolly cart
- Helium balloon

**Slide it up with a stick**

- Clamp that locks when stick rotated
- Clamp with ratchet makes it go only one direction
- Lift it with stick and clamp it directly in place on top

# APPENDIX IV

## Details from Interviews and focus group

**Interviews - Appearance**

The synonymous insight about the expression of a mobile measuring system from the interviewees was that no one thought it should look like a camera, or cameras. These answers were motivated by various reasons, for instance;

*“If it would have been surveillance for safety aspects, security, then there would have been a point in knowing you were monitored, but this isn’t about that”*, highlighting the fact that people think of the measuring system as security surveillance, or;

*“I personally think it is important that it doesn’t look like a camera…it is better that it is blending into the environment and the public space, less risk people will harass it”*, pointing out the possibility of vandalism, another explanation was;

*“They should probably look quite similar to other types of traffic equipment, not camouflaged but made to match similar equipment”,* this answer suggests an alternative to the camera look.

The most common suggestions from the interviewees was that it should have a neutral or anonymous look, so that it is less disturbing to both environment and the people laying eyes on it. One typical comment could be; *“...perhaps it is possible to find a more discreet design, where it is still possible to change lenses and such. Instead of using two separate housings for the cameras, you can put them in the same box, it would make them look less threatening”*

Also, comments like; *“You don’t want to affect people, you want a correct result, it should reflect reality”* and *“It has to be discreet, not to affect people’s behaviour”* is indicating that little impact on bypassers is wanted.

Furthermore, the pure aesthetics of products and how it might affect people was brought up by some of the interviewees. This was stated by one of the traffic engineers; *“When you plan new areas, you always think about the aesthetics, it should look attractive. Then it might not work with a box that looks like a box. City planners often discuss streetlights and stuff like that, it should be aesthetic, look good… If it is ugly, it is a greater risk people associate it with surveillance equipment… if it is attractive you might think more positive of it”*

One last reflection was on the fact that it is a mobile system that is to be developed; *“If they are mobile they will become new, in new locations all the time, then it is a problem that people won’t get used to them”*. This comment touches upon the subject of recognition and how people get used to new things in their environment.

**Interviews - Integrity**

When it comes  to measuring traffic in general and in particular video analysis, integrity issues becomes a part of the agenda. Video analysis technology is restricted by legislation regarding integrity, thus today, a camera permission must be given to perform the measurement. These issues were also brought up during the interviews.

The overall opinion from the interviewees was that integrity issues are important and that the function measuring system has to be trustworthy in what kind of information it collects and store. One interviewee mentions that;

*“We are measuring how many that are walking or riding the bike, that is what we are doing. We are not measuring who”* and this view on how work is to be executed, seems to be pretty much the same for everyone that was interviewed.

Regarding video analysis, there are some of the traffic planners who would find it interesting to analyze the actual video material, but the main objective seems to be the statistics, as mentioned by one of the traffic planners;

*“We have no interest in the film [recorded material], it is only the analysis we want, it is the numbers that are interesting”*. One of the traffic consultants had also experienced situations where residents doubted that their integrity were respected, for example; *“...when videotaping cyclists for a municipality once, there were actually people stopping and asking what we were doing, some saying that they didn’t want to be on tape”*. However, the consultant ensured these situations occured quite rarely, but of course they are also seldom present during the measurements.

None of the traffic planner or traffic consultants that had been in contact with the county administrative board, when trying to get a camera permission for their equipment, found this to be a smooth process. One of the traffic planners expressed it like this; *“It is a long process, it takes 6 months, I’ve been there, it is tough!”* another traffic planner said; *“The camera permission went well, but it took some time, which ruined things for us last year, we had to have a reservation in the procurement, if we didn’t get the permission we wouldn’t like to have the product”*.

Both traffic consultants had previous experience from seeking camera permission for their equipment, and also gave some suggestions for how a system which is not saving any film might be accepted by the county administrative board, and by that be relieved of having to seek permission. One idea concerned the possibility to restrict the access to the data while not being present, which could be some kind of physical barrier or switch. Another solution to this could be to limit the wireless access to the device, while not being present, making it impossible to send video material. It is also mentioned that a feature like e.g. an antenna could typically bring associations to integrity issues and surveillance, since it indicates that some kind of media is being transmitted.

**Interviews - Communication**

Regarding the communication of the traffic measuring activities or who is in charge of the activities, there were split opinions on how this should be done. There were those who were doubting the need of showing either what they were doing or who they were;

*“...We haven’t communicated with the residents how we are measuring, and I don’t know if we have any ambitions to do that either, not that it is a secret, but the question is what to say and how important it is that they know”*. Other comments concerned that information might lead to increased vandalism. One interviewee claimed;

“...a lot of people can’t tell the difference between municipality and the police, they are still authorities in people’s eyes”, meaning that if it was displayed that the equipment belonged to the municipality, people might still think it belonged to the police, since they were considered by some to be the same organization, which might increase the risk of vandalism.

On the other hand, there were also many comments pointing out the benefits of enabling more information to the residents about ongoing activities. Many comments were similar to;

*“There is a point in showing what we are doing, that we are an active municipality, that we do things for the residents”*. Many of the interviewees referred to the positive effects of the bicycle barometers that are becoming more and more common in the cities. The barometers were claimed to be *“...very appreciated”, “...encouraging”, “...a way to promote bicycling”*

There were some ideas on what kind of information that would be interesting to display as well how it might be done;

*“To have the municipality logo or something, make it possible to see who put the equipment there at least…”* or *“...connecting both pedestrian and bicycle count to a barometer, meaning a real time barometer for walking, we have never seen that before and we think it will become a unique product. In this case we really want to display our logotype in some way, show that we are a sustainable city...”* or *“You could have information on the homepage or contact information or similar, or that the design tells you what it is”.* Many suggestions concerned labeling of what the product is, show that it is measuring traffic and to display contact information if someone have questions.

One of the traffic engineers gave an example when the police got a call from someone asking about some cameras in a certain location. There were no labeling or information on the equipment, so the police took it all down, they were worried that it might be some kind of preparation for criminal activity. This person stated that; *“Labeling is incredibly important!”*. Another interviewee wanted to ensure that; *“If a logo should be used, it should be used in a neat way, show that it is counting and not surveillance”*

**Interviews - Vandalism**

When discussing the expression and mounting of a traffic measuring equipment with the interviewees, the subject of vandalism or sabotage were always brought up. Almost everyone had some kind of experience with equipment being stolen, tampered with or even destroyed. Vandalism, in terms of traffic equipment in a public environment, seems to be an unwanted result if the expression or integrity issues fails to communicate the right message to people. The interviewees express their experiences from several perspectives;

*"Sometimes I believe people think the equipment belong to the police, but they also sabotage our christmas trees…"* This indicates that two types of vandalism might be occurring, a more elaborate or ideological type, possibly towards the police and perhaps a more spontaneous type, like the one targeting christmas trees. Unless someone really hates christmas of course.

*"People easily attack stuff the do not recognize, not only for the fun of it"*

*"It is a reoccuring problem, will someone spray, paint, pee or burn it?"*

*"I think you should hide [the equipment], we have had trouble with people stealing speed displays and batteries, don't want it to be desirable"*

*"The equipment often gets damaged, with people trying to break into the radar boxes…"*

They were also asked if the use of cameras as a part of the equipment would affect the risk of vandalism;

*"If you also think it [the cameras] has something to do with traffic tolls, that increases the risk for someone going there, shooting it down with a rifle"*

*"Cameras do feel a bit more vulnerable than the [radar] boxes…"*

*"When you see that it is a camera and maybe see a possibility to steal it, it might be more interesting than perhaps stealing a water container or so"*

These comments indicates that something that look like cameras might be more exposed to vandalism. That either the vulnerableness makes them interesting to break or that cameras has a value and therefore worth stealing. This suggest that a more robust look and avoidance of camera look might prevent vandalism.

**Focus group - Appearance, Integrity, Communication and Vandalism**

The result from the focus gave plenty of input regarding visual expression issues, and how a traffic measuring product should look and work to be satisfactory, from a general public point of view. The focus group also generated some suggestions for possible alternative areas of use for the product.

The discussion regarding this type of products' effect on personal integrity was loud and diverse, in many ways similar to what theory and literature concerning camera surveillance suggests. Several statements from this discussion very much proves the diversity towards monitoring and surveillance when cameras are involved. The following quote came from one of the participants of the workshop, and was a response to a more sceptic statement about the use of cameras in a public environment;

Person 2 *"I feel safe and that is because the law regulates these things. If you are unsure, you have to complain on the law and make sure changes kind of happen. There are certain things they can't do [referring to governments and municipalities]. As long as a camera is up today, I know what is valid. But of course, you have all seen in the United States, or with the FRA and stuff."*

Moderator: "Do you trust that it is done in the right way?"

Person 2 *"No, I might not, but I don't care."*

First, this participant clearly states that he do trust whoever is using cameras for legal purposes, but later on referred to know cases where this trust might have been violated. When then asked if he trusts the monitoring made with cameras, he hesitates but states he might not, and adds that he do not care that much. It is an interesting turnover, which seems to be common when discussing these type of questions.

Another excerpt from this discussion that also shows the diversity and disagreements that this issue creates is;

Person 1 *"...you have to agree on that it is something frightening when cameras are involved. Because it is something anonymous about having a camera somewhere."*

Person 2 *"I don't know, I think it feel a little bit more safe almost, if something happens there are cameras that might have seen it… I don't see any possible way they could be used against me."*

Person 8 *"There are ways"*

Person 7 *"Perhaps not the ones owning the camera, but those trying to reach it?"*

Person 6 *"But that is kind of what you think when you see a camera, you want to know who have it and what they are doing with the information. It is for maintaining traffic, but yeah [doubt], is it something? Is it a camera that some random person have put up there, to monitor what is happening on the street? Then it is really creepy."*

This discussion involved five participants, that could not agree on the level of trust to have for cameras in the public environment. An interesting note is that the visual perception of a camera in a public environment, for one of the participants, signals safety. The connection between cameras in the public environment and the feeling of safety is, like much research suggests, very common. For a product that includes cameras, but does not save any actual footage, the feeling of safety might be misleading. One could argue that, any product that enhance peoples' feeling of safety is good, but will this be an honest product? The feeling of safety related to cameras, is most likely linked to the prevention of crime. People believe that if there is a camera watching, there is less risk of being a victim of crime. This is probably true, and even if the product is not saving any footage, it might still prevent crimes from happening. However, there is a great amount of trust put into cameras, and in reality such a product could not in any way help solving a crime or identify a suspect, which might be expected of a product looking like a surveillance camera.

Other topics that was brought up during the workshop was;

- The importance of not being able to identify or trace certain individuals through the monitoring, if that was not the intention. There were demands on remaining anonymous.
- That the location and direction of a surveillance system affects the perceived perception. A placement towards a door, by a cash machine or in a grocery store, might feel more legitimate, than for instance in a square, since it more clearly indicates its purpose.
- If the owner, intention or function of the product in some way should be communicated to people was discussed and the consensus was that it probably should. How this information should be conveyed, was not entirely clear. To use signs, counter screens, color codes or look like typical road construction equipment were some suggestions.

# APPENDIX V

## Meeting with potential municipality users

This meeting was arranged by the CEO of Viscando, as a follow-up on the findings from the previous interview with representatives from the Gothenburg municipality. The interview with the traffic planner and traffic analyst indicated that there was an interest for a mobile traffic measuring system, like the one that was being developed. Therefore, this meeting could deepen the knowledge and bring new insights on what was desired from possible users.

Attending this meeting was: The CEO of Viscando, representative from the thesis group. From the municipality: A traffic analyst from the traffic planning department, the operations manager from park and nature management and a traffic measurement manager.

The meeting resulted in some interesting new insights and also verified some of the interpretations made from the interviews. The interviews did indicate that measurements during shorter periods (approximately 2-4 hours) are being conducted, but at the same time most interviewees stated that a mobile measuring system should preferably manage at least a week without maintenance. However, this meeting showed at least two scenarios where the shorter time span was enough. The traffic analyst had a great interest in measuring the maximum intensity for morning and afternoon traffic and the operations manager from the park and nature management, wanted to do shorter spot measurements in the city's parks, since they had little knowledge in how people moved, where they were or how many people actually used these areas. These scenarios proved that there is a use in having a mobile system, with a small and lightweight battery solutions for shorter periods of time, that would radically improve mobility.

Questions regarding installation- and calibration time was also stated, and seemed to be of importance. This indicates that the product must be easy to use and easy to understand. Improvement of the product's mounting time, ergonomics and semantics is therefore motivated, since they showed interest in performing the measurement operations on their own.

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