CHALMERS

From function to product

Development of the user experience for an electric delivery vehicle

Master of Science thesis in Industrial Design Engineering

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Göteborg, Sweden 2013

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Cover: Image of the final concept.
The concept is described in detail in chapter 9.
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Abstract

Our society is in many ways defined by our transportation capabilities of both products and people. Our current transportation system has matured into an age where cheap- fossil based energy has been in constant supply and has therefore in many ways grown dependant on it. This basic condition of cheap- high density energy has changed in recent years and the need for more expensive extraction techniques to meet current demands for fossil based energy has increased prices This has opened up new markets within the "last mile delivery sector" meaning the last part of the total delivery chain to the separate households. The preferred transportation methods within this sector has been, up until recently, a combustion engine based car. This is about to change as the leading actors within this industry more and more are locking towards purpose built electrified transportation solutions.

This paper has looked at the existing market of small electric utility vehicles from a user perspective in order to understand the advantages and disadvantages of the different actors on this emerging market. The aim is to apply this knowledge on the development of a new generation of small utility vehicles that are capable of complementing a regular car. As this project is focused on a practical solution, the outcome is not a design study but rather a prototype ready design proposition for an existing company.

The process started with a recap of previous material related to the subject, noteworthy information was gathered in a checklist for future use and summarized in a knowledge base. This was then followed up with a requirement gathering phase consisting of a study of legal requirements, technical limitations imposed by the construction team, field research within three different customer segments and market studies conducted partly by collaborating parties. The input from this phase was then summarized through a developed need analysis and a written persona for each of the customer segments.

Several design concepts where brought forward and analyzed during the form explorative phase. A framework consisting of the previous information gathering, inspiration boards and the brand identity of the company was put in place to steer the project in the right direction. A design direction was chosen and later refined through several iterations

The finished concept is presented in two stages were the latter is an adaptation of the design suited for a prototype series. An evaluation of the concept was done through an improved version of the PUGH concept scoring, indicating an improvement compared to other market solutions as well as the earlier prototype developed by Nimbell. The most significant improvements were made through better user adjustability both regarding ergonomics and functionality. This combined with a distinct brand identity and production feasible concept will ensure that the vehicle is welcomed by its future customer.

Sammanfattning

Vårt samhälle definieras av våra transportmöjligheter, både för varor och människor. Vårt nuvarande transportsystem har mognat in i en tid med konstant tillgång till billig fossilbaserad energi och har därför på många sätt blivit beroende av den. Denna grundläggande förutsättning av billig energi med hög densitet har förändrats på senare år och behovet av dyrare utvinningstekniker för att möta nuvarande behov av fossilbaserad energi har lett till ökande priser. Detta har öppnat upp för nya marknader inom kortdistans leveranser. Den mest använda transportlösningen inom detta segment har varit, fram tills nyligen, en explosionsmotor baserad bil. Detta håller på att förändras när ledande aktörer inom denna industri mer och mer börjar titta på specialanpassade elektrifierade transportlösningar.

Den här rapporten har tittat på den existerande marknaden för små elektriska arbetsfordon från ett användareperspektiv för att förstå fördelarna och nackdelarna hos de olika aktörerna på denna nya marknad. Syftet är att applicera denna kunskap till utvecklingen av en ny generation små arbetsfordon som är kapabla att komplemetera en vanlig bil. Eftersom detta projekt inriktar sig på praktiska lösningar kommer slutresultatet inte vara en designstudie utan ett prototypanpassat designförslag till ett existerande företag.

Processen började med en tillbakablick på existerande material rörande ämnet. Information samlades in i en punktlista för framtida användning och summerades i en kunskapsbas. Detta följdes sedan upp med en kravinsamlingsfas bestående av en studie över lagbestämmelser, tekniska begränsningar uppsatta av konstruktions gruppen, fältundersökningar inom tre olika kundsegment och marknadsanalyser delvis genomförda i samarbete med utomstående partners. Input från denna fas summerades sedan genom en utvecklad behovsanalys och en skriftlig persona för varje kundsegment.

Flera designkoncept togs fram och analyserades i den utforskande formfasen. Ett ramverk bestående av den tidigare informationsinsamlingen, inspirationsbilder och företagets varumärkesidentitet infördes för att styra utvecklingen åt rätt håll. En design riktning valdes och förfinades sedan genom flera iterationer.

Det färdiga konceptet presenteras i två faser där den senare är en anpassning av designen för att fungera i en prototypserie. En utvärdering av konceptet genomfördes genom en förbättrad version av betygsättningsmetoden PUGH. Den indikerar en förbättring både jämfört med andra marknadslösningar och en tidigare version av fordonet utvecklat av företaget innan starten av detta projekt. De viktigaste förbättringarna skedde genom ökade justeringsmöjligheter för användaren både gällande ergonomi och funktionalitet. Detta kombinerat med en distinkt varumärkesidentitet och ett produktionsanpassat koncept kommer säkerhetsställa att fordonet välkomnas av sina framtida kunder.

Acknowledgements

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Rikard for aiding with the electrics.

Magnus for allowing us to venture with him in the night.

Anna for her thoughts and feedback on the report.

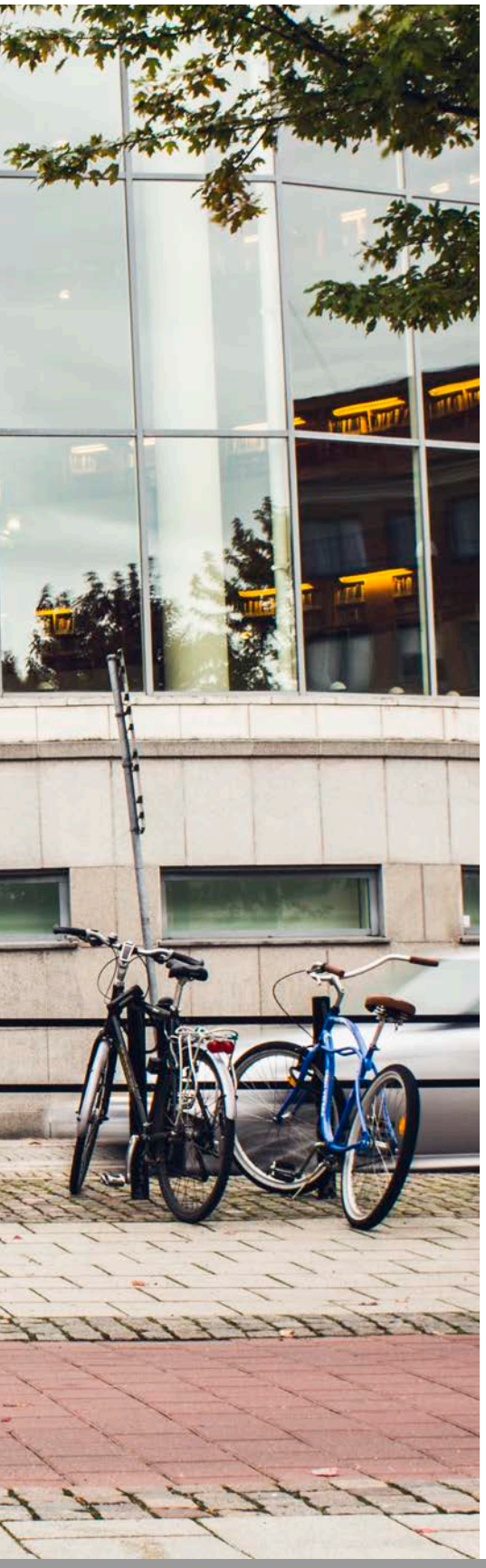
Table of Contents

1. Introduction

Every journey begins with a first step, driven by the curiosoty of discovering what lies beyond the next curve in the road. This chapter introduces the reader to the work made in this report and the first steps that lead to the initiation of it. The purpose of the project and the deliminations governing it are introduced to the reader and a overview of the design process used is presented.

Fig. 1

Authored by:
Patrik & Tobias



1.1 Background

Nimbell Motors is an Encubator Portfolio Company from CSE 2010 based in Gothenburg. Their main business idea is to introduce electric drive solutions into new categories of vehicle to improve performance and reduce environmental impact. The project is appointed by Nimbell which is a rising electrical vehicle company in their start up process. Their focus product is a distribution moped where a demo product is planned to be finished in q3 2011. The products present state is a functioning chassi and a brief concept vehicle body. A previous master thesis has been conducted but the design has been changed since. Some of the ergonomical and expressional materials are however still valid.

1.2 Purpose

The purpose of this masters thesis is to develop the user experience for the Nimbell concept distribution moped called BEMO. This involves the cargo handling, Driver environment, product expressions and also developing a module system for different uses.

1.3 Project Focus

During the initial phase of the project and together with Nimbell, the project focus has been determined to be a detailed user study together with conceptual product development for the interior of the vehicle and use.

The existing concept BEMO shall be improved through an extensive study of the human-machine interaction within the customer segments that are of interest to Nimbell. These segments could include both private and municipal sectors and will be selected during the course of the project. The different environment that the machine will be utilised in and the tasks that the vehicle is expected to perform will be surveyed.

1.4 Delimitations

The development of the Trigo vehicle had been undergoing for over a year before this redesign project commenced. Much research and effort was already invested in both the design and construction aspects of the design and a prototype construction was underway. It was therefore only natural that a number of guidelines and construction demands had already been formed that the design group needed to process before commencing the project. A list of these demands can be seen on the next page.

- The end result of the project needs to be possible to implement in the beta series of the product.
- The concepts need to be adapted to the manufacturing and production methods of Nimbells production partners.
- All concepts should be based on the existing trike wheel configuration.
- The final product will have detachable roof and windscreen.
- The battery box will be placed below the driver seat.
- The vehicle will be controlled through a combination of steering wheel and foot pedals.
- Avoid plastic components, due to the initial low production volume.
- The thesis does not involve the technical specifications of the vehicle such as performance, handling and functional frame.
- Detailed market analysis and cost analysis will be made by an external party.
- The scope will include everything from user studies to CAD specified concepts. Production specifications however are limited by time.

1.5 Organisation

The concept development project is performed in parallel with several internal and external projects that are highly dependent on each other. The different project groups are presented below to create a overview of the responsibility allocations and dependencies of the different projects.

Nimbell AB

The management at Nimbell is in charge of the overlying strategy of the Trigo project portfolio. They are responsible for the financial constraints of both the projects and the production. Customer relations and sales are also a part of their responsibility

The construction team at Nimbell are performing the construction development of the vehicle. Their main responsibility is the undercarriage and powertrain but they will also be heavily involved in the realisation of the concept produced during this project. There have therefore been long periods of collaboration with the construction team where they were involved in the conceptual phases. This has served as an informal sanity check of early ideas in order to keep them within the budget and construction constraints that were placed on the project.

I5 market analysis group

The Industrial Economy Group performed market and customer analyses. The result is used to score the user needs identified in the user studies and rank the different per user segments.

1.6 Design process

Theoretical prestudy
A theoretical prestudy is conducted that includes relevant information from conducted courses. These are summarized in different text documents and as a design-statement list that will be used during the project as a gate-checklist and inspiration/guide list.

User study
A user study will be conducted to find the different user needs and demands.

This user study will be coordinated with Nimbell and will include site studies, observations, interviews and prototype testing.

- Discussion group with prepared questions
- Deep interviews
- Telephone interviews
- Site visits combined with observation
- Usage of present solutions

Idea generation phase
A thorough idea generation phase will be carried out and include innovative solutions for module cargo systems, the driver compartment and a high overall innovative feel that is sought by Nimbell.

The following methods will be implemented in the idea generation phase:

- Need analysis
- Idea generation matrix
- Brainstorming
- Workshop with the construction group at Nimbell
- Sketching of part solutions
- Sketching of product expression

Concept generation
Ideas from the idea generation will be evaluated, combined and visualized by sketches and mock-ups. Different concept themes will be constructed and evaluated from the point of concieveability and user demands.

The following methods will be implemented in the concept generation phase:

- Morfolog matrix
- Concept sketching
- Mockup evaluation
- Pugh Matrix
- Manufacturing potential

Final design proposal
This phase will refine the chosen concept through testing with mock-ups and sketches. After that a finalizing phase made by written function specification, visualisations and CAD will be performed.

Brief evaluation
The concept will be evaluated against the needs identified in the pre- and user study.

2. Project prerequisite

2.1 Previous Work

The original vision of the vehicle developed in this report was created by Douglas Grundevik in 1989 when the first Tugger was produced (Berqvist et al 2011). The three wheeled configuration consisting of a motorcycle with a permanent sidecar contained a novelty in the form of an electrical motor. Stout wheels, an L-shaped cargo bed and exchangeable batteries were seen as the signature features of the vehicle (Pohl 2001). Available accessories included tiltable cargo bed, trailer hitch and weather protection (Pohl 2001). The vehicle was registered as an EU moped and could be purchased for between 44 500 sek and 84 000 sek in 2001 (Pohl 2001) (51 011 sek to 96 292 sek when converted to the money value of 2011; 5 774€ to 10 900€). Low series production continued up to 2002 but Tuggers can still be found in active duty to this date (Berqvist et al 2011).

In 2009 the Tugger concept was revived through a collaboration between CSE (Chalmers School of Entreprenurship) and Douglas. This lead to two parallel product development projects conducted by students at the Product Development master. One group performed a redesign with a mechanical point of view, The other with students from the Industrial Design Engineering master made a redesign from a branding and user perspective. The results of these projects lead to a concept that was presented in 2010. It was based on the same type of wheel configuration as its predecessor the Tugger and the trademark L-shaped cargo bed has also remained. A robust and strong expression is conveyed through the visible frame structure while the clear distinction between driver and cargo area preserves the association towards motorcycles.

A second concept named Terravox was also brought forward in 2010. Its target group was completely different introducing electrical drive to the tool carrier segment. This concept lies beyond the scope of this project but will be taken into consideration from an aesthetical point of view.

2.2 Current Situation

In 2010 the CSE group went ahead and formed Nimbell Motors AB with the aim to bring the BEMO concept all the way to a fully functioning vehicle. The work led up to a finished construction design shortly before the initiation of this project. A working prototype, named BEMO, was then manufactured in parallel with the information gathering phase (chap. 4) and a short evaluation can be seen in chap. 8.2.

During this period several changes were made to the underlying concept, from 2010, for mechanical reasons.

- The hub motors were changed to a regular electric motor.
- The wheel configuration was changed to a trike layout.
- The battery compartment was placed under the seat.
- The front was widened substantially.

This created a gap between the prerequisite that the former design concept was based on and the present vehicle configuration. A redesign of the exterior of the vehicle was therefore needed.

2.3 Limitations

The following demands should be taken into consideration.

- The new design concept will be manufactured in an evaluation series consisting of three vehicles. The evaluation series will at a later stage be followed by a larger series.

Fig. 2

Fig. 2 The Terravox concept is a design proposal for a future tool carrier in Nimbells product portfolio. It´s semantic properties should be regarded in the design process because of shared product properties.

Fig. 3

Fig. 3 2010 design concept with the same wheel configuration as the Tugger. This was the starting point for the development of the BEMO prototype.

Fig. 4 The BEMO concept after the change in wheel configuration from sidecar to trike. The legacy of the first concept can still be seen.

Fig. 5 BEMO prototype sent to manufacturing. The changes made are due to legal and manufacturing limitations.

Fig. 4

Fig. 5


Fig. 6


Fig. 7


Fig. 8


Fig. 9

- The transition betwen evaluation and serie production should only require minimal adjustments on the design concept.
- The substructure of the vehicle will be based on the BEMO prototype test findings.
- Items that are subject to change such as the powertrain, suspension and frame will be developed in parallel by the construction team.
- Standard parts, such as headlights, handles and buttons should be used when possible.
- The vehicle will be powererd by lithium iron phosphate (LiFePO4) batteries without need for regular maintenance.
- The concept should comply with aplicable laws and regulations.
- The same manufacturing limitations that applies to the BEMO prototype shall apply to the new concept.
- A user should be able to remove the roof and windscreen
- The vehicle should be able to switch between different cargo modules.
- Withstand wear and tear with no sensitive protruding parts.
- Total vehicle width of no more than 1200mm.

2.4 Target Group

The groups identified by Nimbell AB previous to this project are the starting point for the user studies (chapter 5). Possible usage areas are mail distribution, indoor transport, park maintenance and within the field of property maintenance. The vehicle therefore needs to target several price categories through modularisation.

These target groups will be further evaluated by the i5 team and their result may be used as a basis to widen or alter the selected target groups.

2.5 Nimbell brand

The branding of both the future vehicle and the company itself has been an ongoing process through several projects and was already well defined when this project was initiated. It consists of four core values defining the internal values of the company and three product characteristics describing the essence of the product.

2.5.1 Company core values

- Creativity

"Nothing is impossible", "The sky is not the limit" (Fig. 6)

- Sustainability

"Care for the environment, society and economic value" (Fig. 7)

- Honesty & reliability

"The steady point in stormy weathers" (Fig. 8)

- Personal leverage

"Together everyone achieves miracles" (Fig. 9)

2.5.2 Product core values

The product characteristics were complemented with describing sentences during

the project to pinpoint how the words were interpreted.

- Nimble

Self adapting to any new obstacles that arise on the road to success.

- Refreshing

Takes the industry by surprise and defines a new standard that others will struggle to achieve.

- Confident

Distinguishing itself from the grey mass while being aware of the challenges that lie ahead.

2.5.3 Market positioning

The market for slow moving electric vehicles (<50km/h) have been growing during the last two decades. The user are primarily in local service industries where tools, equipment and personal require transportation over shorter distances. The largest actors on the market are modified golf carts that are retrofitted with a cargo deck and in some cases a cabin. Purpose built vehicles is starting to emerge on the market and it is Nimbells aspiration to become one of those new players.

The new vehicle should be easy to adapt to customer requirements both when it comes to cargo solution, drivetrain and cabin. This will enable the vehicle to meet the demands of the premium users as well as the upper-end budget segment (Fig. 10). The intention is to be the green alternative available in the gap between regular cars and lighter vehicles such as bicycles and mopeds. A new battery technology will boost duration, making the vehicle a reliable partner even when used as a transit method between different working sites. The vehicle should therefore belong both out on the streets and within the local park and recreational areas of the city.

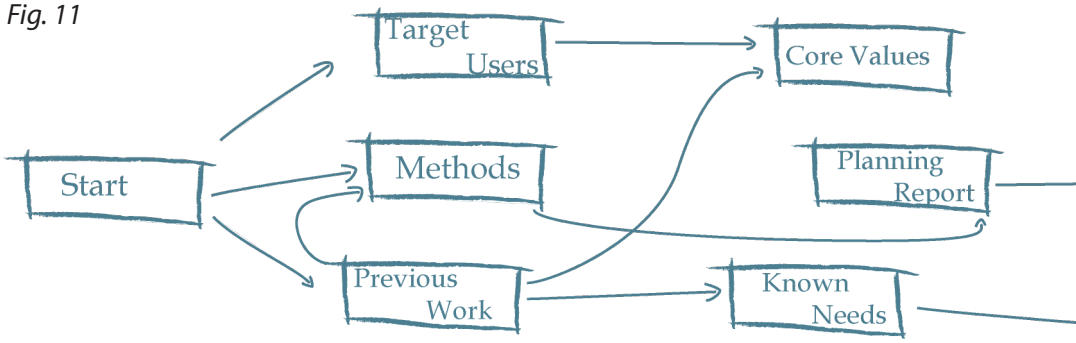
The vehicle should communicate robustness in combination with agility to distance itself from the budget segment consisting of retrofitted solutions. It should be able to handle heavy loads while at the same time be easy to navigate in a crowded suburban environment. The driving experience should resemble a car but enjoy the benefits of having a three wheel layout.

The day to day service of the vehicle should also be painless. Special service arrangements such as charging indoors, refilling the batteries with water or not being able to use winter tires should not be needed which is the case with many competitors.

Fig. 10

3. Project planning

Fig. 11



3.1 Purpose

The project plan is used to define the activities contained within the project and to inform all of the participants about the order of their implementation. This creates a shared view among the project stakeholders on the time, energy and resources that need to be committed to it. Writing everything down creates a solid base for future discussions between project team members and stakeholders. Examples of such documents could include success criterias, stakeholder commitments, project goals and a preliminary project plan.

3.2 Methods

A well executed project begins with a thorough project planning that is based on realistic assumptions and is firmly rooted with all Stakeholders. This was ensured by using three different planning methods during the creation of the planning report that constituted the foundation for the remaining parts of the project. The implementation of the methods is described in short below.

3.2.1 Stakeholder analysis

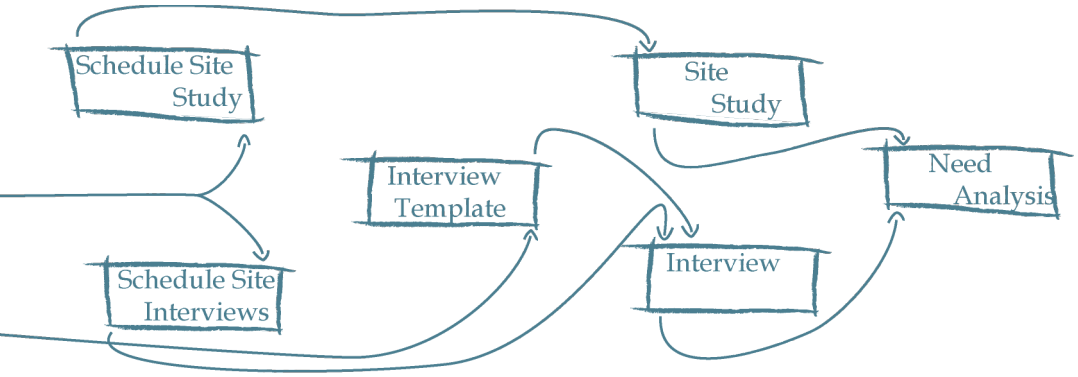
Stakeholders can best be described as "individuals or groups with an interest in the project process or outcome" (Maylor 2010) and consists of people that often have divergent backgrounds where the potential of conflicting agendas should not be underestimated. They all have opinions on how the project should be, what it should do, where the focus should lie and what the result is. The analysis (Fig. 12) tries to identify and categorize internal and external individuals and organisations to ensure that no key stakeholders are forgotten in the planning process.

3.2.2 Bottom up WBS

A work breakdown structure (WBS) is a way to transform a large task such as a project into a hierarchical series of independent activities (Fig. 13). The method is however not limited to activities but can be based on other criterias such as physical functions or deliverables. Two approaches to the method exist independent of criterias that are used. The first looks at the big picture and divides it into smaller and smaller pieces until the each piece can be handled by an individual. This is the preferred way in projects where the management has a small experience of similar projects beforehand. The other way to implement the WBS is the "bottom up" approach where individual pieces are categorised into larger and larger groups until the top level consists of one single group (Maylor 2010).

3.2.3 Network diagram

A network diagram (Fig. 11) is a continuation of the activity definitions carried out in the WBS. The method identifies and documents interactivity dependencies. Several approaches for achieving this exist but the Acticity on Node (AoN), also known to some as the Precedence diagram method (PDM), was selected for this project. The activities listed in the WBS are linked together through the order in which they need to be carried out. These arrangements are called dependencies



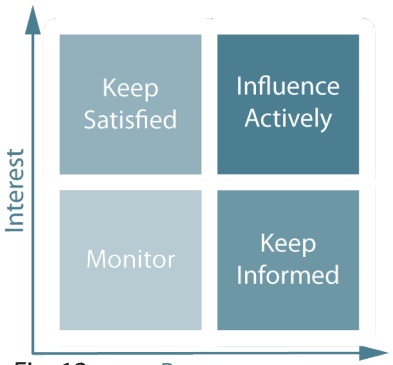


Fig. 12

and come in four different varieties.

- ***Finish to Start***: The predecessor activity must finish before the successor activity can start.
- ***Finish to Finish***: The predecessor activity must finish before the successor activity can finish.
- ***Start to Start***: The predecessor activity must start before the successor activity can start.
- ***Start to Finish***: The predecessor activity must start before the successor activity can finish.

Combining these dependencies with time estimates for each activity results in a project schedule that can be updated when activities change or are delayed (Maylor 2010).

3.3 Results

A list of potential stakeholders was put together and their respective interest in the project was listed. This information was then visualised through a stakeholder map (Fig. 12) where stakeholders are positioned based on interest and influence in the project. This information was then used when defining the project scope, focus and delimitations (chapter 1). Internal stakeholders were then informed of the contents of these definitions and asked to confirm that they agreed with it.

When the foundation of the project was finalised, work with the activity management could commence. A top down WBS was conducted with the aid of Post-It notes that could easily be repositioned as the discussions progressed. The activities defined in the WBS were then repositioned into an AoN diagram (Fig. 11).

The final AoN diagram was then converted into a digital version through Microsoft Project to make it more accessible and easy to update.

The first phase of the project will focus on gathering information relevant to the project (chap. 4) while at the same time scheduling user studies in collaboration with NImbell and awaiting the final blueprints for the BEMO prototype.

Information gathering will then be followed by a user study phase that will consist of interviews, group discussions, observations and social media observations. These activities will be concentrated to the early parts of the project but will be allowed in the later parts as well if deemed necessary.

A sketching and idea phase will run in parallel with the user study. This phase will be iterated several times to capture new input from other methods.

The initial sketching will be followed up by a first mock-up (simplified model of a concept) sessions to get a physical understanding of size limitations and provide as an idea inspiration.

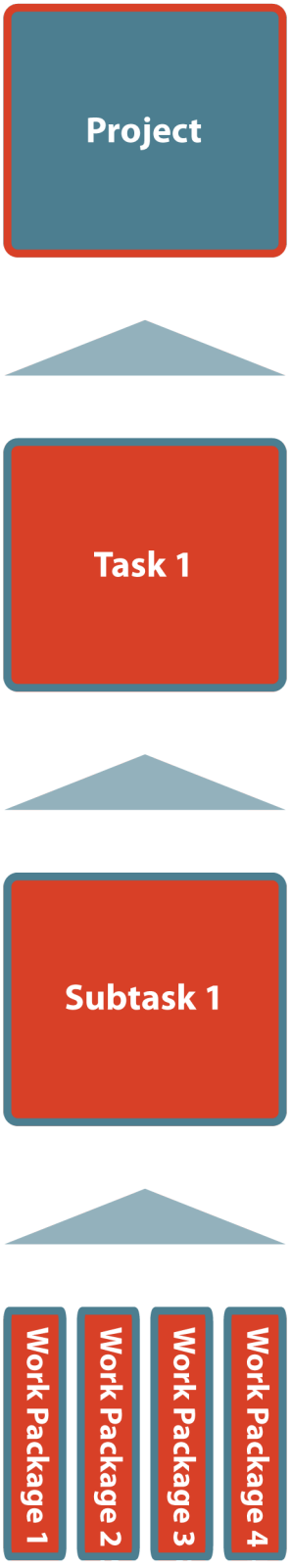


Fig. 13

A second sketch iteration and a rough 3D-modeleing phase will then be conducted to form several different visual concepts. These will then be evaluated through a workshop together with Nimbell. This workshop will act as a decision gate where the sought aspects of the concept will be locked

A concept refinement phase will then start where an intense collaboration with the construction team will be needed in order to mate design concept with the underlying substructure. An ergonomic study of the cargo area and cabin interior will also be conducted in this phase. The visual expression will also be tweaked to compensate for demands uncovered in this phase.

The complete 3D representation of the final concept will then be made and used as input for the construction of three evaluation vehicles by Nimbell.

The final phase of the project will be the evaluation of the project output. Documentation from the different methods used throughout the course of the project will form the foundation of the report.

3.4 Discussion

The normal approach to project planning in smaller projects usually consists of a Gantt-chart based on rough estimates done once before the work is commenced. It is therefore rarely accurate and as a consequence something that is viewed as a obstacle that rarely brings anything of real value to the team members. This proved not to be the case when using the methodology described above. Using the multistep approach where work packages are defined and then estimated both individually and in relation to each other created a rigid project schedule that has benefited the project greatly.

The network diagram allowed for a flexible schedule control capable of taking changes into account that were unknown when it was created. This made it possible to use a concurrent engineering approach throughout the project (Maylor 2010). In practice this meant that activities within the project could overlap with internal Nimbell projects such as engineering, construction, sales and marketing.

3.5 Conclusion

This project will be dependent on input from Nimbell in order to follow the established planning. A time buffer has therefore been implemented to account for factors that lie outside of the project group control. These factors as well as critical internal activities need to be monitored throughout the project. A short list of these factors is presented below:

Input from i5 team must be received before the completion of the user study.

- Available manufacturing methods must be clarified before concept generation ends.
- One user study within each user segment must be completed before the concept generation starts.
- Access to updated 3D models of the final BEMO prototype must be arranged before the first sketching phase is finished.
- The Nimbell workshop needs to take place before the construction team starts with the evaluation prototypes.
- Location and budget for mock-ups need to be decided before it can commence.
- The BEMO prototype needs to be manufactured before the second mock-up finishes.

4. Information gathering

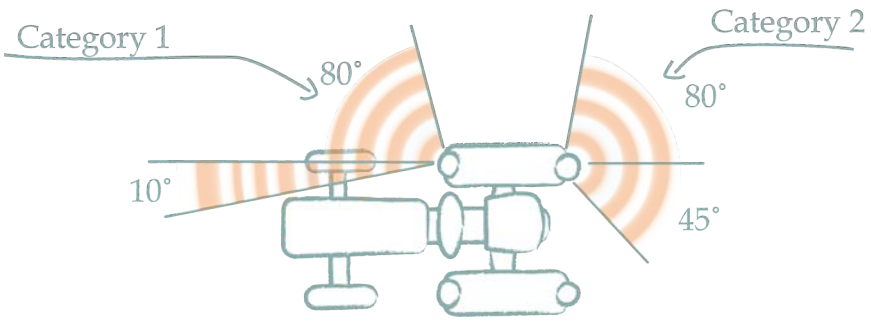


Fig. 14 One of several layouts for turning indicators

The information gathering was conducted in a defined manner with clear definitions on the amount of time allowed for that phase. Old lecture material was examined to get a good overview of the different research fields that would be involved in the upcoming work. This was followed up by a deeper research where findings where gathered and condensed in a joint document.

The information uncovered during this phase is presented below in a condensed format to give the reader the opportunity to get a deeper understanding of the possibilities and limitations that shaped the result of this project.

4.1 Legal demands

Nimbell Motor AB has the ambition to release two different versions of the final vehicle complying with different vehicle categorisations. Customers on the Swedish market should be able to choose from an EU class moped capable of 45 km/h and national categorisation known as "Motorredskap" (self propelled machinery) class 2 that is limited to 30km/h but has the added advantage of transporting heavier cargo. It is important that legal demands of both vehicle types are taken into consideration. Main focus has however been on the national categorisation as the goal with the first pilot series is to reach this classification. . The paragraphs below will only include information relevant to this project and readers are directed to vvfs 2003:27 "Vägverkets föreskrifter om motorredskap" and vvfs 2003:24 "Vägverkets föreskrifter om mopeder och släpvagnar som dras av mopeder" for the complete list.

4.1.1 Self propelled machinery class 2

This type is defined as motor driven vehicle which primary purpose is that of a work tool and constructed for a maximum speed of 30 km/h in such a way that modification to reach speeds above this can only be achieved with difficulty. The legal demands that vehicles within this registration must comply with is regulated by vvfs 2003:27 "Vägverkets föreskrifter om motorredskap". The document is harmonized with European directives through several references to ECE-regulations and EG-directives. Below is a short summarization of the most important demands that affects design and usability.

Steering

The steering system should be executed and dimensioned in such a way that the risk for injuries or degradation of expected performance is small. It should also provide the vehicle with good course stability and soft and well manageable steering.

Lighting and reflexes general requirements

The vehicle may not have lamps or spotlights that can emit or transmit red colour forward or devices that when lit upon can repel red light forward. The same applies to some extent for white light in the rear direction. The exemptions to the rule is rear facing white light from the following sources; registration sign, registration lights, badge of nationality, reversing lights or other lights used while the vehicle is

used as a work tool or similar. Also excluded are additional reflexes on emergency vehicles.

Spotlights, lamps and reflexes need to be mounted in such a way that they within the range of normal driving conditions do not vibrate or change position in such a way that they do not fulfil the demands listed.

Spotlights, lamp and reflexes that are prescribed or allowed in pairs should be mounted at the same height and at the same distance from the centreline of the vehicle. They should also emit the same colour and be of similar luminous intensity. Vehicles that have an unsymmetrical shape should conform to theses demands to the extent possible.

Lights intended to alert other road users of the presence of the vehicle, known as daytime running lights, may only be omitted from daytime running light, fog light or voltage reduced low beam lights. Only two of these lights may emit light at the same time.

Stone chip protection may not be present on lamps or spotlights if the protection substantially diminishes the light.

Headlights

Motorredskap class 2 may have two full beams spot lights that emit white or yellow light. These lights should have the capability to illuminate a stretch of road at least 50m long during clear conditions and darkness. The light may be grouped with forward heading spotlight and lamp but may not be combined with other spotlights or lamps. It is also allowed to have multifunction installations with other forward spotlight and forward daytime running light. The switch between full and low beam must result in all full beam spotlights turning of immediately. An indicator light should alert the driver when the full beam is on through a steady blue light that is clearly visible from the driver position in dark conditions.

Motorredskap class 2 shall when travelling on roads have two low beam lights that emits white or yellow light forward in such a way that they illuminate the road ahead of the vehicle (Fig. 15). The light should not be blinding to oncoming drivers. Motorredskap class 2 without driver cabin and a kerb weight below 600 kg only needs to comply with this demand while travelling on roads in darkness. The low beams should emit an asymmetrical light adapted for right hand traffic and should be capable of, during dark and clear conditions, illuminating at least 35 m ahead of the vehicle.

Low beam spot lights may at most be 400 mm sideways, measured from the outer area of the vehicle. An exception is made if the vehicle has daytime running lights that are placed within the 400 mm sideway limitation and are installed in such a way that the emit light at the same time as the low beam spot lights. The height placement of the low beams must be between 500 mm minimum to 2100 mm maximum.

Fog lights

Fog lights emitting white or yellow light may be placed on the vehicle, the number of lights should always be consistent with two. The sideway placement shall not exceed 400 mm and the height placement must be above 250mm but no part of the light emitting are should be higher than the top of the light emitting area in the low beam spotlights. The light may be grouped with forward heading spotlight and lamp but may not be combined with other spotlights or lamps. It is also allowed to have multifunction installations with other forward full beam spotlight and forward daytime running light.

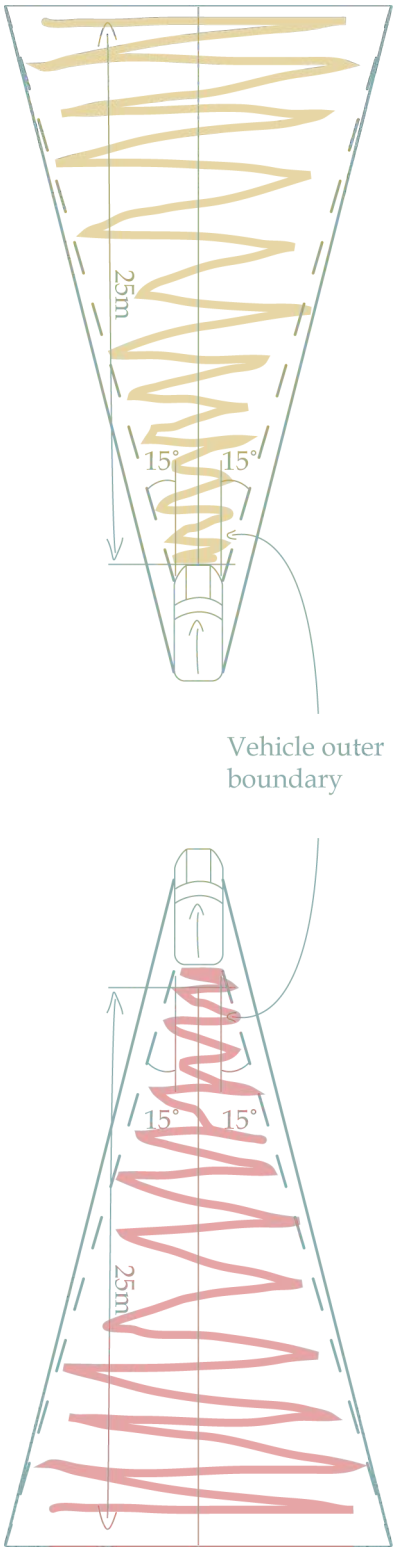


Fig. 15 Front and rear facing zones

Position lights

Two forward position light (parking light) emitting white or yellow light may be placed on the vehicle. Theses lights should indicate the width of the vehicle with a maximum side way distance of 400 mm although class 2 vehicles are allowed an exception if the reason is construction related. The minimum distance between the lights should be 500 mm but may be reduced to 400 mm if the total width of the vehicle is less than 1400 mm. The height should be between 400 mm and 2100 mm but may be up to 3000 mm if the placement severely diminishes the performance. The light may be grouped with forward heading spotlight and lamp but may not be combined with other spotlights or lamps. It is also allowed to have multifunction installations with other forward spotlight and forward daytime running light.

Two rear position lights emitting red light shall be placed on the vehicle if it is driven on public roads. The light area of the position light needs to be at least 20 cm2 and have a light capacity of 1 cd minimum. The lights may be placed no more than 400mm from the side plane of the vehicle but may be increased due to construction limitations. The distance between the lights should be at least 500mm but can be reduced to 400 mm for vehicles with a width of 1400mm or less. The height should be between 400mm and 2100mm. The lights must also be placed in such a way that specific viewing angles are achieved.

Indicator lights

Motorredskap class 2 with driver cabin is required to have direction indicators that emit orange light that is viewable from front and rear (Fig. 14 on page 13). It is also allowed to have direction indicators that are viewable from the sides of the vehicle. The light in all cases should be viewable from at least 30 m in daylight during clear conditions. The distance between the glowing surface of the indicator and the glowing surface of low beam lights and fog lights should be at least 40 mm. The side way placement should not exceed 400 mm but exceptions can be made for class 2 if they are based on construction demands. The distance between inner glowing edges should be at least 500 mm unless the vehicle width is less than 1400 mm in which case 400 mm is the minimum. The height of the indicators should exceed 400 mm for category 1 (forward facing) and 500 mm for category 2 (rear facing) but should not exceed 2100 mm. The maximum height of category 5 (side facing) can be increased to 2500 mm if necessary due to construction reasons.

Category 5 indicators should not be placed further back on the vehicle then 2500 mm measured from the front to the centre of the light emitting area. Indicator lights may be grouped with spotlight and lamp but may not be combined with spotlights or lamps. It is also allowed to have multifunction installations with parking light and may be arranged as a warning device if it emits orange light. Indicator lights should be able to function even though all other lights are turned off.

If the driver can´t view the indicator lights then an appropriate control mechanism should be present in the vicinity of the driver seat. This should be solved optically with green light or acoustically but should also in addition to the above through a different type of indication notify if any of the category 1 and 2 indicators are broken.

The indicator lights must also be placed in such a way that specific viewing angles are achieved.

Brake lights

The vehicle may have one or more brake lights that emit red light when the vehicles brakes are engaged. Minimum distance between brake lights should be 500mm or 400mm if it can't be achieved due to constructional reasons. It should be placed on a height of between 400mm and 2100mm.

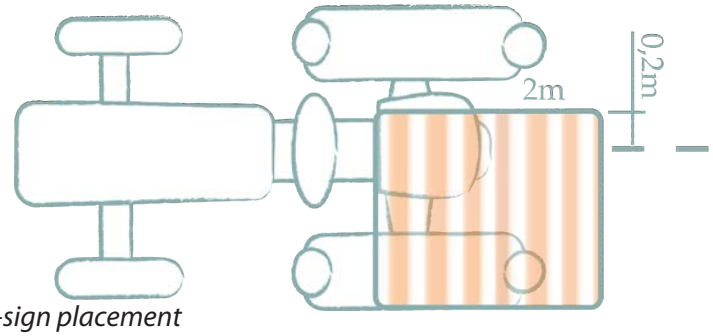


Fig. 16 LGF-sign placement

Brake lights may be grouped with rear facing spotlight and lamps and may form multifunction with rear position light. The lights must also be placed in such a way that specific viewing angles are achieved.

Reflexes

Two non triangular rear positioned reflexes that emits red light when illuminated shall be placed on the vehicle if it is driven on public roads. Minimum distance between reflexes should be 600mm or 400mm if it can't be achieved due to constructional reasons. It should be placed on a height of between 350mm and 900mm but can be increased to 1500mm.

Reflexes may be combined with rear positioned lamps and must be placed in such a way that specific viewing angles are achieved..

Work light

The vehicle may be equipped with working lights. A orange warning light should indicate to the driver if the light is active.

LGF-sign

The vehicle should a rear facing LGF-sign mounted on a height of between 0,6m and 1,8m. The sign should if possible be mounted on the left hand side of the vehicle (Fig. 16).

4.1.2 EU moped

The category L2e under ECWVTA (European Whole Vehicle Type Approval) definitions are a three wheeled moped having a maximum speed of of 45 km/h with a maximum ignition internal cumbustion engine capacity of 50 cm3 or with a maximum power of 4 kW for other engines based on internal combustion or maximum electric motor power of 4kW. The vehicle must be equipped with a speedometer, full beam headlights and is limited to a maximum curb weight of no more than 270kg.

A L2e vehicle with cabin must in addition to these demands be equipped with a defroster device and allow the driver to have an unobstructed view cone defined by vvfs 2003:24 subdirective.

The regulation surrounding this vehicle category is similar to the Motorredskap class 2 regulation. The main difference separating the two directives other then what has been mentioned above is the reduced amount of construction based exceptions and higher demand for documentation of the vehicle. The similarities between the legal demands of the two classifications and the fact that Motorredskap class 2 is the primary focus have lead to the omission of a detailed description of the individual demands for L2e vehicles. Interested readers are referred to the national legislation concerning mopeds VVFS 2003:24 "Vägverkets föreskrifter om mopeder och släpvagnar som dras av mopeder" for further details.

4.1.3 Conclusions Legal

The regulations governing the self-propelled machinery class 2 classification mainly regulates the exterior and interior features that provide information to nearby road users as well as the driver. The EU regulations ads additional details and restrictions governing the vehicle weight, dimension and engine power. The weight restrictions of this category could prove to be an obstacle if the company decides to pursue this categorization in the next production series.

Standard lights that are approved for their function are required if the vehicle should be allowed to drive on public roads. Lights made for especially for this vehicle would need to go through a testing to procedure in order to obtain the correct certifications needed. The cost of this is considered to large for such a low volume series.

The vehicle needs to be equipped with the following lights:

- Two forward directed low beam spot lights with asymmetrical light cones.
- One right and one left forward facing indicator light.
- One right and one left rearward facing indicator light.
- Two rear facing red lights.
- Two non-triangular rear facing red reflexes.

The position of the lights is heavily regulated and need to be a factor in the concept generation and refinement phase.

The visibility angles of the turning indicators might pose a problem. This is especially true for the front indicators where the overall cone shape of a three wheeled vehicle may obstruct the visibility of the left indicator when standing in front of the vehicle on the right hand side.

The vehicle will be equipped with two rear facing red brake lights even though this is not a requirement for the self-propelled machinery class 2 category.

Design concepts need to have a designated space for a registration plate at the rear. The small width of the vehicle could be a problem.

The LGF sign will be a distinct feature when viewing the vehicle from the rear, it therefore needs to have a designated spot in order to not look out of place.

4.2 Competitors

A products success or failure depends largely on how it performs compared to its competitors. It is therefore crucial to know what is presently on the market and the strengths and weaknesses of those products. The concept vehicle produced through this project and the final vehicle produced by Nimbell AB competes in markets occupied by a large variety of vehicle types ranging from bicycles up to four wheeled golf carts. A selection of competitors is introduced below to give an overview.

4.2.1 Alke

Alke has several different electric vehicle combinations but they are all focused on a high cargo carrying capacity (500-600 kg) in combination witha total width of around 120-130 cm which provides it access to many areas out of reach to regular cargo vehicles (Alké 2011). Top speed is 30 km/h which means it cannot be classed as an EU 45 moped due to its weight (Fig. 17).The exterior is well built with a rather modern design language.

The transition between the cabin and the front plastic hood is unfortunately done in a way that makes the front look as if it is bolted on to the rest of the vehicle when the roof is present giving it a less advanced expression.

The driver area of the vehicle can be equipped with roof, doors, doors with sliding windows, integrated heating system, digital speedometer, front window screen washer, safety belts and a dead mans grip built into the seat. The cargo bed is also highly adaptable and can be configured with self tipping cargo bed, body tarp, closed cargo box with optional shelf, raised side panels and also has the option to attach 2 additional seats (Alké 2011).

Fig. 17

Fig. 18

4.2.2 John Deere

The petrol driven Gator series from John Deere comes in several different models ranging from the small Compact version (Fig. 18) up to the bigger 4x4 High Performance versions (John Deere2011). Gator Compact is the one closest to vehicle segment in which Nimbell is competing with a width of 124 cm and 243 cm in length. With its light weight of 312 kg it's easy to manoeuvre but suffers from a reduced cargo capacity.

The large use of plastic panels on the vehicle creates a coherent impression but also communicates that the vehicle is primarily aimed towards private consumers.

The Gator Compact can be equipped with a front mounted dozer blade, watertight cargo bed, electric cargo bed tip, raised side panels, work lights and a rotating warning light,. The driver area can be modified by adding a roof, a foldable windscreen, standalone windscreen, rear view mirrors, interior lighting and a sun screen (John Deere 2011).

4.2.3 Kyburz

Vehicles with a similar wheel layout as the Nimbell trike concept are surprisingly scarce but the Kyburz DXP (Fig. 19) is one exception. It has been designed especially for the Swiss postal delivery service and is a redesign of an earlier model called Classic aimed more towards personal transport. A light compact construction provides easy manoeuvrability while retaining the driving stability lacking on a two wheeled vehicle. The automatic handbrake allows delivery personnel to avoid the repetitious process of securing the vehicle on every stop. Two storage compartments are available on the vehicle. They are placed in front of the driver, on the handlebar, and directly behind the driver, partially protruding behind the vehicle. The cargo carrying capacity has suffered a negative impact because of the light compact vehicle design and is limited to 120 kg. An additional 150 kg can be added through the addition of a trailer but also extends the length by 145 cm bringing it up to 330 cm (Kyburz 2011).

The Kyburtz can be customized with winter tires, snow chains, heated handles, different brake pedals and different cargo baskets (Kyburz 2011).

Fig. 19

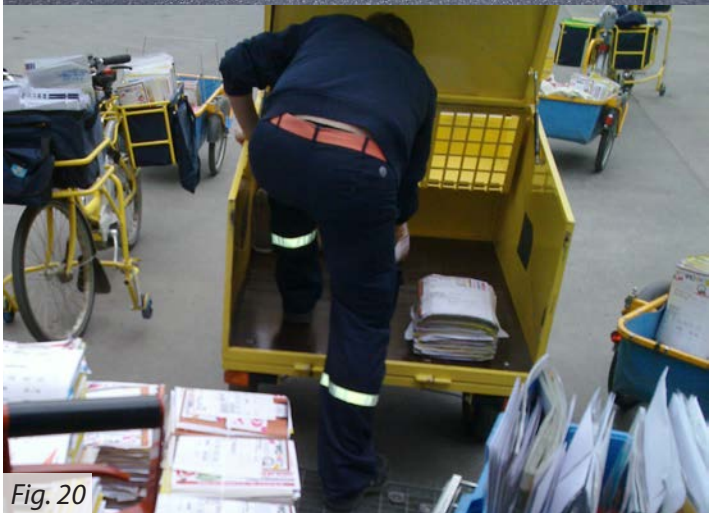


Fig. 20

4.2.4 Norsjö

Norsjö Carrier Electronic Post (Fig. 20) measures only 95 cm in width and can access narrow inner courtyards and pathways present in the areas near apartments. The three-wheeled delivery moped is approved as a class EU 45 moped (top speed 30 km/h) and is primarily intended for the post industry (Norsj**ö** 2011).

The cargo area comes in two different lengths 95 cm and 120 cm long with a width of 95 cm in both cases. The whole platform is covered by a sheet metal cargo box with three smaller storage areas accessible from the driver position (Norsj**ö** 2011). All three boxes are covered by a large sheet of transparent plastic that also acts as a small windscreen when open. The total loading capacity is around 170 kg (Aleksander 2011). The front wheels takes up the main cargo load but is also used for steering the vehicle.

4.2.5 Clubcar

Club Car is an american brand focused on manufacturing small four wheeled vehicles with an electrical drive train. They are most well known for their series of golf carts but also manufacture vehicles adapted for cargo transport. The Carryall 2 (Fig. 21) is however used in a variety of applications such as mail distribution, property caretaking and at cemeteries. The version used by the Swedish mail distribution company Posten (Fig. 22) has a fully covered cabin to allow for easy mail sorting within, independent of outside weather conditions. A specially designed cargo system is placed on the passenger side of the vehicle and is capable of holding up to three plastic containers with mail.

The total weight of the vehicle is 750kg and comes with a cargo capacity of 240kg. A large portion of this cargo is situated at the rear cargo platform measuring 124 cm in width and 126 cm in length (Aleksander 2011). The loading area is covered with a sheet metal box with integrated windows and 2 doors at the rear. The driver seat comes with seatbelts and is adjustable in length and height but a non adjustable sofa is also available as an option. The right side door on the mail version is specially configured to slide along the side of the vehicle to make it possible to drive with the door open (Postnord 2011).

Fig. 21


Fig. 22

4.2.6 Melex

One of the most common utility vehicles in the gardening and cemetery segments comes from Melex. They offer a wide model range of electric vehicles for cargo transport but also have a number of models for the golf industry. The reason for this extensive model supply is that some of the models still being sold, date back as far as 1985 (VGCP 2011). That does not mean that the company is falling behind its competitors; the most recent model line, the N car, was introduced this spring. The new model shows a higher degree of design ambition through its implementation of a more complex design language that requires more challenging manufacturing techniques.

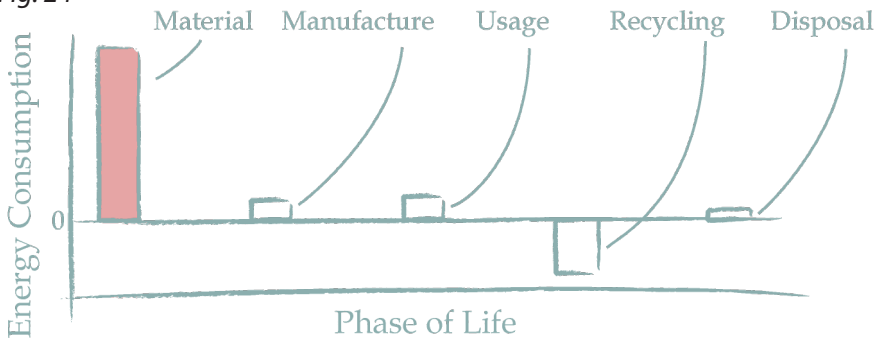
Configurations range from a two seater with a cargo capacity of 250 kg (Fig. 23) to an extended version with a cargo capacity of 1000kg. Most models are equipped with an 3.3 kW engine but can be upgraded to 5.0 kW (Melex 2011).

The interior consist of simple plastic panels but gives the impression of a real vehicle rather than a golf cart. The heating system is integrated into the dashboard with two vents directed upwards towards the windscreen.

The Melex N-car can be upgraded with a front mounted towing hook, galvanised frame, radio, lid to the glove compartment, upgraded front suspension, rear LED lamps, system for refilling water in all batteries simultaneous, 48V electrical system and the car body can have a pearl paint finish if requested (Melex 2011).

Fig. 23

Fig. 24



Drink Bottle

4.3 Sustainability

Limiting the ecological impact of the product that is being developed is becoming an increasingly important aspect. The amount of possible actions that can be taken during product development and manufacturing is unfortunately limited by the time and resources that have been allocated to the project. It is therefore important to identify the positive impact that the different strategies might take. Each product segment has a distinct profile describing its energy consumption pattern throughout its life cycle. This pattern is described by dividing the product life into four phases; production of materials, manufacturing, product usage including transport and the discarding of the product (Fig. 24 and Fig. 25). Determining these profiles is called: performing an eco-audit (Nyborg 2010). In some instances a fifth column representing the energy that can be collected or saved through different forms of recycling is also used.

By checking which product family the product in development belongs to it is possible to get a rough estimate on which product phase that the focus should be in. Typically the product is covered by one of five categories:

- Passive products
- Small appliance
- Large appliance
- Transportation
- Small electronics

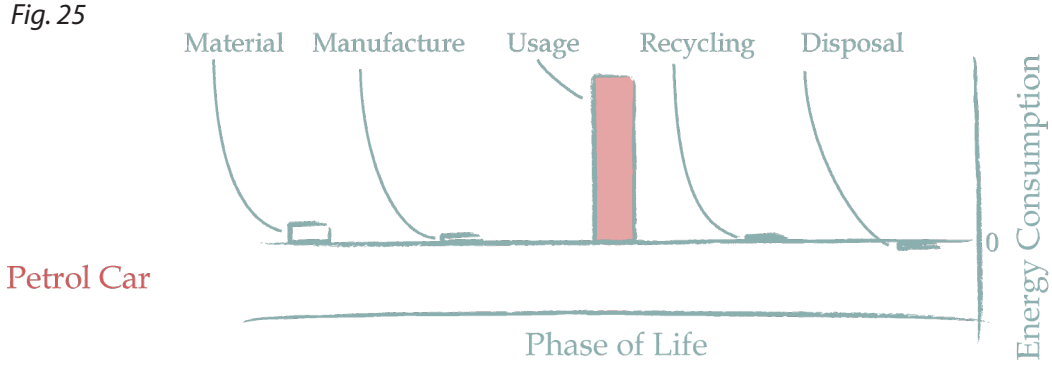
An example of an energy consumption chart can be seen in (Fig. 24) where each bar describes the energy consumed in that particular phase of the products life cycle. Common practice is to then focus improvement efforts on the prevailing product life phase although assessments on how these changes affect the other life cycle phases still have to be taken into account. For example replacing steel structures in a car with CFRP (carbon fibre reinforced plastic) would lower the bar representing the usage phase but would at the same time make it more difficult to recycle.

4.3.1 Discussion

A utility vehicle is similar in its energy consumption to the car although the bar is a bit lower due to its limited range and speed. Improvements that alters the usage phase will have a greater impact than changes in the other categories, even though an electric powered vehicle can be seen as a big first step in that regard compared to other transportation solutions. The impact of an electrically powered machine does require a slightly different view then its fossil based counterparts. The source of the electricity used is an important aspect to consider and is something that the owner of the vehicle can actively choose through different electricity suppliers. Providing information about this aspect to any potential buyer could therefore affect the total environmental impact of the vehicle in a positive manner.

Other measures such as simplifying the process of decommissioning the vehicles at the end of the product lifecycle, creating a business model where owners are encouraged to repair their vehicles and reducing the number of materials used would also be beneficial.

Fig. 25



A more controversial way of contributing towards the sustainability is to look towards the types of transportation solutions that the new vehicle could potentially replace. Replacing a bicycle could create a negative impact where more energy will be required than before. Replacing a fossil based vehicle would on the other hand have a positive impact.

4.3.2 Conclusion

The sustainability of the vehicle could be improved by optimize the decommissioning process. Prolonging product life span through measures that encourage repairs could also could also be beneficial.

The largest impact would however be achieved by providing future buyers with information about renewable electricity and creating a vehicle that can replace petrol driven competitors within the selected market segments.

4. 4 Manufacturing

Knowledge of limitations and strength of relevant manufacturing methods are vital when designing different parts of the vehicle, this chapter is going to brief the reader on these critical processes that must be known in order to make a plausible design proposal suited for manufacturing. This chapter will not focus on the internal decisions and choise of manufacturing method as this is finally decided by Nimbell together with their productions partners.

The numbers in this chapter is based on Nimbells initiation phase scenario where 3 evaluation vechicles is going to be made for investors, marketing and internal testing purposes, 10 vehices will be made for customers as a series production test. Then series production will start with an estimate of 100 vehicles the first year. Most design changes will occur between the 3 vehicle batch and the 10 vehicle batch. Because the first 3 are not to be seen as a finished construction and customer product.

4.4.1 Vacuum forming

Vacuum forming is a comparatively cheap method to make large free form plastic surfaces, often thermo plastics. To make a vacuum formed piece, first a mould shaped as the result is milled from ureol foam, plywood or aluminium. Second a sheet of the desired material is heated above the mold and then stretched on top of it. Vacuum pressure is then applied shaping the plastic over the contours of the mold. The finished plastic part is then ejected by striker pins and excess material is removed after the part has cooled down to room temperature.

Limitations

A draft angle of about 3degrees is demanded to ensure that the plastic sheet is easy to remove. It is important that the draft angle is close to the z axis of the mold. Features with a neutral or negative draft angle will cause the sheet to stick to the molding, damaging both mold and part when it is ejected by the striker pins.

Another aspect to consider when designing for vacuum forming is the thickness of the product in the mold direction. As it increases the need for the plastic sheet being formed to stretch is also increased. This is counteracted by using thicker sheets that can be drawn deeper but also cost more than their thinner counterparts. The precision of the result and especially in areas with sharp corners is also affected by the use of thick sheets since a 4mm sheet can never create a radius sharper than 4mm.

The final thing to consider is shrinkage that occurs as the plastic cools down. This differs between plastics but is around 0.3% up to 3.5%. For instance: ABS-plastics have a shrinkage between 0,3 to 0,8% (Formech 2011) which in a 1m2 sheet means a tolerance range of +- 2.5mm.

Price level and possibilities

Due to the heavy pressure applied to mold the an aluminium mold is required for series production. An ureol counterpart is sufficient for lower series but the mold wears out rather quickly. An estimate made by Andrén plast AB stated that the breakeven point is reached in a series of around 20 individual parts where it is more cost efficient to make it using vacuum forming rather than other small series production methods such as laminating with reinforced fibre glass.

Initiation price Andrén plast: around 20 000kr

Price/piece 1m2. Around 700kr

Toolingcost: 1m3

Aluminium around 300 000kr*

Ureol around 100 000kr*

For a batch of 3 pieces the cost is: 40700kr/piece

For a batch of 10 pieces the cost is: 12700kr/piece

For a batch of 100 pieces the cost is: 1900kr/piece with a ureol mold and 3900kr/piece with an aluminium mold which is recommended for this batch size.

One benefit with making a small series using a ureol mold is that this mold may later be used as a fixture when removing excess material.

Conclusion

Vacuum forming should be considered for the series production, adaptation and design for the draft angle and thickness unsharpening should be thought of in the development process so that small or no changes need to be made when using vacuum forming for a later series production.

A very large amount of the price per part consists of the raw material price based on the volume of the piece. The production technique is therefore price efficient for surfaces with a big surface area but small mold volume, such as a cabin roof, when volumes over 30 parts per batch are reached. Vacuum forming could however be preferred even for small series when planning to use the method in a later stage due to savings in work hours for adjusting the design

For a scenario where 3 initial vehicles are made with one ureol mold, and later 10 vehicles are made with a new ureol mold. Then finally 100 vehicles are made with an aluminium mold. The total cost using vacuum forming for a plastic shell piece with the tool volume of 1m3 would be around: 600 000kr total 5300kr/piece . If no changes are planend between the 10 and the series production batch meaning

**Very approximate estimates derived from discussions on other scales with manufacturers*

the same aluminium mold could be used, the cost would be: 500000kr total and 4500kr/piece. This however demands a good economic situation after the first batch of 3 vehicles.

4.4.2 Glass fiber lamination

Plastic lamination has two major components, a fibre i.e. glass fibre and a matrix i.e. epoxy. Carbon fibre may be used for high strength demands which creates a very stiff, strong and light product. In conformity with vacuum forming lamination uses a milled mold, in contrast this is used to produce a cast of an inverted mold. This inverted mold enables fully sharp edges and is more forgiving with the draft angles as they may be in any direction. The laminate is then applied to the inside of the inverted mould.

Price level and possibilities

Because for laminate is made to make an inverted mold it must not have the same strength as that of a vacuum forming mold. Polystyrene or mdf wood are possible mold materials that are significantly cheeper than ureol or aluminum. However a additional inverted mold must be made and the price/piece are a lot higher. The quality of an mdf mold are however not as high as a ureol mold and ureol is the preferred mold material for laminate as well (Epotex 2011). The production time for lamination is however considerebley longer than vacuum forming.

Price per piece $1m^2$. Around 10000kr* for a low series of 1-3 pieces

Mold mdf $1m^3$ 40 000*

For a batch of 3 pieces the cost is approximately: 23000kr/piece

For a batch of 10 pieces the cost is: 14000kr/piece

For a batch of 100 pieces the cost is: 10400kr/piece

*Very approximate estimates derived from discussions on other scales with manufacturers

Conclusions
Fiber lamination is a sound manufacturing method to use when there are high demands on surface finish, mechanical properties or a small series. It is preferred in this project for the first step where 3 vehicles are made as changes are planned between the first 3 and the second batch of 10 vehicles. These very approximate calculations show that brake-even when vacuum forming becomes cheaper occur at series of around 10 pieces.

For a optimal price scenario where fiberglass lamination is used for the first 3 vehicles and then moving to use vacuum forming, the total cost approximates at 567000kr total and 5000kr/piece when using a ureol mold for the 10 vehicles and aluminium mold for the 100 vehicles. If an aluminium mold could be made for the 10 vehicles the total cost would be around 467000kr and the price per piece 4100kr.

This means that if plastic parts are considered in this project, the design should account for the limitations of both vaccum forming and fiberglass lamination.

4.4.3 Tube bending

Methods for tube bending can be divided into four broad categories; manual-, semi-automatic-, computer numeric controlled- (CNC) and special application bending. Which method that is used is both dependent on the volume of parts being produced, the physical limitations and the technical characteristics required to bend them. The most important technical factors considered for this are (Miller 2011):

- Outside diameter
- Wall thickness
- Bending radius
- Material
- Part configuration
- Bend quality, wall thinning and ovality of bent area

The first three points are linked to each other and as a designer it is important to understand that changing one of them will most probably force the others to change.

Manual bending
This method requires a low tool investment but is hampered in its inability to provide a continuous level of repeatability and manufacturing quality. The reliance on human power limits the range of tube sizes that can be bent, hand benders can usually handle pipes up to a outer diameter of 1" (Miller 2011). This makes manual tube benders best suited for prototype or low volume productions where small diameter tubing can be used.

Semi-automatic bending
This can be defined as bending using machines powered by electric or hydraulic motors. Pipes can be both manually and automatically fed into the machine. The bending operation is preset but is manually activated by an operator. The tube is then repositioned for the next bend or removed physically by the operator. The length and angle of the bends are in most cases provided through hard stops built into the machine as guides for the operator when repositioning the tube. As in the manual bending method much of the production rate and part accuracy is dependent on the expertise of the operator. There is therefore a limit on the complexity of the parts that can be achieved through this method (Miller 2011).

CNC bending
CNC bending operates in a similar manner to the two previously described methods. The difference lies in that a computer controlled electrical servo drives controls the distance between bend and plane of bend. In short the operator engages the process but does not provide any input until the bend process is complete. This provides a high degree of repeatability, quality control and a much higher part complexity. The downside is the high initial cost that makes it hard to utilize in smaller series (Miller 2011).

Special application bending
This category covers machines specialized to produce a specific part that for various reasons can't be produced with a regular bending machine. Meaning that the whole purchase cost of the tool has to be paid by the one part that is being produced creating a very high initial cost (Miller 2011).

4.5 Material

Engineering materials can be divided into five separate categories with an additional sixth category consisting of a combination of the other five, this group is known as composite hybrids (Nyborg 2010). Materials within each group can be compared using different material properties. This can also be applied to comparisons between groups but requires deeper knowledge of the meaning behind the properties as the testing procedures are different for the same material property.

- Density ρ determines the self weight of the material.
- σ_y indicates the strength of the material a higher value will indicates that more force will be required to bend it.
- K_{ic} known as the critical stress intensity factor which provides information on the brittleness of the material.

- Young's modulus, ***E*** indicates the stiffness of the material, a lower value indicates that the material is more elastic.

4.5.1 Metals

Most fabricated metal materials consist of one primary element with several alloys that change the properties of the virgin material in a desired direction. They are solids at room temperature, with the exception of mercury, characterized by high density and melting points. The metals are known for their ductility and malleability. Other properties the group is well known for is their capability to conduct both heat and electricity.

4.5.2 Polymers

Molecules bonded in long repeating chains either by man or nature itself are named polymers. These chains are what give polymers their characteristic properties consisting of strong covalent bonds within chains and weak Van der Waals that binds different chains together. The combination of low density with a relatively high strength make them suitable in low weight applications. Thermal and electrical conductivity is quite low but thermal expansion is the highest among the material groups along with the elastomers. A distinguishing factor of the polymers are the good shaping capabilities.

4.5.3 Elastomers

Low Young's modulus is the signature trademark of the elastomers which enables their ability of high elongation. The other properties of the material group are in many cases shared with the polymer group.

4.5.4 Glasses

Glass materials have a high chemical resistance but low strength. They are easy to reshape if kept above the glass transition temperature.

4.5.5 Ceramics

This group is known for its high strength and low electrical and thermal conductivity. The downside is the brittleness shared by the materials in this group.

4.5.6 Material selection

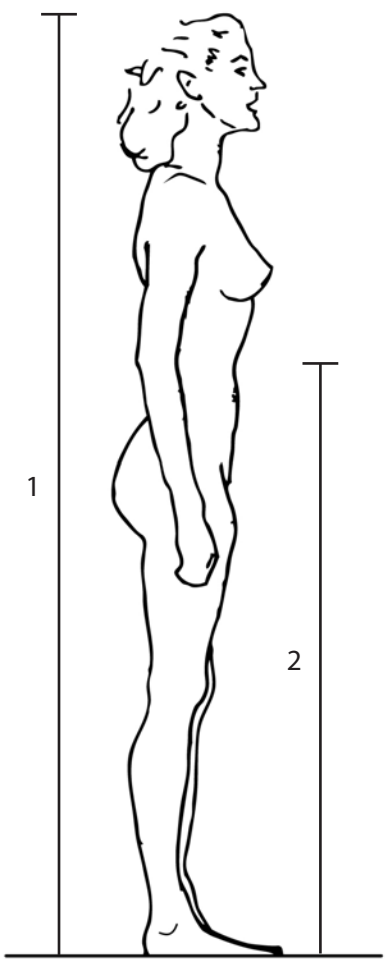
Understanding the environment in which a certain product detail will operate is the first step in determining which materials are suitable. Anticipating operating temperature, exposure to liquids and potential mechanical impact is important to find out what demands that must be met. The four step process of optimizing materials for the intended function among the available materials tries to do that in a standardized manner. The first step is simply to understand the tasks that the manufactured components will carry out during normal operation. Examples of this could be to carry a load, store energy or contain pressure (Nyborg 2010). Once this is defined the next step is to determine the constraining parameters that need to be upheld in order for the part to function in a safe and effective manner. The third step defines the free variables that can be changed without interfering with the function. However in many situations the only free variable left is the freedom to choose material. The final step is to determine the performance measurement that will be used to rank all of the suitable materials. The three most common ones are weight, cost and volume.

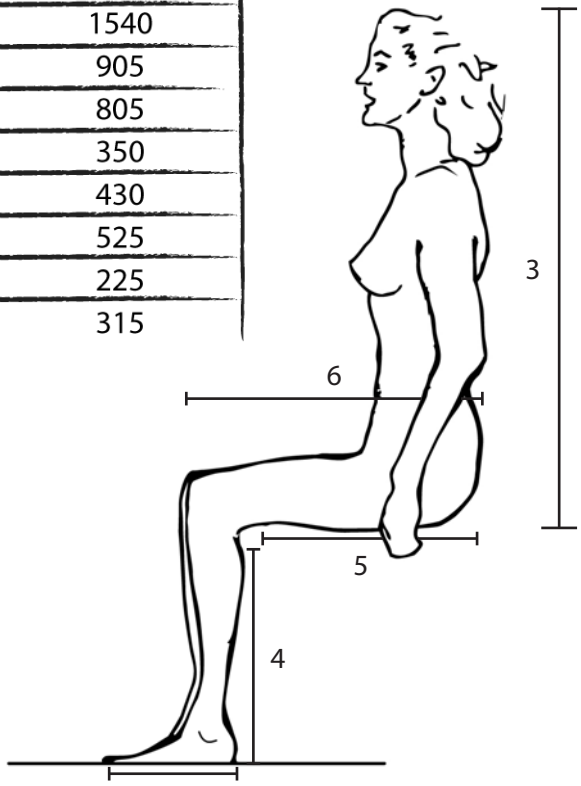
4.5.7 Conclusion

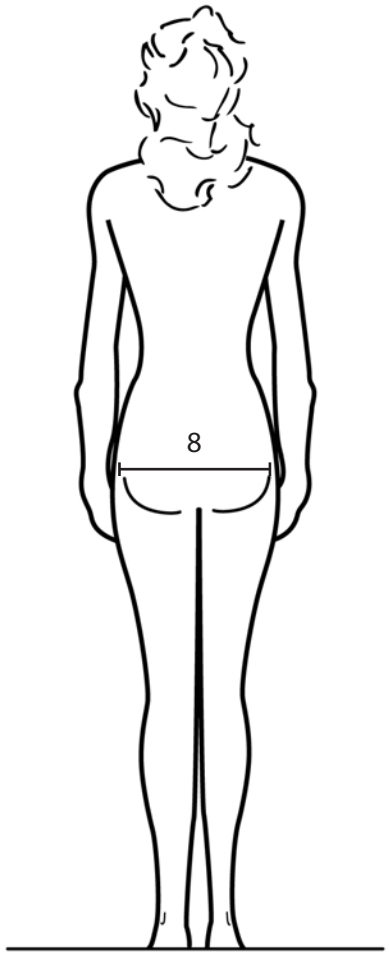
The available material and manufacturing methods are limited by Nimbells manufacturing partners and decisions already made by the construction team regarding the BEMO prototype. Out of the five material groups presented above only Metals and Polymers are relevant to this project. The other groups will surely be found within the vehicle as well but in the form of standard parts.

Dimensions (mm)	5th %-ile female
1. Stature	1540
2. Standing elbow height	905
3. Sitting height	805
4. Popliteal height	350
5. Buttock-popliteal length	430
6. Buttock-knee length	525
7. Foot length	225
8. Hip breadth	315

Table. 1







4.6 Human Factors

The human factor is important for both safety, efficiency, user satisfaction and the integration of risk management for both products and systems. Improvements can be achieved through changes in the physical product, alterations to interfaces but also changes in the contributing factors surrounding the product. These factors can be the way work is organized; the physical environment in which the product is used or the actual task that is performed with the product (Bridger 2003).

The human factor area is vast and many standards and guidelines exist for different product categories. Can it work, does it work, and is it worth it? (Haynes 1999) has been the three guidelines for acquiring material and implementing it in the design process. The first question evaluates if the change will have a positive influence under ideal circumstances. The second question tries to clarify if the product will retain those positive aspects in the environment where it will be used on a day to day basis. Economical aspects are introduced through the last question and evaluate if the cost of the change is motivated by the positive effects that it creates.

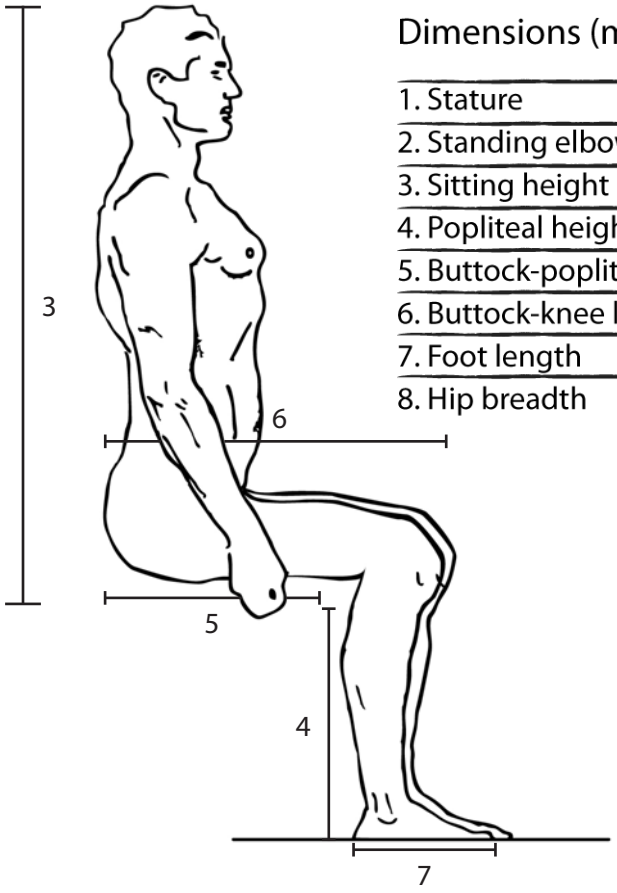
The subject of human-machine interaction was originally divided into two different areas known as Human Factors (originating in the USA) and Ergonomics (originating in Europe) but the two have over time merged more and more and can therefore be called by either name (Bridger 2003). The different areas of human factors can be divided into two main areas; cognitive and physical. The following section will explain the different areas that are important to the design of a functional vehicle.

4.6.1 Physical Ergonomics

The field of physical ergonomics is a big area in itself and covers the human anatomical, anthropometric, physiological and biomechanical characteristics and how they are affected by physical workloads (IEA 2000).

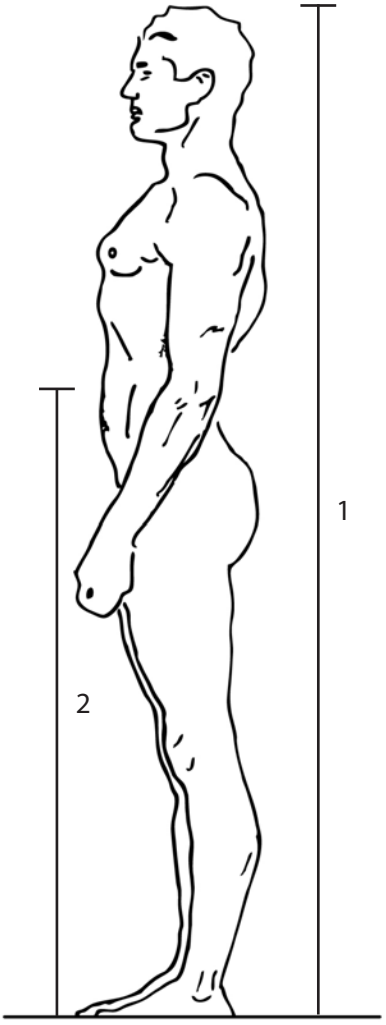
Anthropometric

The normal body size span can vary considerably from country to country but is also affected by both gender and age. Yet young and old should be able to use a product with the same efficiency and ease, irrespective of their physique.



Dimensions (mm)	95th %-ile male
1. Stature	1850
2. Standing elbow height	1180
3. Sitting height	970
4. Popliteal height	475
5. Buttock-popliteal length	530
6. Buttock-knee length	645
7. Foot length	290
8. Hip breadth	410

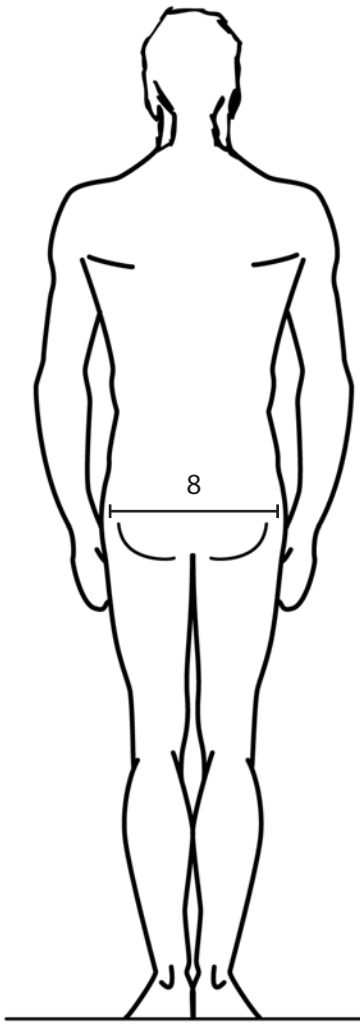
Table. 2



Anthropometry, meaning the study of the measurements of the human body, is an important tool in ensuring that this is the case with products in development (Bridger 2003). This is especially important for vehicles which are one of the few products where the user is surrounded by the product.

The first step in acquiring the correct measurements is defining the user group that the product is intended for. This user group is often spoken of as the user population and covers people with a common denominator such as ancestors, occupations, geographical location, or age. This allows the designer to adapt the product to the user (Bridger 2003).

The second step is to accommodate for the inherent variability within that population. To what extent this consideration is taken is indicated by the percentile chosen to select the range between the min and max body measurements. For example using a height measurement of a 5-percintile woman statistically means that 95 percent of the women in that population would be taller. So choosing a larger range between the upper and lower values creates a bigger gap between them (Bridger 2003).



One thing that is very important to keep in mind when working with anthropometric data is that it isn't static. Improved living conditions can result in an increase in body size. USA and Britain have both seen an average increase of 1 cm per every 10 years during some time periods (Bridger 2003). It is therefore important to be aware of the origin of the data used. The individual differences in proportions of people that share the same stature also ads to this statistical uncertainty; meaning that two people of equal length can have large differences when it comes to other measurements such as arm-, leg- and back lengths (Happian-Smith 2001).

The anthropometric data applied in this project is based on the Swedish adult population (Pheasant, 2003) that will be the primary user group for this product. The 5-percentile female (Table. 1) has been chosen as the min limit and 95-percentile man (Table. 2) as the upper limit. A comparison of the two cases can be seen above.

Physical ergonomic concerning the driver compartment

The "three box" design has dominated the layout of modern cars since the start of the 20th century. One box is dedicated to the engine, one for the passengers and one for the luggage positioned at the rear. The only drastic alteration to this layout throughout the later part of the century was the reduction in height for the passenger box in order to streamline the car body and produce a more fuel efficient car (McIlwraith 1993). This layout does not however apply to the electric utility vehicle segment where the impact of air resistance is insignificant due to its speed while the mechanical characteristics of the engine allows it to be placed elsewhere. It is therefore important to be selective about which ergonomic guidelines intended for cars that are used in this segment.

An ergonomically sound driving environment is based on the driver. In practicality this means that all of the functional surfaces in the driver cabin should be based on the position of the chair. The variation of driver sizes is also needed to be taken into consideration in order to achieve a good driving experience for all users. This is done through adjustability of the chair and steering wheel.

The seat height is governed by the popliteal height of the user population. If the seat is non adjustable then the minimum popliteal height should be used in order to ensure that all users can sit with their feet secured on the floor. The depth of the seat is also important to adapt to the user population in order to ensure that all users have the same advantage of the chairs backrest and do not experience pressure on the upper part of the calf (Bridger 2003). The length of the backrest controls how much back support that is given and also how much freedom of movement the user has. A low backrest stabilizes the hips and gives support to the lower back and lumbar region. Mid-height backs keeps the shoulder blades free while giving extra support to the spine. The tall backrests give support to the whole back including the neck but impede the shoulders from rotational movements (Jansson 2011). If the backrest of the chair reclines then it should do so independently of the seat pan to provide a variation in the angle between the main body and thigh. A gap between the backrest and seat pan should also be provided in order to take full advantage of any lumbar support (Bridger 2003).

The front edge of the seat pan should slant slightly downwards to minimize pressure on the under-thigh. The seat pan should also be indented where the buttocks is placed in order to prevent the pelvis from sliding forward. A material with a sufficient friction coefficient such as cloth should be used as upholstery to further increase the stability (Bridger 2003).

The steering wheel has two different tasks that it should fullfill. First it should be able to provide drivers with sufficient steering torque to rotate the front tires of the vehicle and second it should be able to rotate the tires at a sufficient speed. These two parameters can be controlled with the physical properties of the steering wheel itself along with the steering ratio. The parameters that can be adjusted within the driver compartment are the steering wheel diameter, rim thickness and steering wheel angle towards the horizontal plane. Guidelines governing these dimensions for tractors have been summarized below (Drakopoulos 2007):

- Diameter: 180-553 mm
- Rim Thickness: 19-50 mm
- Angle to the Horizontal Plane: 30-60˚

It is also important to keep the steering wheel parallel with the instrument panel and centered along the same axis as the drivers seat (McIlwraith 1993).

Controls and dials

Most of the communication between driver and vehicle happens through various controls and dials. It is therefore important that each one present inside the cabin is well adapted to its function. The controls are part of a larger system and it is therefore important to take human factors into account when individual controls and dials are grouped and placed on the control panel. The following guidelines for selecting individual controls for tractors has been compiled by Drakopoulos. D. (2007):

- Rotary switches are preferred in situations where multiple settings (max 24) are required. Recommended dimensions are; length 25-100 mm, width ≤ 25 mm, height 12-75 mm and a separation distance of 50 mm.

- Toggle switches should be used for on/off or other two state selections. They may be used in situations where 3 selections are needed but it is recommended to use a rotary switch in those situations. Recommended dimensions are; arm length 12-50 mm and a separation distance of ≥ 50 mm.

- Rocker switches could be used as a substitute for toggle switches if there is a chance that the arm of a toggle switch might snag the sleeve of an operator or in other ways be accidently activated. Another advantage is the ability to label switch positions directly on the switch. Recommended dimensions are; width ≥ 6 mm, length ≥ 12 mm and a separation distance ≥ 19 mm.

- Knobs are preferable to use when low activation forces or precise adjustments of a continuous variable are needed. A moving knob with a fixed index is preferable to the opposite in most cases. Recommended dimensions for when a fingertip grasp is used are; height 12-25 mm, diameter 10-100 mm and a separation distance of ≥ 50 mm. Recommended dimensions for when a palm grip is used; height 12-25 mm, diameter 10-100 mm and a separation distance of ≥ 50 mm.

- Push buttons allow for an effective use of limited panel space and can be used quickly. They can also be used in conjunction with other push buttons and can easily be identified within an array of buttons or through an associated display signal. The disadvantage with button type controllers is the difficulty of identifying the present control setting through visual or tactual means. Recommended dimensions are; diameter 10-25 mm and a separation distance of ≥ 50 mm.

- Hand levers could be used when high forces, large displacements or multidimensional movements of controls are needed. The disadvantage with the hand lever is that they are inappropriate for precise positioning over a wide range of adjustments due to their limited range of movement. Recommended dimensions are; displacement ≤ 355 mm and a separation distance of ≥ 100 mm. Recommended activation force is ≤ 155 N.

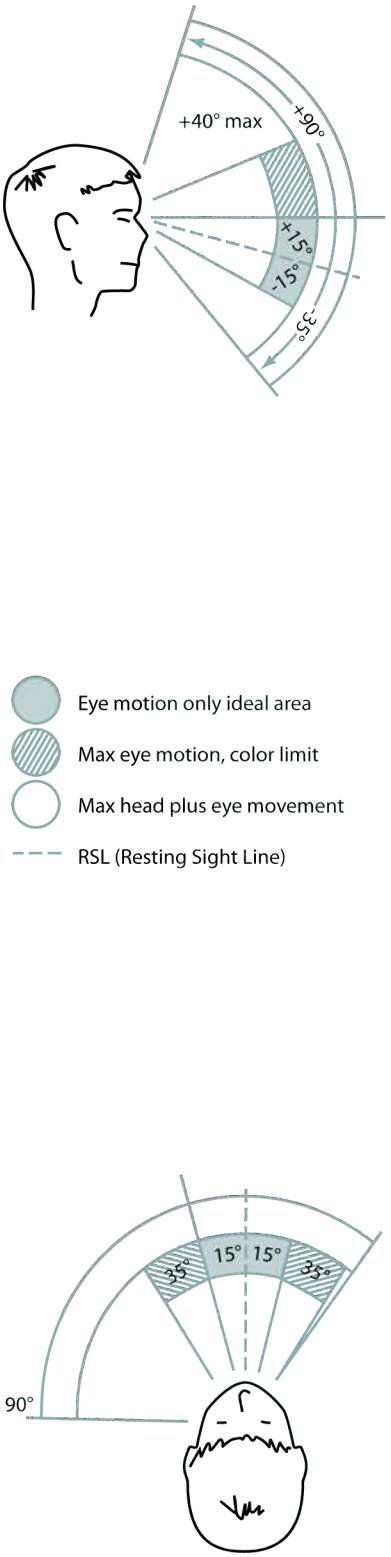


Fig. 26

4.6.2 Cognitive ergonomics

The cognitive part of human factors deals with the decision making process of the human mind. The goal is to design products and services that take this into account in order to reduce the number of errors arising in the human machine interaction. To do this a model of the process which is divided into four different stages is used (Bridger 2003).

Information acquisition is the first stage and involves the search for and storage of information to state the available decision alternatives. This phase may be distorted by selective perception and memory providing a biased decision foundation.

Evaluation of alternative courses of action is the second stage. There are several theories that try to explain how this process works. But most are either based on elimination by aspect or elimination based on probability of desired outcome.

The third stage, execution, takes the selected course of action and implements it. This stage can also involve inactivity if it involves less responsibility and is less emotionally challenging than taking action.

Feedback given for the selected action constitutes the final stage of the decision making process. Identifying incorrect decisions through the consequences of a certain course of action is fundamental for improvements. However the decision maker needs to know that the decision and consequence are linked for improvements to occur.

Another way of modeling how the human perceives information and refines it is presented by Cristopher Wicken. The model describes how sensory stimuli enters the short term sensory storage and is translated into something that is understandable by the perceptual processes within the brain. This is then transferred to the work memory that in turn draws upon and interacts with the long term memory in order to create the perception of the surrounding environments and to determine responses (Hancock et. al. 2004).

Physical interfaces

One of the driver areas where the theories of cognitive ergonomics can be useful is the creation of human machine interfaces. Several guidelines have been brought forward through operational experience and should be used as starting points when developing the layout (Taylor 2007).

- Critical and frequently used functions should be in close proximity to the user.
- Controls and displays should be mounted within the limits of the head and eye motion; 90˚ on each side of the RSL (resting sight line), 90˚ above the RSL and 35˚ below (Fig. 26 on page 30).
- Non-essential information should be avoided, especially labeling controls that have a self evident function.
- Displays and controls should be placed in a way that it is obvious when they are linked.
- Controls with similar functions should be grouped.
- Critical or emergency controls should be emphasized.
- Controls and groups should be arranged from left to right or top to bottom. This mimics the western style of writing but consideration for cultural differences should be made.
- Controls should be placed below or to the right (if the user group is primarily right handed) of any displays that they are associated with.
- Controls that provide a sufficient degree of precision should be used.
- Evaluate if feedback is needed for individual controls and make sure that the feedback occurs directly.
- Tasks that don't require a high resolution indicator or meter should use low resolutions tasks. For example using millimeters for the trip meter would provide unneeded information to the driver.
- Rarely used functions should be placed in areas that are less accessible to the user.
- Analog indicators should be used when trend indications or fast status indications are needed. Digital indicators should be used in situations where absolute numerical values or text segments are needed.

- Indicators that use a moving point meter is preferred over moving scales (for example spedometer) since they provide an immediate indication of status.
- Grouped indicators should have parallel point meters in the normal range. This makes it easier for the user to identify abnormalities.
- The number of warning and indicator lamps should be kept to a minimum.
- Controls and indicators should use standard symbols as labels.

4.6.3 Discussion

The anthropometric measurements that are presented in the chapter have been the basis of the previous concepts presented in chapter 2. It is therefore important to review these measurements when evaluating the BEMO-prototype and if necessary make alterations.

The majority of changes that could improve the ergonomics within the driver compartment would also impact the substructure of the vehicle. It is therefore important to have well-founded arguments to answer the question "is it worth it?" before approaching the construction team. It is also important to have a good understanding of the construction limitations to be able to know what changes that are possible.

4.6.4 Conclusion

The short driving distances and more frequent user ingress and egress should be taken into consideration when the driving position is formulated. Guidelines intended for regular cars may not be applicable to this vehicle type.

Knowing the users interactions with the vehicle is critical. The user study needs to be under way before the ergonomic work can commence. An evaluation of the manufactured BEMO-prototype should also be done.

Positioning the driver seat should be the starting point for any future ergonomic work. It is therefore important to determine the actual chair that should be used before this phase starts.

The driver seat height should be adjustable from 350mm to 475mm.

Floor space dedicated for the drivers feet should start at the latest 430mm in front of the driver seat backrest when in the lowest position and end 820mm in front of the driver seat backrest when in the highest position.

The 1200mm width of the cabin compared to the max combined hip breadth of two sitting passengers of 820mm creates little room for additional equipment between seats.

The guidelines concerning the driver controls should be taken into consideration when evaluating standard parts. Specific measurements should however be viewed in the light of the space demands within the specific vehicle. Having a control layout that is easy to interpret and positioned to account for user frequency is more important than adhering to a specific measurement.

4.7 Form Design

The product experience is what defines the design value in a product and could be argued to have a great effect on the desire for that product. Hekkert (2006) states that the holistic product experience consists of:

- The degree to which all our senses are gratified (aesthetic experience)

- The meanings we attach to the product (experience of meaning)
- The feelings and emotions that are elicited (emotional experience)

The main area of communication between the buyer and the product before any based- experiences have emerged are formed through visual communication or form of the product.

The challenge for the designer is to find the right visual design, one that fulfills all the parts of a good product experience: it should have pleasing aesthetics, communicate the correct and desired qualities and make sense for the beholder. It should evoke a "good" emotional response.

There are different teachings that could guide a designer when creating a good product experience which are briefly described here:

4.7.1 Gestalt theory

When the world is perceived, what is seen is not the objective truth but rather a holistic interpretation of the whole surroundings and all objects relating to each other. The human phenomenon to interpret things as a whole instead of as the sum of their parts is called Gestalt.

The gestalt theory is one of the oldest and most practised theories in design and was formed in 1912 by german-chech psycologist Max Werteimer (Rock et al. 1990) The gestalt psychology can be applied in numerous ways, as help for product understanding as well as aesthetic purposes. Even though the gestalt theory covers many aspects, the most famous part is the laws of grouping which often in today's design literature is referred to as "The gestalt laws".

Some of the most basic grouping principles are hereby illustrated as an introduction to the gestalt theory.

The law of good continuation (the good curve)
Objects arranged in a smooth curve or continuous lines are seen as a unit (Fig. 27).

The law of similarity
Objects of similar shape are grouped together within a system (Fig. 28).

The law of closure
According to the law of closure connected objects create surfaces and are grouped together (Fig. 29).

The law of proximity
The law of proximity states that objects close to each other are grouped together (Fig. 30).

Implications of gestalt theory for product development and design

The gestalt theory explains how an object is perceived by a human mind and is so universal that it is applicable in almost all cultures and even animals. In design this means that the gestalt theory approach can be applied when working towards any target group and in many situations.

Product styling, aestetics

The visual sensory system is one of the most important for the human to experience in order to interpret the surroundings. The mind looks for things that support identification, meaning and navigation which in essence are called gestalts. Hekkert states that when these meaningful relations in the environment are found, when one finds order in chaos, the brain gets stimulated and finds aesthetic pleasure. The more powerful the gestalt the product has, the more order and meaning it expresses and thereby has a more aesthetic design.

Human factors

Using the Gestalt laws when creating products with a need for good ergonomics and semantics can be beneficial in many ways. When creating button layouts or other types of human-machine interactions the laws of grouping give examples for how to place object that should be connected.

Product visualisation

When a certain expression is desired in a visualization, the gestalt laws give hints on how the mind interprets objects. The literature defines what aspects make the mind think of an image as painted, rendered or photographed, or how a object is seen as heavy, light, big and so on. This can be translated into product visualization and concept communication. As mentioned on many occasions during design education, sometimes it is better to make a prototype rendering look sketched to communicate that the product still is in development. It is then easier for the viewer to fill in the gaps and provide their own opinions on how to change the prototype.

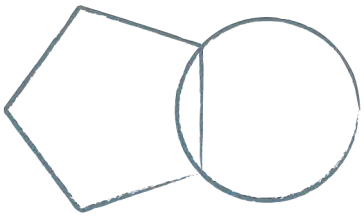


Fig. 27

4.7.2 General guidelines for good design:

Many good designers and scientist have tried to put a finger on what makes good design. Some uses their own experience, some uses quantitative studies to find out universally good properties and other uses evolution as en explanation. This chapter will briefly report guidelines from different sources of what makes a good design. More guidelines are shown in appendix 4.

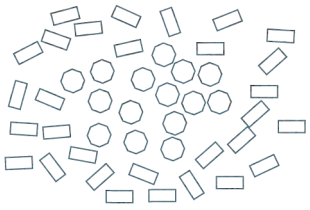


Fig. 28

The complexity of a design is most pleasing when neither to complex or simple
Different cultures have different tolerances for complexity, find and try to use this level of appropriate complexity on your design.

Try to use multi-modal identifiers
When communicating for instance quality, let the product not only look qualitative, make it feel and sound qualitative as well.

Try to use variations in basic patterns
"Variations in basic patterns are well suited to enhance 'syntactic expressive power', increase the abundance of forms, and extend

Fig. 29

The 'aesthetic information"
When designing towards a specific intention or want a special expression think of what changes that message gets during the communication chain *(*Warell 2007*)*

The product should be self-expressive

A design should booth be stereotypical and novel
An archetype or familiar form is much easier to accept and appreciate, however novelty and what is new also have a attractiveness. A good level to think of is: making something new based on the archetype of the function and with a coherent brand identity.

Try to make a product that is as advanced yet acceptable as possible
similar to the stereotypical and novel guideline but regarding technical properties. It must be trustworthy but not boring.

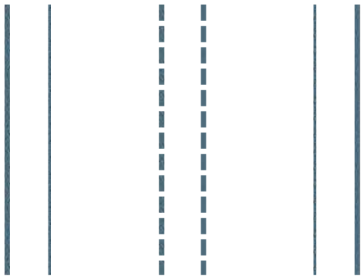


Fig. 30

A design should use metaphors
Drawing upon imagery from external sources may give the product a more descriptive appearance and assist the user in their process of interpretation (Crilly et al 2004)

Avoid Clichés

When too many products are seen to use the same visual references, such products may be interpreted as cliché's. For instance, phone design to similar to the old iPhone, the metallic frame and black surrounding a screen have become a cliché

Try to accomplish "Unity in variety"
Derived from the gestalt principles, the unity creates connections and meaning which makes it possible to appreciate the form.

Use "Consistency of impressions"
we tend to prefer products that convey similar messages to all our senses

4.7.3 Good form derived from a evolutionary perspective

What is beauty or what does visual appreciation of an object comes from? Many writers for instance Peter D. Stebbing in "a universal grammar" derives visual pleasure as a mean for evolution to guide humanity towards making good decisions. It is stated that many occurrences that are regarded as good form are in fact the brains way of rewarding that we made sense of a visual stimuli, Paul Hekkert describes it "like finishing a puzzle for the brain." Humans want to find meaning and connection in what we observe which is derived from our survivalist nature. When such connections are made sensorial pleasure is achieved. For instance, form communicates that a building with good aesthetic balance and symmetry has better chance of not falling down and it helps you to discover and make sense of natures signals of warning and danger. These concepts are greatly connected with the gestalt theory that describes this as a neurological reaction of making sense of visual stimuli.

Some might say that all guidelines for good design in some way could be derived from an evolutionary perspective but the list below are a sample of those with the most obvious connection to human survival, reproduction and early lifestyle.

Account for the waist to hip ratio and the cheek curve
Humans prefer shapes with a waist thinner than the hip. The preferred ratios are for men 0.9 and women 0.7. In products that should communicate masculine values use the ratio for men and vice versa. Also the cheek curve are a very powerful gestalt and a universally pleasurable form element.

Consider baby-face bias
A baby face shape are genetically found and have round features large eyes, small noses, high foreheads, short chins, and lighter hair are perceived as baby like attributes: naive, helplessness, honesty, and innocence.

Consider masculine/feminine face structures
Same as above but gives corresponding expression based on masculine/feminine

Design elements that needs attention threatening
As stated the human are very good at finding threatening visual signals. Use this when designing objects that needs attention.

Account for balance in objects
Good aesthetic balance is shown to cause visual appreciation.

Make an "eye spot" gestalt to draw attention.
The human vision is almost magnetically drawn to gestalts that look like eyes. Use this to draw attention.

-Use the golden ratio or fibonatchi sequence.
The golden ratio is visible everywhere in nature because it a factor to optimize energy efficiency in many ways, such as spiraling flows, packing, surface exposure etc. Some states that humans are able to see and subconsciously appreciate this property. Others however states that the golden ratio does not affect appreciation for an object.

-Consider symmetry
Also a more general principle but could be derived as a quality indicator. For instance a symmetrical human face is considered more beautiful as it implies of better genes and health.

-strive to maximize effect from minimal means.
It is universally pleasing to observe an optimized form for its intension.

-Use a design language that uses elements that support navigation and identification.
As stated earlier, indicators of direction gives meaning and connection to the visual stimuli and thus sensorial appreciation.

4.8 Brand recognition

Visual brand recognition is the way a company communicates its values through its product lineup using sensorial and semiotic expressions.

Brand recognition is a vital way to differentiate a product against competitive products, it is also a good way to transfer values from one product to another. Since Nimbell does not have a previous lineup of products the brand recognition is a preparation towards future products and product concepts within Nimbell.

Short guideline for brand recognition incorporated design:

Find segment, style and brand typical design features.
The design format analysis (DFA) by Warell is a method for finding similarities and style implications within any group of products. Depending on how the method is used the result can show visual similarities in a specific brand, product category or style category depending on how the result is analyzed. It also shows how well one specific product corresponds to the measured group allowing the fining of "archtypes".

Identify criterias for positioning against different brand.
This is not regarding the company's brand values but rather what to focus on for the specific product and if other new core values can be used. Are there any holes in the market? On which aspects do you want to stand out?

Make sure the product fits its core values in all communications aspects.
The PPE-framework by Anders Warell defines product experience by: recognition, comprehension, association, emotion, appreciation and impression. Are the products core values present in all these aspects? Especially important is to evaluate the emotionally response against the core values for example, how does the emotional response "aggressiveness" correspond to the core value "safety"?

Incorporate identity of the product in many different layers
Make sure the visual brand recognizable features are apparent in many different form layers such as: product whole/outline, major design features, detail elements and brand communicators.

4.8.1 Conclusions

- Visual branding are vital for the evaluation and choice of semantic expression.
- The developed vehicle should have emotions that correspond to Nimbells brand values.
- It is preferable but not vital that that the design of the vehicle connects to the Terravox concept.
- Test and make sure the developed vehicle give a preferable emotional visual response.

4.9 Usability

The essence of usability is defined by ISO 9421-11 as: "Usability is the effectiveness, efficiency and satisfaction with which a specified user can achieve specified goals in particular environments" For instance, the fastest car could otherwise be regarded as the most useful in transporting a user from a to b, But if it is illegal to drive on the road, extremely hard to maneuver and is driven on an unobtainable fuel it could not be considered useful. Usability considers all these aspects to make a product as useful for the user as possible.

4.9.1 The different aspects of usability

Effectiveness:

The level a products task is performed when used. A boat that should be able to sail in 10knots but the user only manages to sail it in 6knots is said to have a effectiveness of 60%

Efficiency:

This regards the effort to make the product do the task. If one boat can do exactly the same sailing with the same speed and safety but the user may also relax and chat when doing it. It is considered to have a better usability.

Satisfaction:

This regards the users subjective appreciation when using the product. An auto piloted motorboat could be regarded as having a better usability but the satisfaction of the user is then not considered.

4.9.2 The different components of usability

Usability could be separated into five different components: Guessability, Learnability, Experienced user performance, system potential and reusability. (Jordan et.al 1991)

Guessability:

Regards the usability of a product the first time it is used. In safety equipment and public interaction products this property is the most important.

Learnability

With this means the usability up until the user feel familiar with the product. It measures the ease of learning and memorizing how to perform a task. It is especially important for complex products where the user have to learn by themselves such as in computer games

Experienced user performance

This is closest to the general definition. It means the effectiveness, efficiency and satisfaction with which specified experienced users can achieve specified tasks with a particular product. The goal is to have this as close to the system potential as possible

System potential

This marks theoretical limit of performance achieved from a specific product.

Re-usability

The ease of which a previous user have of reaching the previous familiarity and experience level after a long time since last use.

4.9.3 Discussion

Usability is important to minimize irritation. It helps increase productivity. It rises safety both in safety equipment where the user must understand it the first time and in products used when doing something that might be unsafe such as a car-stereo. And finally it is a great tool to increase the competitiveness and sales of a product.

4.9.4 Conclusion

There are some guidelines to ensure that usability is achieved when designing a product. These should be considered in this product development project to incorporate all the good properties of a high usability. Some of these are:

Work towards a high consistency
Tasks should be made in a similar manner through the product. Experience from one part of the system should help in all similar parts.

Ensure compatibility and follow customs
If a task usually is made a certain way the user expects it to work that way.

Consideration of the user resources
Design that way that a user don't get overstimulated from one type of stimuli, for instance use sound or touch if sight is overloaded such as during driving.

Give feedback
the user should always se a connection between its execution and the consequences. It is important the user know that input have been registered by the product or system.

Incorporate Error prevention and recovery
When the user does something wrong make sure the consequences are minimal and the recovery to the last right stage is easy.

Ensure visual clarity
Use Fitts law to make the importance of a message correspond with the visual impact.

4.10 Checklistofproductdevelopmentstatements

4.10.1 Purpose

Many valuable design statements are proposed by literature, lecturers, visiting lecturers and general media only to be forgotten when we would have needed them. The purpose of this list is to collect all those statements and present them with its source in one place. This list is then meant to be used as a general design checklist or gate list that could be refered to in every design project. It is meant to give inspiration and make sure nothing important is missed.

4.10.2 Method

This checklist is made by first listing all classes that have mentioned things related to design projects. Then raw data from these classes is gathered, things like lecture notes, handouts, lecture slides, presentations and class literature, often from archived class homepages. This raw data is then filtered by deciding which prats could be valuable for future use, for instance, method chapters or conclusions in reports. These parts are then read and when useful information is found it is rephrased into a design statement. In addition to this, some statements based on own experience are added

The collected statements are sorted and placed into the checklist based on main categories such as user centered design and sub categories such as interviewing

techniques.

The statements are also phrased in a short form and also in a long form, the short form presents the statement in one sentence, the long form specifies what the sentence means and how to apply. An example can be seen below:

- Design for the colorblind.
Make sure that messages are not dependent on color alone. Even people with good color vision have poor color recognition ±30° from the resting sight line. Use flashing lights with 3-5 repetitions per second as warning indicators.

The methodology was developed by the project group during the information gathering phased to cope with the amount of material found.

4.10.3 Results

An excert from the checklist can be seen in (Table. 3)

4.10.4 Discussion

The method used for this checklist was rather straight forward even if it were a newly created way of gathering and presenting information. The different sources varied in their usefulness. Class literature proved to specific to fit as statements and required additional work to shorten and rephrase it. Lecture slides where personal experience were shortly summarized proved to be more efficient.

4.10.5 Conclusion

The general design process checklist summarizes most parts from the information gathering into one big chart. In some ways this could be considered unpractical but as a gate list to brief through when moving from one stage in the process to another it does a great job at ensuring that no important aspects, processes or methods are forgotten. In some way this chart is to information gathering what the need analysis is for the user study.

Table. 3

Main Category	Sub category	Abbreviations	Description	Comment	Reference
Ergonomi		IG, KD	Minimize vibrations	handform 2.5m/s^2 Body: 0.5m/s^2	Wildander, Bergquist. (2008), (p.29) The re-design of an electrical distribution moped
		KD, Co	Ensure that access holes necessary for service and repair are sufficiently sized	Make sure that the size is adapted to the clothing that the user wears. Also test if blind access is sufficient or if the user need to have a clear line of sight.	j. a. taylor B2 s7
			Design based on physical characteristics	The product should be adapted to the largest possible user number within the TARGET GROUP.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd. London.
	seating design		try to let the seat to adjust automaticly to every users specific features	check the ending of this TED talk to get inspirations: http://www.stumbleupon.com/su/video/1qzfTs	http://www.stumbleupon.com/su/video/1qzfTs
Sustainability					
	Lifecycle	PI	Identify the most energy demanding life phase of the product	Material production, Manufacturing, Product Usage and delivery, Disposal. Measure in CO2 or energy.	Lecture: Material selection in industrial design
	Lifecycle	AN	Estimate the product lifetime	Don't design for failure on specific parts but instead look at the whole product and let material choices depend on it.	
	Sustainable packaging	MP	Minimize packaging material		j. a. taylor C2 s2
	Sustainable packaging	KD	Use recyclable or biodegradable materials		j. a. taylor C2 s2
	Disposal	KD, Mp	Simplify the process of reusing parts	Reusing parts is far better then simply reusing material.	
	Disposal	KD, MP	Enable disassembly with simple tools	Increase modularity and use design for maintainability as a guide.	
	Disposal	KD	Make it possible to disassemble into single material pieces	Use non permanent fasteners. Avoid molding in metal components, exotic material blends, composites, several colours and metal plating of plastic.	
	Disposal	MP	Use material codes when necessary	Ex. plastic codes	
	Quality in Quality	An	Get free of known culprits	the known flaws are the easiest to improve	
	Quality in Quality	An, Mp	Perform an LCA (life cycle analysis)	List of relevant energy and material inputs and environmental releases. Evaluate the impact.	
Manufacturing					
	All manufacturing	KD, MP	Check material availability and cost		j. a. taylor f2 s2
	All manufacturing	KD	Check production volumes	Make sure that the local production plants and their capacity is taken into consideration. Ex. vac form tool $1500 and injection moulding tool $75.000	j. a. taylor f2 s2
	All manufacturing	KD	Size or weight limitations		j. a. taylor f2 s2
	All manufacturing	KD	Necessary strength	type and size of the applied load on the part.	j. a. taylor f2 s2
	All manufacturing	KD, MP	Surface requirements	Min and max finish that can be produced	j. a. taylor f2 s2
	All manufacturing	KD	Radius requirements	Min and max differs between different techniques	
	Design for assembly	KD	Parts must be designed to consistently orient themselves when fed into a process.		Bersquist, Wildander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Product design must avoid parts which can become tangled, wedged or disoriented.	Avoid holes and tabs and designed "closed" parts. This type of design will allow the use of automation in parts handling and assembly such as vibratory bowls, tubes, magazines, etc.	Bergquist, Wildander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Part design should incorporate symmetry around both axes of insertion whenever possible.	Where parts cannot be symmetrical, the asymmetry should be emphasized to assure correct insertion or easily identifiable feature should be provided.	Bergquist, Wildander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	With hidden features that require a particular orientation, provide an external feature or guide surface to correctly orient the part.		Bergquist, Wildander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Guide surfaces should be provided to facilitate insertion.		Bergquist, Wildander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Parts should be designed with surfaces so that they can be easily grasped, placed and fixtured.	Ideally this means flat, parallel surfaces that would allow a part to picked-up by a person or a gripper with a pick and place robot and then easily fixtured.	Bergquist, Wildander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Avoid parts with sharp edges, burrs or points.	These parts can injure workers or customers, they require more careful handling, they can damage product finishes, and they may be more susceptible to damage themselves if the sharp edge is an intended feature.	Bersquist, Wildander. The re-design of an electrical distribution moped 2010
		MP, PI	Design the work station area to minimize the distance to access and move a part.		Bergquist, Wildander. The re-design of an electrical distribution moped 2010
Material					
	Design in wood	MP	Use grain orientation to achieve strength in desired direction.		j. a. taylor
	Design in wood	MP	Select radial cuts of timber instead of tangential cuts to reduce distortion.	Radial: from the middle to the edge	
	Design in wood	KD, MP	Hide end grain where possible		
	All material's	KD, EV	Operating temperatures	Check both short term and long term temperature span. Don't forget transportation environment.	j. a. taylor f2 s2
	All material's	KD, EV	Exposure to liquids	Water, solvents and chemicals.	j. a. taylor f2 s2
	All material's	KD	Electrical properties		j. a. taylor f2 s2
	All material's	KD	Thermal properties		j. a. taylor f2 s2
	All material's	KD, EV	Surface requirements		j. a. taylor f2 s2
	All material's	KD	Check Eco-properties	Production energy , Carbon emissions, Recycleability. Becomes more important when most energy is spent in material production.	Lecture: Material selection in industrial design
	All material's	KD, Co	Its hard to compare technical data (material properties) between material groups	The technique to measure theses numbers are different because of practical reasons. It is very hard to bend a brittle material for instance. Material groups: Metals, Polymers, Elastomers, Ceramics, Glasses and Hybrids	Ashby, M. F. (2011). Materials Selection in Mechanical Design –4th ed. Kidlington: Else
	Quality Impression	KD, DK	Account for ageing of the material	"whilst some metals and woods acquire an attractive patina overtime, in general, polymers do not age gracefully". "Inconsistencies indicative of hand finishing are also valued by consumers and may encourage the formation of emotionalattachments."	Crilly et al. Seeing things: consumer response to the visual domain in product design (2004)Design Centre, Department of Engineering, Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK.
	Material selection	Kd, Co	Identify the function	What does the component do (in mechanical terms)?	Ashby, M. F. (2011). Materials Selection in Mechanical Design –4th ed. Kidlington: Else
	Material selection	Kd, Co	Identify the constraints	What conditions must be met (both non-negotiable and negotiable)? Ex: stiffnes, strength and cost.	Ashby, M. F. (2011). Materials Selection in Mechanical Design –4th ed. Kidlington: Else
	Material selection	Kd, Co	Identify the objectives	What is to be maximized or minimized? The optimization criteria. Ex. minimize weight, minimize cost, maximize performance	Ashby, M. F. (2011). Materials Selection in Mechanical Design –4th ed. Kidlington: Else
	Material selection	Kd, Co	Identify free variables	What parameters of the problem is the designer free to change? Ex. Material, cross section, thickness	Ashby, M. F. (2011). Materials Selection in Mechanical Design –4th ed. Kidlington: Else
		Kd, Co	Find material indices that optimizes given objective	limited by constrains	Ashby, M. F. (2011). Materials Selection in Mechanical Design –4th ed. Kidlington: Else

5. User study

	Observation	Social Media	Group Discussion	Interview	Phone Interview
Cemetery 1	■		■		
Cemetery 2	■		■	■	
Property Caretaker 1	■		■	■	
Property Caretaker 2	■		■		
Newspaper delivery	■	■	■		
Mail Delivery	■	■			■
Vehicle service department	■		■		

Table. 4 User studies conducted throughout the project

One of the dangers of the early product development phase is to make assumptions that are carried over into later phases as a researched truth. One of the ways to minimize this as much as possible is to acquire first hand information about project stakeholders, the environment where the product will be used, the systems that the product will be used in and the people that will use it. This process has been ongoing throughout this project but the main bulk was carried out in the requirement capture phase which consists of information gathering and user study. Several different methods of data gathering were used to fit in with the different contexts where the user studies were conducted. The norm was to use several methods during the same user study to extract as much information as possible. A common theme throughout all of the methods was the focus on qualitative data gathering. The decision to limit the use of quantitative methods was based on a combination of previous bad experiences among the project group when implementing such methods in dynamic question formulations. The decision was also based on the ability to acquire such information through other sources within the company.

5.1 Information gathering methods

Several different methods were used to approach product users and the environments that they worked in. An overview of the user segments and methods used can be seen in Table. 4.

5.1.1 Social media survey

The social media survey gives a unique insight into a potential user's daily challenges. It is created by the user and therefore has no influence from the observer. The downside to this research method is that it is hard to assess the quality of the information gathered and what the original intention with giving the information was. Caution is therefore advised when interpreting the information and it is important to be aware of that the information can be inflated in order to achieve a higher impact.

An online search was conducted where the aim was to find blogs written by people employed within the Swedish mail delivery industry. Blogs with content newer then 5 years where then examined in order to extract information related to their employment. Images (Fig. 34 on page 43) where downloaded to an image bank where they were incorporated into the persona creation (chapter 5.3). Fig. 33 depicts an image series taken by a mail carrier based in Jönköping.

5.1.2 Target User Discussion Groups

The discussion groups were carried out to provide insights into how potential users think and talk. They were also intended to provide information about which

Fig. 31


Fig. 32

product characteristics that were important for the different departments within a customer company. Discussions in small groups gives a good overview of differences in opinion compared to asking individuals and also creates a forum where those differences can be discussed (Taylor 2007).

A majority of the discussions where done in conjunction with sales meetings with potential buyers. The management of the companies were asked to include people within their organization that they believed could be the end users of the product to these meetings. This was done in order to recieve opinions from both users and potential buyers and to get them to view their needs in relation to each other. The number of people present at these meetings ranged from 2 to 8. The meetings were initiated with a presentation of the company and the concept to give an overview of where the vehicle would be used. This was then followed up with an open discussion were questions covering important topics were introduced into the discussion if they didn't arise naturally. The discussions would typically start off with the type work that the users did on a day to day basis with focus on behavioral patterns around different vehicles available to them today. This was then followed by questions regarding their immediate working environment followed by development needs. The discussion groups was summarized by a few questions related to the persona creation that can be seen in chapter 5.3.

A total of five group discussions were made throughout the project. The majority were organised events with prepared questions but one of these happened quite spontaneously during a coffee break at 5 am at a local newspaper delivery hub(Fig. 32).

5.1.3 Interviews

The traditional interview is a good supplement to the discussion groups as it provides an opportunity to go deeper into individual questions. This creates a better and more detailed view of the primary users daily routines and work cycles. They are used to clarify uncertainties uncovered during the previous group discussions and the literature review.

Two personal interviews were made in conjunction with the discussion groups and two additional phone interviews were done on a separate occasion. The interviews were done in order to get a more detailed view of individual users. This part was carried out in a more structured manner than the group discussions. Two users with experience of electric vehicles were interviewed at each occasion by two interviewers with an exception for the two carried out on the phone. These were conducted with one interviewee at each occasion for practical reasons. The main questions were prepared in advance but follow up questions were asked based on the answers on the main question. Notes were taken during the interviews (appendix 3) but audio recordings were also conducted as a backup

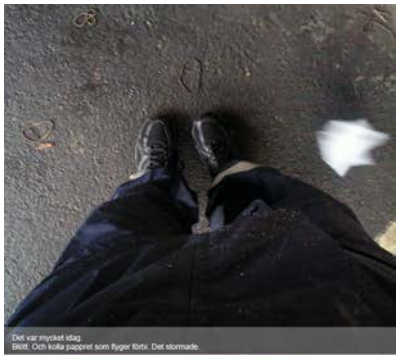



Fig. 33

5.1.4 Observations

People often screen what they say and therefore don't tell you about everything they need, think and feel. The reasons for this are numerous but in many cases people simply are not aware of exactly how it is they do certain tasks. It is therefore important to observe users in the environment where they would normally perform their tasks. Observations are also made to get a better view of the environment that product will be function in and remove any preconception that may exist. It also gives a good view of the competitors and users own solutions. This method can be used both quantitatively or qualitatively through objective observations or participation.

The conducted observations can be divided into two categories, passive and participatory. The latter were performed in conjunctions to other user activities but a few were also performed on separate occasions. Participants were asked to give a short tour of their work place with focus on the vehicle fleet that they used on a day to day basis (Fig. 32). During the tour they talked about their different work tasks and gave examples of good and bad characteristics their present tools and vehicles have. One surprising aspect that surfaced during these tours was the amount of user modifications on the vehicles making them better adapted for specific work tasks as can be seen on "Fig. 36" on page 45. Interestingly despite this, the users when asked were very satisfied with their vehicles even though they easily could spot several major flaws and shortcomings that they either learned to live with or solved themselves.

The passive observations were the results of several spontaneous encounters with users performing various tasks where mopeds or utility vehicles were involved. These observations where sporadically documented by cell phone photos (Fig. 35).

Fig. 34

Fig. 35

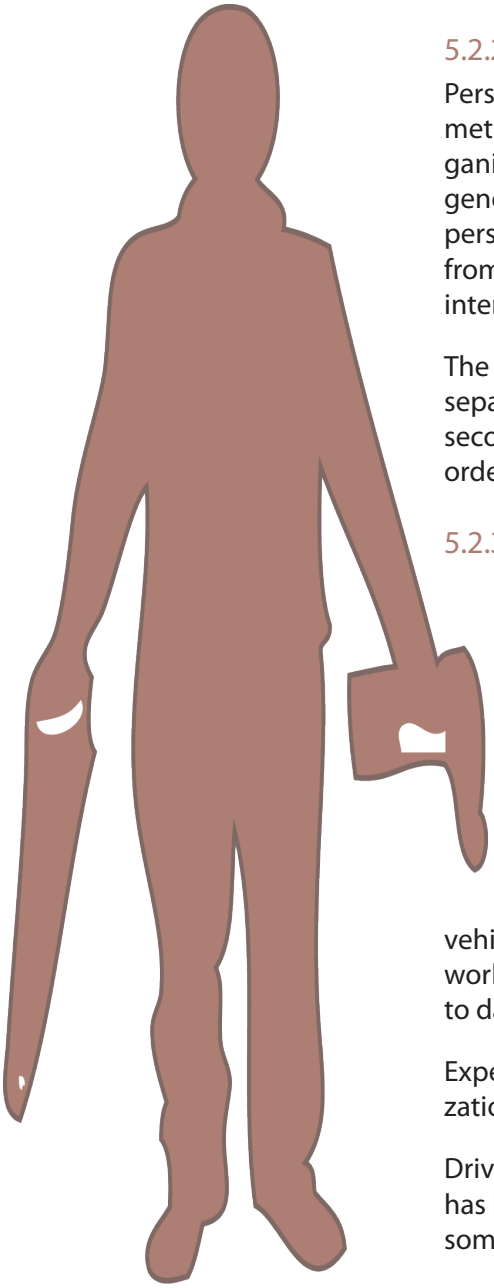
Fig. 36

Fig. 37

5.2 Generic user descriptions

5.2.1 Purpose

The nature of the vehicle in development results in several different target groups with different needs. This leads to very specific usage requirements that are not shared among the target group. It is therefore important to highlight the unique traits that separate them in a manner that is easy to digest for both project members and external parties involved in future development. The persona method distills the gathered knowledge into something concrete that can be discussed while making key decisions and during compromise discussions. This leads to a tangible vision of the user that is shared among the project team.



5.2.2 Method

Persona is a short description of the character traits of a fictitious person. The method is initiated by collecting the information already known within the organization. This is done by talking to people engaged in similar previous projects, general management and actively involving identified stakeholders. These rough personas based on second hand data are then refined through continuous input from user studies. This ensures that the constructed personas are updated when internal beliefs within the company differ from the current user behaviors.

The persona is presented through text and images and focuses on traits that separate it from the general user. The descriptions are divided into primary and secondary users based on that group's importance. This gives a clear prioritizing order when compromises are needed.

5.2.3 Results

Vehicle purpose: General transport

Short distance transport of personal and tools, such as property caretakers and service personal at larger industrial sites.

Persona
Mr Fixer

Age: 40

Company Culture: They have positive previous experiences of electric vehicles in the form of three wheeled mopeds and modified golf carts (clubcar).The work patterns have evolved to the point where vehicles are an essential part of day to day business. The types of vehicles used vary from department to department.

Experience: He's an old timer at his company and has been through several organizational changes that have affected how he does his work.

Driving experience: He has driven both mopeds and small electric cars before and has learned to adapt to the peculiarities of each vehicle. This is however not true for some of the new seasonal workers that struggle to achieve this.

Fig. 38

One of the utility vehicles used by Mr Fixer. Tools and spare parts are stored on the open cargo bed.

Fig. 39

His personal belief is that the more electronic gadgets in the vehicle the more visits to the car workshop.

Work assignments: Together with his colleague he is in charge of repairs and service errands to the apartments in their area (1-2 km radius). Typical work assignments are sewage blockage and exchanging light bulbs.

Work environment: All the workers are based at a local office close to the apartment buildings that the company own. It contains a dining area and a few offices for the administrative staff. The cars are parked in the open behind the building when they are not used. A garage is located nearby and supplies him with the spare parts that he needs during typical repairs. Some tools are more or less permanently stored on his vehicle.

Typical work day: He starts at 8 am at the office and usually heads out at around 10 am with his work mate. Repairs are done when they arrive unless they need to go back to the office for the right spare parts. They eat lunch at around 12 am at the office or at one of the nearby restaurants. Then they resume their work until 4 pm when they head home to the garage.

Fig. 40

Fig. 41

Fig. 42

Work conditions: He uses the vehicles for short distance transportation mainly on asphalt. A large part of his working hours are spent indoors or in the heated cabin of the Clubcar.

Vehicles used: Two Clubcars (Fig. 38) with attached cabin, three electrical mopeds (Fig. 31 on page 42), minivans, lawn movers and mini tractors.
Equipment: Stepladder, paper, document holder, tape, big key chains, ordinary lamps, cardboard boxes, tube lamps, plunger, tool box, electrical spare parts (wall sockets), buckets, cleaning alcohol and power tools.

Development needs
A large portion of the items that Mr. Fixer has on his cargo bed (Fig. 37) is sensitive to water and is damaged when it is left outside when it rains. He feels that a flexible cargo area that easily can be covered with a roof could be a potential solution. But the roof needs to allow for higher cargo like the stepladder. Another problem is the long fluorescent light tubes that tend to end up at the bottom of the cargo bed and brake when things are placed on top.
The ability to safely store theft attractive items such as power tools or keys inside the vehicle would be very beneficial for him. It doesn't feel good to leave such items unguarded but there are many cases where it isn't possible to bring everything along. Some additional storage for clothes and paper documentation would also be beneficial.

Selling points
Nimble
Flexible weather protected cargo area
Cargo volume capacity

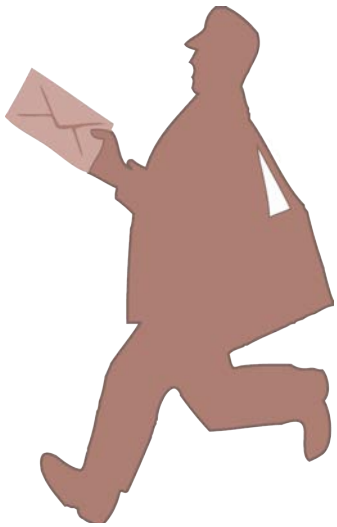



Fig. 43

Fig. 44

Vehicle purpose: Postal delivery

Last mile delivery of mail and packages in an urban environment.

Persona
Ms Delivery

Age: 19

Company Culture: These post delivery firms have unlike Posten no previous experience of electric vehicles (Fig. 43 and Fig. 44). They are open to new brands and collaborations but are infamous in the car business for being very rough on their vehicles.

Experience: Has worked on several summer jobs before this one and knows the meaning of 8h labor.

Work assignments: She is responsible for picking up newspapers at a pickup point and delivering them to their customers. The correct newspaper needs to go to the correct house and they all need to be delivered in time.

Work environment: The newspapers are delivered in three ways; by foot, by bike or by car. Although some use their own cars on the foot and bike delivery runs because it takes less time. All work is conducted by night and they have a limited time between the delivery of the newspapers and the delivery deadline.

Typical work day: She starts at 1 am by loading the newspaper bundles (which can be heavy) from the floor into a company car. They are placed in both in the front and backseats of the car. The number of magazines is predictable but varies from day to day because of weekly deliveries. She then drives to her delivery run and starts working. She drives the same delivery run every night but there are always changes. The A4 delivery list helps her keep track of it all and renewed every time there are more than 15 changes. She works until 6 am when all newspaper should be delivered.

Work conditions: All work is conducted at night so it can be hard to read on the list. Some of her co-workers use the interior lighting of the car to make it easier to read but the downside is that it becomes harder to see outside. She has also experienced problems with the exterior lighting in the new cars. They are equipped with very narrow headlights that make it harder to see the numbers on the mailboxes. There are extra lights mounted on the roof but they are rarely used because they don't provide light where its needed.

The cold can also be a problem on during winter nights, it's okay when you walk or cycle but can be a problem when you deliver by car and has the windscreen open.

Vehicles used: Shoes (Fig. 42), bicycles (Fig. 41), minivans, smaller cars (Fig. 39) and in some cases private cars.

Equipment: Delivery list consisting of several pages of A4, knife to cut cable ties and a mobile phone.

Development needs
She wants a easy navigated vehicle that is comfortable to drive and deliver from. She is very aware of the many non ergonomic movements that she does to improve the delivery speed. Both she and the safety manager from the company believes that the only way to get rid of these behaviors is to force the users to do it right. The vehicle should make it easy to reach the different newspaper piles from the driver's position. It should also be easy to reach the mailboxes without needing to get out of the car.
She would also like somewhere to put all the cable ties that she cuts of from the newspaper bundles.

Selling points
Quality
Cargo volume capacity
Ergonomic
(Branding)

Vehicle purpose: Heavy bulk and tool transport

Short distance transport within a confined area, such as parks and cementarys.

Persona
Mr. Garden

Age: 55

Company Culture: Loyal towards their current brands, vehicles are modified if some functionality is missing.

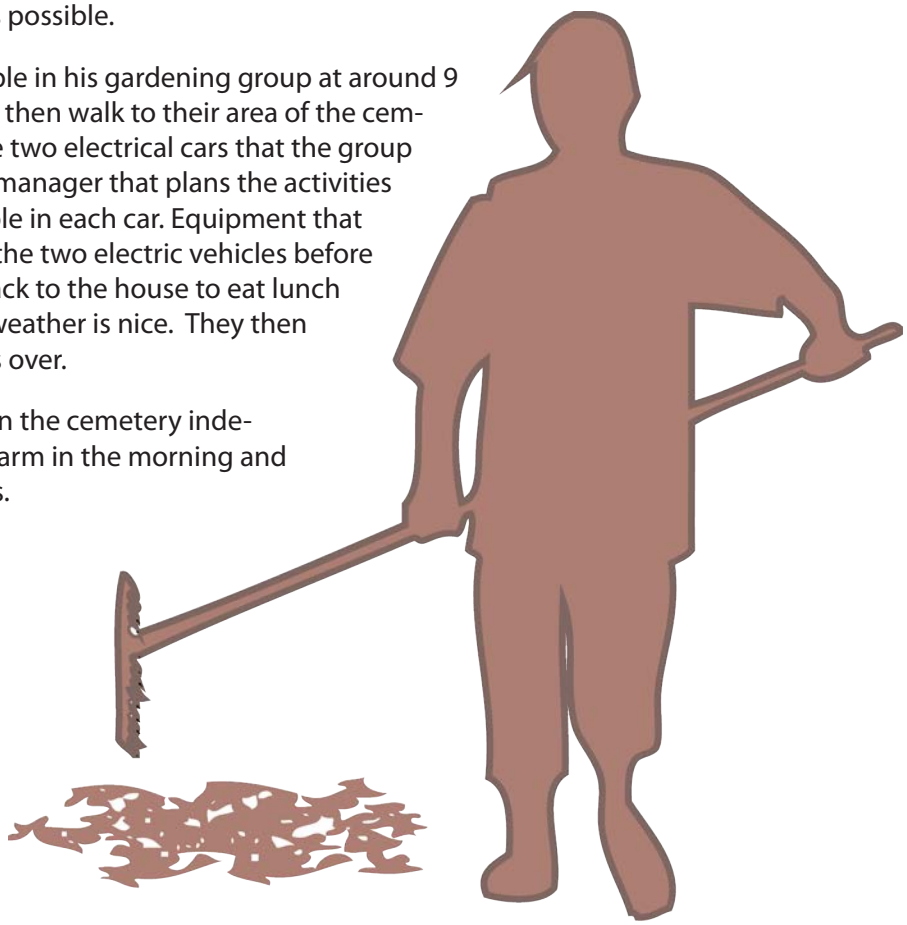
Experience: Been working at the cemetery since he finished gardening school. He knows the cemetery and the work assignments inside and out.

Driving experience: Drives a hatchback car back and forth to work and has long experience with electric vehicles. Modern vehicles are a breeze to drive compared to the old deathtraps they had before.

Work assignments: Gardening work in the area of the cemetery that his gardening team has been assigned. The work varies with the seasons and provides a good task variety. Early spring consist of removing old dead plants and spruce spray that protected the flower beds. Spring is mainly about preparing flower beds, providing nourishment and planting new plants. Summer tasks are related to maintaining the flower beds and keeping the cemetery tidy. Autumn and early winter is the preparation period for the next season.

Work environment: The work area is predetermined and transport needs rarely exceed 2 km. There are civilians around him when he works and there are regularly situations where he needs to work as quiet as possible.

Typical work day: He meets the other 10 people in his gardening group at around 9 am. They go through the tasks of the day and then walk to their area of the cemetery. Sometimes you get a ride on one of the two electrical cars that the group has access to. Who drives the car is up to the manager that plans the activities of the day, since there are only 2 seats available in each car. Equipment that they use throughout the day is fetched from the two electric vehicles before work commences. At 12 they start walking back to the house to eat lunch although they often eat lunch outside if the weather is nice. They then resume work until 5 pm when the work day is over.



Work conditions: Work is conducted outside in the cemetery independent of weather conditions. He dresses warm in the morning and removes clothing when the temperature rises.

Vehicles used: Modified Melex (Fig. 46 on page 49), pickups and Wille compact tractors

Equipment/material used: Small trailer for Melex, rakes, shovels, brush cutters, helmets, pots, buckets, dirt, gravel, sawdust, spruce spray, garbage bags, tool box, water bottle, brushes, knives, pruning shears (Fig. 45), ear muffs, paper binder, rain clothes, thermos and sometimes lunch.

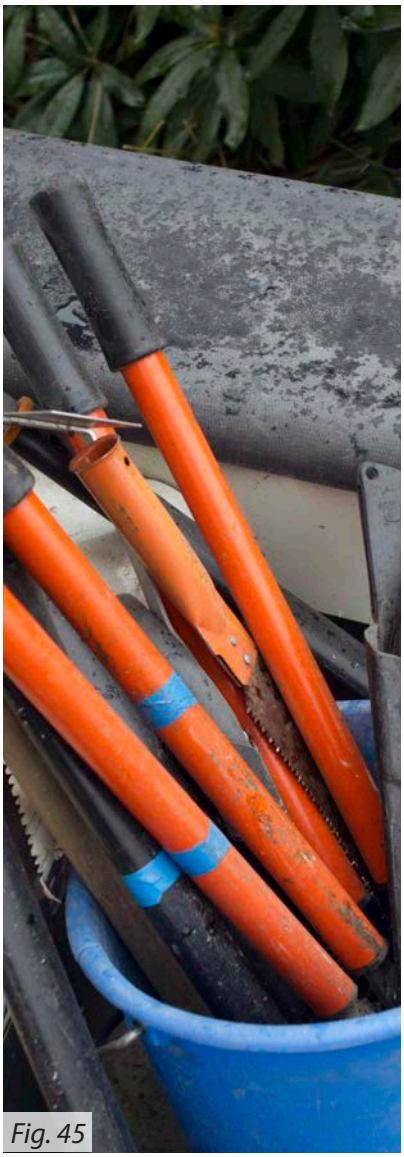


Fig. 45

Development needs
He is looking for a vehicle with larger storage capacity, mainly weight vise but also volume. He also wants a better storage solution for the long items that they need to have with them without adding width to the vehicle or removing the possibility of a passenger seat. Their current solution is a homemade storage solution on the roof. Another thing that annoys him is the fact that the seat gets wet when it rains; this is particularly frustrating when it is cold outside.

They currently don't have any cargo bed on their Melex (Fig. 47) but wouldn't mind it if it would still allow them to use the trailer if needed. A tipping solution that provides a steep tipping angle while being easy to use, even when the cargo bed is fully loaded, would be appreciated.

He would also like a small compartment where he can keep papers and stuff that is sensitive to water. Two to three extra seats wouldn't hurt either.

Selling points
Cargo capacity
Nimble
Quality

5.2.4 Discussion

The creation of an accurate persona relies heavily on the research that goes into it. Second hand data can be used but the method is truly valuable when it is used as a summary for a larger amount of data that might be time consuming for external partners too process. This can be seen when comparing the first version of the persona (Appendix 2) with the final result created after the user studies. The story format also creates a natural way of selecting customer segments as it demands unique traits to be able to form interesting character stories.

One danger with the persona creation is over simplification in order to reduce the number of personas to a manageable number. For example all three segments listed in the result section above include both young and old co-workers with

Fig. 46

varying degrees of experience and could therefore theoretically warrant a higher number of personas to cover all types. It is therefore important question if a certain trait is unique for a certain segment.

5.2.5 Conclusion

The vehicle will be separated into two different vehicle configurations based on the personas. The new vehicle configurations will be named "Worker" and "Logistic"

Mr. Fixer and Mr. Garden are fairly similar in their basic demands and will be viewed as the same segment, Worker configuration, in the future. Identified differences are so small that purchasable options can bridge the gap between them. This can be seen in Table. 5 where the usage frequenzy is shown in speed and distance.

Users in this segment are looking for a sturdy vehicle without the need for daily maintenance. They are accustomed to the low range on their current vehicles and need to experience the benefits of longer range before they will alter their organization in such a way that they will benefit from it.

The price of the basic vehicle will influence their purchase heavily since there are established competitors on the market. It is therefore important to offer add-on packages that can be mounted to the vehicle.

As seen in Table. 5 Ms. Delivery is a more demanding user that hasn't found a suitable electric vehicle on the market yet. The cars used today offer a poor work environment and adaptations to improve it are in most cases aftermarket modifications. A purpose built electric vehicle that can meet the minimum performance demands will therefore be very attractive.

The vehicle needs to feel at home in an urban environment and be viewed as a small car. Cargo needs to be stored dry and large portion should be stored inside the cabin. Long delivery runs requires a cabin comfort that is on par with cars in the low-price segment.

Ms. Delivery, Logistic vehicle configuration, will be seen as the primary user segment.

Fig. 47

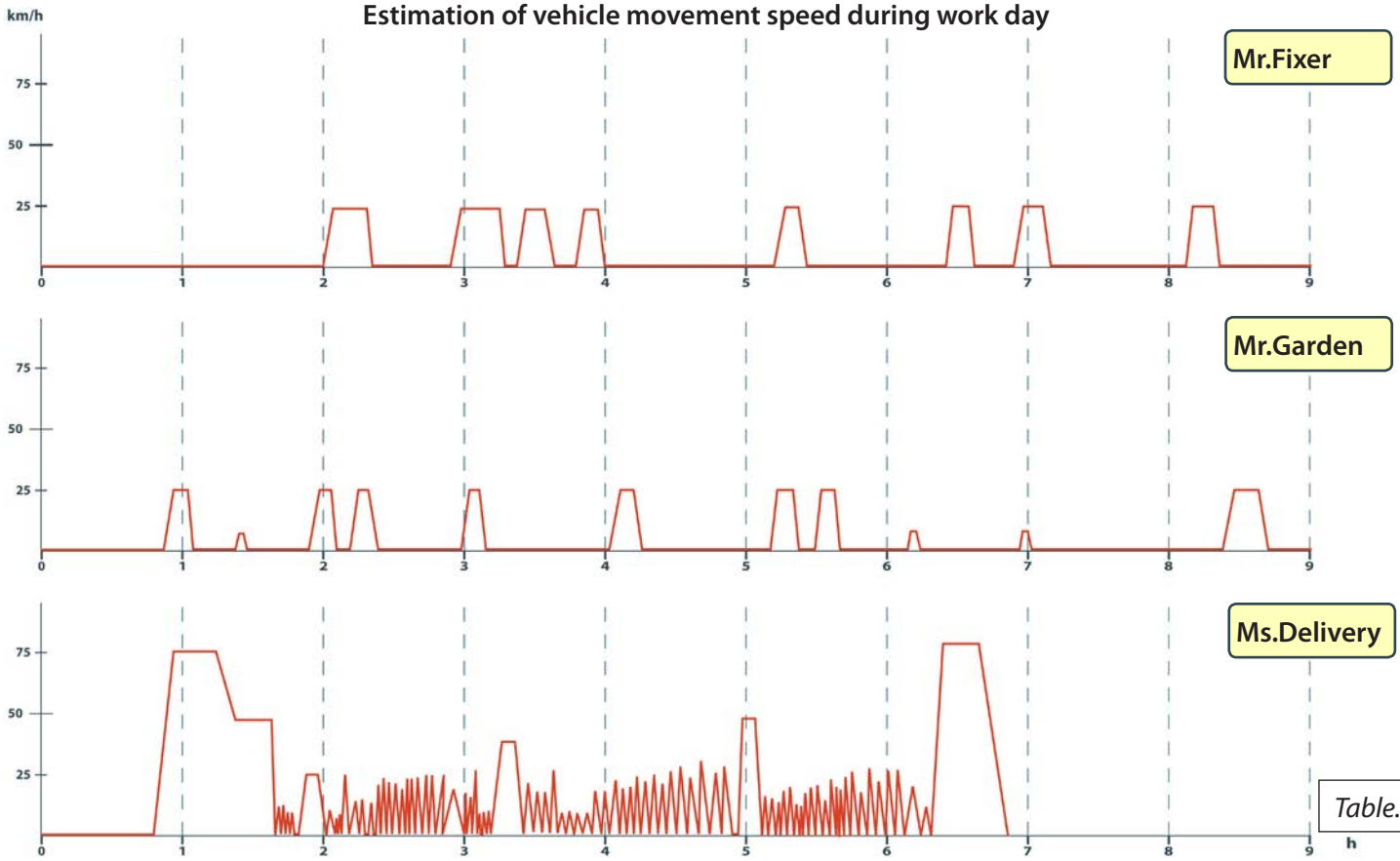


Table. 5

5.3 Need analysis

5.3.1 Purpose

The need analysis collects and organizes all of the requirements that have emerged from the information collecting techniques described in this and previous chapters. The need analysis is conducted in order to acquire an objective overview for the whole requirement image. The need analysis also works as the foundation for the Pugh analysis and this chapter will therefore intertwine with the Pugh chapter even though the Pugh was used later in the developing process.

5.3.2 Method

The need analysis is created in an excel chart where a different user need was placed on each row. The stated needs where then followed up with a comment column clarifying the need further and explaining the surrounding situation. Each need was then linked to the original sources where the need was identified. If the need came from several independent sources then they were all listed in the source column. This made it possible to make a quick evaluation of the importance and credibility of each individual need. A need with none or few sources was considered less urgent to fulfil compared to needs mentioned by several sources.

The needs were then sorted as either basic needs or performance needs, where the basic needs must be fulfilled while the others were rated on a scale from 1-6 based on the importance for the primary user segment (Logistic) and then again based on the importance of the secondary segment (Worker). As a preparation for the Pugh matrix the non basic needs were coupled together in categories based on different design purposes (the reasoning behind this is explained further in the Pugh chapter). For example needs that would lead to better comfort were sorted under the "Comfort" category.

A combination of discussions with personnel from Nimbell and a final workshop was then initiated and during which a total of 200 category points where distributed among the categories (Fig. 48); once based on the primary segment and once on the secondary segment. The allocation of the category points were done without disclosing individual demands within the categories to avoid the possibility of bias affecting the outcome. The category comfort as an example was given 40 points for the Logistic segment but only 20 points for the worker segment. This was done in order to implement the views of the marketing, finance and construction "departments" into both the project and the need analysis.

The original weight of each need was then combined with points given to its category creating a new weight using the following formula:

[=(budget value/sum(the weights of the first row to last row in subcategory))*specific needs weight]

Example:

[=(E5/**sum**(E6:E15))*E6]

This new weight gives a good representation of the importance of an individual need when viewed through the overlying strategy of the company behind the product.

5.3.3 Results

The result that came from using this method was an excel chart where 140 specified user needs and demands were sorted and analyzed based on their importance and their impact on the design. All of the needs were given a value from 1-6 in order to represent this in a numerical fashion. The list was thereafter sorted into 7 different categories based on different design purposes. Points were distributed between the different categories once for Logistic and once for Worker. The total

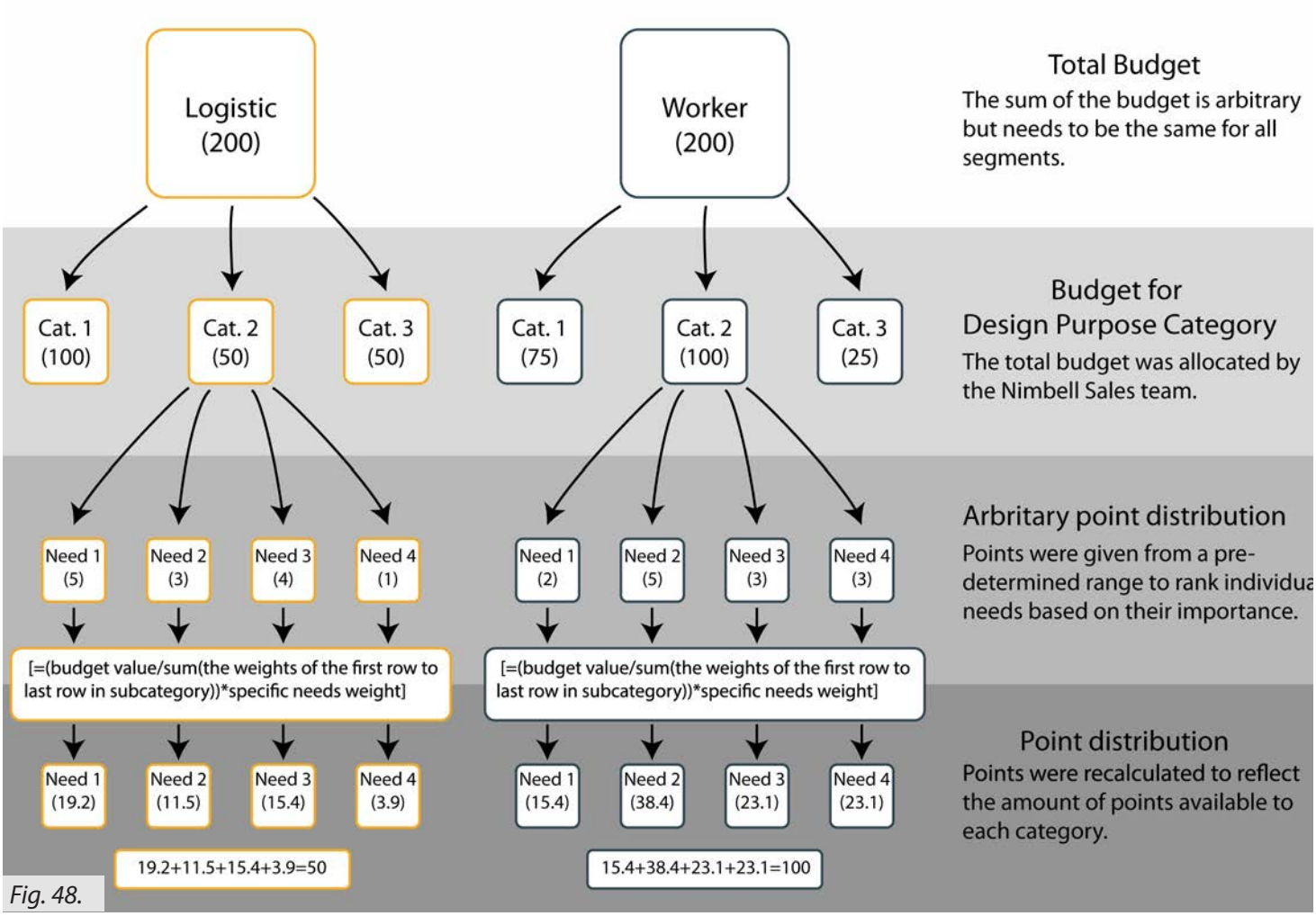


Fig. 48.

amount of available points for each segment was set to 200 points. If for example the comfort category were to be budgeted with 200 points then the remaining category would not receive any points as there would be no more to give. The points allocated to a category would then determine the importance of the needs identified in that category. The point distribution can be seen below:

Comfort:

Logistic: 40 Worker: 20

The comfort category is dominated by Logistic needs as this user segment spends a higher degree of their working day inside the vehicle. This segment also has higher expectations on their vehicle as a majority are used to driving regular cars.

Comfort is valued lower for the worker segment as the users tend to spend more time working in close proximity to their vehicle. The distances traveled within this segment are also relatively short.

Communicate brand values and semantic creditability for its tasks:

Logistic: 30 Worker: 20

The Logistic segment is given a slightly higher value here to accommodate for the fact that much of their market presence is exerted through their vehicles and delivery personnel. What they drive defines, to some extent, the type of company they are.

The worker segment doesn't have the same need for brand communication. The challenge here is to create a product that can convey the robustness needed for the user to feel confident in the vehicles capability to perform on a day to day basis.

Increase customer happiness and differentiation from competitors:

Logistic: 20 Worker: 40

The Logistic segment has received a quite low value in this category due to the lack of strong competitors on the market with similar traits. The vehicle needs to rather meet the basic performance demands to compete in this segment.

The high value for the worker segment is motivated by the fact that the minimum performance bar required to be effective is much lower compared to logistic. This increases the number of viable competitors that a potential purchaser has to choose from. Offering the correct features along with the basic vehicle becomes more important.

Increase ease and performance of usage:

Logistic: 50 Worker: 40

Delivery runs involve long distances with continuous start and stop cycles making it a challenge even for modern vehicles. The predetermined routes are also very time sensitive and therefore require a vehicle that works in an intuitive manner. These two arguments together motivates the high amount of points budgeted to this category in this category.

Users within the worker segment have adapted their work patterns to the range limitations of their current golf cars. The high point value that may at first hand seem as unwarranted is put their in order to influence their usage patterns. Introducing them to a vehicle capable of transporting them between different working sites will remove the need to store tools and vehicles locally.

Increase the safety for the user:

Logistic: 20 Worker: 10

Both of the segments have been given low values in this category. The underlying reason was that the vehicle should meet the safety standard of its competitors but not exceed it. The Logistic segment was however given a slightly higher value to compensate for the amount of time it would spend on public roads.

Increase the usage time due to robust design and easy repairs:

Logistic: 30 Worker: 30

The companies within the Logistic segment all manage large vehicle fleets that experience a higher amount of wear and tear than normal. Reducing the amount of repairs needed will be one of the strongest selling points when comparing it with a regular car.

One of the most frequent complaints, from the worker segment, towards their current electric vehicles is the frequent service that is needed. Reducing it to a point where user performed service tasks are no longer needed would be beneficial.

Increase the vehicles use areas and flexibility:

Logistic: 10 Worker: 40

The work tasks within the Logistic segment remain similar independent of the company that performs the service. The need for flexibility is therefore quite low.

The tools and tasks for the Worker segment vary from site to site and the vehicle used needs to adapt to these changes. This is currently solved by different modification performed by the users themselves. Developing solutions to these problems would demonstrate an understanding for the users need.

Identified needs

The needs within the categories presented on the previous page can be seen in appendix 4 and will form the basis for all future concept developments. The amounts of demands make it impractical to present them all, the needs that received the highest scores after implementing the categorization weights are therefore presented in Table. 6. Weight points in the first column is the values given to each individual need and the second column shows the weight after the value of each need has been adjusted according to the importance of its category.

5.3.4 Conclusion

The need for being able to customize the vehicle is larger in the worker segment. How they use the vehicle is dependent on what other machinery that is available to them as well as the geographic characteristics of the area that they are working in. They are dressed for outdoor activities and prioritize vehicle robustness over comfort. Vehicles that they use are not seen as status symbols representing the company in public in the same way as in the logistic segment.

Personnel in the logistic segment spend a great deal of their working day inside their vehicle and therefore require a cabin adapted for this purpose. This also requires a larger battery capacity in order to be able to handle a full day of deliveries. They too tend to damage their vehicles in a similar extent when compared to the worker segment but have a larger need of promoting the company through the vehicles that they drive. The cargo that they carry is also more sensitive raising the demands on the vehicles storage facilities.

The main difficulty in covering both segments with one product will be to create a vehicle where the design feels complete on all vehicle configurations. Another

Logistic	Pre	Post
Damage Protection	4	6
Allow customer branding	5	5.8
Protect driver from vind	6	5.3
Allow mail delivery from drivers standard position	5	5.1
Cargo area should fit with Posten standard boxes	5	5.1
Reach cargo stored in cabin from driver´s position	5	5.1
Provide good manuvrebility	5	5.1
Allow high operating time	5	5.1
Allow safe transport	5	5
Appear professional	4	4.6
Appeal to target customers	4	4.6
Offer god environmental protection for sensitive vehicle parts	3	4.5
Provide easy access to the cabin	5	4.4

Worker	Pre	Post
Customisation using different components (pre sale)	5	6.5
Minimize width (110-135)	5	6.5
Bring extra person	5	6.5
Damage protection	4	5.7
Ability to pull trailers	4	5.2
Enable a high tip angle	5	4.9
Offer good environmental protection for sensitive vehicle parts	3	4.3
Ease of exchanging battery	3	4.3
Provide good manuvrebility	4	3.9
Allow fast charge	4	3.9
Options for extra high cargo bed sides	4	3.9
Replaceable battery	3	3.9
Flexible/detacheable weather protection for cargo on cargo bed	3	3.9

Table. 6 The top scoring needs for the Logistic and Worker segments.

challenge is to create a vehicle expression that doesn't appear too fragile when viewed from the worker segment perspective while at the same time not being too crude for the logistic segment.

5.3.5 Secondary value and uses for the need analysis.

The purpose of the need analysis is to collect and organize information from several previous information gathering methods and also to be a foundation for the Pugh matrix later on. During the need analysis other benefits of the method were also revealed and are presented below.

Personal processing of user needs and complexity of the product
One of the unexpected but useful side effects of the need analysis in particular but also for analysis tools in general was the personal processing that occurred. The need analysis gave an holistic view of demands stated by parties other than the user. Demands from manufacturing, market, sales, maintenance and purchaser are easily missed when developing from a user perspective. Understanding that the buyer and user may have different sets of needs is important. A great product still needs to reach the user before it can be appreciated.

Discussion groundwork for communication with Nimbell
During development and cooperation with Nimbell different priorities from the different departments: manufacturing, economics and design made it hard to develop a mutual understanding of each other's perception of which aspects are important and which should be a priority to develop and later on include in the final design. The need analysis worked as a communication tool for ideas and concepts where the importance of these concepts could be attributed with both our and their point distribution. The grouping and group weights also lead to a mutual understanding because Nimbells developers could give their view on the importance of brand element, semantic design and form design. It worked as a eye opener when comparing the importance of visual and user centered demands against construction and performance demands. This effect worked both ways as the developers could argue for their cause as well.

User group analysis and target market analysis
The excell chart (appendix 4) visualizes the possibilities and disadvantages with the design when viewed by different user groups. A design purpose such as "increase performance and usability" showed great possibility due to the three wheel design and powerful drivetrain solutions that almost only were beneficial towards the logistics user group. Because of the use of a dynamic excel chart it was possible for the different departments within Nimbell to add and discuss their own numbers and views until a mutual value were agreed upon.

Priority evaluator within the development group
As with the communication with Nimbell where different views made it hard to agree on different solutions, the same were true for within the project group except for that the agendas were more similar. When processing the needs and together adding the values an understanding and discussion are made until agreement.

Creative idea generation underlay
The need analysis were used as a underlay for creative ide generation in sketch form as well as mockup form, specific needs shown to have big impact or previously ignored were brought up and solutions were developed around them.

Several workshops were conducted together with Nimbell around the need analysis where the values, design purposes and priorities were discussed. This approach resulted in a better mutual understanding between the project owners Nimbell and the project group but also within the project group. The initially proposed and generic uses of the method to collect needs are overshadowed by the importance of the secondary usage areas of the method.

5.4 Discussion

The demands and wishes found during the user studies and information gathering shows a high amount of improvement possibilities based on the current competitors encountered on the market. Most competing vehicles cannot be considered to be fully developed products but should rather be viewed as construction solutions forced through a series of production limitations. This is unfortunately something that is a imminent danger for Trigo as well considering that Nimbell in the role of a start up company has a limited budget. It is therefore important that the strengths of available low production methods are maximized in the design while always checking that the developed concepts are feasible without design altering compromises further down the production process.

The personas further strengthen the demand for a highly customizable vehicle with the added strain on the flexibility of the design that follows. It should be successful in communicating the product core values independent of the individual configuration that a potential customer has ordered. The configuration need does have some advantages as well since it gives the opportunity to enhance certain core values towards specific customer segments. One example could be the design of a potential cargo bed module targeted towards the gardening segment, such a module could benefit from conveying confidence rather than nimble and refreshing.

6. Idea Generation

Finding new solutions and ideas through problems experienced by the user is a cornerstone in product development. This chapter describes how the functional solutions incorporated into the final concept were created.

6.1 Userproblem - solution matrix

6.1.1 Purpose

During the user study phase ideas tend to form during interactions with users. The user problem matrix (Fig. 49) was created based on this need to store differently defined ideas together with their corresponding user problems and user needs. The link between idea and user need is important to motivate why they should be realized but can also be used to uncover both new needs and ideas. It also encourage looking for sub-ideas and different versions of every idea. Having all ideas collected in one place made it possible to use the document as a priority and planning document for the project regarding further development of ideas, visualization needs etc.

6.1.2 Method

Identified user problems were written down in a column and ideas that would solve this were placed in the cells adjacent to it. Thereafter ideas were created to fill in the gaps in the matrix. Some ideas emerged before having an observed need that it could solve, the user problem that idea solves were defined afterward's. If no user problem and need could be defiend the idea cold be discarded as irrelavant for the product. This made it easy to verify the need for an idea and to find different ideas based on needs. A small brainstorm session was conducted on every need and problem. Osborns idea spurs were used on previous ideas to redevelop them. Also the document helped with inspiration for sketching sessions.

The matrix was stored by an online spread cheat to make the document available when it was needed.

The matrix were roughly layouted as following:

Defenition of need or user problems	**Different priority levels for sorting and filtering**	**Defenition of different solutions and comments**

Defenition of needs or user problems
When an idea suddenly appeared during the development, it was redefined as a solution and the corresponding need were defined. Sometime the solution was better to connect to a specific user-problem when the underlying need is too wide, Such as:

Need: –Have a safe work environment for the user.
Specific user problem: –The user steps on the pedal on the way out.

In these cases the user problem were used in the matrix instead of the need as it is more relevant for the brainstorming.

However some needs were directly inserted from the need analysis if the need were the type that could connect to a certain solution such as:

Need: - the cargo must be protected from weather.
Specific user problem: – The cargo gets wet.

In these examples the need were used instead of the problem formulation as it eases the process.

Different priority levels.
During different idea generation sessions the need for filtering and sorting the ideas emerged. This was made by creating priority level columns. Many different priorities were used such as:

• Sketch priority – The problems/solutions must, should or need not to be illustrated

• Find solutions priority – The problem/need must, should, needs not to be solved (similar to the weight levels in the need analysis)

• Test priority on the mockup – The problem/solutions must, should, need not to be tested.

Defenition of different solutions and comments
The development work was then made from high to low priority as illustrated in Fig. 49.

Wide use of color.
The filtering and status updates were all illustrated by colors in the document.

• The different priority levels were illustrated by color. From green (must) to red (needs not to)

• Status updates for individual solutions, such as: The solution are illustrated (green), illustration Initiated (yellow) Must be made soon (red) Other status updates could be on the other priorities.

• Value of the solution: a filtering were made so that what were considered a good solution (green) probable solution (yellow) were filtered out for further use in the development process.

6.1.3 Results

The results from the idea-solution matrix are 70 collected user-problems and needs with an average of four solutions for each, many which are illustrated. The full list is considered to be a competitive advantage for Nimbell and can therefore not be displayed as a whole in the report. However a illustrated examples can be seen in Fig. 56 on page 67.

6.1.4 Discussion

The idea solution matrix showed to be a good method in all its uses. As a documenting place for the sudden ideas it worked well because these ideas instantly connected to user need and the need analysis, also it prevented ideas from getting lost as they tend to do when they are written down on a scrap piece of paper, in a notebook or not at all.

As an idea generation tool, the method was excellent as it could give an endless supply of inspiration for brainstorming and sketching. There were always an empty spot, indicating a problem that needed to be solved or sketched.

The last use for the matrix was as a planning document when the implementation of the ideas was to be tested. It was a good way to properly evaluate all of the solution in a controlled way. The downside for this additional usage of the matrix was the filtering and sorting. For this it tended to be a bit cluttered and hard to understand due to many colors with different meaning on different spots. A better way to filter, sort and "tag" different needs and solution could increase the usability of the method.

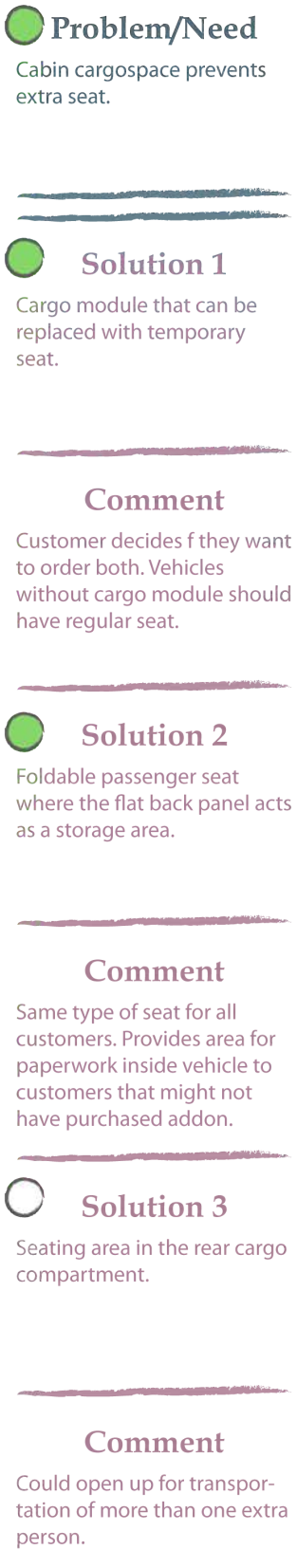


Fig. 49

Fig. 50 An early version of the mockup created to provide a mental model of the vehicle size during initial idea generation.

Fig. 51 A later stage of the early mockup. A dashboard and seats have been added to represent the cabin volyme in a more realistic manner.

6.2 Earlymockupconstruction

The mockup is a very versatile development tool where physical representations of ideas or existing products are used to simulate different use scenarios. It has been an integral part of almost every phase in the development process during this project. The purpose of it has however changed significantly during the project and the method has therefore been divided into two phases named early and late mockup construction (chap. 8.1). The first phase was an explorative and experimental phase to give understanding of the proportions and space of the vehicle. The second phase were used later to make adjustments and ergonomic fine tuning of the decided vehicle.

6.2.1 Purpose

The early mockup construction were initiated during the start of the idea generation phase. The purpose of the method was to act as a physical framework for the other idea generation tools as well as an own idea generation tool.

Another main usage for the mockup is as an ergonomic testing rig where the interior and exterior design are developed based on ergonomic measurements and tests conducted on the mockup.

6.2.2 Method

Several mockup sessions were conducted in which the project group would re-enact user problems and tasks uncovered in the user study to get a more intimate understanding of the source of the problem. The physical shape of the mockup itself varied between each session and would during the initial sessions consist of items found in a regular office. For

example a tabletop would act as a cargo area, a doorpost as the A and B pillar and a dining plate would serve as the steering wheel. This later progressed in a more advanced mockup constructed in a prototype workshop, the progressions can be seen by comparing Fig. 50 with Fig. 51. This mockup was based on the construction measurements provided by Nimbell. A conveyor belt construction set of aluminium profiles were used as the skeleton of the construction and plywood surfaces were attached on to these. The testing surfaces of the construction were made by cardboard and Styrofoam that could easily be reshaped and replaced.

The re-enactment process did however remain the same independent of what the mockup consisted of. A problem or need discovered in the earlier phases of the project was simulated and debated with four focus topics in mind.

How – What exactly is it that is causing the problem?

Why – What underlying factors contributes to the problem arising at all?

Severity – What are the potential consequences of this problem and how does it compare with the other problems identified?

Solutions – What can be changed to prevent the problem from arising?

Some solutions were then implemented into the mockup and a new session started to validate those changes. A positive side effect to this method was that new problems were uncovered during these reenactments and made it possible to apply the method to them as well.

6.2.3 Result

The main contribution from the mockups has been gathered in the idea solution matrix described in chapter 6.1. This matrix does however gather input from several sources and it can therefore be worthwhile to mention the more important results generated through the mockup.

• The importance of an L-shaped cargo platform was re-evaluated and other solutions were brought forward.

• The cargo area in front of the steering wheel was re-examined from an ergonomically standpoint.

• A glove compartment was added to create storage for personal belongings.

• A conflict between a correct positioning of the steering wheel and the ability of handling mail inside the cabin was identified.

• The information that the ability to estimate the vehicle width was hindered by the cone shape of the vehicle was discovered.

6.2.4 Discussion

The implementation of rough mockups throughout the initial parts of the project produced some solutions and uncovered a few problems that would otherwise have been overlooked. Examples of both types can be found in the problem/solution matrix described in chapter 6.1. The combination of mockup and idea generation also created a greater confidence in the ideas selected. Evaluating them on a static object removed the simplifications often imposed on conceptual ideas and made it easy to determine if they were unrealistic. This was especially important on the carry over ideas from previous project work done before this project. For example the L-shaped cargo solution was already implemented in the prototype and was a heritage that had been carried forward through all of the previous projects involving the vehicle. This cargo solution had been questioned in the user study but it was not until we had evaluated it in the mockup that the supporting arguments for its removal as the primary cargo solution were strong enough.

7. Concept generation

The Concept generation phase takes the individual ideas from the idea generation and merges them to holistic concepts where the full user and usage needs are considered as well as brand, aesthetics and market influences. Due to some uncertainties on behalf of Nimbell, regarding manufacturing limitations, brand focus and the design goals different expressions and user group focuses were explored (that should have already been decided upon during the user study).

The proposed manufacturing methods, going in to the concept generation phase, were a combination of tube bending and sheet metal. This imposed severe limitations on the product expressions that could be achieved. The design group therefore decided to develop concepts that would be feasible with this limitation in mind but also explored concepts in parallel were alternative manufacturing methods were considered. The hope was to show what would be lost and gained by choosing one manufacturing method over another.

7.1 Inspiration Board

7.1.1 Purpose

An Inspiration board functions as a common reference point for the project members during the concept generation. It can be used in several different manners from pointing out a certain design direction for other project members to showing particular details such as design lines or clever solutions of problems. The common denominator is the communication by visual imagery during concept discussions.

7.1.2 Method

The board is a collection of graphics and images displayed on larger paper formats (A1) to create a wall of imagery. It should be placed in such a way that it is easily visible during idea generation and sketching phases.

The images are in most cases gathered by the project group and follow a theme agreed upon before the work is commenced. The images usually have an equal amount of space but may vary in size if it is preferable to highlight certain images.

7.1.3 Results

Approximately 100 images were gathered, mainly consisting of different transport and cargo vehicles. These were printed on several large A1 sheets and arranged in two categories, consisting of design- and function-oriented imagery, and mounted on cardboard sheets to make it easy to move around. The large image boards were then complemented with several A3 sized papers containing images of potential users to serve as a reminder of the personas created earlier (chapter 2).

7.1.4 Discussion

The inspirational boards Fig. 52 were consistently used throughout the project although the medium in which they were displayed varied a lot during the project. Digital inspirational boards were used as a substitute to gain more mobility but had the negative side effect of being limited to the available screen real estate. An unforeseen benefit with the digital format was the ease of adding new images (Fig. 53) to the existing collection that grew throughout the project.

The Inspirational boards created throughout the project have been a powerful communication tool both internally and to external stakeholders. It has made it easy to share design intentions and to highlight differences between different conceptual ideas. They have allowed for a very practical approach when communicating with the mechanical engineers that have worked alongside us for the whole length of the project. The boards have been the reference point when design features have been questioned due to construction or price concerns and have allowed the design team to show how they are used in other products. It has also functioned as a motivator to create a better vehicle then the ones displayed on the boards.

Fig. 52

Fig. 53

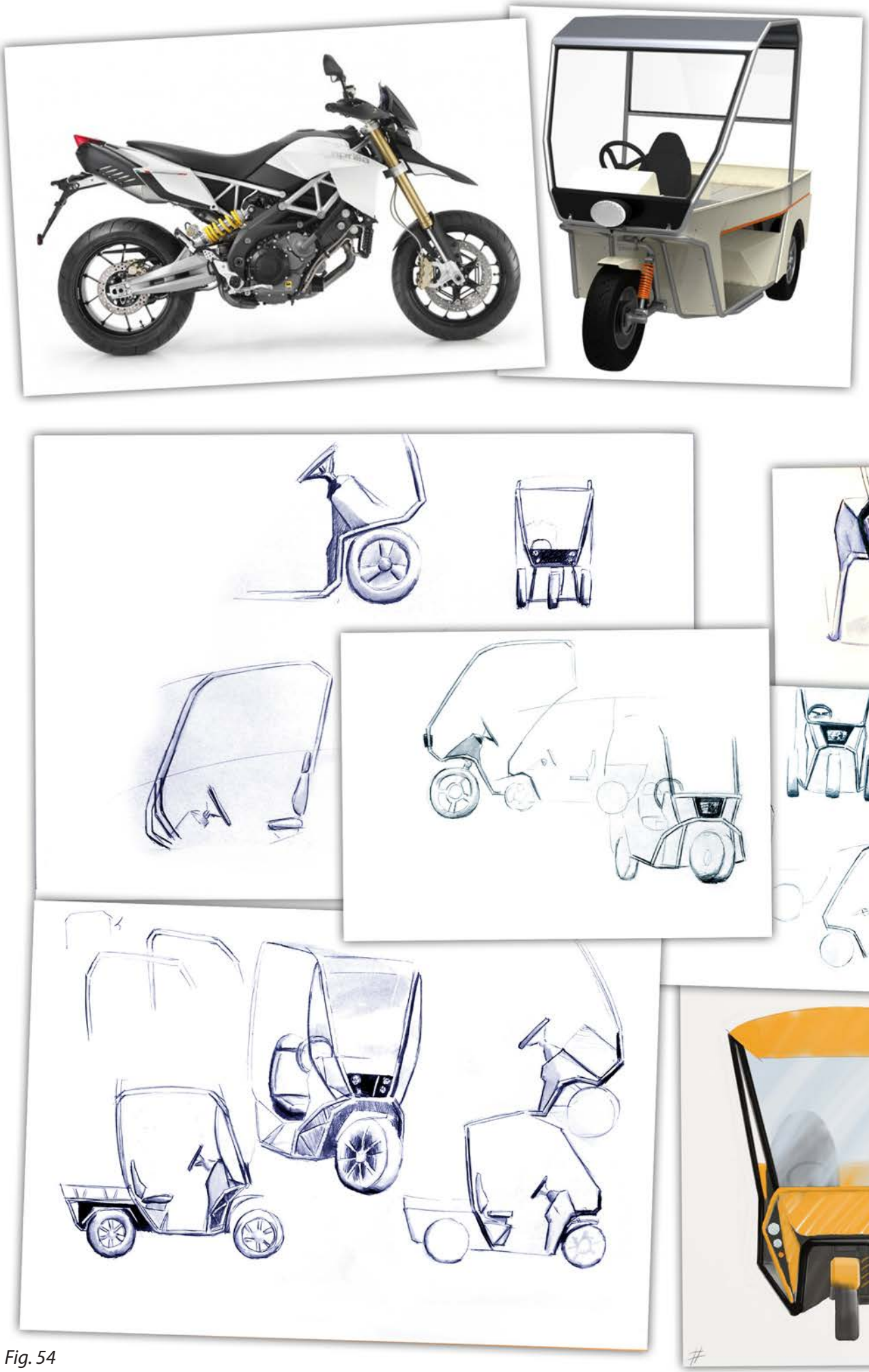
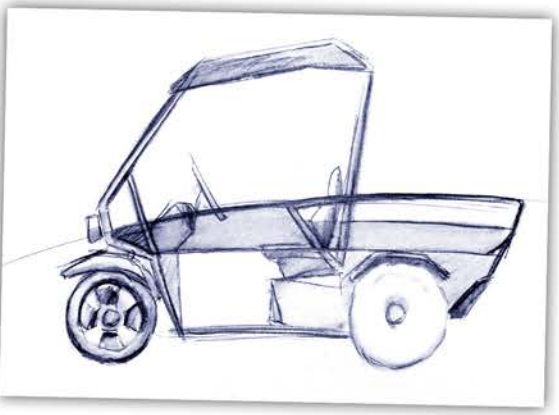


Fig. 54

7.2 Form development

Previous to this master thesis a major mechanical re design of the vehicle were made due to a move from a side cart to a trike model. This together with other changes in the vehicle demands such as cabin weather protection and newly uncovered legal demands associated with the width of the windscreen created a need for a thorough visual re-design that went a lot further than originally planned.



The limitations from Nimbell at this stage were:

- The concepts must be possible to manufacture in a small series of 1-3 vehicles at a low cost.
- Use of plastics are not desired
- The manufacturing partner does not have the equipment to make large curved surfaces and complex tube bends.
- The design may not affect the function of the substructure or chassis.
- The design should be possible to apply on a larger production series with minimal alterations.

The design experience during the form development phase was formed from the three base product key words (chap. 2); Nimble, Refreshing and Confident. These were built upon and expanded during the project. Iterations of the design experience is summarized in chap. 7.2.6 and 8.4.

7.2.1 Sketching

Purpose

Sketching is a fast and efficient way of exploring different shapes and connections to function; the freeform sketching sessions in this project were often closely connected to function developing and especially the problem solution matrix.

This chapter are not chronically arranged in the development process as the sketching process were made parallel to the whole project.

Fig. 55

Method

Except for pure free form exploration sessions, there are two structured ways the sketches have been done:

The first was to have several inspiration boards (Fig. 52 on page 62) in front while sketching. Different sketch concepts have been explored by picking suitable shapes, expressions or solutions from these inspiration boards and applying them on the trike vehicle. For instance if agility were a desired expression, different agile shapes from other insporational products were applied into the sketch.

The other is by applying ideas from the problem solution matrix into visual sketches.

Result

The first image set (Fig. 54 on page 63) illustrates ideas influenced by earlier concepts created by Nimbell. These have exposed bent tubing as the main design driver. Conveying a feeling of a robust structure ready to absorb impact while at the same time creating associations to the more agile types of motorcycles. The two inspirations are examplified in the top left corner of Fig. 54. Early sketches were also heavily affected by the fact that the next generation would be manufactured with the same methods as the prototype. This changed during the progression of the form development and an exception was made to accommodate the need for a freeform front cover as can be seen in Fig. 55.

After the initial user study meetings with gardeners from Västra kyrkogården amongst others the desired expression changed from light/agile towards more robust, the main inspiration segment were from ATW (all terrain vehicles) and other four wheel driven (4x4) vehicles. During this phase it was still undecided whether to use a freeform front cover or rely only on flat sheet metal panels. Some of the designs reflected this limitation while others were allowed to explore the possibilities of freeform.

Later during this phase the facet design expression as well as the forward leaning knee-joint wheelhouse was developed. Also the use of steel tube front guard was implemented in the design due to feedback from the ongoing user study.

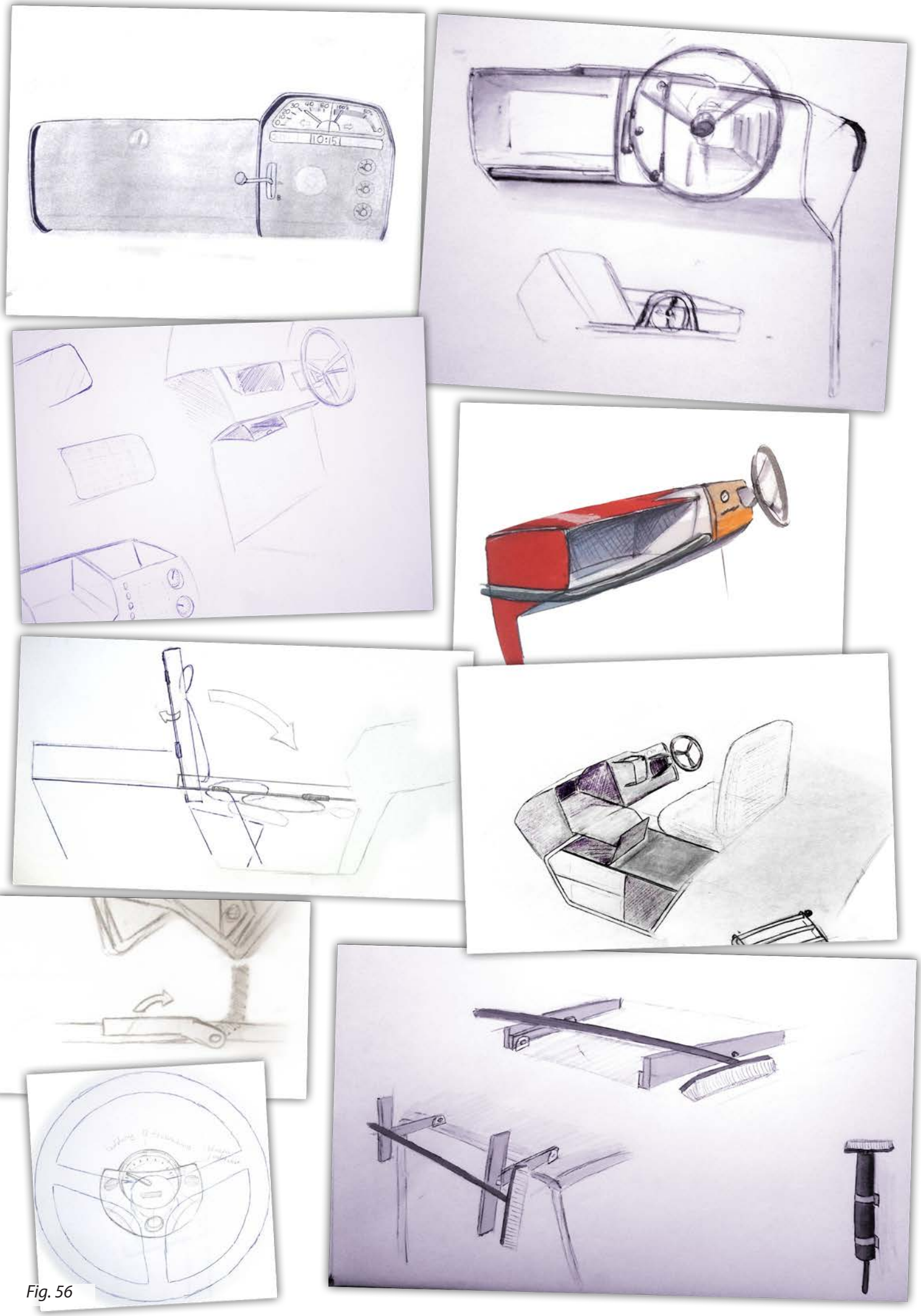
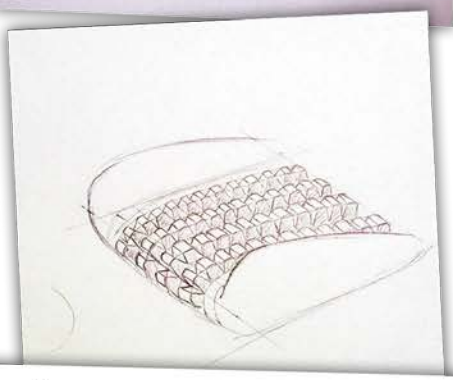
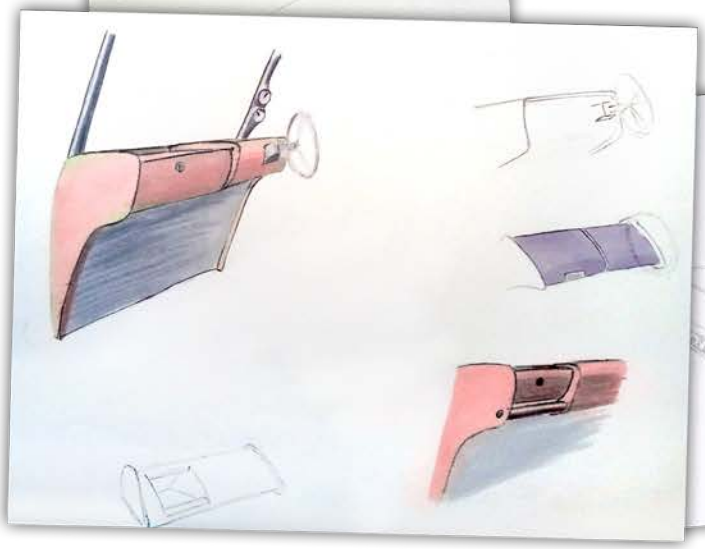
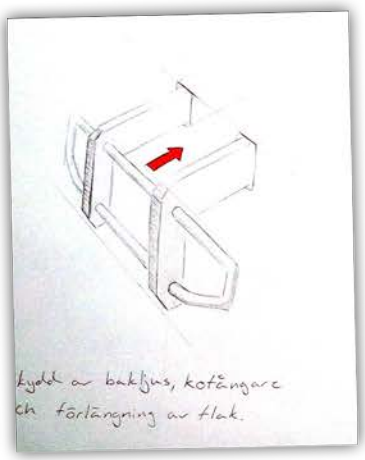


Fig. 56







During the end of the sketch phase the delivery and postal usage of the vehicle were again brought forward due to a strategy meeting at Nimbell, which eased up the terrain expression of the design and tried to make it more adapted to an urban environment moving the design language towards cars and personal vehicles. One big decision to be made in this phase was whether to place the "hood" in front of the window or inside the window.

(Fig. 56) shows examples of the exploration of detail and idea sketches made as an supplement to the idea-solution matrix (chapter 6.1). Also different interior expressions were explored. The interior were during the entire time limited by the construction demand to only use metal surfaces. As a consequence to this the interior design were minimalistic and got inspiration from older sport cars, airplanes and boats which features a single metal surface with gloves-compartment and instruments. The implementation of a metal tube as a handle as well as a fixing spot for cargo and a hanger for miscellaneous things were explored as seen in many of the sketches. As with the front design and user study, there was initially a greater focus towards the gardener user group but shifted towards delivery later on.

Discussion

Sketching as a form driving method is very efficient and was present during the whole project. The resulting sketches can be divided into three different phases; ideas heavily influenced by the existing material provided at the start of the project, diverging shape explorations and finally refinements on established concepts. A consensus on which areas of the vehicle that would be the main design drivers emerged during the transition between the first and second phase. These areas; front, roof, rear and side area would need to communicate a consistent design to tie together the cabin area with the more robust cargo area. The front was deemed to be the primary design driver, influencing the other areas. A decision was therefore made to establish a design expression for the front and let the other areas react to that in the concept refinement.

Conclusion

- Freeform manufacturing methods enables more powerful visual semantic expression.
- The interior will be largely affected by available standard parts.
- The primary design driver will shape the other design drivers.
- The underlying tube frame should be considered as a design element

Description

- söt - cute
- kreativ - creative
- miljövänlig - eco-friendly
- skadlig - harmfull
- robust - robust
- proffesionell - proffesionell
- smidig - nimble
- stabil - stable
- pålitlig - thrustworthy
- glamorös - glamourus
- mystisk - mysterious
- överdådig - luxurious
- elegant - elegant
- maskulin - maskulin
- feminin - feminine
- skör - fragile
- stark - strong
- Snabb - fast
- säker - secure
- snäll - kind
- gammalmodig - old fashioned
- retro - retro
- alldaglig - quaint
- modern - modern
- praktisk - practical
- ödmjuk - humble
- tråkig - dull
- ärlig - honest

Emotion

- Lycklig - Happiness
- Förvånad - Surprised
- Arg - Angry
- Glad - happy
- Ledsen - sad
- Butter - grumpy
- Extatisk - extatic
- Självsäker - self confident
- Nervös - nervous
- Sexig - sexy
- Stolt - proud
- Lättad - relieved
- Irriterad - irritated
- Avundsjuk - jealous
- Besviken - dissapointed
- Lugn - calm

Table. 7

7.2.2 Concepts and refinement in 3d-cad

Different form directions explored during the sketching sessions were compiled into different groups and reviewed. Several of these were then selected and explored further through simple 3D-models. All of these were based on an existing substructure being developed in parallel by the construction team. This allowed for a better understanding of the manufacturing feasibility of the different concept at an early stage.

Result

Based on the sketches three different concepts were developed into rough 3D models. Slight variations on the themes were done such as adjusting window placements, changing headlights and adding bull guards. Finally three altered models (Fig. 57, Fig. 58 and Fig. 59) were chosen each one representing a different form language.

7.2.3 Semantic concept analysis

The selected concepts from the first 3D session were put through a semantic analysis to confirm the perceived and sought semantic responses that emerged during the modelling process. Images of the existing BEMO prototype were also included into the survey to form a base line for future discussions. The test was conducted on different random test participants as well as the whole Nimbell developing team. Optimal for the test would however be representation of all "design stakeholders" of the project such as buyers, users, manufacturers and relevant spectators from the business. This test is based on neutral parties outside the form development group to give an objective view of what semantic communications spectators without previous knowledge of the project would have.

Method

The main theory behind the semantic test were based on the PPE-framework which is presented in the pre-study (chapter 4.7). This says shortly that to understand the full visual experience of a product one have to consider the following form aspects:

- Impression
- Appreciation
- Emotion
- Recognition
- Comprehension
- Association

As many of the aspects in PPE are based on either experience or actual encounter of the object this test has focused on the ones that are easy and accurate to test with use of product renderings, mostly emotion and association. This were made by letting the participants pick words from preassembled lists (Table. 7) that they thought were descriptive of the vehicles shown to them, booth in regards to the emotion it expresses or generates (such as angry or happy), and interpreted properties of the form (such as Modern or Fast). The participants were also permitted to pick "anti-words" that describes the opposite of the form. (this rule are not used consistently used, read more of this in the discussion)

A smaller unstructured interview were made on the other aspects of the PPE framework, this however were abandoned after a couple of interviews as it took too much time compared to the worth.

Result

Words selected by two or more interviewees are displayed on the previous page(Fig. 57, Fig. 58 and Fig. 59). Green (•) are attributes that comply with vehicle and red (*) are words that is the complete opposite.

Fig. 57

Fig. 58

Fig. 59

- Robust - robust
- Praktisk - practical
- Självsäker - self confident
- Stolt - proud
- Nervös - nervous

- Smidig - nimble
- Snäll - kind
- Ödmjuk - humble
- Skadlig - harmfull

- Ledsen - sad
- Nervös - nervous
- Lugn - calm
- Proffesionell - proffesionell
- Modern - modern
- Praktisk - practical
- Söt - cute
- Snäll - kind
- Feminin - feminine
- Retro - retro

- Arg - angry
- Självsäker - self confident
- Irriterad - irritated
- Lycklig - Happiness
- Glad - happy
- Lättad - relieved

Discussion

The time needed to conduct a test was concluded to take to long during the first set of pilot interviews. This in turn led to a decision to focus on a qualitative approach resulting in a reduction in questions and number of interviews. The participants were also allowed to freely choose how many words that they wanted to pick on each question.

The benefits and disadvantages uncovered during the pilot phase related to how the number of words available to the interviewee should be limited. The different standpoints on the preferred way for a quantitative subjective information gathering is presented below:

- Equal impact between subjects standpoint:
All test participant are obligated to pick a specific number of words to connect with the shape, regardless of how powerfully they agree upon it.

Arguments for:
Every test subject have the equal impact on the final result. If someone is given more picks the one other the test will be ruined because their taste and subjective opinion are over represented. Also the same number of answers on every concept and participant makes it a lot easier to compare the concepts.

Arguments against:
This method could give more inaccurate picks as some are forced. A easy to analyze result but which are more inaccurate and possibly less in quantity have a lower credibility.

- Not forced opinion standpoint:
The participants must agree to a certain degree on a word to pick it and the number of picks are unimportant.

Arguments for:
The goal for the test is to find correlations between the feelings and properties and different shapes and concepts, the possible extra pick are not less true as long as the participant agrees with it strongly, also a forced last pick might be a "if I have to choose" pick which might be more inaccurate.

Arguments against:

Comparing the different designs and analyzing the test may prove difficult if one concept is given more answers then another and give low credibility to conclusions.

Credibility of the test.
Since a mix of the standpoints were used and the "not forced opinion standpoint" ruins the analyzing credibility of comparing the different vehicles. One could argue that in these comparing the credibility are low. However the major trend within each vehicle and its connected feelings and properties could have a much higher credibility.

Conclusion

- The result from the first concept reflected the design intentions (Fig. 57).
- The second concept should appear more confident (Fig. 58).
- The third concept was viewed as far too aggressive (Fig. 59).
- None of the concepts were viewed as modern.
- The level of a feeling/property result between concepts is not comparable.
- The feeling/property levels within the concepts are credible.

7.2.4 Second cad iteration

The input from the semantic analysis was used as a starting point for second form iteration on the 3D-modells previously made. Proportions and design details were altered through joint discussions to reduce or amplify identified traits. During this iteration process a fourth theme also emerged and was added in as a "wild card".

Result

The wild card (Fig. 60) was a late addition to the other more matured concepts. The wider midsection helps to protect the outer side of the driver from rain and mud. It uses a rounder design language that is in stark contrast to the other concepts. Another difference is the front that ends at the windscreen and doesn't protrude into the cabin area. This concept was meant to be the bold modern alternative with the wide mid-section that was to resemble small agile sport road cars such as Renault spider.

Fig. 60

The second concept (Fig. 61)remained unchanged during the second cad iteration. It was meant as the modest workhorse of the thin mid-section concepts. Its shape was also made so that it still were possible to manufacture using sheet metal, something desired by Nimbell.

Fig. 61

The third concept (Fig. 62) was given a makeover in the area around the headlight. The circular cut out for the headlight was tweaked into an oval shape to give it a more purposeful look. This was further enhanced raising the outermost part of the line above the headlight creating a curved hint of an eyebrow. The last change was to change the colour of the lower front surface from yellow to grey. This concept were the modern road vehicle alternative with the thin mid-section.

Changing the position of the windscreen was the largest change in the last concept (Fig. 63). The front bull guard was also changed to reduce the aggressive undertones. The last change affected the top surface which was given a rounded protrusion. This was needed because of the added surface area exposed by the windscreen change. This concept is meant as the robust working alternative with the wide mid-section. It should communicate functionality prior to good looks and also have the possibility to be manufactured in sheet metal.

Fig. 62

7.2.5 Final form decision

The aim of the workshop was to get a final decision regarding primary user group and implementation of a plastic hood. This would then lead to a decision on which concept to develop further. The four concepts represent variations of manufacturing techniques and primary segments.

Method

The final form decision was made together with the Nimbell team in the form of a workshop where different aspects such as, primary user group, manufacturing and changes to the substructure were discussed. The workshop was initiated with a short presentation of each concept. This was then followed by individual input from the workshop members and a joint discussion. Pros and cons for each concept were compared and the development potential of each solution was taken into consideration.

Result

Decisions made during the workshop are presented below.

Discussions of primary user group
A focus shift was made from the Worker segment towards the Logistic segment as the delivery firms appreciated the BEMO prototype more than the worker segment did.

Fig. 63

Adapt the design toward a street use
The design language should be adapted to fit in a street environment, too rough design were to be smoothened. A general shift from heavy duty look towards modern city car look due to the shift towards the logistics sector.

No L shaped cargobed limitation
During this workshop the L-shaped cargo bed with a part in the cabin were being challenged. It were a old idea that were not as well received by the costumers as expected. Janitors wanted two seats, delivery firms wanted to use their own solution. It were therefore decided that the L-shaped cargo bed could be an added feature but the limitation on the design to enable it were removed.

Hourglass shape preferred
During the test and discussions with Nimbel there were concluded that the agile and nimble expression given by the hourglass shaped concepts (Fig. 61 and Fig. 62) were preferred to enhance the main key selling point of the vehicle. It were therefore decided to proceed with one of these.

Use of plastic decided
The increased form freedom, shift towards logistics and desired modernity expression have convinced Nimbell that plastic parts should be used.

Bull guard removed
The move towards a freeform front lead to a decision that the bull guard should be removed. The need to have an extra visual element, masking a visually plain hood no longer existed to the same extent.

7.2.6 Presentation of chosen design experience

All the design decisions connected with the visual experience are here analysed in a PPE manner of dividing the form aspects in: Impression, Appreciation, Emotion, Recognition, Comprehension, Association

Impression: Modern/new vehicle type/unique solutions

The first impression of the vehicle should be of something new and modern that fit in a street environment and expresses its functionality.

Appreciation: Calm/functional/agile

The vehicle should have a calm and harmonic design where different parts fits together and communicates the desired abilities such as agility and performance.

Emotion: Confident

Strive towards a confident emotional expression of the vehicle to convince the users of its abilities. Is should however also be calm and secure rather than to shout about it.

Recognition: professional/road vehicle

It were decided that the design should be recognised more as a professional road vehicle rather than work vehicle or golf car. Also very important to move away from all recognition as a tuc-tuc

Comprehension: hourglass shape

It is desired that the design of the vehicle should communicate its usage areas and its strength. This is made by the forward tilt of parts of the vehicle and the hourglass shape to show the speed and agility. Also the wide base and powerful wheelhouse communicates robustness and shows its professional usage area.

Association

Two important perspectives should be considered when adding association values to the design: the associations communicated from the manufacturer to sell the vehicle and the associations communicated from the user/byer to show their preferences and brand values. In both these cases there were preferable to suppress associations with tuctuc cars and to have a design that associates more with cars and road vehicles rather than golf-cars, except possibly towards the gardener segment.

7.2.7 Selected concept

Input from the workshop lead to a concept selection that can be seen below (Fig. 64, Fig. 65 and Fig. 66).

Fig. 64

Fig. 65

Fig. 66

7.3 Defining the different models

The Worker and Logistic segments will be catered by the same concept vehicle. What will separate them from each other are the accessories that they carry with them. The intention from Nimbell is to have several preconfigured models that cater to both the budget and premium customers.

7.3.1 Method

Possible accessory areas on the vehicle were defined in cooperation with the construction team. Solutions identified in the user problem - solution matrix (chap. 6.1) were then compared with needs that they would solve and the points that those needs had been awarded in the need analysis (chap. 5.4). Some were discarded because they provided little gain to user and others were put on hold because they were deemed to require additional development. The remaining solutions were divided into the premium and basic categories based on a brief cost estimation.

Area	Logistic Premium	Logistic Basic	
Cargo Bed	Hard box, lockable	Soft hood, suported by metal frame	
Cabin solution	Solid Doors	Soft fabric doors suported by metal frame	
Roof module	Roof rack with lights	None	
Dashboard	Cargo module extending into glove department, paperclip, adjustable light	Cargo module extending into glove department,	
Inner Ceiling	Adjustable lighting, radio	Fixed lighting	
Heating	Enclosed heating system, seat heating	External heating system	
Passenger Seat	Cargo module	Cargo module	
Passenger Leg Space	Open cargo space	Open cargo space	
Driver Seat	Premium Seat with height adjustable gas spring.	Premium Seat with slide adjustment	
Hood	Bull guard	None	
Table. 8			

7.3.2 Result

Trigo was divided into four different models, one budget and one premium for each user segment. The accessories given to each can be seen below (Table. 8): Nimbell later decided to combine the Logistic premium and basic into one model.

7.3.3 Discussion

The accessories listed below shows what an ideal version of each model would contain. It should therefore be seen as a goal to work towards by Nimbell rather than something static that should be implemented straight away.

7.3.3 Conclusion

Accesories that can be bought as standard part or delegated to subcontractors should be fast to implement. Accessories requiring internal development projects will take longer time to implement.

	Worker Premium	**Worker Basic**	**Extra Accessories**
	Tiltable flat bed, removable sidecovers with hinged rear cover	Fixed cargo bed, removable sidecovers	Sectiondivider inside cargo bed
	Roof, safetynet covering rear window	None	Roof, solid doors, soft doors
	Roof rack	None	Warning light
	Open glove department, paperclip	Open glove department	Lockable lid for glove department
	Fixed lighting	None	Fan, radio
	Enclosed heating system, seat heating, seat heating	None	External heating
	Foldable seat	Seat	Premium Seat
	Leg space	Leg space	Additional shelves
	Premium Seat with slide adjustment	Seat with slide adjustment	Raincover for seats
	Bull guard	None	Extra lights

7.4 Evolution of design intentions

In the optimal design process the brand values, main target group, material limitations and design intentions should be decided upon prior to the creative phase. Sadly this were not the case due to the novelty of the heavy-trike delivery vehicle and the early stage of Nimbell company where both economical and brand aspects were not established. This led to a process where the design intensions shifted and were iterated many times when defining aspects were changed.

Sketch phase 1
During the initial sketching, the project focus were not on changing the visual expression, therefore the band values from previous work and the expression of the BEMO concept were influential. However new input from testing the BEMO showed that a structural re-design were necessary, and therefore also a more thorough visual re-design. Next page (Fig. 67) shows the visual intensions during this phase. The vehicle was more focused towards street-use and with a robust nimble expression as with the BEMO.

The user study went on alongside with the initial sketching and some basic brand value evaluations were made on gardeners and property caretakers whose importance increased during this stage. These demonstrated that obvious design intensions were considered something bad as they were very construction focused and not so keen on change. Also they were sceptical of the BEMO design, mainly its stability and wear protection.

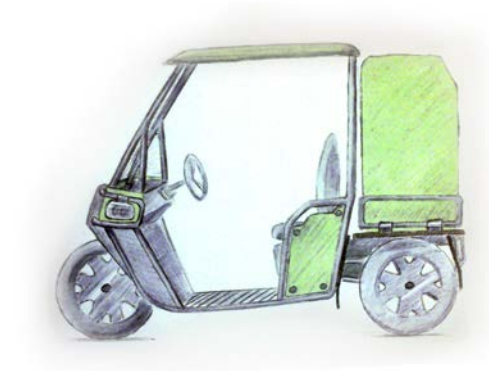
Sketch phase 2
During this phase the design intensions have shifted towards more heavy duty and robust as this were the wish of the gardeners and care-takers. Changes to the structural design of the vehicle led to a situation were plastic parts in the design became an possible option. This was explored but in a way that it would be possible to transfer the design to sheet metal on the prototypes that were developed.

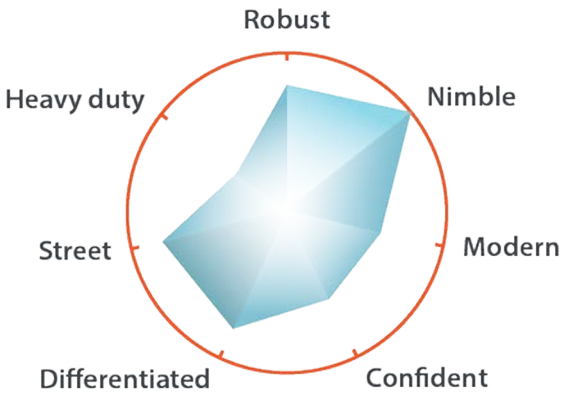
First 3d cad mock-ups
When the shift from 2d sketches to 3d cad the benefits of making freeform surfaces became more obvious, also it made it possible to exaggerate the expressions for a better contrast between the design concepts. It also made it possible to make a more modern look that was preferred by Nimbell despite the gardeners feedback. These designs were then tested with a semantic evaluation that showed that the design needed to be overall less exaggerated.

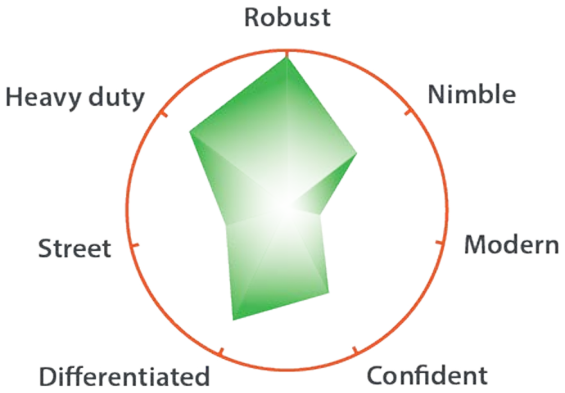
Second Cad mock-ups
During this phase some strategy changes happened within Nimbell that were to have an impact on the design exploration. It were decided to focus on the delivery market segment where the competition were cars rather than old golf cars, therefore the modern expression as well as street expression were increased. Due to this more modern focus, it were finally decided that at least one and possibly 4 design surfaces were to be made in a freeform manufacturing method. This made it possible to decide on a final design intension to use for the future development of the vehicle.

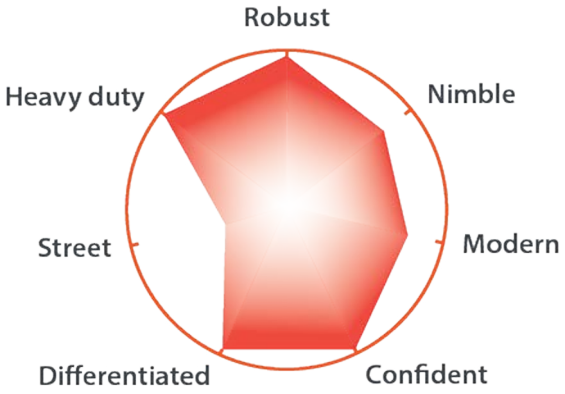
7.4.1 Discussion

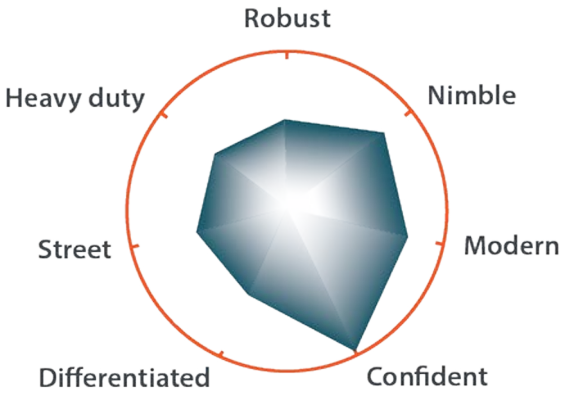
Altering the design intension during an on-going process is very troublesome but was deemed necessary in reflection to the changed project limitations regarding manufacturing. The manufacturing method governs what intensions that are possible to focus upon and should have been decided upon before the creative phase were initiated when the strategy focus were more defined. This is however something that is easy to say in hindsight especially when the design team lobbied heavily towards a change in manufacturing limits themselves.

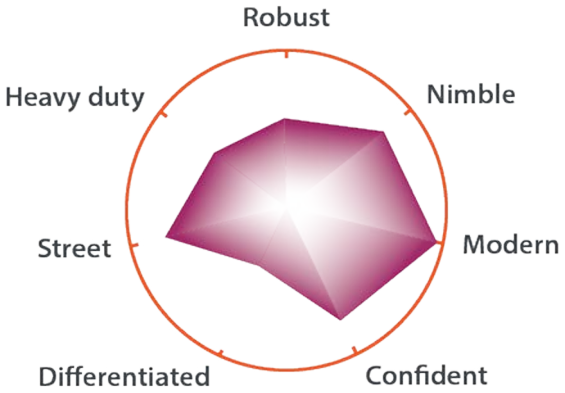












Sketch 1
Gardener meeting
Sketch 2
Plastic possibility
Cad 1
Semantic analysis
Cad 2
Plastic decided, strategy shift
Final
Robust
Nimble
Modern
Confident
Differentiated
Street
Heavy duty

Fig. 67

8. Concept refinement

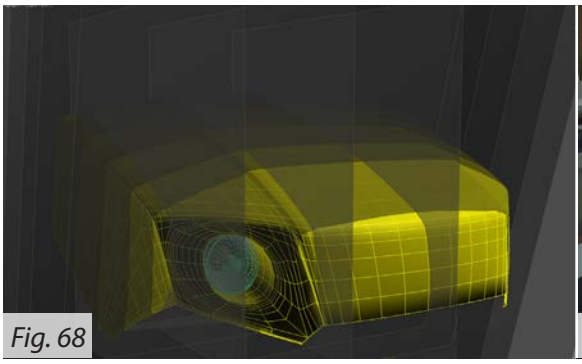


Fig. 68


Fig. 69

8.1 Late mockup

8.1.1 Purpose

Evaluating the concept decisions that are made in a product development project is important to confirm that it is still on the right track. An important tool in that work is the evaluation through physical objects. The purpose is to test if the theoretical assumptions made through sketches and digital models still are valid when tested in a physical environment. In this second phase of the mockup construction the purpose shifted from leading to new concepts to manifesting the 3D design of the final concept.

8.1.2 Method

Normally a 3d printer is used to translate three dimensional computer models into the physical world. This works very well on smaller items but less so when a full scale model takes up 3 m2 of floor space. The solution to this problem was to do a compromise where the mockup from the previous phase was readjusted to fit with the measurements from the 3D model through a series of control measurements on critical areas. The more complex area of the front was created through a technique where several cross sections where printed in full scale. These then acted as templates for a cardboard skeleton that formed a rigid substructure that could then be covered by thin cardboard and pape mache (Fig. 68, Fig. 69, Fig. 70 and Fig. 71).

The mockup (Fig. 73 on page 81) was tested through the following scenarios:

- Entering vehicle
- Sitting and holding steering wheel
- Delivering a 2 kg "phonebook", represented by an 8 cm thick plank, from several different positions inside the cabin into a box symbolizing a mailbox.
- Exiting vehicle
- 2 ppl seated inside cabin
- Loading cargo into cabin
- Loading cargo onto cargo bed
- Unloading cargo from cargo bed

The first five test scenarios where performed by a 1.9m tall male representing the upper percentile of the potential users and a 1.6m tall female representing the lower percentile of the potential users (Fig. 74 on page 81). The three last test scenarios where conducted by a 1.9m tall male and a 1.7m tall male. All of the tests used the same mid height seat. Several of the scenarios where also tested with two other seats covering different amounts of seat padding.

The tests performed on the mockup were also conducted on the BEMO prototype to get a better view of the differences between it and the mockup.

Fig. 70

Fig. 71

8.1.3 Results

Testing the mockup resulted in several confirmations on the assumptions that had been made in the computer based 3D model. However we also gained a number of new insights and identified a few new problems. Crucial measurements were conveyed to the construction team ("Fig. 75" on page 81) so that the subframe could be altered accordingly. Some measurements such as max floor length and minimum seat height were unfortunately restricted by construction demands (Fig. 72).

Human factors

- Measurements done lead to the conclusion that the lowest position of the seat must be decreased slightly to accommodate the lower percentile. A steeper angle on the seat ramp does however require more force from the user when the seat is adjusted upwards.

- The Measurements based on the top the seating pan does not take into account that the weight of a person sitting compresses the seat and reduce the distance. This lead to a second adjustment of the height of the seat in the lowest position, increasing it by a few centimetres.

- The steering wheel was adjusted slightly downwards to accommodate the change in minimum seating height.

- The distance between the steering wheel and the dashboard could be reduced to make it easier to reach buttons and levers.

- The front is low enough to allow users between the specified lengths to get a good oversight of the vehicle and its surroundings.

- A broader cabin roof protects more from rain but makes it harder to exit the vehicle unless the height is increased.

- The steering wheel is most comfortable when tilted at an angle of 45 degrees compared to steeper angles.

- Moving the seat impacts the steering wheel reach more than the pedal reach. This lead to a recommendation for a steering column with both depth and height adjustment.

- The steering wheel position found most convenient when handling and delivering mail from the cabin was found to be close to the instrument panel and the driver's legs. This was in direct conflict with the positions that allowed the easiest entry and exit from the vehicle as well as the recommended driving position.

- The cargo system on the passenger side was divided into two sections with different heights; one low parallel to the driver and the second one placed at the same height as the glove department. This made it possible to have two cargo boxes that are both placed at the appropriate distance from the shoulder of the driver and also take advantage of the extra space provided by the glove department. A width increase on the second platform was also performed after it

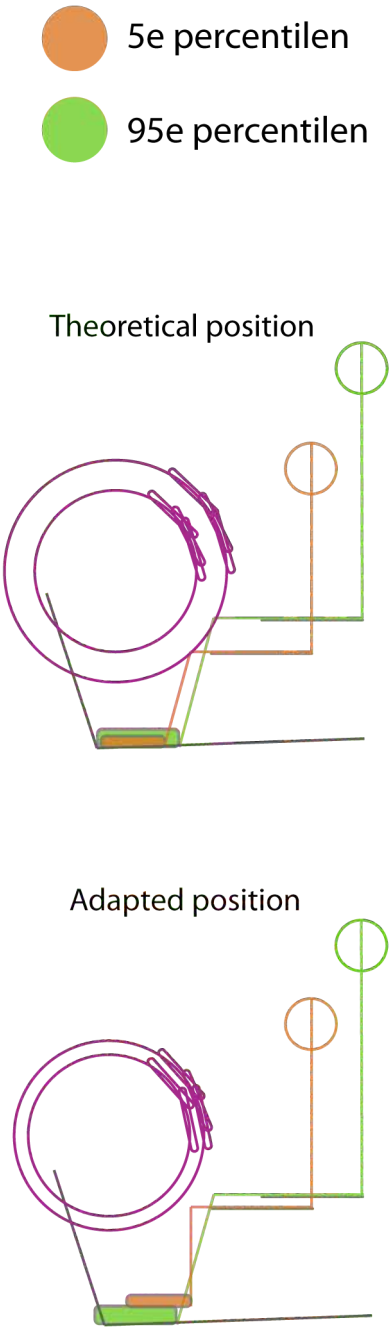


Fig. 72 The top view shows the ideal layout of the driver compartment. The lower view shows the changes made to accomodate the needs presented by the construction team.

Fig. 73

Fig. 74

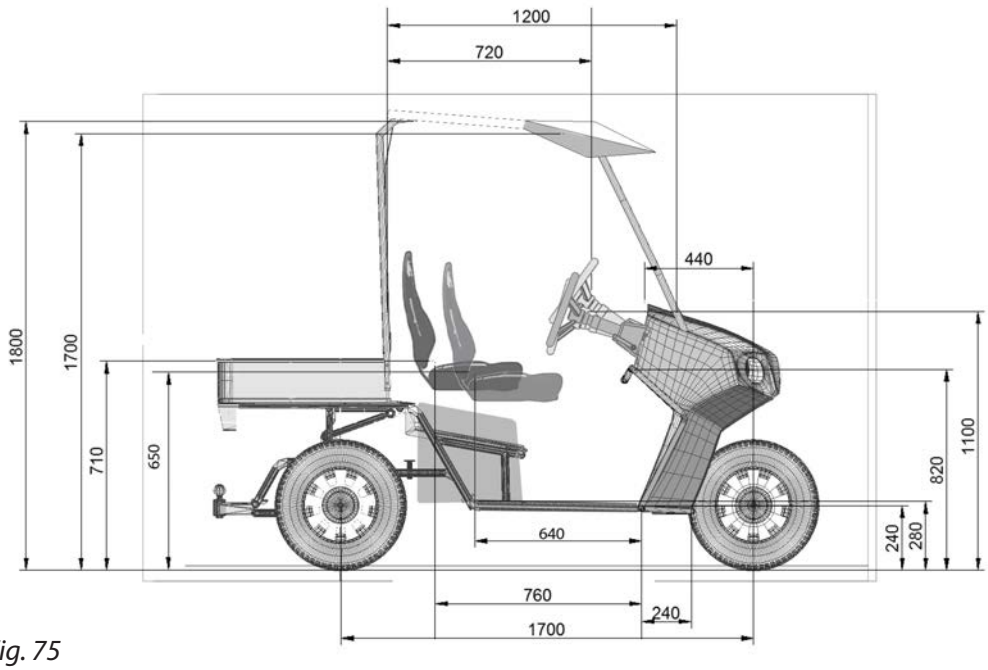


Fig. 75

was confirmed that it wouldn't interfere with the drivers legs.

- The empty space below the cargo system was dedicated to low frequency items such as personal items that would normally go into the glove department.

Construction

- Due to the space demands for the users shoulder during driving discovered during mockup testing, constructing a closed cabin will require substantial changes in the existing prototype as well as the 3D concept. Solid doors should only be considered if a large percentage of the users require it or if a change of construction partners allows for variable radius steel tubes as this is not the case today. Soft plastic doors could be a compromise.

- The centre line of the chair need to take into account the width of all chair varieties that are going to be used in the vehicle

- Any potential cabin doors need to be bent in order to accommodate wider "ergonomic" chairs and provide space for the right elbow while manoeuvring.

- A seat with height adjustable gas spring isn't possible due to height restrictions.

8.1.4 Discussion

Performing the tests on the mockup as well as building it may have been one of the most important parts in the development process, having said that it may also have been one of the more challenging parts. Creating an accurate model of an entire vehicle requires access to a well equipped workshop in direct connection with a large space where it can be built. The solution in this case was to have

material transported between two different workshops and a construction site. This logistical constraint leads to some unanticipated delays and limitations in how advanced we could make the model. For instance a large portion of the frame that was intended to be made in wood had to be done in blue construction foam. This helped to compensate for the delays by being easier to shape and transport but came with a downside. It was harder to take accurate measurements because the mockup tended to compress slightly during testing due to the added weight of the tests subject.

8.1.5 conclusion

The width of the vehicle from the driver seat up to the steering wheel needs to be widened if doors should be implemented in this or future models.

A tilted sliding ramp under the seat wont accommodate the whole 95th - 5th percentile range without making the angle of the ramp to steep. A minimum height required for battery storage also prevents this.

The roof can be lowered signifcantly compared to the BEMO prototype.

Fig. 76


Fig. 77

8.2 WorkshopBemo prototype

8.2.1 Purpose

The development of the BEMO prototype had already taken place before the initiation of this project but the actual construction took place in parallel with the preparation and development phase of this project. Comparing it with the mockup was therefore important to get a good understanding of how they differed. This would in turn show how much development work that would be needed

for the next iteration of the vehicle. It would also give a confirmation on which changes that where feasible.

8.2.2 Method

A workshop was organized with the BEMO prototype and the mockup in the same locale for easy comparison. Attending the workshop where the construction group that had been in charge of the development leading up to the BEMO (Fig. 76) and also actively involved in the next iteration of the vehicle. The tests performed on the mockup were repeated on the BEMO prototype but in a more informal way due to time restrictions (Fig. 77).

8.2.3 Result

The following observations were made during this workshop.

• When comparing the BEMO prototype with the model it was found that bringing the steering wheel and instrument panel closer to the driver makes it possible to move the front wheel closer as well. This would improve the turning circle even further and at the same time make it possible to make a more distinguished wheel arch.

• The seat height in the highest position should be raised to accommodate a larger range of the upper percentile.

• The roof is placed to high and can be lowered without jeopardizing entry or exit.

• Placing cargo in front of the steering wheel is impractical because of the distance to the driver and the fact that it needs to be raised above the steering wheel before it can be put into a mailbox.

• The horizontal distance between the pedals and the steering wheel should be increased (Fig. 78).

• The existing roof solution makes it impractical to implement doors.

• Creating more volume inside the instrument panel is possible.

• The A-beams can be moved further back in order to implement the new front hood.

• The cone shape of the BEMO prototype promotes a notion in the driver that the vehicle is smaller than it actually is.

Fig. 78

8.2.4 Discussion

Having the BEMO prototype in the same room as the mockup provided a solid base of discussions between design and construction team. Decisions regarding advantages and feasibility of proposed changes could be easily made on the spot.

8.2.5 Conclusion

The windscreen will be moved back closer to the driver in accordance with the proposed concept in chap. 7.2.5. The dashboard will broadened to cover the whole driver compartment and together with the steering wheel moved closer to the driver.

Driver compartment and cargo area will be completely separated creating a rectangular cargo area behind the driver.

8.3 Pugh

8.3.1 Purpose

The purpose of the pugh matrix is to give a objective foundation to the choice of concept. When choosing solutions, within a group different favourites are formed subjectively and the reason for choosing a solution are often hard to define. This method should supposedly work so that a solution that solves the users needs best are given a better score. However the method tends to still favour the designers preconceived choice as the weightings and defined need distribution are up to them.

8.3.2 Method - The adjusted Pugh matrix

The evaluation done is based on the demands found in the need analysis matrix (chap. 5.3). The main reason for a improvement work of the established pugh matrix is that problems have been identified. The impact of a user need can today be too high if the designers are able to define many needs in certain areas and miss other. For instance in a driver environment pugh matrix conducted in a earlier project, safety issues were greatly under represented because only one specific need were found here as opposed to ergonomic needs which are less important but given a lot higher representation on the scoring due to the number of needs defined.

There are several improvements made in our pugh matrix. First of each need is sorted under a selling point (formulated as a design purpose) with a specific weight budget. Therefore different selling points can determine the actual weight of the need. in this case “Comfort” is given 30p vs “Vehicle flexibility” 20 for the BEMO pro. Each need connected to comfort have therefore 30p to share amongst them. This means that if the designer are able to define many similar needs around comfort, the overall impact on the concepts scoring are not increased (chap. 5.4). This means that the strategic goal of the design are better implemented. Also in the excel chart a later change in strategy updates the chart so it can be easily adjusted for different markets.

The way the chart are laid out due to this makes it also easier to rate different needs. The weight only have to compare to other needs in the same category and may be stated in any range that fits. The charts then accounts for this and makes a new “true weight” based on the budget given to the specific selling point.

Another difference that are made comes from the problem of interpreting the score. how much is 20p improvement compared to the reference? Instead of showing a point score our result are a percentage score compared to the maximum possible outcome. All this i neatly automated in the chart. A score of 20p is now translated to 3% of the maximum possible outcome which quickly gives a indica-

tion of that it is a rather small difference.

Calculations
The functions in the excel chart are made by the following formulas:

Translating the subcategory weight to a budget based "true weight" is made by:

[=(budget value/sum(the weights of the first row to last row in subcategory))*specific needs weight]

Example:

[=(E5/sum(E6:E15))*E6]

The calculations for the percentage score are as following:

[=(score in points/(all weight points*difference to reference design))*100]

Example

[=(N116/(J116*3))*100]

Additionally, the results were illustrated in the excel chart by programming effects with colors. A slight adjusted weight were given no color, a medium weight a dim green color and a high adjusted weight were given a bright color. The same were done to the scoring as followed: Red, yellow, white, dim-green, bright green where red is the most negative score and green the most positive score. This made it very easy to find the big impact needs.

8.3.3 Results

The primary generic result and use for the pugh matrix is the numeric supposedly objective comparison between different concepts. These results (Table. 9) showed that the old prototype were -4.8 points or -1.2% of total possible points better than the worker norm the new Melex n-car which could be regarded as negligible. Its major advantages were the manoeuvrability and its ability to pull trailers. Its biggest disadvantage is its limits to remove battery pack and the cargo bays lack of tipping function.

The new trigo worker basic had a positive score of 11.6 points which means 2.9% of possible scoring. Most of this improvement is due to branding and visual changes. Some new disadvantages have appeared with lesser environmentally protections for mechanical parts due to lesser capsulation for weight gain reasons.

The trigo worker deluxe had a more significant 54 point difference from the Melex which is a whole 13.6 percent of the total possible difference. This score is based on the user experience and does not take price in consideration and the trigo worker deluxe is noticeably more expensive. The main improvement areas are in performance enhancements due to better battery, drive train, cabin and cargo area.

The results for the logistics user group where the norm value are set by postens Club Car the Trigo logistics price vehicle got a positive score of 25.5 points or 6.4% of total possible difference. This could be stated as a rather distinct difference especially as it is expected to be sold at the same or lower price. Here the manoeuvrability and form factor which enables the driver to come close to the post boxes have a huge impact on the score. The rest of it is mainly due to the club cars outdated battery and drivetrain system and the general outdated design of the clubcar. The biggest disadvantage are Trigos perceived safety issues as a three wheeled vehicle. The advantage however exceeds the disadvantage and confirms the three wheeled design choice for the logistic sector.

The trigo logistics deluxe vehicle gets a stunning 61.3 points advantage meaning 15.3% of the possible difference. The reasons are a better cabin, seating, mail han-

dling area, and other quality aspects. This version of the vehicle will have a higher price tag that normalizes some of its advantages.

Secundary uses for the Pugh matrix

The Pugh matrix is made as a additional part of the need analysis matrix and as for the need analysis the pugh matrix have many secondary uses except for the concept scoring generic use.

Concept refinement prioritizing tool
When the weighting and the adjusted weighting of the different needs were done it were possible to thing of doing the method backwards. Instead of finding out which needs that showed to be beneficial in the products it could be used to find which needs that could be most beneficial to refine, much like solving a labyrinth backwards. For example, damage protection were the most impacting need for the logistics user group with a adjusted weight of 6, also the current score for the trigo logistics were 0. It is therefore most beneficial to enhance the damage protection in the refinement development as the possible score improvement in this need is 18points. Better encapsulation of parts, lights and more robust body should be considered.

Personal processing and analysis.
As well as for the need analysis the pugh part of the matrix also lets the developer process and understand the user situation.

Communication and joining of opinions between developing groups.
Also the same as for the need analysis part, the Pugh matrix have been used as foundations in workshops and discussions together with Nimbell, mainly on discussing which to be the target customers and which of the trigo versions to focus on.

8.3.4 Discussion

As well as for the need analysis the generic uses for the pugh matrix are greatly overshadowed by its secondary uses. When the developing group and with other developing groups in the same project are agreeing upon the weights and level of fulfilling needs different views and agendas are minimized.

Credibility of the chosen weights
This method greatly relies on the weights given to the needs. Each developer has its own agenda and prioritizations which is reflected in the weights and therefore also the concepts scorings. To avoid this it is possible to let the users make the weight by surveys. This however has its drawbacks as the users often have hard to imagine the possible benefits and effects of others solutions than the ones they are used to and have adapted their work to.

This Pugh matrix weight is made in workshops together with Nimbells marketing and mechanical developers. These three different viewpoints are taken into account when making the weight. It could be recommended to have surveys made with the needs and the design purposes as well but this were only made to a small extent but user opinions gathered by interviews were involving the weights.

basic norm worker	old basic concept (prototyp 1	weighted score	Trigo worker deluxe (function)	weighted score	Trigo worker standard (price)	weighted score		Basic norm Logistics	Trigo logistics function	weighted score	Trigo logistics price	weighted score
0		-4.8		54.4		11.6				61.3		25.5
		-1.2		13.6		2.9				15.3		6.4

Table. 9 The upper row shows the actual points from the PUGH and the lower the percentage score

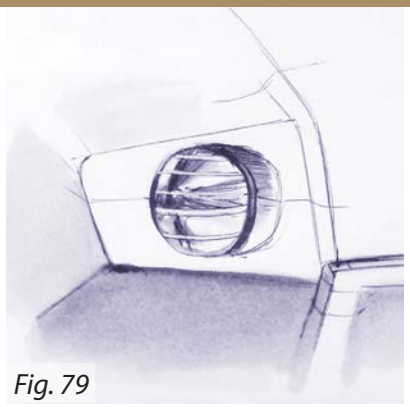


Fig. 79

Fig. 82

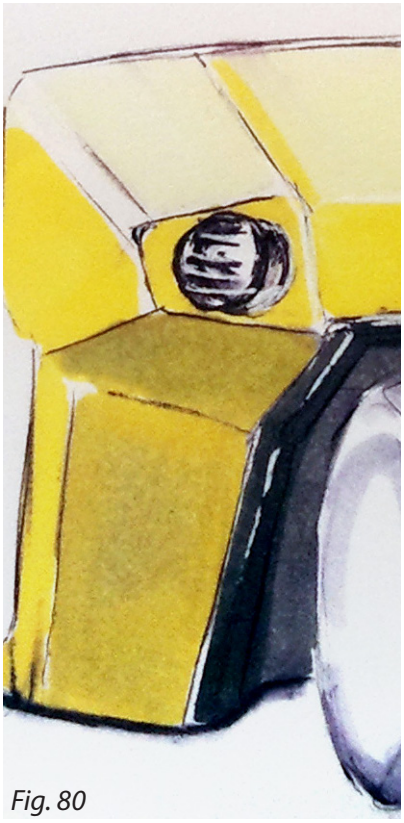


Fig. 80

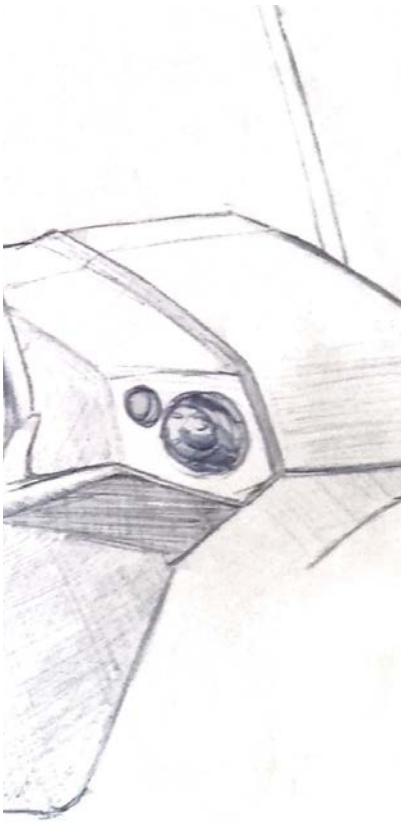


Fig. 81

8.4 Review of design intensions

8.4.1 Purpose

Refining the ergonomicall and functional aspects of the concept created a pause in the design development. This created a possibility to reflect on the work done so far and process it along with input from Nimbell on their customers reaction to the first prototype.

8.4.2 Method

Discussions were held both internally, with customers and with Nimbell regarding the product core value show they were represented in the current concept and how that would evolve in the coming months. The results from these discussions were summarized under each core value.

8.4.3 Result

There are three main expressions that were decided to be sought for the vehicle:

Modern: To show our intensions that it is not a product that is aspire to be as advanced as the competitors but rather above.

Nimble: To emphasis the key selling point for the vehicle as a trike model. To express the nimbleness is necessary for showing it benefits as a trike layout because this has been responded with some scepticism.

Robust: To finalize the credibility for the vehicle as a great professional vehicle that fits were the competitors fail. The robust feel is important to convince that this is not a designed toy or premature concept. The modern must be towards modern-innovative/effective/environmental rather than modern-cool, also the nimble expression must be towards: nimble-performance rather than nimble-unsteady.

This is why the robust expressions are important.

Modern

The modern look is desired to meet the competition of today's and future competitors. Even if the market is not particularly design demanding the product should as a launch product for a new brand and product look and feel as new or newer then competitors to have credibility for its core values. As of now many competitors are launching new updated versions of their product portfolio. What is common is that these new products have a much higher emphasis on design then previous models and Trigo will be compared to these.

Sleek mathematical surfaces:
Some of the modern look in the new trigo is made by making relaxed double curved surfaces. This is achieved through the same software used by leading car makers and gives a high surface quality both visually and mathematically. Limitations in the building method demands high quality surfaces from the modeller with a detail attention that can be overlooked in more traditional solid-modelling tools. This attention to detail incorporates an expression that is shared by modern car design and premium consumer products.

Fig. 83

Fig. 84

Chamfers instead of rounds:
A other modern look that is used by many modern products is to use chamfers and sharp corners between large surfaces with little curvature. This is very obvious when comparing the outdated version of the style icon Audi tt with the new one. This design feature are also connected with the "stealth look"

Fig. 85

The stealth look:
The stealth look is created when using different diagonal but rather flat surfaces in facets to resemble that of a stealth fighter jet (Fig. 86). A car brand that for some time have used this is Lamborghini (Fig. 84) although later models have moved towards a softer, less edgy look.

In the Trigo concept this shape will tie together the nimble urban part of the design with the more robust design features. Usage of it can be seen in several places on the concept (Fig. 64) for instance the front wheel house and he diagonal light socket surface, that is almost flat as a facet.

Fig. 86

Nimble

The agile and nimble look is very important as it is the major key selling point against the competitors. This is mainly created by making the overall hourglass shape, illustrated by "Fig. 98" on page 91. Another important design feature that enforces this sensation is the tapering towards the ends of the vehicle, both in front and in the rear end of the vehicle.

The sport motorcycle resembling wheelhouse gives a lean-forward and performance look in the front. The bend in the front aims to look like a animal knee joint (Fig. 88) ready to pounce, when the vehicle is viewed from the side.

Results from the semantic analysis indicated that an integrated hourglass shape with its accentuated waist are correlated with nimbleness. this were chosen to be a design feature and are kept as much as possible along the refining process, problematic are the loss of space this leads to. It is therefore desirable if this could be design as an illusion with help of colors and shapes.

Fig. 87

Robust

The last main desired expression for the vehicle are the robust feel that are the final point that will give the vehicle a high quality value and professional appeal. This is worked towards in the whole design by using the previously described stealth-look as well as in design features that tries to resemble heavy duty vehicles, one example of this is in the side plates of the cargo bay, these are meant to resemble that of dumpers with protruding parts that looks load-bearing (Fig. 85 and Fig. 86). These also double as a sturdy and clever lock mechanism for the removable cargo sides.

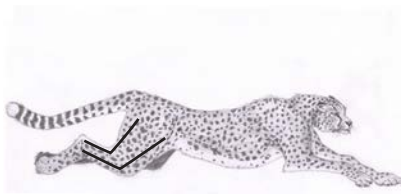


Fig. 88

Another robust designed part is the front wheelhouse. This is designed with deliberate strict edges, no rounds or curved surfaces. This is as well meant to resemble heavy duty professional equipment. It is necessary to maintain this rough feel in the front to connect to the back side plates, making them stand out less from the overall design.

Fig. 89

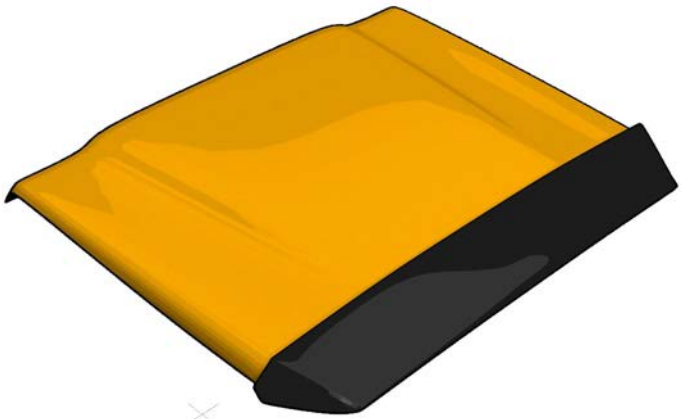


Fig. 90

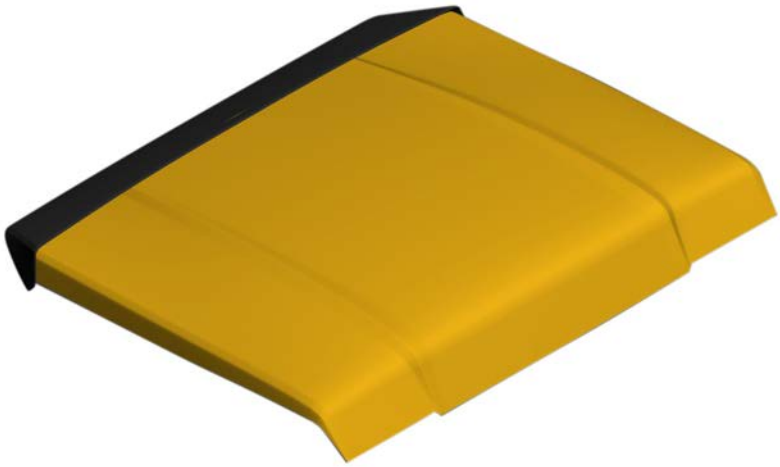


Fig. 91

What was important here was to not make the robustness become un-modern, the placement of the robust parts as well as their link to modern - stealth expressions are vital.

Terravox affinity

It were preferred if the Nimbell Trigo were visually connected with the Terravox concept that are intended to be released in the future. The "terravox shape" as well as the chamfer-design are parts that should be thought of.

8.5 Design of part solutions

The work of 3d modelling the remaining areas of the vehicle commenced after the review of design intentions. Some alterations were also done to the hood.

8.5.1 Roof

The roof was refined in two stages to connect with the design intensions of the vehicle. The rounded protrusion in the middle were given sharp edges. These chamfers were made to connect with those on the hood as well when viewed from above. The side surface of the roof gets larger as it approaches the roof cap to tie the two pieces together. It also gives a third spot of colour to the vehicle when it is viewed from the side.

The complexity of this part requires it to be made in a similar manner as the hood. This is unfortunately not possible in the prototype series where this part will be replaced by a flat sheet metal roof.

The cap are a vital piece for the design language and were refined to work well together with the roof. It creates a nice transition between the roof and the flat windscreen, while hiding the attachment point for the windscreen wiper engine.

8.5.2 Cargo bed

The carg obed (Fig. 92) were redesigned to implement the robust design features found on dumper trucks. Painting it in the same colour as the side panel positioned below the seat helps to tie the rear and mid sections together. Tilting the sides inwards also creates a subtle resemblence of the rear end of race bikes. Smaller tweaks such as adjusting the distance to the tire to provide a suitable travel for the suspension and modifying the light ramp to make the indicator lights visible from the side were also made.

Also concepts for different sizes of the cargo bed were created.

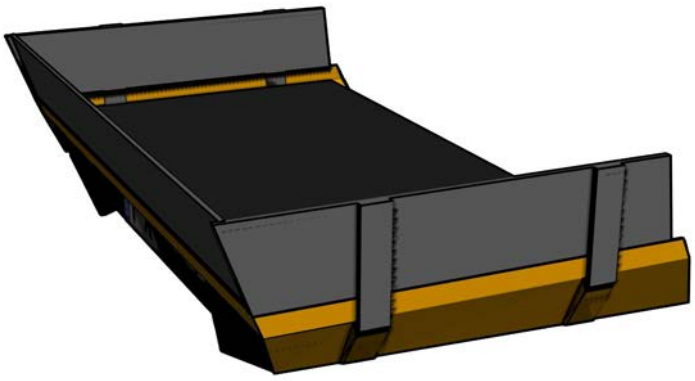


Fig. 92

8.5.3 Light ramp

The lighting ramp contains indicator lights and stop lights with incorporated rear facing reflexes. The ramp started out as two separate pieces with a rear bull guard protecting the lights (Fig. 93). This was later changed to a single part that starts out thin and becomes large at the centre of the vehicle (Fig. 94). This makes it look even more capable of transporting heavy loads. The flat facets surrounding the lights also ties together nicely with the stealth look of the other sheet metal parts.

Fig. 93

Fig. 94

8.5.4 Dashboard

The dashboard design were not fully decided during the end of the development process due to uncertainties on limitations and the construction solution for the interior part of the hood. Two different solutions were evaluated by Nimbell from a construction feasibility perspective. The first being a split hood with a interior and exterior part and the later a single component were the hood would protrude into the cabin area.

However recommendations for the control placement were made (chap. 9.3.4).

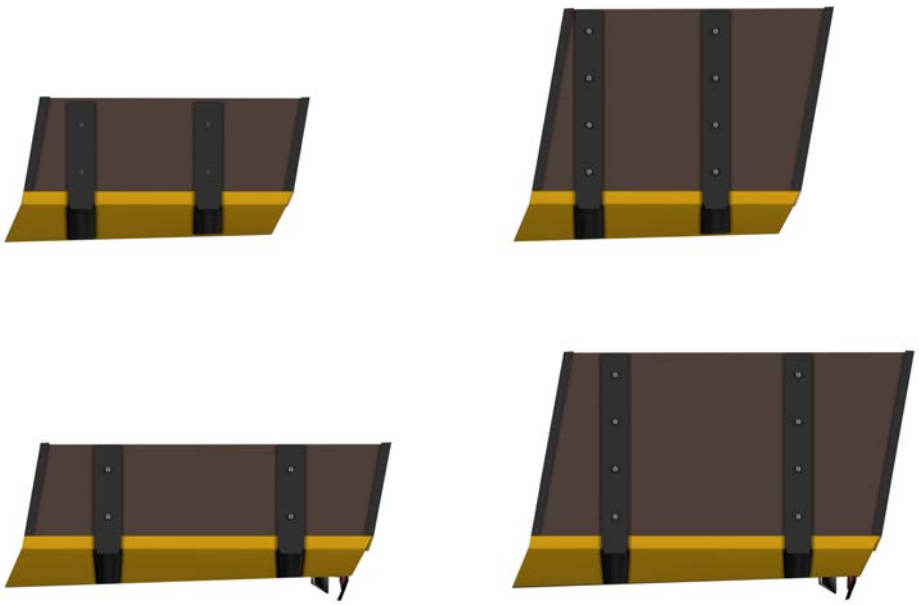


Fig. 95

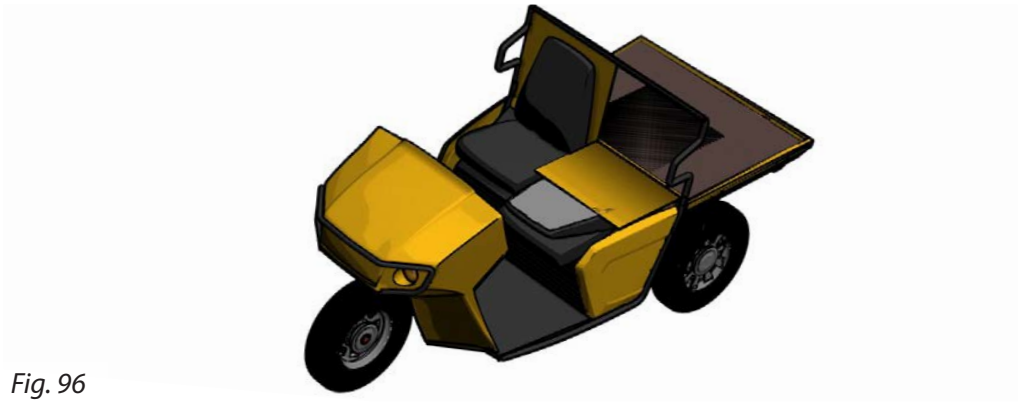


Fig. 96

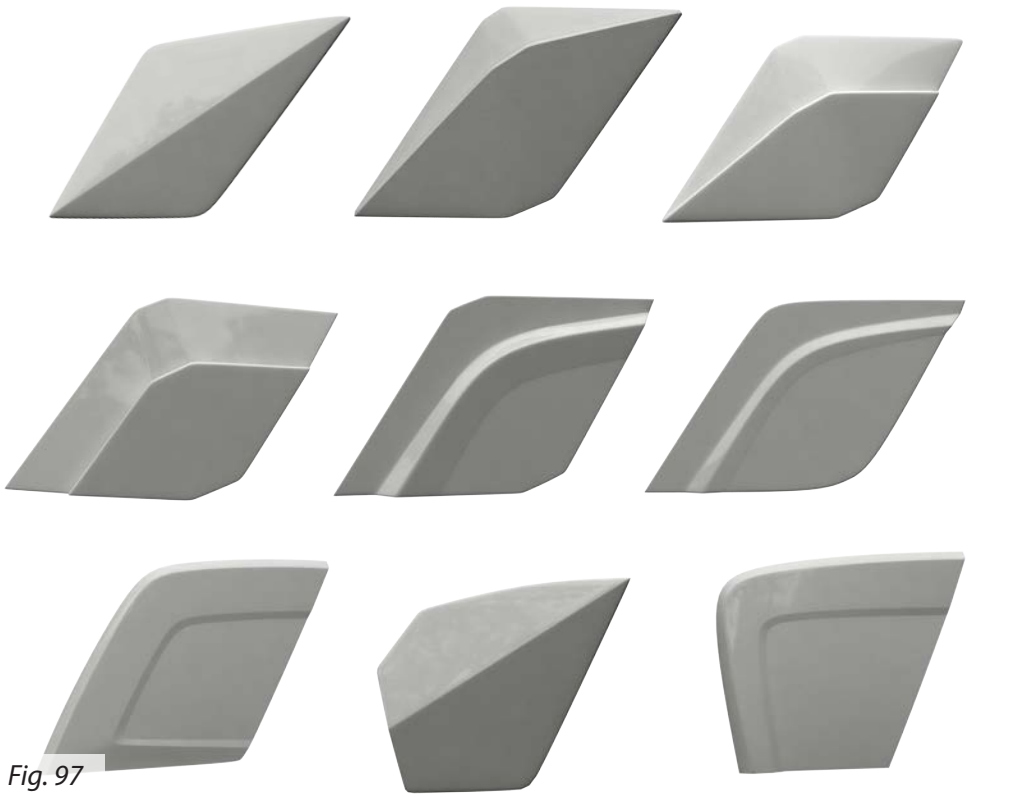


Fig. 97

Fig. 98

Fig. 99

8.5.5 Hood

The area where the most work and thought were made in the form and design aspects were not surprisingly the front piece of the hood. The final hood design (Fig. 102) was made using the software alias studio-tools with a high emphasis on surface quality and continuity between surfaces. Some final adjustments were made to fit the hood with the rest of the construction on a more practical level.

Legal requirements and their impact on the design of the vehicle were a big part during the project to ensure that that the light placement could be preserved. These lighting areas were designed in such a way that the size and shape of the light could be changed in order to accommodate standard lights from different suppliers (Fig. 100 and Fig. 101).

8.5.6 Side panel

As the side panel are the only big design part to connect the front and the rear a lot of work were made into it. As many as 9 different refinement versions were made (Fig. 97) until a satisfactory result were made. The backward tilt found on the early versions changed to a small forward tilt during the last two iterations. This helped with the ingress and egress of the vehicle as well as creating a sense of forward momentum. The frame following the top and left side of the side panel increases the connection to the side of the cargo bed creating a unit when viewed from a distance.

8.5.7 Seating area

The layout of the seating area were made in the mockup as a measurement refinement and not worked upon visually except for the connection between the passenger seat and the front storage compartment. The capability to fold the passenger

seat and rear wall (Fig. 96) was added to help accommodate longer items without needing to store them on the roof.

8.5.8 Weather protection and doors

Our solution for solving the need for weather protection were to have a cloth and plastic canopy. This enables the full form freedom to make a cheap curved side to give sufficient space for the drivers arms as well as no overall design alterations to make it fit. A future possibility of a rigid door solution were however preferred by Nimbell. This was achieved by reducing the roof width (Fig. 98 and Fig. 99) so that it matched the outer side of the floor. This would allow for a rigid single curved door to be attached in a later version.

Door attachement points
Three different attachment solutions for the door were evaluated. The positive and negative aspects of each solution are presented below:

Hinges placed at the rear
Positive
- May be driven with open doors provided that the backside of the vehicle are not wider than the hinge placement as long as the doors remain relatively flat.
- Easy to find good hinge placements.
- Easy to reach handle/good leaver.

Negative
- Closing movement is not preferred ergonomically.
- May feel unusual

Hinges placed at the front
Positive
- Better swing movement in opening and closing
- Most commonly accepted solution
- Back side of cabin may be free of support beams meaning the door opens further back, giving a whider opening when leaning out of the vehicle.

Negative
- May not be driven while open.

Slide door solution
Positive
- May be fully opened in tight spaces
- May be open while driving
- Easier o close from fully opened

Negative
- Expensive
- Have high impact and demands on overall design of the vehicle, only works with a full hight straight surface loading compartment.

Fig. 100

Fig. 101

Fig. 102

Door design
The evaluation of the different door positions lead to joint decision with the construction team to have the hinges placed at the rear. This would enable the vehicle to be driven with doors fully open while providing attachment points that could be easily removed with the rest of the cabin. Some refinement (chap. 9.3) were done mostly to make sure it would work both ergonomically, mechanically and visually.

9. Result – final concept

Fig. 103

The chapter presents the end result of the master thesis project. The underlying design intention is described and the different vehicle configurations are presented.

The end result is introduced in two stages with one part focusing on the final concept as it will be when the Trigo is ready to be introduced on the market (Fig. 103) and a secondary slightly reduced version adapted towards the manufacturing limitation of a low volume pilot series (Fig. 104). Both versions have been developed through collaboration with the manufacturing team to combine the strong core values brought forward by Nimbell with the functional demands from future customers and identified manufacture possibilities. Effort has also been made to integrate design features from previous concepts developed by the company into the design guidelines used for the final result. This was done to form a stable visual brand foundation that can be used in future products.

Fig. 104

- Agility
- Low emission
- Low running cost
- User centered
- Performance
- Customizability

The final concept incorporates the driving customer demands identified throughout the user study. This is reflected through the tangible functions and more abstract design cues. The vehicle will distinguishes itself from other market competitors through its agility, performance and user centred design. This in combination with its low running cost and low emissions creates a first product in a new generation of electric utility vehicles.

9.1 Product vision

The product vision is the final proposal of the intended vehicle design, used as a communication bridge to allow the parallel development of vehicle frame and chassis. Individual surfaces decided to be manufactured where then adapted and can be seen in the pilot series chapter.

9.2 Product design

For the overall design language guidelines were created to communicate the important angles, lines and relations of the visual design. These guidelines (Fig. 105, Fig. 106 and Fig. 107) were given to the manufacturing team of Nimbell to make sure the visual cues are maintained during the transition from pilot series to series productions. The cues rely on connections and proportions to define the intended design language which makes it robust and hopefully compatible with future changes.

Most of the general design cues are derived from the gestalt theory where shape relationships is created to make a harmonious design. Examples of relationships are: parallel lines, angle mirroring and common focus points for different lines.

The roof is slightly tilted to give a sense of speed to the vehicle while it's stationary. A subtle angle was deemed best to preserve the robust appearance but was purposely made slightly steeper than the floor angle to create a perceived meeting point far ahead of the vehicle.

The height of the roof sides increases as they reach the windscreen to create a good transition between cap and roof. Two reinforcing protrusions follow on either side of the roofs midsection slightly approaching each other as they travel to the front. These same lines flow over the back of the vehicle creating a downwards protruding midsection that faintly mirrors the rear light plate.

The sun-cap is a possible after market part that we have decided are important enough as a design feature to be standard equipment. It should be made of either a sheet metal piece or vacuum formed plastic part. The shape of the cap is made to both protect the driver from the sun from both in front and the corners as well as to fit with the overall product design.

The design features in front are placed in such a way that the eye of the observer is drawn towards the front tire. Together they create a strong association to the head of bird with its focused eyes and striking beak.

1. *Parallell lines, horisontal along the cargo bed, slightly tilting down after the cabin pipe.*
2. *Begins parallell bit starts to move closer after the first bend.*
3. *Parallell*
4. *Shared centerpoint*
5. *Parallell*
6. *Cheek curve- reused*
7. *Mirrored angle refer to nr6 goes expanding parallell*
8. *Parallell*
9. *Mirrored angle through whaist line of vehicle between lights and cargo bed*
10. *paralell chamfer meet chamfer at hood*
11. *lifted double chamfer that expands and meet the hood curve*
12. *Angle towards front of wheel*
13. *Main form element, continuos curve*
14. *Expanding chamfers, common focal point*
15. *Corners and centers points towards front wheel*
16. *Waist of vehicle, express agility*
17. *Tapering towards centrum, gives agile expression*
18. *cheek-curve, reuse.*
19. *zig-zak contrast edge, refers to stealth design to enhance modern expressions*

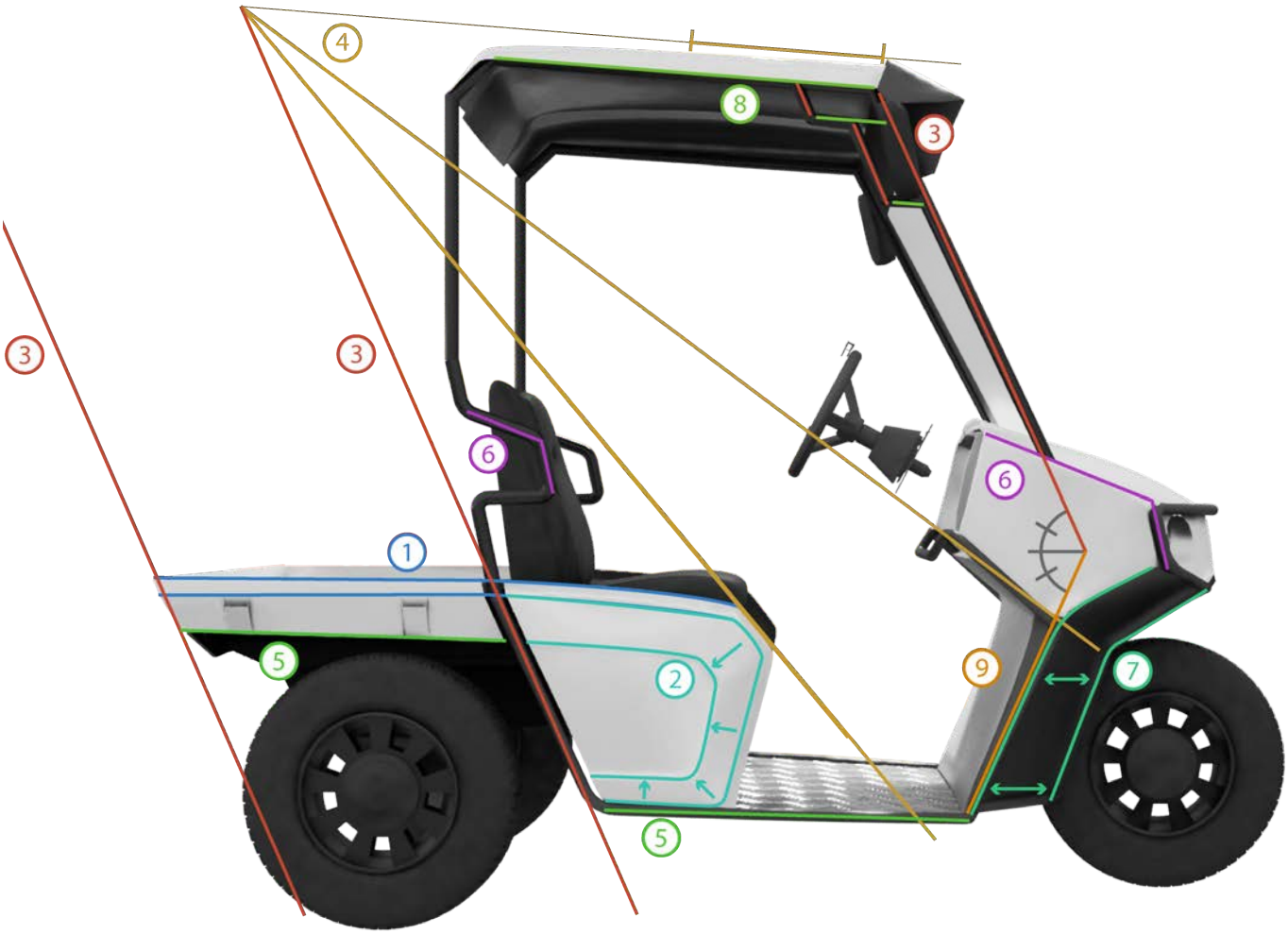


Fig. 105

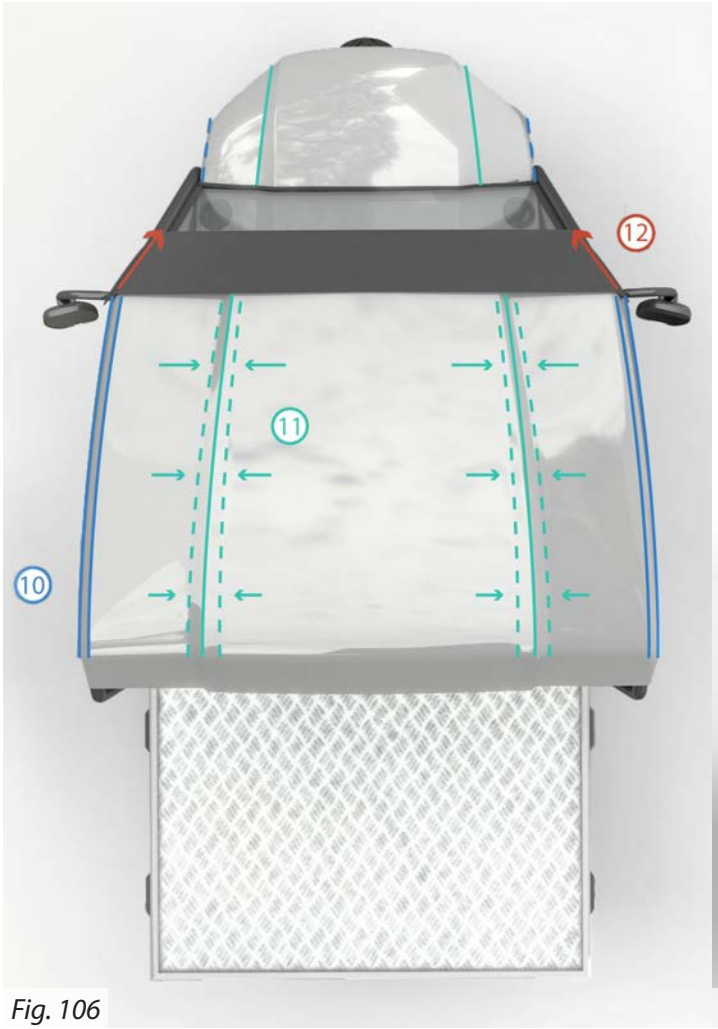


Fig. 106

Fig. 107

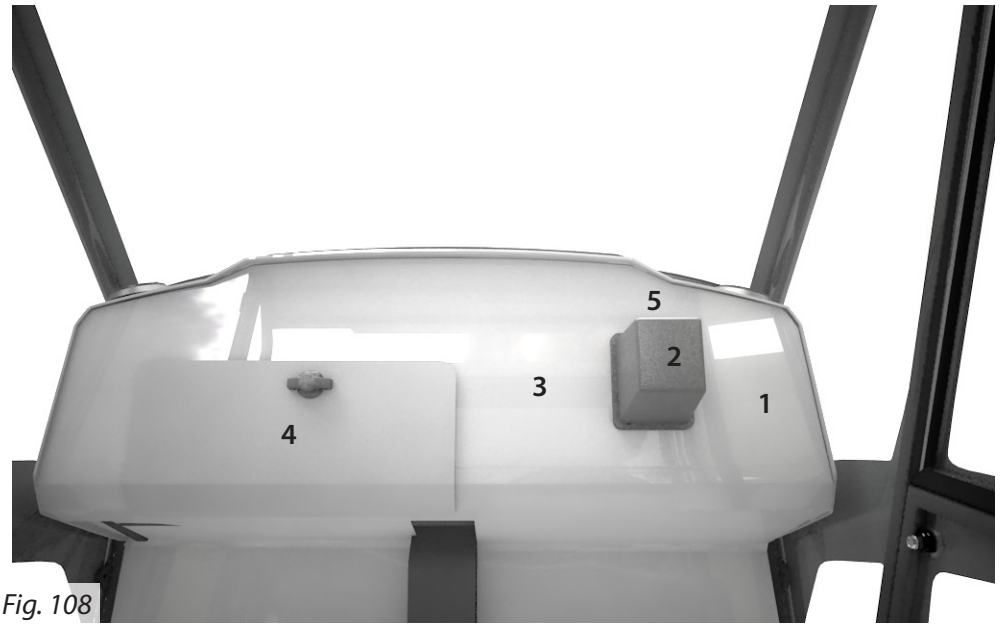


Fig. 108

9.3 Ergonomics

User centered design is one of the selling points stated by Nimbell from the beginning of the project and were also a feature that were lacking in some of the competitors examined in. It has therefore been a focus point throughout the project and this chapter will present the vehicle ergonomics and the solutions that we have chosen to incorporate into it. The bulk of the human factor considerations went into the cabin area although studies were also done to evaluate the height and depth of the loading platform. Doing this work in parallel with the development of the vehicle frame has allowed the ergonomic findings to be incorporated in a way that otherwise would not have been possible. Measurement mentioned in this chapter are in relation to the prototype evaluated in chapter 8.2.

9.3.1 Seat adjustment

An optimized seating area for ergonomics and space demands were developed to take advantage of the limited space inside the cabin area .The aim was to provide both leg room, good sight around the vehicle and a ergonomic seating height suitable for the task at hand. This was done by moving the cabin rear wall 10 cm back and raising the angle of the seat sliding ramp creating a higher maximum seat height. The added cabin length also provides the space needed to incorporate an optional larger seat with more padding to support the driver. Both the standard seat and the thicker option are adjusted through a lever beneath the seat. Sliding it forward lowers it while moving it backwards raises it.

9.3.2 Door entry

The floor of the vehicle is flat without protruding parts close to the door frame to ensure a smooth entrance and exit for the driver. Lowering the floor line would enhance this further but a minimum vehicle height of 15 cm is needed to traverse sidewalks during delivery runs. The floor in the cabin has therefore a slight angle to it creating a floor with its lowest point where the drivers feet are placed and its highest point where the vehicle width is at its maximum.

Further work to ensure a good ingress and outward reach from the driver positions were made. The side cover is designed to give a trade-off between the feeling of safety from not gliding out of the vehicle during cornering and a good access to the seat. This optimized line were then used as a major design feature.

9.3.3 Cargo bed

Our research suggested to place the loading platform at the lowers height the construction allows as the optimal cargo bed height are were tested to be lower

Fig. 109

than that. The researched length of the cargo bed were suggested to be changeable toward different user segments based on the tradeoffs of cargo space, stability, price and the maximum possible length of the vehicle.

9.3.4 Optimized steering wheel position and flexibility

The work done on the mockup contributed to the optimization of the steering wheel position and to find a suitable level of flexibility to adjust the steering wheel position by the user. Different sizes of users using the specified flexibility of the seats gave their view of the optimal steering wheel position. Other aspects such as ergonomic guidelines and cargo handling during delivery were also accounted for.

9.3.5 Dashboard

Interfacing the driver to the vehicle in such a way that it works in a satisfying manner for both beginners and veteran users is a challenge with many variables that changes throughout the development of a vehicle.

The available space and the number of controls that would need to be implemented into the dashboard space would not be fixed until the work with the undercarriage construction was well under way. The solution to this was to develop a layout guideline of the instrument panel dividing it into areas that should be used for different functions (Fig. 108) based on the ergonomical guidelines introduced in chapter 4. It was then later used as starting point for both the future concept and the pilot series. This solution gave the construction team the freedom to adapt the layout due to construction demands that were unknown when the layout was created.

The area on the right side of the steering column (nr1) is primarily for controls and switches that affect the driving experience directly but are used in an infrequent way. Controls that affect the driver cabin may be placed here as well if space allows for it. The controls and switches should be grouped in accordance to the following functions; exterior lights, gear switches, interior heating and lighting and radio controls.

The steering column (nr 2) should be used for functions that affect the driver experience and are used frequently or needs to be accessed in swift manner in order to be effective. Examples of this are directional lights, low/full beam, horn and window vipers.

The middle area (nr3) to the left of the steering column is intended as an attachment point for external devices such as PDAs, cell phones, drink containers and

paper notebooks. This area should also have a power outlet in close vicinity to make it possible to charge electrical devices. There should also be possible to equip the area with a retractable light in certain models.

The far left section (nr 4) of the instrument panel is intended for a watertight storage compartment. The hatch should be large enough to hold a A4 document folder.

The area above the steering column (nr 5) is the most easily seen by the driver and should therefore contain the displays that give feedback on the actions of the driver. Examples of this could be speedometer, battery indicator and exterior light indicators.

9.3.6 Cabin height

The final concept has a reduced cabin height compared to the prototype in chapter 8.2. This makes it easier to reach tools carried on the roof and also has the added benefit of lowering upper vehicle weight.

9.3.7 Shoulder width spacing

A vehicle with such a small width as the Trigo carrying two passengers is bound to struggle with shoulder space. A lot of testing of usage simulations was made to find the narrowest possible cabin that could fit two persons with good comfort and mail handling possibility. The elbow and shoulder proved to be the critical areas where the cabin should be at its widest. The cabin door concept therefore went from a flat soft top door to a slightly egg shaped outer shell (Fig. 109 on page 98). This was done by bending the mid tube of the frame to make it protrude outwards creating additional width for shoulder and elbow.

9.3.8 Trigo shape

A specific trigo shape was made to have common design features throughout the whole vehicle. The intention was to create a simple general design gestalt that would be cheap to make and easy to incorporate in the design. It is also heavily inspired by the "terravox shape" established in a earlier design project for the Terravox concept. This is to further enhance a common brand design language. An example of the shape can be seen by watching line nr. 6 in Fig. 105 on page 96.

9.3.9 Connections to brand portfolio

Terravox shape- trigo shape
The terravox shape developed during the terravox concept project have been used as an inspiration to the Nimbell trigo shape. Both these shapes have a similar function in the product and resemble each other in a way that connects the different products

Chamfer lines
The Terravox concept uses similar chamfers as the Trigo for its main body parts.

Brand values and semantic design language
The Terravox concept have many similar visual brand values to the Trigo:

Robust:
The Terravox concept have a boxy overall feel and many visual thick steel bars to enhance the robustness of the concept.

Agile:
In Nimbell Trigo this brand value are called "Nimble" but are very similar, both strive towards a agile expression, Trigo with its taperings and the hour-glass shape and terravox with its articulated joint.

Modern:
Both products uses the same double curved "sleek mathematical surfaces" and are meant to connect to the current style-trends.

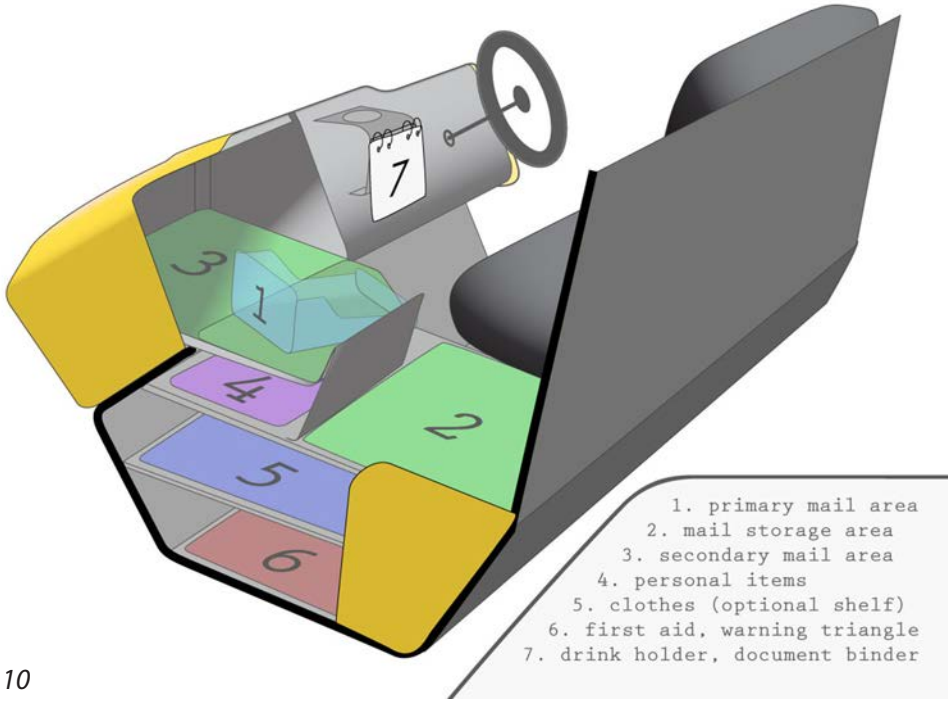


Fig. 110

9.3.10 Bull guard

The Nimbell Trigo has an optional steel bar front guard to protect the vehicle from rouph treatment and double as a universal tooling mount. The shape of this guard can also be found on the Terravox and are in both cases connected to the products main visual identifier, the trigo shape and the terravox shape

9.3.11 Charging

The vehicle will be connected with an external charger to minimize the weight and cost of each vehicle. The charger inlet is situated below the seat on the driver hand side in the pilot series due to technical limitations. We propose that this will be changed for the series production moving the plug to the front of the vehicle, on the driver side just below the plastic hood (Fig. 122 on page 105).

9.4 Platform

The identified target segments that are of interest for Nimbell all share a high demand of specialization towards their individual needs. The solution to fulfil both current and future demands is to develop a modular cargo and cabin solution. This is made possible through the shared platform that has been developed in cooperation with the manufacturing team. The basic vehicle is made up of a tubular undercarriage that takes up the load of both passengers and cargo and is together with the front and battery compartment the only parts that will be present in all models. It is therefore important that these parts have a design language that can stand on its own while being enforced further by additional modules. This can be compared to designing a car that will have a competitive design language that is shared by a hatchback, pickup and convertible version.

9.4.1 Modells

The Trigo vehicle is to be divided into three basic models based on the performance needs of the different customer segments. All three models come with the option to further customize the vehicles through purchasable add-ons.

Logistic

The logistic version (Fig. 111) is adapted towards users that spend the majority of their working hours inside the vehicle. This puts additional demands on the long

term comfort of the driver while being seated but also on the performance of the vehicle. The vehicle is equipped with a full cabin including lightweight soft top doors to keep the driver warm on longer transport distances. The passenger side has been modified with a mail distribution platform to provide sorting and close proximity storage.

Fig. 111

Worker price and Worker deluxe

The workhorse in Nimbells product offering is named worker and highly configurable to suit the varying needs of the maintenance segment. The user usually operated around the vehicle and this is reflected in the driver area. The standard configuration is an open vehicle with a cargo bed with side panels. This can be upgraded with a cabin with or without doors and an optional mesh cage for storing low density cargo.

Nimbell have chosen to market both a deluxe (Fig. 112) and a price model (Fig. 113) based on input from i5 economic project group. Both price and deluxe share the same chassis and engine but could have different battery packs and accessory kits

9.4.2 Form and function

Logistic specific

The specific model made for logistics are the focus model to fit to the primary user group. This means that most features of the vehicle are made to fit for this model. For instance, the high demand of weather protected cargo made by this segment has led to the shape adaptations in the development phase to make the vehicle work with doors. The focus on this model lies in the creation of a continuous efficient workflow for the driver. The vehicle should be an elongation of the driver in order to reduce delivery time.

Fig. 112

The cargo bed is equipped with a closed cargo box that can be locked in order to protect valuable cargo while the driver is away(Fig. 114).

Mail handling system

The mail handling system (Fig. 110 on page 100) is especially developed for Nimbell Trigo logistics. It is divided by different zones based on distance to the driver and reachability. Also it does take in consideration the aspect of sorting.

1. Primary mail area.
The primary mail area are chosen to be the spot closest to the drivers hand and eyes during driving. It is also given some extra space customize the box placement for the driver.

2. Mail storage area.
This zone is developed to fit posterns standard large mail boxes and to maximize ergonomic posture during refilling the primary mail area. The height of the base are adjusted to be reachable without leaning.

3. Secondary mail area.
This zone works as a placement buffer zone for the primary mail area as it connects to it, it also works as a second mail area for other not as frequently handled mails.

Fig. 113

4. Personal items shelf
The personal items shelf are placed in the same reachable height as the secondary mail area but are hidden from view and items are more firmly placed. This is also possible to use as sorting or as a special mail compartment.

5. Optional storage shelf
This shelf are not to be used regularly as it is hard to reach, but it fits well as a large compartment for the drivers spare clothes . If removed, the area beneath could be used as an extra mail storage.

Fig. 114

6. Ground level
the ground level is fitting to use for additional equipment such as first aid box and warning triangle.

7. Drink holder/ document binder.
The drink holder and document binder are placed away from the mail area but still close to the driver. The area could also be used to mount a smartphone-dock.

Worker function specific

The Nimbell Trigo Worker is a loading and transportation vehicle that specializes on the secondary usage groups defined in the Persona method (chapter 5.3) known under the pseudonym of Mr. Garden and Mr. Fixer. These user segments have a range of needs that differ from the segment represented by Ms. Delivery. The focus lies on user customizability and two different models of the Worker is therefore available to cover the whole price spectrum.

The Worker comfort version shares the same platform as the Logistic version and is configured to provide a nimble load carrier that combines a large travel range with low maintenance. The cabin area accommodates two seats with low backrests that provide a high degree of freedom while providing stability to the hips and lower back. The padding in the chair is slightly less luxurious compared to the logistic version but is motivated by the relatively short distances travelled. A glove compartment is positioned on the passenger side to provide a dry storage area for spare clothes or documentation.

The worker price version is a stripped down version were focus lies on the basic function to keep the cost down in order to compete with today's regular delivery trikes. It comes without a roof and the windscreen present on the other configurations is replaced with a shorter version to provide a windbreaker in the otherwise open cabin. The lithium ion batteries are replaced with more affordable car batteries. Also the advanced wheel suspension is removed in favor of a stiff rear axle.

Both versions of the Worker can be fitted with several additional modules de-

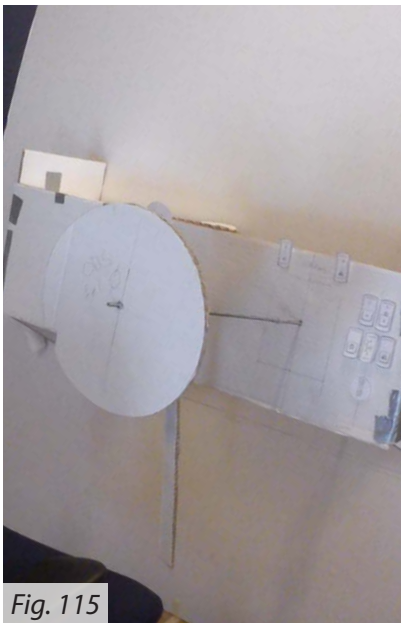


Fig. 115

A small mockup of the dashboard done in the adaptation phase.

Fig. 116

scribed below.

Foldable Chair
The loading platform has been kept relatively small compared to larger vehicles such as pickups to keep the wheelbase small. The foldable chair (Fig. 116) provides the user with the option to lengthen the cargo area on the passenger side in order to transport longer tools such as rakes, shovels or small ladders. This provides a more versatile cargo system that can be adapted to the present situation. Storing equipment in this manner instead of on the roof also has the added benefit of lowering the total centre of gravity for the vehicle leading to increased stability.

Roof
The small windscreen on the price version can be replaced with full sized version with an accompanying roof. The whole assembly is fully detachable providing the user with the ability to dismount it during the summer months.

Full Cabin
The roof can be further customized through the addition of doors and a rear wall to create a fully enclosed cabin. This provides a heated environment that the users can withdraw to during the cold season. The modular aspect of the doors makes it possible to remove them during the warmer season.

Side walls
The loading platform can fitted with numerous attachments through the two side slits on either side of the vehicle. One of these is the sidewalls that enable the vehicle to carry bulk loads such as dirt and gravel that would otherwise pour over the edges of the platform. The rear segment can be opened to unload the cargo through a tipping motion.

Loading cage
The height of the side walls relates directly to the maximum weight that the user can load on the vehicle. The loading cage makes it possible to load low density materials such as leaves in sufficient amounts while ensuring that the vehicle can't be overloaded with high density materials such as dirt and gravel.

9.5 Pilot manufacturing adaptations

The overlying goal of the design work for Nimbell throughout the project was always to create a design that would be feasible to manufacture in a series production. This design was however not seen as feasible to implement fully into a low volume pilot series. A simplification and adaptation was therefore needed to infuse the core design into this series (Fig. 117 and Fig. 118).

The main difference between this concept and the earlier ones lay in the translation of freeform design features into the more restricted flat sheet metal manufacturing processes and adaptations to make room for standard parts. Another dominant change was the move towards solid doors due to customer feedback uncovered during the later stages.

An overview of the implemented changes can be seen in Fig. 103 and Fig. 104.

The side cover hiding the battery box was removed because all vehicles within the pilot series would be fitted with doors covering that region from view. The main design intention of that piece, to tie in the cargo platform with the cabin was translated to the side panel of the door (Fig. 119) to give the same effect. It was then further strengthened by an additional window section to make up for the transition from 3D to 2D.

9.5.1 Dashboard

The dashboard was finalised using the guidelines created in chap. 9.3.5. This was done though a short mockup session were a number of different standard switches from contacted suppliers were printed in full scale on paper. These were then moved around on a mockup dashboard where underlying obstacles were marked (Fig. 115).

Switches related to the driving experience such as: ignition, forward/reverse and slow/fast were placed on the right were they would be easy to reach but shielded from accidental input from passengers. Secondary switches were placed on the left side were they can be accessed from both passenger and driver. These were; 12V, traffic horn, cabin heater, wind screen wipers, headlights and work light. The turning indicator was placed on the steering column

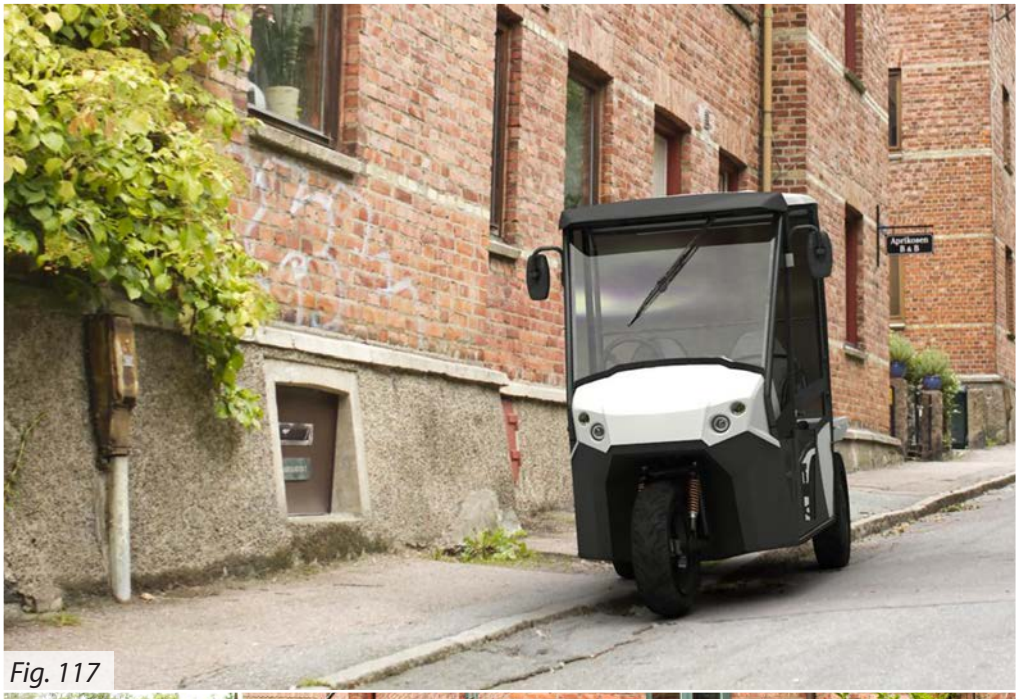


Fig. 117

Fig. 118

Fig. 119

Fig. 120

Fig. 121

Fig. 122 Future placement of the charging inlet.

for easy access.

Some deviations from the guidelines had to be made though due to the sheer amount of equipment and suport beams residing just below the dashboard plate. The main change was the information display that had to be moved from above the steering wheel to the middle of the console. This display contains information about battery status, charging and turning indicators.

9.5.2 Steel under plate

The lower segment of the front was mostly unaffected by the move to a sheet metal manufacturing technique. The tension of the forward bend diminished slightly through a move from tilted lines slowly approaching each other to the implementation of two parallel lines in the lower half (Fig. 119). A bending line was also introduced dividing the upper and lower segment of the lower front cover into two distinct areas.

9.5.3 One plastic cover

The placement of the roof pillar was changed due to structural constraints moving it from the outside of the lower front cover (Fig. 109) to the inside (Fig. 121 and Fig. 122). This introduced a gap between the upper and lower front cover that had to be resolved, keeping the upper front cover on the inside of the roof pillar. The resulting triangular flange altered the appearance significantly and can be seen as the biggest deviation from the original design intention during the pilot series adaptation.

9.5.4 Headlights

Two additional cavities were added to the front (Fig. 123) to accommodate standalone turning indicators. The cavities for the main headlights were also moved slightly to make room for the attachment points of the light units. Introducing two smaller design segments into the front further increased the gestalt line that flows all the way from the wheel thru the lights and along the side of the hood using the “god curve” gestalt law (chap. 4.1.7) to strengthen this design feature.

9.5.5 Bent pipes

Restrictions in the available pipe diameter that could be bent using variable radius bending prevented the implementation of a soft top door in the pilot series. This change in combination with new input from Nimbell lead to the development of a flat sheet metal door as a substitute.

9.5.6 Solid flat panel doors

The plastic canopy doors were replaced by solid doors composed of a metal framework and transparent polycarbonate panels (Fig. 124). The reasoning behind this was that the lighter canopy door could be percieved as fragile and cheap by the end users. A solid door would also have the added benefit of supporting driver and passenger windows . The downside to this new manufacturing choice was that the door segments had to remain plane and the frame of the concept had to be changed to accommodate that. A quick concept was developed in collaboration with the construction team (Fig. 125) with the aim of implementing the new door concept while retaining the original design intentions.

The solution was a cabin side divided into three segments where each segment tilted slightly inwards towards the centre of the vehicle. This helped to retain the cone shape of the vehicle and also created a visually appealing faceted surface. However the hour glass shape could not be saved although a slight hint of it is still conveyed by the hood. The main door was divided into an upper and lower segment creating a large area that could be opened for newspaper delivery (Fig. 126).

The first concept were then slightly adjusted to blend in with the overall look of the vehicle. The lower portion of the door was also raised slightly to enforce the feeling of being safely seated within the vehicle.

Fig. 123

Fig. 124

Fig. 125

Fig. 126

10. Credibility of concept

This chapter shall summarize and argue for the credibility of the different aspects of the concept shown in the previous chapter. Initially the project goal were not to create a finished product but rather credible suggestion on the interaction in both visual and usage areas of the vehicle. This overall credibility can easily be argumented for since the concept is actualized into a physical working prototype series. The market potential of the concept is however still rather unproven.

10.1 Visual design and semantic expression:

The final concepts visual design language are heavily supported by testing using the semantic analysis tools recommended by (Warell 2008) also a own developed testing method were created to make the design communicate intended messages. However this methods improvised execution made its result questionable. The pure aesthetic are not evaluated and can only be argued for by the skill of the creators and the conditions and freedoms of the design. However many guidelines for good design from literature such as the gestalt laws have been accounted for. Due to the high restrictions in terms of form freedom and manufacturing methods one could argue that the result meets the expectations for the visual design to represent the product and the brand against the competitors in the decided core values. It is however important to regard the market segment and the user groups relationship towards the product and its design. The user study indicated that there is a distinct difference between how a user evaluates a company work vehicle and their own vehicle. On a work vehicle users tend to down grade the importance of visual design. In the electric utility segment this could be reinforced further due to the previous immaturity of the vehicle segment and the professional Business to Business (B2B) nature of the market segment where the user and the buyer are separated. However during the project period several new products have emerged that indicates a change towards more user adapted design and a more mature/ up to date visual design. This emerging competition will cultivate a need for visual product branding as the customers' expectations increases.

10.2 Ergonomics

In the BEMO prototype that was designed previous to this project, some ergonomic related issues were found. With the help of literature, full scale testing on a mockup combined with testing tools from the master course "physical ergonomics" a redesign of the ergonomic user interaction were made. Due to the extensive work done to enhance the ergonomics throughout the whole vehicle its ergonomics should be considered to have a good credibility for for a large span of users.

The minimum sitting height 5th percentile female could however not be reached. Some compromises were made due to the limited size of the vehicle and the minimum height of the battery compartment placed below the seat. The height of the seats is therefore slightly above the seating (popliteal) height of the 5th percentile female. Also the leg space and chair tilt are not optimal for the largest percentiles as a longer vehicle would impair the vehicles turn radius. Despite this, optimiza-

Fig. 127

tions have been made to minimize these problems with help of good customizable seating positions and steering wheel adjustability.

The new Nimbell Trigo has many ergonomic advantages during mail handling compared both to a conventional car and the previous BEMO prototype. During mail delivery the user leaves and enters the vehicle in a high frequency, this has influenced the shape of the new vehicle in many aspects. Handles have been placed in the top right region of the door in a way that it may be used horizontally or vertically but still as close to the roof and side beam as possible to enable easy entrance. The seat are placed higher to ease the exit of the vehicle. The B-beam is located as far back as possible creating a big door opening to enable easier access and exit out of it. An upright seating position provides an easy ingress and egress from the vehicle. This removes unnecessary strain on the knee especially for users constantly moving in and out of the vehicle. The low window edge combined with the thin door provides another advantage to the Logistic users, giving better reach to awkwardly placed mailboxes and removing the need to lift above the shoulder region. Also the three wheel design and great turn radius allows for the vehicle to get up close to the mail box.

A dashboard moved slightly closer to the driver provides easy reach to primary switches gathered on the right hand side. Less important instrumentation are placed in the middle part where it can be overviewed by both passenger and driver.

The interior mail handling (Fig. 127) are also improved, due to the lack of mid-section between the seats the distance to the mail area are reduced, lowering the ergonomic stress on the user. The mail areas in front of the steering wheel that were implemented in the BEMO prototype showed to be impractical and have been removed in favour of a wider cabin with an improved sight cone.

10.3 General design

10.3.1 Semantic analysis on expressions and associations

The pilot adaptation design differs fundamentally from all previously analyzed competitors. Which effect this design have on customers are hard to predict without a proper survey. It is suggested that a thorough semantic analysis are made to confirm that the intended expressions and associations are conveyed to the customer. These should be compared with the Nimbell brand core values and possible alterations should be proposed.

Below is a short list of proposed alterations to the pilot manufacturing adaptation that should be made before mass production.

10.3.2 Chassi and frame

On the pilot series, the roof pipes are placed outside the hood for space and price reasons but our vision is to place them inside the hood plastics to better connect the top and bottom half of the vehicle. Also the pilot series solution makes a cut-out in the side plate of the hood piece that makes the vehicle look unfinished when without the roof.

10.3.3 Hood

The hood is the part that sets the tone for the vehicle's visual communication. This part should be preserved except for minor changes described below.

New indicator or indicator positioning
The current indicator lights are too big to fit well into the design, a smaller round indicator light could be placed in the same spot or the placing and shape should be reconsidered.

Remove side flange
The side flange (Fig. 128) is a consequence of the outside placing of the lower sheet metal surface and the placing of the roof pipes. It is suggested that these could be placed inside and creating a flat side.

10.3.4 Main light

The main lights on the current versions were chosen for underlying structural reasons. They could be replaced by less expensive alternative with a shorter light cone while maintaining legal requirements in future versions. A model with a larger lit area would also fit to the design in a better way. However to secure a change the frame beneath the hood must be redesigned.

10.3.5 Door solution

Curved soft doors would be preferable in future versions. They greatly increase the design possibilities and adheres to the main design intention to be modern. It also creates needed space for the user, especially the users arms, without widening the vehicle near the front as the door may follow the curve of the arm while driving.

The current manufacturing partner situation does not enable freeform curved pipes. This is no extra cost if a suitable machine park is present. It is suggested to either manufacturing these parts elsewhere or persuade the current partner to invest in these tools.

10.3.6 Cargo space

Many ideas were defined on how to increase user value with cargo solution add-ons. These were unfortunately not included in the pilot series adaptations due to restrictions in development time. Further development on these ideas should be made when the production ready Trigo is launched.

10.3.7 Seating and interior

The user study and pugh matrix shows that the foldable chair solution is needed by the maintenance segment and should be implemented later on to enable long and heavy cargo to be loaded on low height instead on the roof to increase vehicle stability during transportation of such.

10.3.8 Roof equipment

All the users in the maintenance segment that were visited during the user study had their own ceiling equipment securing solutions for rakes, spades and other long tools. A high quality built in solution by Nimbell could raise the customer

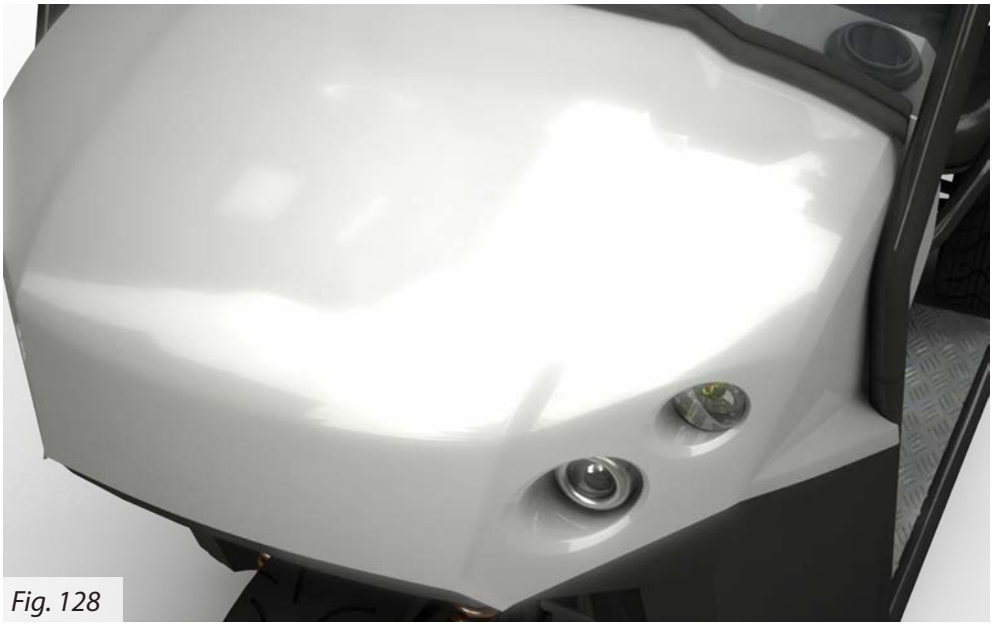


Fig. 128

satisfaction.

10.3.9 Front passenger handle

During testing of the BEMO prototype and the user study a need for a good handle on the passenger side were found. It was removed in pilot adaptation phase but should be reconsidered in the next development phase. One of our early handle solutions (Fig. 66 on page 74) provides extra functionality by providing extra support for the mail handling system. Connected with the foldable chair it would also act as a wear protection for the dashboard.

10.3.10 Front cargo space

Should be increase in size if possible to allow for A4 documents to be stored dryly. An ability to connect with backside cargo space with the foldable chair solution is desirable.

10.3.11 Dashboard

The present instrument panel has a rough and un-modern expression as well as adding a lot of weight on the vehicle due to its metal construction. A move towards plastic in the next version would prove to be cheaper when larger volumes are considered and more easily adapted to the underlying construction. The possibility of a more refined design expression would also be an added bonus.

10.4 Pilot series evaluation

This chapter compares the final result with the user demands identified during the user study phase. The final concept is evaluated through the customer demands that were seen as most critical in chapter 5.

10.4.1 Logistic

Damage protection

Sensitive parts such as light sources are placed in such a way that other more rigid chassis parts will make contact first in the case of smaller collisions. The placement of the frame tubes has also done in such a way that the critical contact points of the vehicle have a tube directly beneath it to absorb the impact. The manufacturing adaptations on the hood are however less protected but an aftermarket front guard is developed if this shows to be problematic.

Allow customer branding

The large storage compartment on the cargo bed has flat side panels unobstructed by other features such as doors. This provides a large surface for customer's graphic that can easily be seen when the vehicle is parked. The rear chamfer in the roof as well as the front cap provides supplementing areas for additional text or logos.

Protect driver from wind

The full cabin creates a protected environment where the driver can sort mail undisturbed. Having a complete cabin also prevents turbulence even if the driver side door or window is open during delivery runs. The interface between hood and front window could however be improved to provide a better seal.

Allow mail delivery from the driver's standard position

Having a vehicle with a short cone shaped front end enables the driver to manoeuvre close to individual mail boxes. This in combination with a door that can remain open during delivery creates a vehicle where the driver very rarely has to stretch beyond their comfort zone to reach the mailbox.

Cargo area should fit with Postens standard boxes

Posten has several different standardized boxes that they use in their delivery process. Small adjustments to the cargo bed area have been made in order to fit a set of whole boxes. Avoiding a situation where a box would nearly fit was seen as most important to avoid. The total cargo volume is seen as more than adequate for the cargo volumes intended.

Reach cargo stored in cabin from driver´s position

Cargo can be easily reached from the mail module when installed into the vehicle. The modularity of the system makes it easy to implement customer specific solutions if the need arises.

Provide good manoeuvrability

A three wheeled configuration does in itself provide good manoeuvrability but is further increased by transparent panels in the lower door panels to provide a clear view of the surroundings. A curb to curb turning radius of 3,5 m makes it easy to perform U-turns. The rear view is however obscured by the windowless cargo box fitted on the Logistic model.

Allow high operating time

The battery capacity can be adapted to fit individual customer demands. Eco driving capabilities in the vehicle interface could be introduced to make this even longer.

Allow safe transport

The driver seat comes fitted with a safety belt creating a safety zone in combination with the rest of the cabin in case of an accident. The vehicle itself does lack in more advanced safety equipment present in regular cars but this is seen as excessive when the vehicle top speed is considered.

Appear professional

The exposed tube frame protecting critical areas of the vehicle from impact damages gives the observer a resilient first impression. Having a dark colour throughout the lower region of the vehicle ties it together with the plastic protective covers on cars aimed for terrain and rough usage.

Appeal to target customer

This demand have been one of the main focuses on this project which is thoroughly mentioned in chapter 9. It communicates robustness while blending in with an urban environment.

Offer good environmental protection for sensitive vehicle parts.

A hard to fulfil need that in some cases conflicts with weight and price demands. The space beneath the hood provides a good location for the 12V electronics needed in the instrument panel as well as the heating system. Further space is allocated beneath the cargo bed where electronics related to engine is stored in a protective box. Enclosing the area were the motor is situated could provide further protection from tire splatter to the vehicle.

Provide easy access to the cabin

This was evaluated through the mockup that were made. Seat placement, door-positions, the cabin proportions and the dashboard shape are adjusted to account for this need. Also roof handles are proposed and developed but not implemented in the pilot series.

10.4.2 Worker

Customization using different components

The project had high ambitions regarding the customization and adapting the concepts towards it. Many of these have however been delayed by manufacturing and cost demands. However those implemented still apply in a good fashion such as detachable doors, detachable cabin and different cargo beds. The vehicle can alos be bought with different battery packages and driveline configurations seats etc. making the vehicle competitive through flexibility.

Minimize width

The optimal with were found to be around 110cm. The vehicle have been developed to never exceed this but still make use of the possible width where it is needed such as the cargo bed which overlap the rear wheels and the seating area of the cabin.

Possible to bring an extra person

A passenger seat has been accounted for when placing the driver seat. Adjustments have been made to the cabin width to make it comfortable.

Damage protection

Sensitive parts such as light sources are placed in such a way that other more rigid chassis parts will make contact first in the case of smaller collisions. The placement of the frame tubes has also done in such a way that the critical contact points of the vehicle have a tube directly beneath it to absorb the impact. The manufacturing adaptations on the hood are however less protected but an aftermarket front guard is developed if this shows to be problematic.

Ability to pull trailers

The backside of the vehicle is intentionally designed to be open to give a better reach for the hitch. Also the length of the cargo bed is adjusted the the same reason.

Enable high tip angle

The tipping angle of the vehicle is somewhat lower than originally thought due to a collision between the lower plate holding the rear lights and the frame where the

towing hook is mounted. It is still sufficiently steep to provide a easy unloading of cargo from the bed but could be improved further.

Offer good environmental protection for sensitive vehicle parts.

A hard to fulfil need that in some cases conflicts with weight and price demands. The space beneath the hood provides a good location for the 12V electronics needed in the instrument panel as well as the heating system. Further space is allocated beneath the cargo bed where electronics related to engine is stored in a protective box. Enclosing the area were the motor is situated could provide further protection from tire splatter to the vehicle.

Ease of exchanging battery pack

This need was closely tied to the usage of lead-acid batteries as the vehicle energy storage. Modern lithium and sealed lead acid batteries have removed many of the reasons that made the need arise in the first place. The need to exchange battery packs has therefore diminished since the Trigo won't have the obsolete lead-acid technology. It is still possible to remove the built in battery pack but the process will require access to a workshop.

Provide good maneuverability

This demand is fulfilled in a similar fashion as described under the demands for logistic. The requirement between the two segments differ, the difference between the two two lies in the need from some customers to have grass tires on their vehicles; a demand that unfortunately could not be met while maintaining the need for road tires.

Allow fast charge

This demand was deemed to lie outside the scope of this project.

Fig. 129

Options for extra height cargo bed sides.

A solution on a custamizable cargo bed side system have been developed where the user may choose which sides to use. Also concepts on how to stack different sides on top to customize further.

Replaceable battery.

Changing batteries is possible but has been, due to restriction outside the scope of this project, been restricted to licensed service personal.

Flexible detachable weather protection for cargo on cargo bed

There are a lot of work done and concept solutions exists that however have been exluded in the final concept and manufacturing adaptation (Fig. 129) due to cost and a focus toward the logistics segment. Concepts made are however still valid for future work.

The cargo box developed for the logistic modell could be seen as a solution to this need.

10.5 Summary

We who have developed this concept are gratefull for the project given to us and look forward with confidence to the day when it will be recieved by its users. We wish Nimbell the best of luck on their way to realising the dream of a new electric vehicle.

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Appendix 1

Stake holders

The individuals and organisations that could have an interest in the project.

The end user
Logistik or park worker

Ej dolda fel, Positiva överraskningar, Billig produkt, Långvarig produkt, Utföra behov med så små uppoffringar som möjligt, Skryt (bättre användare)

The purchaser
Local distribution companies, Industries, municipalities, park management

Billig produkt, Långvarig produkt, Pålitlig, Inga störningar i vardagsrytmen.

The project owner
Gustaf, Jonas

Product on the market, expansion

Chalmers
Ralf

Konkret resultat, Smidig process, Lärorikt, Mycket metoder, Bra akademisk rapport, Reklam för programmet

Sales and Marketing
I-gruppen

visuellt lättkomunicerat, sellingpoints (functions and design), strenghts and weaknesses

Legal and regolatory affairs (copywright, patent)
Gustaf, Jonas

Senior technical management
Tugger entrepenour

Genomförbart, Vill inte att projektet växer för mycket, influera?

Maintanenace and Reliability
-

Product development manager
Gustaf, Jonas

Product designer
Patrik, Tobias

Flashigt resultat (visuellt lättkomunicerat), Göra Nimble nöjda, Kredit

Model maker
Patrik, Tobias

ev mockup på mässa,

Human factors

Patrik, Tobias,

Product enginer
Oscar & Marcus , Msc thesis machine

Löpande input, feedback konstruktionslösningar och design.

Packaging and point of sale designer
-

Senior management within manufacturing (safety function, purchasing function, production engineer)
The production company

Product testing function
Organisation standards (iso)

EU

Assurance that you comply with the rules.

Local authorities (interest groups)
-

Competitors
Dobbin, Nordsjö, Pgo scooter, Club car, Kyburz dxp

Investors

Encubator

Financialy independent company

Appendix 2

Ver. 1 Segmentering/Personas/målgruppsstudie

Syfte

Personas syftar till att ge utveklare en möjlighet att själva se sig in i en användares vardag för att bättre kunna hitta krav och behov. Segmentering görs initiellt för att finna lämpliga personas

Metod.

I detta dokumentet kombineras personas med en målgruppsbeskrivning.

Möjliga segment

Verktygstransport

Tung industri, VOLVO Byggarbetsplatser Godshamn Flygplats

Lämpliga företag

Volvo Skanska

Grupp-preferenser

Blandad ålder och bakgrund. Studenter och yrkesarbetare. främst män.

Arbetstyp
Blandad frakt av tunga redskap, råmaterial. Mellan nivå från lastbil, pallar. Kan ha längre arbetspass, bitvis enformiga uppgifter. Stora områden, ibland längre sträckor

Förhållande
utomhus och inomhus, ibland sämre underlag, dåligt ljus, kallt, smutsigt, grovt slitage yttre detaljer och lastutrymme från oöm last.

Selling points
Smidig manövrering, bra närvaro med omgivningen, flexibilitet, lättlastad

Persona
Göran 45, jobbar på volvo lastvagnar som vaktmästare och maskin tekniker.

Göran har kört flakmoped under sin uppväxt och under sina arbetspass eftersöker ett fordon som ersätter deras gaffeltruck och bil vid mindre transporter på området. Han går mycket och har ett allmänt fysiskt krävande yrke vilket ibland leder till värk och krämpor. Bältet är fyllt med verktyg och vid just transport av sig själv och tyngre redskap eftertraktar han ett fordon. Han är klädd i blåkläders oömma kläder vilka ger bra värme på vintern men kan vara tunga och otympliga sommartid. Han kör sin vita volvo 740 till jobbet tidigt varje morgon och därefter hämtar han sina barn från skolan efter jobbet. Utöver yrket är han fackligt engagerad i METALL. Han har stor yrkesstolthet över sin breda kunskap och vet vart varenda mutter sitter på området. Han gillar sina arbetsfordon och ser det som sin egendom. De är fyllda med plåtter, verktyg och listor men han vet alltid vart allt ligger. När han arbetar är stress långt borta, arbetsuppgifter görs på rutin efter gamla metoder och inte mycket förändras i vardagsarbetet vilket görs i ganska lågt tempo.

Alltiallo

Campus Eventplatser, ullevi, festivaler Fiskhamn millitäranlägningar/värnpliktiga

Lämpliga företag
WoW Metaltown Ullevi/gammla ullevi

grupp-preferenser
Mycket yngre användare. sommarjobbare till akademiker, funktionärer. kort inlärningsperiod.

Arbetstyp
Många korta resor utomhus hela året. Används av olika personer. förvaras främst i garage men ska kunna stå utomhus. Fraktar både personer och materiell Sällan specifika fraktyper.

Förhållande
utomhus, gräs/grus kan förekomma, dåligt ljus, kallt/varmt, medel slitage, elektronik, av ovana användare, kör in i saker, kör fort

Selling points
körkortsfri, pris, flexibilitet, storleken

Persona
Fiona 17 år, jobbar som volontär på festival i utbyte mot fribiljett. Har hand om uppbyggnaden av festivalområdet och ser detta som sitt första steg in i arbetslivet. Hon känner att det är lite pinsamt att köra runt i fula arbetsfordon men det spelar inte så stor roll då det bara är ett par dagar som hon ska hålla på med det. Arbetsdagarna är långa och intensiva men arbetet är varierat och det finns många spännande saker att testa på. De flesta jobbar i sina egna fritidskläder och har enbart fått arbetshandskar av festivalarrangören.

Tidigare har cykel och buss varit det främsta transportmedlet och moped är inget som varit intressant att skaffa då körkortet kostar pengar. Men på bara ett par dagar har hon fått ansvar för att köra ut stängsel, scenmateriel och tält som väger flera hundra kilo till ytterkanten av festivalområdet där de monterats. Hon känner sig som en riktig grovarbetare men får syrliga kommentarer om att hon kör för söligt av sina kompisar som också jobbar på festivalen.

Utomhusskötsel

Kyrkogårdar Parker fastighetsområden kommunskötsel grönområden

Liseberg

Lämpliga företag
Liseberg Park- och naturförvaltningen

grupp-preferenser
Samma personer som kör fordonen från dag till dag ofta den som är äldst i gamet. Lång arbetserfarenhet bland personalen.

-västra kyrkogården:

Golfbilen körs av alla, bla. sesångare som kör vårdslöst

Arbetstyp
Långa pass utomhus men inte aktiv användning av fordonet. Transporterar sig själv och verktyg och tillbehör som krävs. Används året runt men mycket varierande uppgifter. Ofta långa trädgårdverktyg tex. kratta. spade och röjsåg.

-västra kg:

ca 3h om dagen körs fordonet. mest som persontransport + mindre verktyg.

Förhållande
Kallt/varmt, blött, tyst omgivning , civil personer runt omkring, asfalt/grus/gräs/betong/lera, trafikintensivt främst vid transport

Selling points
Tyst, korta om-ställningstider, klarar gångvägar, liten och smidig, lastkapacitet

Västra kg:

bekvämlighet

Persona
Rutger 40 år har jobbat inom parkförvaltningen i flera år. Han är arbetsledare över två nyanställda och de tre jobbar för det mesta ihop ute på stan. Det bästa med jobbet är möjligheten att få jobba utomhus och de tidiga mornarnarna med möjlighet att sluta tidigt på dagen. Jobbet är väldigt fritt och arbetslaget har själva ansvar för hur de vill planera arbetsdagen. Rutger beskriver sig själv som en van bilförare och har både B och C-kort.

Parkförvaltningen delar på fordonen som finns och vilket man använder beror på behovet som finns just då. Gänget som jobbar på avdelningen är ganska litet och alla känner alla. Saker blir ofta liggande i hytterna på fordonen tills plastchefen får ett ryck och beordrar till vårstädning.

Arbetskläderna är enkla men färgglada med monterade reflexer för att bli så synliga som möjligt ute på stan. Men hjälm och skyddutrustning är ofta med ute på turerna i de fall motorsåg eller röjsåg ska användas. Verktygen som används är en förlängning av yrkesstoltheten och kvalité är hårdvaluta. Enligt Ruther finns det inget värre än strulande maskiner som inte håller måttet.

Förutom verktygen så har Rutger en arbetstelefon för att lätt kunna kommunicera med de andra grabbarna på stan och komma överens om lunchtid på närmsta Sibylla. På transportsträckorna mellan parkerna lyssnar han på P1 i hörselkåporna.

Postutdelning

Paket/brev Tidningar/reklam Expressbud

Lämpliga företag
Posten, City-mail

grupp-preferenser
Yngre, blandade kön, stadsbor,

Arbetstyp
Långa arbetstider, kör på allmän väg. många korta moment, många på och avstigningar. repitativt. belastande.

Förhållande
kallt/varm, blött, högt slitage, utomhus, asfalt, stöldrisk?, mörkt

Selling points
Ergonomi, räckvidd, tyst, snabb postutdelningscykel, lastkapacitet, bra vägegenskaper

Persona
tidigare erfarenhet

arbetssituation

förhållande till fordonet

klädsel

statusbärare

stilreferenser

Privat

lantbruk öboende

Lämpliga företag

grupp-preferenser
Blandade grupper, dock oftast äldre eller mer välställda då det kan ses som en lyxprodukt här. Mest män. konkurrerar lite med "fyrhjuling" fast för grusväg

Arbetstyp
Persontransport av föraren och mindre laster. Ibland andra uppgifter, dra kärra, lasta tungt, plankor, fiskenät, fodersäckar.

Förhållande
håller länge, garage, försiktigare hantering, används mer under bra väder, stöldrisk, används av en person eller familj

Selling points
pris, mångsidighet, status, nyhetsvärde, bekväm, driftkostnad, speciellt korta sträckor

Persona
Flakmoppe är ascool bland ungdommarna på ön. En modern trehjuling är en pensionärsmoppe.

tidigare erfarenhet
arbetssituation

förhållande till fordonet

klädsel

statusbärare

stilreferenser

Lager distrubution

Postorderlager Däckfirmor

Lämpliga företag

grupp-preferenser
Blandat egenföretagare och lågstatus yrken. män.

Arbetstyp
Tunga lyft till flak, körs korta sträckor. Endast objekt transport.

Förhållande
ömtåliga laster, inomhus, medel slitage, jämt slitunderlag

Selling points

manövrersmidighet, inomhus, lastyta, pris

Persona
tidigare erfarenhet

arbetssituation

förhållande till fordonet
klädsel
statusbärare
stilreferenser

Sekundäranvändare
Säljare Reparatörer urhyrare

Lämpliga företag
Parkförvaltningen Etp partille

grupp-preferenser
Meckarfolk

Arbetstyp
Kör inte fordonen själva, möjligtvis korta sträckor, reparerar och ska komma åt överallt

Förhållande
inomhus, bitvis kallt

medelgod belysning, lysrör

Selling points
Robusthet, Lätt att serva, Tålig, Bra komponenter

(Lastförmåga, dragförmåga, drifttid.)

Persona
tidigare erfarenhet

Har bra koll på alla fordon men endast tekniskt, gymnasiekompetens eller endast meckar-bakgrund. Erfarenhetsbaserade kunskaper

Arbetssituation
Stort garage-verkstad, 7-14

förhållande till fordonet
Lite problem- eller mycket problem...

klädsel
Arbetskläder

statusbärare
Immuna mot design

stilreferenser
Praktiskt/opraktiskt

Appendix 3

Material from the performed user studies

Spontaninervju: Bring brevbärare:

Arbetsfordon cykel.

maxlast 60kg

Hade en karta som behövde avläsas.

han pratade mycket om tid, hur viktig varje minut var i konkurrensen som finns. Problematik fanns i att cykeln var för bred för delade cykelvägar.

Köld och vind var ett problem när det var riktigt kallt. Annars fanns passande kläder för andra omständigheter Heltäckt inget måste.

Vindskydd viktigare än regnskydd, dock även för luftmotstånd vid cykling.

brev behövde väderskyddas men inte stöldskyddas. inte här i Sverige i alla fall.

tog lång tid att låsa boxarna.

Platsstudie: Parkförvaltningen Ringön.

Platsstudie
Park-förvaltningen ringön.

Gamla tugger:
(huvudfunktion var nästan att den kunde köra släp utan körkort)
endast broms bak - problem
Magnetbroms - bra
Enkel laddning
Stark motor - bra
Tak, bra till posten. Ogillas av "kretsloppet". Speciellt att packytan är inglasad.
Jätteklumpigt uttryck pga. glasrutan
Egenbyggt extra säte av gamal kontorsstol, Behov för två säten finns altså
Bra med släp.
Batteri dåliga på vintern.

Norsjö:
Lager och bussningar går paj.

lastvikt 270kg ? viss förvirring

Önkemål
Flak fritt från tak
personhytt inglasad
tillbehörs sats, krattor på taket osv.
mycket verktyg åker med. verktygslåda/servicelåda/reservdelar
Tjänstevikt ska vara hög.
Gärna mindra batterier som håller en dag än stort som håller två, pga. dyr/jobbiga byten och att

cykeln blev lång.

Smörjnipplar

Balja för salt så denna inte förstör fordonet.

Viktigt att komma åt:
Motor, bromsar, säkringar.

Övrigt
-Kunden kör mycket på småvägar, bostadsområden.

-Permanentmagnet motorer är mycket sämre!

-Bränner motorn i branta backar med mycket last.

-1.5KW för lite.

-INGA REMMAR/KEDJOR

-Blybatterier - Central batteripåfyllningMed

-"Riktig klump till motor"

-Tar med nyckeln, överhängande stöldrisk. Inget extra lås.

-reglage på styre fryser fast av fukt.

-Vanligt att en extra åker med. Skjutsmöjlighet

-Motorbroms, bra/dåligt blandade känslor

-Gillar hydraliska bromsar

-elektrisk broms + reservbatteri finns

-Mekanikerna testar fordon innan inköp

-Kort moped bra! Svängradie

-EGENFIX: Den startar inte med handbroms i. Lätt för föraren att missa denna, kör sönder motorn och bromsen.

-Täckplåtar bra mot salt, saltstänk och speciellt salt som rinner ner från flaket.

- Se till att inga känsliga delar är blottade mot marken (styrkula på norsjö)

-Upplevde att hytt begränsade vad som fick lastas, inte lika oöm, kunde inte bara slänga in flis, salt osv.

Selling points enligt gubbarna (ej säkerställt)
Lastförmåga

dragförmåga

drifttid.

på flaket:
flis

gräsklippare

Platsstudie: Västra kyrkogården

Kvinnlig brukare - tyckte mycket

Mekaniker - tyckte mycket

+4 som pratade inte så mycket. När de uttalade sig vad det för att stödja åsikter från de två andra.

Observationer, Foton finns!
- Sittposition: lång sittplats gjorde att man satt ifrån ryggstöd

Fötterna placeras på instrumentpanelen pga, dåligt benutrymme, bättre stabilitet.

- Backspegeln är placerad inne i taket som en spegelpanel. många små speglar vinkade åt samma håll.

-lastutrymme under flak fyllt med handskar och tomburkar på flera fordon.

- Dubbel-lastkrok, de använde främst sprintmodellen.

- Eget kvastfäste på taket. hål igenom plankor som fäst med plattjärn mot sidolisterna.

- Gummi/plast-list längs hörnorna som dessutom höll fast rutan. fyrkantsprofil snäppt

- Hörselskydd fast runt rattstång på många fordon.

- Handskfack öppet med sekratörer och småsaker, dumt att denna inte går att låsa. för god insyn.

- Armstöd vid sidan av gick endast halva vägen pga långt säte. höll inne passageraren på sätet.

- Önskvärd gallerhöjd på lämmar är max strax under taket så man kan lägga långa saker längst taket och fortfarande tippa.

- Lämfästen, krokar. En kraftig (typ spännband) och en klen fästskruv (typ pjäxsnäppe) som gick sönder.

- Användarsituation. kör och pratar i telefon med häftiga manövreringsrörelse - [handsfree?]

- Kraftig kofångare fram, täckte endast mitten av fordonet med grov gummilist.

- Baklycktorna satt vid takhöjd vilket var bra! gick inte sönder

- Golvet är helt plant och oskyddat mot smuts dylikt. GAS/BROMS/HANDBROMS monterat på golvet, vissa använder ej vanlig broms utan motorbromsar.

- Instrumentpanel. långt från ratt uppradade stora knappar/indikatorer och en stor stoppknapp. De vanligaste funktionerna satt på ratten (ljus/blinkers?)

- Flaklås: plattjärn som stack ut under flak på vänster sida som behövde hållas bak medans man manuellt tippa flaket

- Flakhöjd ca 30cm, endast en dm grus räckte för att fylla 200kg.

- Lampor fram stack upp kraftigt fästa från bottenpunkten, blinkers satt under och denna gick oftast sönder

- Flaket stack ut långt bakom, vikten behövde placeras rätt för att den inte ska riskera att välta.

- Medli mini, fordon: stack ut långt utanför hjulbasen. kraftiga lämmlås. stort flak, Hydralisk tippning bakåt, kan tippas åt tre håll.

Inget förvaringsutrymme gjorde att sekratör var fastbunden i ett handtag.

Inget tak gav bättre köregenskaper och mindre ljud.

- Wille trucken hade snäppfästen för kratta spade på hjulhusen och en liten ändespad-korg på en motorkåpa.

- Begravningsgångarna är smala och omringade av vassa hörn från gravgårdar.

Arbestyp

- Arbetspassens längd och frekvens av fordons användning

7:30-16:00 Fordonet används korta turer under hela dagen ca 3h konstant. laddas varje kväll..

- Vilka typer av fordon har ni på området?

Melex golfbilar, Medli eltruckar som lastar mer samt stora midjestyrda verktygsbärare.

- Vad är de olika fordonens huvuduppgift?

Melex: persontransport+ löv, mindre lastning, Medli: grövre lastning.

- Hur många åker på fordonet (bara föraren)?

Alltid 2 nästan. förr i tiden 5pers men inte längre pga regelverk

- Mycket transport sker på allmän väg?

Kyrkogården räknas som allmän väg, dock oftast lugn trafik

- Utförs mycket av arbetet i utanför inhägnat område (vid vägar)?

Inget, förutom det som görs på små gravstigar.

Förhållande

- Säsongsspecika problem (kallt, varmt, halt, blött)

Kylar försämrar räckvidd, väta förstör elektroniken speciellt gaspådrag.

- Krav på buller nivå?

Nej inget uttalat men ändå omtyckt med tysta fordon.

- Hur förvaras fordonen

Garage och utomhus.

- Vilka underlag används fordonen på och är några av dess jobbigare?

Gräs och lutning är jobbigare. annars grus och asfalt.

- Brukar det vara mycket folk runt omkring fordonet när ni arbetar?

Ibland mycket besökare i kyrkogården

- Har ni några haft stöldproblem? (om ja/nej varför?)

nej inte hittils. Dock många inbrott i garaget. De tar max ut nycklarna, dock lämnas dessa kvar ibland då flera använder samma fordon.

- Förekommer det att fordonen hanteras på ett mindre säkert sätt?

HANDBROMSSLADDAR! Speciellt på vintern. Inget bälte används.

Överlastning av flak

- Brukar ni ha saker liggande i hytten mellan arbetspassen?

JA: Trädgårdsspade, sekatör, flaskor, listor hörselskydd, Jacka, verktyg.

- Vid vilka tillfällen väljer ni bort en elmoped. (melex)

o Vad väljer ni istället, VARFÖR

När det behöver lastas mer, eller när det skall lastas nåt långt så som stege.

Behov och utveckling

- Tak:

Bra att ha då det regnar. Skönt med skydd

Togs bort pga stabilitet, Kan förvaras upphissat i tak, inte önskvärt dock. För jobbigt att ta på och av. lämnas på.

o behov av att transportera föremål på taket

Skaftverktygshållare har monteras på.

o väggar?

Blandade meningar, ganska otympligt och de gick sönder pga. så många ur/in stigningar. Väger extra och extra kostnad. inget alternativ men skönt ändå att kunna stänga om sig på vintern utryckte brukaren.

- Vad vill ni ha på flaket

Jord, löv, trimmers, röjsågar, blandade verktyg.

Använder höga galler för löv timmer, röjsågar och granris.

- hur/om vill ni kunna tippa flaket eller fälla väggar

Måste kunna tippas bakåt och fälla väggarna är krav, sidorna är tippa inte behövt och fälla ett vagt önskemål!

- höjd på flaket

Medelhögt så man inte luras att lasta för mycket och inte för högt för det är jobbigt att lasta

o varierbar höjd på väggar?

Om det går att lösa smidigt, galler skramlar, stänger som håller inne långa lutade objekt är ett önskemål.

- speciella infästningar önskemål

Ej rörhål i botten/sidor för det fylls med jord

- Säte önskemål /storlek, nackskydd, Armstöd, värme

Gärna allt, ett bra säte är viktigt, vilostunden på arbetsplatsen och den används många timmar om dagen. dock av olika personer.

I dagens sitter man för långt fram pga. dåliga inställningsmöjligheter. sjunker ihop

Reglage:

- Vilka reglage indikatorer är viktigast

De vanliga behövs, batterimätaren skall vara analog eller i steg likt en mobil.

o önskemål:

timmätare är bra för att veta senaste service.

o hur skulle ni vilja elförbrukningen representeras, tid kvar/momentant?

Nej. inget av det,

- Har ni behov av GPS/hastighet/karta/körstatestik/Radio/

NEJ, vill inte ha möjlighet till radio-leder till oväsenden.

o hur sker eran internkommunikation

Alla har mobil.

Persona

- Vad brukar du ha med dig?

Vattenflaska, mobil ibland plånbok, listor, infoskyllt stickor, planteringsspade, sekatör.

- Vad skulle du vilja ha med dig?

Extrakläder kanske.

- Varför har har du inte med dessa föremål idag?

ont om plats, krok skulle kunna möjligöra kläder.

- Vad är obekvämt med dagens fordon?

Regnade in.

- Finns det några irritationsmoment(har deras arbetsmönster ändrats pga av detta)?

Tippningsspaken, man behövde tippa manuellt med vänstern medans man höll spaken med högern.

- Vad har ni för arbetskläder?

oömma arbetskläder, reflexytor blå varma. inte så vattenskyddade.

- Varierar detta beroende på säsong och arbetsuppgift?

ingen jacka sommartid.

- Hur ser ditt ultimata fordon ut?

Lastar 1000kg, tight svängradie. hytt för två. bra motorstyrka. Välter ej. ej för bred.

- Kan du se om ett fordon är bra? - hur ser du detta:

man kunde se dåliga konstruktionslösningar, kort hjulbas. dåligt konstruerade lösningar, fuskbyggen syns. Utstickande detaljer sågades då de går sönder.

Selling points

- Vilka huvudegenskaper är absolut viktigast (storlek,styrka last, färg)?

Tyst

Klarar gångvägar, liten smidig

styrka

Lastkapacitet

Komfort.

blandade Påståenden

- Kyrkogårdsförvaltningen kräver 18år för att köra
- 220kg batterivikt på melex
- Backspeglar skall inte sticka ut.

- Blinkers fram går sönder
- Sesångare kör vårdslöst
- Baklämmen på gallret användes inte pga. osmidig lösning när man ska komma åt lasten.
- ingen värme på framrutan hos melex.
- Gick endast att fälla bakläm, inget problem
- Två säten ett måste. -Permanent lösning för detta
- Värmeisolerade säten, annars en möjlighet för liggunderlag eller dyl.
- inget körkort i dagsläget, internkrav på körkort planeras.
- Hydralisk motor tjuter, STORT MINUS - kan inte användas nära besökare
- körglädjen är relativt viktig
- Får inte modifiera, kräver tillstånd av tillverkare.
- vill ha överlastningsindikator eller brytare
- kör ej med hjälm på.
- värdelöst med elektriskt skruv-ställdon för flak (långsam, smutsar sönder låser fast flaket)
- vill ha kraftiga hakar för lämmen
- möjlighet att hänga stege på utsidan av fordonet (vid tvåsitsig)
- Magnetbroms förkastligt, om den låser när fordonet är trasigt
- ingen rattknopp nödvändig
- maxbredd 1.1m
- kort hjulbas önskvärd
- gillar inte kedjestyrning. tungt! wobbligt
- tak över passagerare
- Förlängning av lastutrymmet kan ske genom fällning av bakläm.

Kommentar: test av olika fordonsbilder
Utryck blandat

- Mekaninkern bedömde bilderna efter dämpning och däck.
- Gula fyrhjulingen var en leksak tyckte dom. Den röda föredrogs starkt.
- Modernt = miljövänlig (aerodynamik vägdes in)
- Modern,styling = Dåligt arbetsfordon....
- El motorcykeln var stark och inte alls miljövänlig.
- Gammal plåtdesign, ärlig design = pålitlighet.
- Antidesign = eftertraktad design av mekanikerna.
- Tydliga designintentioner ratades. MEN semantiska utryck uppmärksammades.

ATV
1 arctic cat (används av en i gruppen)
klassiskt enhetligt
låg komplexitet/detaljrikedom delvis pga svartmålning
enhetlig i färgen, stora stycken svart och röd.
funktionell inkapsling av fronten
snott jeep-fronten
lojal
“stora ögon”
packytor och plastdetaljer hör bäst ihop på denna
=
pålitligast

smidigast
kraftfull
bästa arbetsfordon

2
två färgad, gråblå
lättast utryck
ljusram och synligt underede
extrem frontplast
brett mellan hjul i förhållande till hjulens bredd
ingen glidplåt
ljusta laststänger
“motorhuv”
medel complexitet/detalj täthet
spretigt designspråk
lite giftig, sportig, orm.
=
minst pålitlig
minst kraftfull
lite arbetsfordon
miljövänligast (kan bero på lätt utryck och lite kraftighet)

3
Högst design intentioner
Spräcklig färg, sport ettiketter
extrema sport hjul, ofunktionella fälgar
liten packyta
många plastytor (utstickande)
hög complexitet/hög detaljtäthet
enhetligt designspråk
Arg
=
minst arbetsfordon,
minst miljövänlig
inte helt pålitlig

Slutsats:
Bäst är att hämta inspiration från arctic cat.
Lojalt utryck
enhetligt utryck
gammaldags och klassisk arbetsfordon utryck
funktionell design,
ej arg/lugn

Mopeder med tak
1
Många småytor/hög komplexitet
tunna detaljer

enfärgad
en stor plastyta
svårdefinierad
överdimentionerat avgasrör
segmenterat tak
spretiga humörutryck på olika design detaljer (arga, söta och naiva lyktor)
=
minst pålitlig
minst smidig
ej miljövänlig
kraftfull

2
klena hjul
låg kontrast
mjuk/rund
lägst komplexitet/spartansk
funktionell/viktoptimerad
lite tvetydligt designspråk, tak/kaross
=
smidigast
klenast
bästa(ända) arbetsfordonet
miljövänligast (gammalmodig och därför ej enligt en användare)

3
futuristisk
högsta designintentionerna
kurar ihop sig
enhetligt designspråk
medel komplexitet (svåra men enhetliga designytor)
framtung
stabilt utryck, pga. dubbla framhjul
=
Smidigast
ej miljövänlig
inget arbetsfordon

Motorcyklar
1
Kompakt
Kompromisslös
balanserad
komplex
snäva tolleranser
dominant motorum
framåtlutande snabb form
=
minst smidig

sämst arbetsfordon
lite pålitlig
kraftfullast

2
extremt lojal
inga utalade designintentioner (antidesign)
avskalad
funkis
långsam
stora ögon/lampor
=
smidig
Mest omtyckt
pålitligast
miljövänlig (ser lätt ut)
kraftfull
Bästa arbetsfordon

3
Futuristisk
höga designintentioner "snygg"
apple-design
äggformad, extremrund enhetliga linjer
en kropp, liten komplexitet (svåra ytor dock)
lite högfärdig
små lyktor
=
smidig
klen
miljövänlig
ok arbetsfordon
lite pålitlig

Verktygsbärare
1 (egholm)
gubbig (ser ut som gammal gubbe) lamporna påminner om läsglasögon
långa designlinjer
svepytor
puttar framåt
Underdog
snäll
låg/medel komplexitet.
=
smidigast
varken eller

2 Terravox
Låg detaljrikedom

luftig
höga designintentioner
ser lite truck ut i vinkeln (kanske pga. låg framkant nära mark fram)
baljig bakvagn i bilden
=
Ej uppskattat
opålitlig
klen
minst arbetsfordon
miljövänligast
ser elfordon

3 Wille (används av gruppen)
Gruvmaskin
metallisk
jättemotorpaket
stor
stora hjul
hög detaljrikedom
inget ansikte
grovsnickrad
ser extremt funktionell ut (pga. alla lampor avgasrör och stort hydralsystem)
=
Pålitligast
kraftigast
bästa arbetsfordon
minst miljövänlig
mest uppskattad

Taklösningar
Mycket skiftande åsikter
längsta taket ser minst pålitligt ut
gillar inte tvådelade taklösningen
mindre skyddad med större hytt
bakåtlutat takdel känns osäker

Generella åsikter
lampan ser oskyddad ut
Gillar öppen lösning bak
vill ta ut batteriet uppåt

Platsstudie:Östra kyrkogårdsförvaltningen

Blandat gäng av brukare, ledare och informatörer.

ca 8personer gamla som unga.

haft tugger, köpte en melex redan 1991

Observationer, Foton finns!
Grupp preferenser

- Vad har ni för arbetsuppgifter?

Trädgårdsarbete/skötsel samt städning och reparationer

- Har ni någon typ av introduktion innan personalen får använda fordonen?

Ja kort kurs

- Vem kör? Baserat på erfarenhet?

Alla, valt av arbetsledaren för dagen

- Är det en eftertraktad arbetsuppgift?

Ja

- Arbetar ni i grupp eller enskilt?

Grupp om ca 10 pers med två fordon

- Hur kommunicerar ni med varandra under dagen?

Isolerade arbetsområden tar bort krav på lång kommunikation

- Vilka arbetstider gäller på parkförvaltningen?

9-5

- Behöver man förkunskaper för att hålla på med parkförvaltning?

18år + introduktion

Arbetstyp

- Arbetspassens längd och frekvens av fordons användning

Heldag ca 8h, minus raster. Fordonen körs korta perioder och står parkerat medans arbete pågår. Vid vissa arbetsuppgifter används dock fordonen under längre perioder tex. rensning av ris under våren.

två fordon/arbetslag

25 fordon totalt (västra östra och kviberg

- Vilka typer av fordon har ni på området?

Melex elfordon med släpvagn, pickup och wille.

Melex

Alla melexfordon har en kärra bak, istället för eget flak.

Bra insteg, men dålig komfort pga stor öppning och ingen dörr.

BRA: lasthöjd, insteg,smidighet.

Håller 1.5 arbetsdagar ca.

- Vad är de olika fordonens huvuduppgift?

Melex: persontransport lätta-medel lastuppgifter

- Hur många åker på fordonet (bara föraren)?

2 oftast, fler eftertraktat.

Många under en dag, men står stilla runt 70% av tiden. Under vissa omständigheter används den kontinuerligt.

- Mycket transport sker på allmän väg?

Alla vägar räknas som allmän väg

Förhållande

- Säsongsspecika problem (kallt, varmt, halt, blött)

Blött i hytten (sätet), kallt på vintern. Inomhusparkering

- Krav på buller nivå?

Nej

- Hur förvaras fordonen

Inomhus

- Vilka underlag används fordonen på och är några av dess jobbigare?

spån i backar

- Brukar det vara mycket folk runt omkring fordonet när ni arbetar?

ja

- Har ni några haft stöldproblem? (om ja/nej varför?)

Nej

-Nyckeln tas nästan aldrig ur.

- Förekommer det att fordonen hanteras på ett mindre säkert sätt?

nja.....

- Brukar ni ha saker liggande i hytten mellan arbetspassen?

Mycket kläder och mindre trädgårsverktyg, handskar

- Vid vilka tillfällen väljer ni bort en elmoped.

När större lastning krävs

o Vad väljer ni istället, VARFÖR

Stor traktor

Behov och utveckling

- Vad tycker ni om möjligheten att ha tak?

Ska vara tak

o Behov av att ta av taket

nej

o behov av att transportera föremål på taket

JA!, skaftverktyg och skyfflar. upp till 10 åt gången.

o väggar?

Nej för det instegstid och de har bra kläder istället.

- Vad vill ni ha på flaket (kärra)

större verktyg, fyllmaterial(jord grus etc.) Granris.
ev. stege, plankor men då används kärra
krukor, spannar osv.

- övrigt som ska med:

Sopsäckar, verktygslåda, skaftverktyg, småborstar.

- hur/om vill ni kunna tippa flaket eller fälla väggar

-Ja bak är ett måste.
-Att tippa från förarplats skulle vara önskvärt.
-Hög tippvinkel är önskvärt.
-idag kan man inte låssa spärren och flaket om man har fellastat.

- höjd på flaket

Alla nöjda som vanligt..... knä höjd var detta. dock fanns modifierade för bättre (skarp lutning) tippning.

o varierbar höjd på väggar?

Ja tack, men endast galler är önskat.

- speciella infästningar önskemål

Ju mer ju bättre. skulle användas

- Säte önskemål /storlek, nackskydd, Armstöd, värme

Värme!

o värdering, hur viktigt är ett bra säte

Inte så viktigt, förutom att det blir kallt/blött

Reglage:

- Vilka reglage indikatorer är viktigast

Batterimätaren! Gärna i %-kvar form -dagens är opålitligt, ojämn minskning

- Har ni behov av GPS/hastighet/karta/körstatestik/Radio/

nej

- Behöver man nå flak från förarmiljön? -varför och i vilka situationer?

Nej

Persona

- Vad brukar du ha med dig?

Blandade småprylar, mobil, mp3. kniv sekratör, hörselskydd. pärm, regnkläder, lunch, termos

- Vad är obekvämt med dagens fordon?

Blött på sätet,

- Finns det några irritationsmoment(har deras arbetsmönster ändrats pga av detta)?

tippningsmomentet, många steg. Markfrigång, backa med kärra.

- Vad har ni för arbetskläder?

grova vanliga arbetskläder.

- Hur ser ditt ultimata fordon ut?

Många funktioner i ett.

- Kan du se om ett fordon är bra?

JA! man ser om det är för mycket leksak

Utryck blandat

-Gillar tyska bilar, MEN de ska vara smarta och miljövänliga, inte sticka ut för mycket.

Enkel klocka inte för prålig. avskalad analog.

Selling points

Som melex men öka smidighet

bromskapasitet.

Generella åsikter

-Glömmer laddningskabel i

-ingen diffspärr

-Flak på fordonet är för litet. (om flak försämrar

-kärr-möjlighet ta bort) - svårt att sätta på kärra med flak

-krattor på taket skall inte skramla

-BEMO - kändes som ett ensamarbetsfordon. (sidoyta)

-tre hjul bra, om den inte välter.

-Konservativ inköpskultur. fordon måste uppfylla det som förra fordonet uppfyllde (nya fördelar är underprioriterade gamla funktioner)

-Endast 2pers pga arbetsmiljöverket /:@

-Garageplats begränsar antalet fordon (egetligen är fler/arbetslag önskvärt så ingen måste gå)

-Bränslekonsumtion hög, men låga miljökrav utifrån.

-Kraftstationsiden jättebra. men knöligt med sladd.

-Lätt kyrkogård att köra runt på, mindre gårdar är bökigare och trängre

-häng på och ta av dörrar pga säsong om det är enkelt.

-Inget behov av vinterdäck.

-Jobbigt med tyst fordon mot besökare som inte hör, men de har vant sig.

-Möjlighet att separera organiskt material från sopor.

-ALLTID HA MED KRATTA SKYFFEL OCH BORSTE

-Eftersöker bra frakt för skyfflar eller skaftverktyg med handtag.

-Man får inte bredda fordonet, bredd mycket viktigt, max 120 mellan hjulen.

-handbroms för klen. på melex, extra stoppkloss används.

-ingen förvaring av kläder vilket eftersöks, speciellt för blöta regnkläder.

-förvaring av pärmar och dokumentation eftersöks.

-Lunchlåda och plattform för detta skulle vara trevligt.

-Alla förvaringsutrymmen som finns används!

Telefonintervju: 1 Karlskrona

Frågelista

- Vad kör ni? (relevans av vissa frågor)

Elmoped i de flesta fall men också clubcar. Elmopeden (flakmoped)används i innerstaden och clubcar i bostadsområden.

Grupp preferenser (ca

- Vad har ni för arbetsuppgifter? (för att förstå användaren)

Sorterar post

- Har ni någon typ av introduktion innan ni får använda fordonen? (guessability)

Liten introduktion av brevböärare första gången (uppfattades inte som komplicerat)

- Vem kör moped/golfbil? Baserat på erfarenhet (målgrupps specificering för moped)

Använder flakmoped till stadsdistrikt, clubcar till villa områden. Inga speciella människor som kör fordonen.

- kommunicerar ni med andra under dagen? (komunikations hjälpmedel/ krav)

Nej man är helt ensam, Ibland ringer de och frågar när man kommer tillbaka. Ingen interkom radio eller liknande.

- Vilka arbetstider gäller? (ergonomi, och belysningskrav)

Börjar 7 eller 8 och kommer till terminalen och sorterar upp posten i sitt distrikt. Man kommer ut vid olika tider beroende på hur mycket post man har. Sorterar man sin egen post?Man sorterar sin egen post. Ibland börjar några senare och då hjälper man dem att sortera deras post. Man kommer halv tio / elva vissa kommer ut 12 (mycket post). Rundan tar till två och en halv till fyra timmar beroende på post /

reklam mängd.

Sker bara på dagen, vissa dagar under vintern blir det mörkt innan man kommer tillbaka.

Förhållande

- postrundans längd (ergonomi)

(ej svar)

- Säsongsspecika problem (kallt, varmt, halt, blött) (målgruppsbehov och extremkrav)

Det är jobbigt på vintern när det är snö på vägen. all vikt ligger i fronten och sen är den bakhjulsdriven vilket gör att slirar i backar. Det hade varit bättre om det varit trehjulsdrift alternativt framhjulsdrift. Ibland får man ta hjälp av folk som får sätta sig på flaket eller putta.

Problem med driftstiden under vintern? Inga problem med batterier. Har hänt en gång i vinter att de fått börja en moped, halva batteriet kvar på sommaren

- Har ni några haft stöldproblem? (om ja/nej varför?) (kravbild?)

Nej, svårt att se om det snotts post. I övrigt nej, men finns en risk eftersom att det är så öppet och inte går att låsa. Men alla värdesaker har man på sig ändå.

Är det problem med kyla? Jo det kan vara riktigt jobbigt och då man kör till och från rundan är det ett par kilometer. Sen i Karlskrona blåser det som fan, kan bli kallt om kinderna och även fingrar.

Blir det problem när det regnar? Nja, på vissa mopeder läcker det in liet vatten i flaket så att posten blir blöt. men postsäckarna skyddar. Det är de äldre varianterna det läcker in i, det är bättre i de nyare.

Sommaren, problem att det är varmt? Nej, då är det skönare att köra moppen än bil eftersom man är i friska luften.

- Brukar ni ha saker liggande i hytten mellan arbetspassen? (kravbild)

Då har vi post liggande i bilen. Några personliga saker? Ah de skulle väl vara om man har en jacka eller nått sånt där.

- Vid vilka tillfällen väljer ni bort en elmoped. (konkuransmöjligheter segmentering)

Området bestämmer

o Vad väljer ni istället, VARFÖR

Behov och utveckling

o Behov av att ta av tak

Det hade varit skönt! (att ha tak) Att ta av tak? Clubcaren blir varm på sommaren. Finns en sån funktion att framrutan kan man lossa och trycka fram vilket ger lite vinddrag men det är inte tillräckligt.

Är det alltid väggar på den?

o väggar, på, av?

Ah det är alltid, fast man kan ha öppet. Fast det är inte tillräckligt för att få den kall? Nej, det tycker inte jag.

VARFÖR?

- hur/om vill ni kunna tippa flaket eller fälla väggar (kravbild)

Inget behov ute på rundan men man kan tippa flaket för att fylla på vätska (batterierna) Ah för att komma åt batterierna Mmm precis de ligger under flaket Men ni har inget användningsbehov av det? Nej det skulle jag inte påstå (skratt)

- höjd på flaket (Ergonomi, kravbild)

Mmm, nja höjden är nog rätt bra som den är. Man sitter rätt stabilt och ser jäkligt bra.

- Behöver man nå flak från förarmiljön? -varför och i vilka situationer? (krav-

bild)

Ja, iofs man har ett utrymme framför styret där vi då lastar av moppen. Den posten man ska när man ska gå ut då har man längst fram uppe framför styret. När den tar slut fyller man på ny från flaket och då hade det varit bra att komma åt flaket ifrån sittplatsen.

Hur ofta? har ni har backar eller tar ni ut den löst

Den ligger löst i facken Sen har vi blåbackar i flaket De kommer man inte åt alls när man sitter på moppen. Då måste man hoppa av moppen och öppna upp hela flaket.

Ni tar alltså ur posten och lägger dem i speciella fickor?

Ah exakt, det är jättelätt att nå från sittplatsen

Hur ofta måste man last på post i fickorna där fram?

Det beror på hur tjock posten är men man skulle ju … vissa dagar är det en jätteliten bunt till varje hus och vissa dagara är det jättemycket. Men en normal dag så kanske det är fyra gånger per runda.

Känner du att det är ett problem att det är för lite post i fickorna?

Det hade varit skönt att lasta om fyra gånger men det tar inte så långt tid och det kan vara skönt att göra något annat. men visst lite mer utrymme kan vara bra.

Reglage:

- hur skulle ni vilja elförbrukningen representeras, tid kvar/momentant?

Ah, nu har vi ju procent tal som står hur mycket som finns kvar och det tycker jag är bra.Kul att veta hur mycket den drar per minut.

Men tid kvar eller uppskattning i minuter är inte intresant eller?

Ah tid kvar skulle vara bra också

- Har ni behov av GPS (kravbild)

Neh, eller man kan ju sin runda. Skulle vara i så fall för en nybörjare. Nu är det så att är man ny får man öva med en erfaren brevbärare. Kanske chefen skulle gilla det för då slipper man ju öva men det är nog inte värt de pengarna.

- hastighet (kravbild)

Nja, de går nästan mindre än 30 km/h åh hastighetsbegränsningen ligger över där.

- karta (kravbild)

Inte mopeder men personbilar. Men inte i clubcaren heller? Ne, kartor behöver vi bara om man ska åka lite längre och då används bilarna

- körstatestik (kravbild)
- Radio (kravbild)

Ja det hade varit fräckt

- I detalj beskriv momentet då du lämnar brev till lägenhet/ brevlåda

stäng av/ dra i handbroms, lyfta post osv...

Elmoped är inte till för att lämna vid villa. Annars så när man går in i hyreshus hoppar man av moppen och tar man med den posten man ska och går in i hyreshusen.b Det är rätt bökigt i villa distrikt, vi har ett distrikt där man måste ha moppe och då måste man hålla en hand på bromsen, för vi har handbroms då, samtidigt som man ska ta reklam och post och grejer så det funkar inte alls bra. Då hade fotbroms varit mycket bättre. Ni tar altså fram och tittar på post under tiden ni bromsar eller förebereder er? Ja å då harm man bara en hand att göra det med och då ska man ha en en hand att öppna postlådan. Hur ser det ut vid lägenheter? Då stannar man vid porten så nära man kan sen tar man av sig den posten reklamen man behöver. Ibland tunn reklam och då har man den uppe vid styret men är det tung så är den på flaket. Då måste man öppna flaket vid varje port.

Brev hantering (behovsinsikt)

- sorteras breven efter Brevlåda/lägenhet eller efter område?

När brevbäraren kommer till terminalen finns alla breven som kommit till området på hans lilla kontor. Sen läser man ett namn och så finns det olika fack för varje person/hushåll sen tarman med det så det är i rätt fack.

Sorterar ni efter hur det ska upp i varje trappupgång eller vad som skall dunkas i varje brevlåda.

Det är ett till varje hushåll. Om vi säger att jag bor … så får man alla breven för … i rätt ordning. Så finns det hiss åker man högst upp och då ligger den som bor högst upp högst i högen så att det kommer i rätt ordning. Det står först i högen vilken gata/vägen det är

Så ni vet precis vilken bunt som skall upp i vilken trappupgång?

Ah, precis

Hur lastar ni fordonet från terminalen?

Då kör vi ut vagnar sen har vi en brygga. Först lastar vi ner buntarna, som vi slår gummiband (1) runt, en för varje uppgång. Sen stoppas man ner i dem en blålåda som stoppas ner i en vagn som körs ner till bryggan. sen hämtar man moppen sen kör man den till där man ställde blålådorna

Hur hög är bryggan

Ca 1,5m lite högre än flakets botten.

Some en lastbilsbrygga?

Ah precis, kanske lite högre

Står ni på marken?

Ah precis

Vad händer med backarna när de tar slut?

Man får ta ut den och ersätta med en ny och lägga den tomma där den nya var.

Hur fort tar den slut?

Samma sak som inne i stan att det varierer, en halvtimme kanske

- hur lastar ni post till fordonet
- hur fort töms en back, hur många brevlådor/tid
- vad händer när backen vid föraren är tom
- hur tunga saker dunkas

2 kilo ungefär, kanske mer om det är paket. Läggs i direkt i brevlådan.

- hur lång tid är det i genomsnitt mellan avlämningar

10 sek ungefär. 30 sek mellan lägenheter. Beror på hur man räknar några minuter om man räknar från att man kommer ut ur trappuppgången och sen kör iväg.

- hur ofta lämnar ni fordonet, tid mellan avstigningar/påstigningar

500 hushåll per runda (räknar) ca 60 trappuppgångar. men man kan ta flera trappuppgångar om man parkerar och går runt lite också. Vi har en väg där man kan ta fyra ställen genom att ställa mopeden. Så kanske 40 gånger i så fall.

När ni parkera den så, går ni tillbaka till moppen och hämtar mer eller tar ni all post på en gång?

Ja det beror också på hur mycket post är det väldigt lite kan man ta med flera hus på en gång. Vissa dagar har man ingen reklam. Då slipper man ju köra moppen också.

Problem att det är tungt att bära post i lägenhet?

Vi har ju en väst som kan lasta på om man har med sig. Det har de utvecklat faktiskt.

Hur många räcker den till? ett hushåll flera

Nu är vi där igen med hur mycket post man har. Jah, även om man har mycket post kan man nog lasta till två hus.

Funkar den som en babysele?

Ah precis som en babysele, man har posten på magen så kan man last upp till hakan från midjan.

Används den mycket?

Ja brukar använda den en del. En del folk använder den varje dag. Från början använde folk den bara till reklam men nu använder folk den till att ha så mycket post de bara kan så de ställer moppen och går läng en gata. Sen är det en del som inte tycker om den, när man lastar så mycket så ser man inte, så det är en del som ramlat för att de inte sett stegen.

Vad är bäst en ergonomisk justerbar back eller många backar nära styret.

Så mycket inne i clubcaren som möjligtför då slipper man lasta om.

Så du har helllre många backar som är lite svåra att nå eller en som sitter perfekt?

Ja jag tycker det är lite tråkigt att lasta om så jag hade nog haft det lite trängre inne i förarhyttan. Men det där är nog väldigt individuellt och vissa hade nog svarat tvärt om.

Var tror du är den absolut bästa platsen att ha posten, framför styret eller vänster sidan?

Tänker du moped eller clubcar nu?

Vi har ju varken eller (vårt koncept) men clubcaren syftar vi på. mer aktuellt.

Om du tänker dig att du skulle kunna ha post framför ratten på clubcar skulle det vara bättre eller sämre än på vänster sidan?

Ja, det är iofs ett jobbigt moment för man måste ju vrida och vända på sig inför varje ny brevlåda. Så det hade nog varit bättre att ha den så långt åt höger som man bara kan ha den.

- fyller man på med mer post under dagen
- behöver du titta på breven under körning eller innan dunkning

Jo man måste ju innan man stoppar ner breven i varje lådan så att det är rätt.

Känns det farligt någonstans när man tittar ner på breven medans man kör?

Ah, iofs behöver man inte läsa på breven innan man kommit till lådan. Då man redan står stilla.

Så man tittar inte på breven medans man kör?

Jo det händer ibland och det är väll en säkerhetsrisk också för då tappar man blicken från vägen. Men det är upp till en om man gör så eller stannar och kollar på breven när man står still.

När det gäller dunkningen i clubcaren, behöver man sträcka sig jätte långt ut eller är det bara att sträcka ut handen?

Ja det beror ju på vägen. Egentligen får man inte köra upp på trottoarer me de här clubcararna men det gör man ju ändå. Men vissa lådor sitter jäkligt dumt så då får man sträcka sig och det är inte alls kul.

Finns det något att luta sig på?

Nej det finns inget och det kanske skulle vara skönt att ha. Iofs kanske det skulle komma ivägen i andra lägen senare.

Hände det nånsin att ni fyller på brev under en dag?

Nja, breven brukar alltid få plats på flaket men däremot reklam om det är jättetjock reklam då behövs det så många buntar att det inte får plats och då blir det att en del kör ut dem. Man kör aldrig tillbaka och hämtar utan då är det en kille som kör ut dem till en plats där man hämtar där man velat ha dem utkört till. Då är det ungefär av hälften ...nånting... som man lastar om och då är det efter ungefär halva rundan som man lastar då.

Hur många blåbackar är det som man kan ta in i mopeden?

Ja en 8-tio om det inte är nån reklam.

Reklamen är altså i buntar och inte i backar?

Hur tar ni ut reklamen?

Nej de är lösa i buntar så de hamnar inte i några backar

Och ni använder hela det utrymmet för 10 backar utan reklam?

ah

Fyller ni hela lastutrymmet i clubcaren så att det är upp till taket i den.

Ah det händer också, är det mycket reklam så fylls den. Då ser man bara i back-speglarna på sidorna.

Blir den inte överlastad då i vikt?

JoJo det har vi nog gjort många gånger.

Blir det jobbigare att köra då eller?

Jo det märker man, det blir jobbigare att svänga och sånt där och man märker att den inte mår så bra i axlar. Det har tom. hänt att man inte fått igen flaket för att det blivit för mycket.

Ah såpass?

Händer det att ni kör sönder fordonen?

Nja inte elmopeden men styret har faktiskt gått sönder några gånger.

Bränner ni nånsin motorerna?

Clubcaren har vi nog brännt sönder nån gång.

Vad skulle du vilja ha med dig inne i hytten. Då tänker jag på clubcaren. Vad skulle du vilja ha med dig på en runda?

Ah det man vill ha med sig är vatten, clubcaren har ingen vattenhållare.

Ingen kopphållare?

Ne en flaskhållare 1,5 liters och möjlighet till radio

Möjlighet att ha vantar och personliga föremål?

Ah hade varit bra med ett fack för mössa, jacka, vantar eller en krok. Fast det blir svårt på mopeden men clubcaren funkar bättre

Är det något som ni inte har med idag idag som du skulle vilja ha med?

Ne, man får lägga in det där bak i lastutrymmet. Man börjar med jackan, när man börjar rundan är man lite kall men sen när man sprungit en runda blir man varm och får ta av sig jackan och då får man lägga det bak i clubcaren eller på flaket i moppen. Så det hade varit bra om man kunnat hänga upp den i förarhytten på något smidigt sätt.

Obekvämt?

Lite skönare sadlar på mopeden.

Men stolen i clubcaren är bra?

Ah, det tycker jag.

Åh insteg är bra?

Ja det går rätt lätt, nära marken så inget stort kliv.

Är lastutrymmet bekvämt?

Ah det skulle vara att lasta in, vi har ju lite lådor och sådär inne i förarhytten. Där är det lite för långt att lasta in. Där får man böja ryggen lite för långt och då är det risk för skador. Lastutrymmet funkar bra. Det som är dåligt med mopederna är back-speglarna skulle vilja ha lite större för man ser inte så bra idag.

Ändrat arbetsmönster?

Inget jag kan komma ihåg. Det är många småsaker man stör sig på men inget jag kan komma på.

Ah men tex att dunka post med mopeden?

Ah den är jobbig iom att man måste bromsa samtidigt.

Helt enkelt 2 fria händer vid låda?

Ah om man nu måste ha moppen i ett sånt distrikt.

Hjälmen har man på sig den under turen?

Ah polisen vill ju att vi ska ha på den så du kör moppen ska du ha den på dej, men det är jäkligt jobbigt att ta på sig den 50-60 gånger per dag. Jag har bara på den då jag kör till och från en runda. Men det är ju en del som åkt dit på att inte ha den på sig.

Vart ligger den när du tagit av den.

Den ligger bakom i en liten plast box där kan man också lägga jackan.

Selling points (prioriterings ordning utryck)

- vilken egenskap är viktigast /minst viktig hos ett fordon

Vilken är den viktigaste egenskapen?

På moppen?

Clubcaren

Kapaciteten finns ju där också. Ah så man kommer s å nära brevlådorna så att man slipper sträcka sig. Därefter hur posten ligger inne i clubcaren så att den ska vara så lätttillgänlig som möjligt i hytten.

Oviktig egenskap?

Kan inte komma på nått.

Ah behövs inte, kan vara svårt

Det var sista frågan åh vi får tacka så jätte mycket!

Telefonintervju 2: Kungälv

Frågelista

- Vad kör ni? (relevans av vissa frågor)

elmoped, clubcar och bil. Ett fordon/vecka

Grupp preferenser (ca

- Vad har ni för arbetsuppgifter? (för att förstå användaren)

Sorterar min egen post och sedan kör jag ut den.

- Har ni någon typ av introduktion innan ni får använda fordonen? (guess-ability)

LIten introduktion av brevbärare första gången (uppfattades inte som komplicerat)

- Vem kör moped/golfbil? Baserat på erfarenhet (målgrupps specificering för moped)

Använder flakmoped till stadsdistrikt, clubcar till villa områden. Inga speciella människor som kör fordonen.

- kommunicerar ni med andra under dagen? (komunikations hjälpmedel/ krav)

Nej. förutom vid problem

- Vilka arbetstider gäller? (ergonomi, och belysningskrav)

kör från kl 12 i ca 4h. Andra kör morgonrundor med samma fordon

Förhållande

- postrundands längd (ergonomi)

4h

- Säsongsspecika problem (kallt, varmt, halt, blött) (målgruppsbehov och extremkrav)

Varmt på sommaren, kallt denna vintern annars inga problem.

- Brukar ni ha saker liggande i hytten mellan arbetspassen? (kravbild)

Gärna inte pga stöldrisk, lämnar ändå nyckeln i men stänger dörren lite.

Det har hänt att fordon körts iväg av andra.

Behov och utveckling

o Behov av att ta av tak

fina dagar kanske, men inte längre perioder

Är det alltid väggar på den?

o väggar, på, av?

det är bra med väggar, man kan öppna dörren om det är varm. dock kan dörren vara trög

- höjd på flaket (Ergonomi, kravbild)

Mmm, nja höjden är nog rätt bra som den är.

- Behöver man nå flak från förarmiljön? -varför och i vilka situationer? (kravbild)

Nej tror att det blir ett obekvämt arbetsmoment

Hur ofta? har ni har backar eller tar ni ut den löst

Jag tar med buntar fram till hytten och har blåbackar i bagaget.

Ni tar altså ur posten och lägger dem i speciella lådor?

Ah exakt, det är jättelätt att nå från sittplatsen

Hur ofta måste man last på post i lådorna där fram?

beror mycket på. men överlag är det inget problem

Reglage:

- hur skulle ni vilja elförbrukningen representeras, tid kvar/momentant?

procenttal är bra. men har inget problem med nivåstaplar

- Har ni behov av GPS (kravbild)

nej man kör samma runda varje gång

- hastighet (kravbild)

Nej

- karta (kravbild)

Nej

- Radio (kravbild)

Ja den använder jag idag

- I detalj beskriv momentet då du lämnar brev till lägenhet/ brevlåda

stäng av/ dra i handbroms, lyfta post osv...

Jag trampar ner bromsen och kollar till posten innan jag sträcker mig om man når och dunkar posten.

Om jag går ur så stannar jag. tar fram den bunten jag förberedit för denna trappa och kliver ur, lämnar nyckeln i. drar igen dörren litegranna och går iväg

Brev hantering (behovsinsikt)

- sorteras breven efter Brevlåda/lägenhet eller efter område?

jag sorterar själv breven i exakt rätt ordning med avskiljare

Hur lastar ni fordonet från terminalen?

på en vagn som vi rullar ut till fordonet

- Vad händer med backarna när de tar slut

Jag använder dom inte i hytten utan hämtar en ny bunt för sig.

- hur fort töms en back, hur många brevlådor/tid

beror på helt.

- hur tunga saker dunkas

riktigt tunga paket ibland.

- hur lång tid är det i genomsnitt mellan avlämningar

svårt att säga men kanske 30 sec.

- hur ofta lämnar ni fordonet, tid mellan avstigningar/påstigningar

på vissa sträckor hela tiden. kanske en gång i minuten

- fyller man på med mer post under dagen

nej

- behöver du titta på breven under körning eller innan dunkning

lite snabbt innan man dunkar

- en ergonomisk justerbar back VS många backar nära till hands

Viktigast är att den håller för tung last. därefter är ergonomisk viktigare

Persona (målgruppsanalys)

- vad vill du ha med dig i hytten

Vattenflaska är det ända jag kommer på. Den behöver skydd så den inte spiller på posten

- finns det föremål som du inte kan ha med dig idag VARFÖR

inget jag kommer på

- Vad är obekvämt med dagens fordon?

Tung dörr. som kan smälla igen vid inbromsning, kan då klämma armen om man är emellan eller ska dunka.

ingen flaskhållare. Stötdämpningen är inte tillräcklig. Det är lite jobbigt att byta batterivätska själv. speciellt efterssom vi måste lyfta ur och torka av syra manuellt

- Finns det några irritationsmoment(har deras arbetsmönster ändrats pga av detta)?

samma som ovan

Selling points (prioriterings ordning utryck)

- vilken egenskap är viktigast /minst viktig hos ett fordon

Komfort. En bättre stol skulle vara mycket bra.

Platsstudie:Guldheden fastighetsbolag

Intervju Fastighetsbolag Guldheden

Tycker postens moped ser klumpiga och otympliga (undrar vem som lurat på dem).

Anmärkte att det fanns en sådan modell framtagen av nån tidigare, (Tugger) lite klumpig däck som bildäck.

Finns inte idag små maskiner som är anpassad för någon som är 1,90 lång. Motorcyckel med sidovagn.

Kommer den alltid vara öppen, är det hela designen du visar?

Vi har ju täckta här vilket är bra för värmen på vintern. Vi har ju värmare och allting

Vad använder ni den till?

För vår del är det bara transport sen kan det ju finnas nån låda där man kan ha verktyg och reservdelar, vattentätt. Fast det tar ju en del av lastytan som finns där också.

Persontransport för oss och lite last då va reservdelar o grejer och lite skräp som står nånstans man plockar upp. Lastytan är ju lite för liten för oss ibland, INLÄGG: när man väl behöver den för det ändamålet ja, då tycker man ju det är dåligt, det går ju aldrig att få ett fordon som passar till allt ….Det är ju det som saknas för att använda den i utemiljö, park o trädgård, ett lite större flak eller lastflak alt släpkärra med elektrisk tipp eller nånting.

Det har man ju alltid tyckt i trädgårn med de där moderna traktorerna där du reser på rumpan så dör ju maskinen var tionde meter, då är ju en sådan här idealisk att bara ha en vagn o flytta fram. Vi kan ju halvera våra driftskostnader.

Men bostadsbolaget är ju egentligen ganska dålig på att investera i sånna här elbilar tycker jag. Fast det är ju en 80 100 kkr för en sån där.

Men det är ju som jag säger idag, man klarar sig inte utan en sån här idag, jag fattar inte hur vi gjorde förr. Jag menar man blir ju väldigt effektiv med en sån här när man lägger upp jobben.

Fast man blir ju ganska bekväm också.

Ja det är klart men du kan ju tänka själv, det är ganska långa avstånd, tänk dig då att du glämt nåt, ska du då gå och hämta det? Ne då blir det nästa dag man gör det jobbet, fast man blev ju lite smalare (småler)

Men man blir ju effektivare de kan man ju inte säga annat

Hur långa sträckor?

De är nog inte minuter utan meter, området är ju max 1 km i omnejd som är max avstånd. Mycket start och stopp helat tiden. Så är det ju även i trädgårdsarbetet. Man jag har ju i alla år förundrad över att man, speciellt i haga och centrala stan ligger och kör med traktorer. Jag tycker det är absurt att åka in med en traktor i Haga.

Pratar om terra

Sen vet jag ju inte om vi kommer in på tyngre saker om det tar för mycket kraft i anspråk.

Fär man känner ju redan här när man knör in tre i golfbilarna att effekten är begränsad.

Pratar Bemo

O det blir ju lättstyrd också?

Ja det är ju det som är tanken att med låg tyngdpunkt som ligger på bakhjulen så att den blir som en trike. Är det någon som ni ser som en fördel?

Ja absolut, Det mesta kan man köra omkring, det är ju bara jord och sand som man får ta traktor till, men det mesta som avfall och rensning är det ju ingen tyngd i .

Det är snarare volymen?

Ja hela sommaren kör man omkring med skopan full med ogräsrens och löv och ja menar det är ju ingenting (syftar på vikten).

JA vi har ju ingen entreprenad på stora marker så det är ju gräsklippningen och snön där det krävs rejäla grejjer.

Mmm, osså en släpvagn till så är det ju perfekt.

Har ni släpvagn till de elbilar ni har idag?

Ne, inte till dom ne.

Men ni använder inte den typen av fordon idag (trädgårdsarbete)?

Elmoppar har vi 2 stycken och dom använder vi ju…

Fast det är mer.., ni kör ju bara dem för transport när det är bökigt att ta traktor, ni får ju inte hela konceptet med den.

Ne nackdelen med den är ju att du har ett väldigt lite flak och korgar när du rensar,

så du får ju åka väldigt ofta och tömma då va. Det får ju inte plats några mängder, man vill ju ha, när det är ogräs och sånt, lite yta så det blir ett lass så man inte får åka var tionde minut och tömma korgar. Det är ju det som är nackdelen med mopederna då.

Och då räcker inte batterierna till slut.

Ja fast vi kör ju väldigt mycket sommar med dom fram och tillbaks och dom klarar en hel arbets dag även om man kör väldigt mycket så det är faktiskt inga problem.

Här har vi ju vanliga blybatterier, att vi inte har geel-batterier det förvånar mig.

Pratar fördelar med nya batteritekniker

Batterierna på mopparna klarar väll 2,5 år max 3 år

Moparna går april till oktober

Varför inte vinter?

Det går ju men det blir väldigt kallt..

Men om vintern ar du ju inte behovet av att köra..

Ne det stämmer, fast vi ligger ju och tömmer papperskorgar och städar så tar man den biten så är ett elfordon där man inte sitter ute som på clubcaren då Sån hade varit idealisk hade vi kunnat använda den även vintertid naturligtvis med enklare transporter.

Inga vägegenskaper som påverkar vintertid.

Ne de är ganska tunga så de tar sig fram ganska bra i snön (clubcar)

Mopederna har de inte häller klagat på..

Ne de tar sig fram bra de också.

Behov av flakyta (frekvens)

Det skulle la väll va konstant, men det innebär ju inte att det behöver bli så himmla mycket vikt utan det är ju bara yta.

Menar ni ytan på bottenarean eller volymen som är mest viktig?

Ja det beror ju på, är det högt då får du ju lyfta högt. Då är du ju inne på ergonomi här.

Har ni behov av att köra långa saker på flaket (krattor, stegar)

Ja stege saknar man ju många gånger men då hittar man ju på konstruktioner själv.

Vi har ju två olika här, elbilar, den äldsta är väl lite mindre, smidigare på nått sätt, mer kompakt, dörrarna öppnas .. uhm .. normalt så att säga. Medans den andra (den har ju mindre flak också (syftar på den äldre)) har större flak, är mycket mer otympligare och dörrarna öppnas farmåt så att säga i den. Så bara dom två maskinerna skiljer sig där man mer förespråkar den mindre egentligen.

Så den hör smidigheten är eftertraktad?

Jaa, mer för våran del (fastighet)

Så det skiljer sig lite?

Ah

Sidoflak eller två säten?

Ja, vi skulle ju vilja ha tre i dem. (skrattar) ja men två säten vill vi la ha

Ja det var en bra fråga, om man pratar för egen del (fastighet) så är la två säten…

Ja , de vill vi nog också ha (park) så man kan åka två i o det känns ju ganska viktigt.

En nackdel då med flakmopederna tex?

Ja det är det ju, man har sommar, ungdomar, praktikanter allt möjligt. Och då kan man ju sätta dem, för de är ju ofta 2 eller 3 stycken, då kan man sätta dem så de åker åtminstånde 2 tillsammans o jobbar tillsammans.

Sen vet inte jag, vad krävs det i en elbil? Är det traktorkort eller?

Motoreredskap 30 km/h så är det utan men 45km/h kräver ju EUmoped kort.

Behöver man EU-kort för moped som kör i 30Km/h också?

Nej men då är den klassad som motorredskap i vårt fall.

Och det går väll alla små traktorer under också?

Ah

För det underlättar ju för oss med sommarjobbar om man inte behöver kort.

För ni har inga krav på era sommarjobbare att de ska ha körkort eller så där?

Jo, på traktorerna.

Jag menar när ni tar in sommararbetare och sådär?

Nä, det är bara åldern som …, men alla fast anställda ska ha körkort.

Ja man vet ju alltid me de här elmoparna när det kommer extra folk när fram och back var där uppe då var det bara en tidsfråga innan nån körde i väggen nånstans. För vissa var ju vid gasen där och ofta var det ju, de har ju kört in i dörren på sexan, rakt in i garaget..

Fast de är ju gamla mopparna

.. nått sånt hände alltid (glatt minne) för det kräver ju ändå att man kan spelet o så

Sen finns det ju inga bromsar på de gamla modellerna heller, trumbromsar, ja kan ju stå med hela mina 96 kg på bromspedalen och det är 60 m bromssträcka så det är ju obefintligt.

På elmopederna ja

På de gamla, på den nya vi har är det ju skivbromsar och den är vi skitnöjda med.

På de nya är vi nöjda med då är det nån man faller över så är det nån haka som slår i, lite farligt om man kommer åt bara när man kör. (syftar på parkeringsbromsen)

Förklaring till trumbroms fördel …. Ni förordar skivbromsar?

Ja vi har ju bara de hör två gamla som vi har haft. Vi har ju lämnat in dem på reparation så många gånger och de kommer tillbaka lika dåliga. De renoverar dem men de kan inte fixa dem. Vi fick ju ställa av en för det gick inte att sätta en säsongare på den, det hände ju olyckor. Men det är ju motorbroms på en som vi har nu, den gammle, men den fungerar bara ibland när man slår av gasen så man kan inte lita på den man vet inte när den motorbromsar. Ibland funkar det och ibland inte så att säga. Men den är ju gammal.

Skratt

Men man kan nog säga att tvåsitsigt är att föredra i fastighetsbranshen

Hur många brukar ni vara som max i fordonen, kör ni 3-4?

3, ah vi har knött in tre

Men det var när åkte o äter o det tror jag gäller generellt i fastighetsbrannshen att man vill kunna åka flera stycken, minst två stycken.

Pratar lite terravox…

Bostadsbolaget ska ju gå in och göra en satsning på miljö nu så det kan ju vara läge för er att gå in.

Mer strategi

Poseidon har väll gått ifrån sin egen personal när det gäller trädgård, va?

Ja många outsourcar och lägger ut det på entrepenadfirmor.

Mer info kring terravox (komentarer summerat nedan)

Klagar på ljudnivå i hytt på småtraktorer. Uppskattar låg ljudnivå. Tidsplanerar gräsklippning runt ljudproblemet, detta är ett större problem för entrepenadfirmor som har större ytor att klippa och därför måste börja klippa tidigt på morgonen.

Har ni (nimbell) varit och pratat med Partillebo om detta också?

Ne

De använder Melex väldigt mycket för de kör väldigt långa sträckor. De kör till bostadområden i hela kommunen och ligger på de stora vägarna och allting och stoppar trafiken.

Partillebo hette de det?

Ah, de har ju väldigt många elbilar. De ligger ju och kör från Parille, motorväg upp till Öjesjö, runte hela kommunen egentligen.

Ja, tror ju att de bör ha ett behov av lite 45 kilometare fö de kör så pass lång sträcka.

Ja då gör det ju stor skillnad.

Smådetaljer i det hela är ju hur man inreder i sånna här bilar med dörrar å grejjer, att det finns mera fack och grejjer i bilarna. Å lite sånt där va.

Vad är det ni brukar ha med er i fordonen?

Lite papper o grejjer o sådär, man har ingenstans att lägga det.

Pärmar o sådär kanske?

Ah, lite sånna där grejjer. Vi försöker ju hitta på själva (se bilder). En liten tillvalslista sen det är inte fel.

Vi har sett det finns behov av att allt inte syns, att det finns behov av att gömma saker om man vill lägga in något som är lite halv värdefullt.

Det är ju som ibland har vi ju stora nyckelknippor med oss, kanske en 50 nycklar eller nånting. Då åker vi ner till resturangen då får man ju ta med sig hela knippan in för det går ju inte att lägga ifrån oss nått då va. Annars är det ju ganska ärligt här uppe, men ändå.

Vattenflaska är det nått ni tar med er?

Naeh, men det finns det uttag för i bilen.

Det är ju anpassat för golfare, måste ha plats för groggen (småler)

Sen en liten grej, ett enkelt kapell om man har en liten enklare bil där man inte har någonting annat. Om man kan komma på nån sån där persien, markis menar jag, som man kan dra över så va, rätt över.

Över sidan?

Naeh, inte över sidan bara över taket lite lätt där, för rätt som det är så står bilen där och så har vi grejjer på då va, och så regnar det. Så kommer vi ut där då så är allt nästan förstört på bilen med grejjer, vi glömmer av det.

Istället för väggar då eller?

Ah, inga väggar behövs egentligen inte

Ja ett litet kappel eller tak skulle räcka.

Istället för tak helt också?

Naeh, bara över flaket. Jag tänkte mig en kasset där uppe, så drar man bara över den på nått sätt, båge eller nått.

Ah, vi har funderat lite över det. Det finns insynskydd som man har i kombis idag som man bara drar över för att man inte ska se vad som är under. Är det en liknande sån lösning eller?

Ah, de är ju enkelt en rullgardin som man drar ut egentligen.

Är det höga grejjer som ligger på flaket så den ska vara i taknivå eller är det bara att man vill dra över en lämm som är så här hög (måttar 30 cm).

Ja det räcker på hälften om man säger så, en sån grej som man bara drar över så, lätt.

Vi har funderat över om man ska ha en grej som man drar över från marknivå till marknivå (ritar horisontella streck med handen) eller från tak snett ner som ett triangeltak som ett litet tält.

Ah

Men vad är det som ligger på flaket och blir förstört? Är det motorsågar som ligger och rostar eller?

Allt möjligt, det ligger lampor och pappkartonger och det blir förstört.

Ah de förstår jag om man bara går in ska fixa nånting och så glömmer det.

Ja, vi har ju haft hinkar med grejjer stående och de blir ju fulla med vatten.

Ja det är ju ingen höjdare kanske.

Lämnar ni papper och sånt i hytten också?

Ah

Fast ni hade väggar i eran, om man inte har det så kanske det förströrs.

Ja vi har ju väggar och värmare i våra bilar.

Men det är en liten bensinvärmare då eller?

Ah, diesel.

Vad tycker ni om hytten i de elfordon ni har idag? Förutom problemet med att det inte finns några fack i dem.

Vi tycker ju att de är ganska bra, de får jag ju säga, sen vet vi ju inte om något annat men för oss är dom jättebra.

Vid vilka tillfällen väljer ni bort Melexen (visade sig att det var clubcar de körde) för ett annat fordon?

Jag o Dick har ju bilen hela tiden, vi har ju ganska långt ner till nästa torg om man säger så (fastighet)

Vi väljer ju bort mopeden när den saknar lastkapacitet och problemet med att få med sig verktyg å sånna saker, maskiner. Du ska ha med dig en jordfräs (park)

Måste flaket kunna tippas, är det viktigt?

Ah, det skulle underlätta.

Hur mycket brukar det väga som man tippar? Är det så att man fälla flaket för hand eller vill man ha något som hjälper till?

Man skulle nog kunna fälla det för hand, det finns ju sådana hör käcka hydralkolvar som hjälper till så att man inte behöver dra.

Gasfjädrar?

Gasfjädrar ja, som med rätt avvägning säkert skulle räcka för att tippa det manuellt.

Gruppen delas upp i två där gustav pratar med park om gräsklippning och Patrik/Tobias frågar om fastighetsskötarnas användning av Clubcar.

Hur länge jobbar ni?

Du tänker med maskinen eller?

Ah, precis

10 till 4 får jag nog säga då.

Ah 10 till 4 med bilen.

Händer det någon gång att man är ute och kör med dem på natten så man behöver bra belysning?

Bara dagtid, det är ju på morgonen ibland som det är mörkt det är det ju.

Men ni känner att det räcker med de lampor som finns på?

Ah de gör de, har nog knappt aldrig tänt dom, kanske om man varit inne i garaget nån gång.

Sker mycket av transporten på allmän väg?

För egen del är det ju Alards gata men det har ju med områdets beskaffenhet.

Har ni några säsongsspecifika problem när det är kallt eller varmt, blött, halt?

Ja vi märker ju att batterierna tar slut fortare när det är kallt?

Är det problematiskt fortare eller är det..

Asså man faller ju inte på att, man tycker ju inte att det är så allvarligt att..

Det är ju så att vi kör dem de 6 timmar de är igång, hur mycket kör vi på den stunden, sen kör vi ju in den och laddar den till nästa dag. Den håller ju för det vi behöver.

Finns det några underlag som den är jobbig att köra på? Grus eller jord?

Ja vi kör ju bara på asfalt och det är ju inte ofta man kör på gräset med den.

Så det aldrig så att några underlag som det är jobbigt att köra den på?

Nej

Vi tycker den går jättebra fram på allting, snö åhh…

Har ni haft några stöldproblem? Eller anpassar ni er pga av att ni är rädda för stölder? Tex det ni sa med nyckelkedjan.

Här är ju, peppar peppar, men man har ju nästan aldrig blivit av med nått, verk-

tygslådan står ju på golvet, nu är det ju bara handverktyg som man inte vill ha på sig. Men det har ju aldrig, vi tar ju inte ens ut nycklarna, de sitter ju kvar i. Vad är eran tanke här då?

Det är ju behovet av att ha låsta utrymmen, låsta fordon.

Dee…

Det skulle nog behövas för…

De är ju kassa på de här maskinerna, det har väll gått sönder på bägge maskinerna just det här med låsningen och kolvarna i ramen har nog ingen kvalite.

Är anledningen till att ni inte tar ut nyckeln att det är många personer som använder samma fordon så det är bökigt att en person har nyckeln?

Det är nog bara bekvämlighet.

Tar den lång tid att starta?

Vad sa du?

Är det lång uppstartstid från det att man stoppar i nyckeln?

Nej. Ingenting sådant

Det är lathet, ren lathet.

Å ingen anledning till att ta bort den, det är väll det som är anledningen

Förekommer det att de (elbilarna) hanteras på ett mindre säkert sätt? Tex att de körs in i väggarna.

Inte, vi låter ju inte, det har ju inte varit så många andra som fått köra dem heller. Det har väll varit nån sommarkille som eller sånna praktikanter som vi har från skolan. Men dem har vi ju visat innan hur de fungerar. Så det är ju nästan ingen annan som kör dem.

Inget sådär som ni själva känner är lite småvårdslöst men som ni bara gör korta sträckor?

Det är väll mer att man ibland sitter på flaket och sådär eller använder den som förhöjning alltså stege.

Händer det att vill ha sittplatser där bak också, om man ska till restaurangen eller så?

Ah, naeh det behovet finn nog inte.

Ah okej det är tre på soffan i så fall.

Man har ju suttit nångång där bak men det är inget.

Ställer man ofta stegar på flaket?

Ah vi har ju oftast en trappstege, 1,5 m höjd, räcker inte den till så kan man ju se bilen… och flaket kan man ju ställa stegen på.

Har ni med er krattor och längre grejor på fordonet?

Vi har ju inte det, du menar räffsor och redskap?

Ah precis

Naeh, det som är vårat behov är kanske inom fastighet är ju att ha lite verktyg, det kanske är å ha lite mindre reservdelar. Men man kan ju inte ta med för mycket för man vet ju av erfarenhet att varje vägguttag som ligger där och skramlar blir ju förstörda till slut, den här vita plasten. Så det är ju mycket pengar som hanteras i reservdelar som inte är bra att ha liggande på flaket när det regnar å det rostar. Men vi är väll ändå rätt duktiga…

Jo jo men ändå så står det ju nån hink där ibland halvfulla med vatten.

Sen är det ju en fördel att kunna ha lite lampor i en egen låda. Nu är det ju med lågenergilampor en djungel, det är ju inte tre typer av lampor längre, nu är det ju 15 typer av lampor.

Finns det något annat ni har med er?

Ja det kan ju vara de här, de är ju standard inom fastighetsskötseln, smockarna.

Aha en sån här rör rensare (gummisug).

Det är en som alla har i bilarna inom vårat. Sen har vi ju rensvajrar och en plats där

man kan ha långa lysrör. Det är ju alltid ett dilemma när man lägger sånt på flaket och lägger nånting annat på.

De går sönder då?

Ah precis

Kanske hänga upp dem?

Ah inne i hytten har vi hängt upp de korta i band där de hänger lösa. Sen är ju de facken, det är ju alltid något handskfack där.

Men ni skulle nästan vilja ha något större skåp där bak där man kan ha lite olika reservdela och sånt? Lite smålådor och större fack?

Ah, fast samtidigt inte häller. Men ibland är det bra att kunna låsa in nånting, man har med sig nån borrmaskin eller nånting på flaket. Bara att få nån täckning.. Sen är det ju inte så mycket att ha reservdelar konstant det är inte det som är behovet det ligger så pass smidigt med verkstan så….

Det ligger så pass nära.

Finns det något obekvämt med dagens fordon?

Våran är ju ganska trög i ratten.

Ah den är trög.

Den är väldigt trög i ratten.

Och dålig svängradie till skillnad mot den andra lilla. Jag tror inte du vänder här utanför vi containern ens.

Det hoppas vi ju är fördelen med trehjulingen.

Ah

Finns det några andra irritationsmoment där ni känner att det här gör jag bara för att fordonet inte kan göra det på ett annat sätt?

Dörrlåsen, eller inte låsen, stänger ju inte riktigt utan man får ju smälla igen dom, den hoppar ju ut en sån bit.

Ja den står ju lite öppen.

Det är dålig konstruktion på den själva dörrgrejjen kan jag nog säga. Dom öppnar sig ju väldigt mycket hela dan.

Tippar ni flaket ofta?

Ne, det är inte ofta. Det är när vi rensar den ibland kanske.

Tycker ni den är lätt att tippa?

Ja, den är rätt enkel. Man drar i en stång, jag vet inte om ni har sett den?

Vi har fått lite klagomål på att den är jobbig.

Ja den är ju alltid lite trög.

Västra har klagat på att den är jobbig att öppna med en hand (detta gällde melex lösning,de använder clubcar).

Ja, vi öppnar den så få gånger så det är nog inget vi reflekterat på, ibland när man ska titta till batterierna. Öppnar man den ofta är det en annan sak.

Ah det är så sällan.

Ah för våran det är ju nån man måste öppna för att fylla på batterierna? Eller var det den andra bilen… ah våran tömmer vi ju i nu direkt på ett ställe på den andre måste man ju öppna flaket för att gå in å…

För nu har vi ju en automatisk påfyllning för alla batterierna. Men på den andra måste man fylla varje cell.

Och då får man öppna.

Ah då får man öppna för att komma åt alla celler där bak.

Vi öppnar ju bara våra två gånger om året.

Nä men va ä den? Är den två år gammal eller?

Hur upplever ni insteget i den bilen ni har idag? Är det smidigt att gå in i den eller är det för högt golve eller slår man i huvudet i taket eller nått sånt där irritations-

moment?

Nä, jag är ganska stor, jag tycker det var bra, lätt.

Frågan är med de här, backen ligger ju på den ena ligger ju här, va? Är den där nere vid panelen? Frågan är varför de satt den så och inte har någonting vid ratten kanske.

Är det jobbigt att nå reglage?

Det är ju där man trycker fram och back bara.

Använder ni vindrutetorkare?

Ja den sitter ju också där ja.

Är det några instrument som ni skulle vilja ha vid ratten istället som på en personbil?

Ja det är ju fram och back i så fall som man har på… vilka är det man har det på, vilka maskiner? … det är ju egentligen ingen som har det där.

Ne man har ju ingen växelspak.

Vad tycker ni om att ha sånt på pedaler? Fram och back, på en eller två pedaler, det finns lite olika lösningar.

Njae då föredra jag nog att ha allt på samma, samma funktion. Man får alltid nytt grepp- Jag vet när man körde snön mycket med de här midjestyrda med sånt. Den tycker jag inte om när man får lägga hälen ner, det tror jag ingen tycker om va? Har ni hört er för om de eller?

Njae, det är nån som efterfrågat det.

Du menar en sån med back åt ena hållet och fram åt andra?

Ah

Tror det var en gammal truckförare som efterfrågade det. Han hade haft det i sin truck.

Ah men de har nog mycket mer sånt där man får ….

Det stötte vi på när man var ute och plogade snö…

Ah men då är det mer sånt, precis.

Men helt enkelt en spak som ändrar från back till fram.

I det här fallet, iofs hur ofta lägger man i backen? Det är ju som med bilen.

Men hur kom det sig att folk backade in i väggar?

Men det var elmopederna. De reagerade så olika just vid gasningen, de stack iväg direkt.

Aha det fanns ingen accelerationkurva.

Naeh, ah den kom så fort och så var dom inte vana heller. Det hände ju aldrig dom som kört den innan de visste ju.

Man lär sig fordonet.

Ah precis! Det var en tidsfråga varje gång.

Men det är såna grejer som man intet tänker på att säga till den som ska köra utan det är mer att det upptäcker de själva.

Och sen som Tomas sa, bromsarna var ju obefintliga.

Hur är det med radio och sådär?

Radio i dom?

Ah både kommunikationsradio och vanlig radio att lyssna på.

Det finns inte för det fordonet som vi har.

Karta och gps? Inget sånt?

Vill ni ha hastighetsmätare?

Nä jag tycker inte det.

Vad är det för instrument som används i fordonet idag?

Det är väll bara blinkers.

Jag tänkte på batterkapaciteten.

Jo det är ju värmaren som vi har på men den är ju diesel.

Men ni har ingen sån där, kollar ni på batterimätaren ofta?

Den är väll åndå, den där indikatorn, vet inte hur korrekt den är. Tycker den sitter å blinkar.

Är det problem att den visar fel?

Nä, fast man tar väll inte så stor vikt vid den. Man vet ju bara att kommer den inifrån så är den ju full och när man lämnar den är den lite lägre ner. Men det är ju ändå bra att den finns den här indikatorn.

Ah precis, men det är nått man kollar nån gång ibland bara för att säkerhetstsälla att den ladats på natten?

Sen vet jag inte om ni kollat på såna digitala där man kan se spänning och så?

Ah vi funderar ju på det, vad vill dom ha visat och var ska den vara placerad.

Vi tittar inte så mycket på tekniken utan bara representationen.

Ah men det är nog det man föredrar man sätter sig ju inte in i om det på 24,5, att det är halva, då är det bättre att ha 5 steg som visar.

Ah exakt, de vi pratat med hittills har sagt att de vill ha nånting som visar hur mycket som är kvar av helheten. Sen om det står i watt eller vad det är…

…har ingen betydelse

Men ni skulle inte vilja att den räknar om i hur många timmar ni har kvar att köra eller sådär?

Näh, jag tycker inte det.

Procent är ganska bra eller?

Ah speciellt om man vet om att den klarar det behovet vi har, hade man legat på gränsen så kanske det varit annorlunda.

Hur många mil som är kvar?

Nej det tror jag inte. Sen är det ju alltid så att så lite teknik som möjligt som kan krångla är att föredra.

Ah precis, men skulle antalet timmar, hur många arbetstimmar den har gått vara intressant?

Det hade inte varit fel att ha en sån ja.

Ne man kommer ju aldrig ihåg.

Tex att när den har gått 2000h kan en röd lampa lysa, det är ju ändå rätt lätt.

Ah jo precis, det behöver ju inte vara elektroniskt, det finns ju mekaniska med.

Vi har ju sett på norsjö har de en cyckeldator som sköter det mesta. Så det är ju inga dyra komonenter.

Ah men det är ju inte fel att ha.

Sen tänkte jag fotutrymme är inget som är ett problem? Att det är för långt, för kort eller att man inte når fram till pedalerna?

Vi har ju alltid en låda som står där men det har jag inte tänkt så mycket på. Bälte satte vi ju in, var det tvång?

3 och 4 hjuliga Eu-mopeder har krav på säkerhetsbälte. Men hur det står till med arbetsfordon (motorredskap) det vet jag inte.

Ah de satte de in extra för det kom inte med från fabrikanten. Sen sitter det bara bälte till en person.

Men tycker ni att det känns farligt att man glider ut i sidled?

Ne det tycker jag inte.

Men ni har ju väggar, just det ja.

Ja vi har väggar ja.

För annars har vi upplevt när man svänger att det inte finns några vettiga handtag och att man glider lite.

Ah du menar ifall man inte haft dörrarna då?

Ah precis

Då hade det nog varit bra med en stropp eller nånting.

Är det så att passageraren vill ha nånting att hålla sig i?

Jag vet inte hur det ser ut.

Sätter man upp fötterna nån stans eller har ni dem på marken?

Uppe kan du inte sitta med dom, sånt utrymme finns inte.

Så gjorde dom på västra men dom kanske har lite annorlunda, då satte man upp foten på brädan, passageraren då.

Ne, ja fan det tycker jag inte att man…

Det kanske ser lite annorlunda ut då, det var Melex ni hade?

Det är ClubCar

Då är det olika fordon och då är det inte så konstigt kanske

Ne det är ju en annan

De har ju en instrumentpanel som känns som att den är gjord för att man ska ha foten emot den i stort sett.

aha

De har alltså lutande, så slänger de upp foten.

Har ni regnkläder och sånt i?

Ne det är sällan vi använder

Det är aldrig så att ni hänger av er kläder nånstans?

Ne, det finns inte plats för det.

Men om det funnits?

Ja vi har ju jackor, vi slänger dom på flaket ifall om det är nått.

Men det händer att ni hänger av er kläder på flaket?

Mmm

Var ni skeptiska mot elfordon från början?

Det var ju el-mopederna som kom först, å då hade man ju ett minna av den..

Tugger?

Tuggern ja,

Var det ett gott minne?

Ja den var ju, jag vill inte ens köra, inte ens sätta mig på den. Den var ju, gudarnas, den var så klumpig å dan.

Var det jusst att den var svårstyrd då eller var det några andra grejor som?

Ah ja vet inte, jag vill inte va på den ens. Jag cyklade hellre då.

Ja den var en liten tank kan man säga.

Men el-mopparna dom som kom de första

Men det var flakmoppar då?

Ah det var det, det var de här gröna från början va? Nortell fanns det nån.

De blev ju ganska snabbt populära…

Ah de blev dom!

Bland fastighetsföretagen som transport

Det gick ju jätte fort, bort med mopparna, två taktarna.

Men förut var det så att området var uppdelat, vi hade mycket närmre till våra arbetsplatser förut, till våra kunder om man säger så. Så vi gick ju mycket sen nu ligger vi långt ifrån så därför så; vi hade ju bara en bil ifrån början och den hade ju sten från början för han hade ju längst, då hade han bilen. Och du cyklade va? Och jag gick ju för jag hade ganska nära till mina kunder. Sen när vi flyttade då blev det ju att vi fick en bil till.

Ne det blir ju en effektivitetsfråga, man kan ju inte hålla på och gå och böra grejer överallt.

Så vi har ju en jättegammal elbil som står som vi tog över.

Var det den lille du sa där?

Nej nej, det står en ytterliggare, vi har en tredje gammal som står i ett garage.

Ni kan ju ta och utveckla den (skratt)

Det är ju faktiskt bara växeln i huset som gått sönder.

Har ni modifierat fordonen något? Byggt om den själva eller så?

Naeh

Lagt till några lådor eller nått sånt?

Naeh det har vi inte, … har ju satt på några vp-rör och du har väll gjort mycket på din traktor?

Platsstudie:Akademiskahus/chalmers-prototypdiskussion

Obs ej antecknat, taget från minne.

Kör:
Norsjö. flakmoppe, Personbil

Arbetssätt:

- Kör allt som kan lastas och behövs runt om i området. Mest i boxform som lastas på flaket
- Mestadels lätta men stora saker
- aldrig rågods som jord eller liknande
- sällan med långa stegar. mest kortare modeller som lastas stående på flaket
- kör korta sträckor, många åker med ibland på flaket. vanligast är 2-3personer
- Samma person som kör fordonet, de har olika ansvar.
- inte många utsteg

behov:

tak:
Ja, lastar inget på taket. men behovet kan finnas.

flak:
Behöver inga höga lämmar eller tippas. vill inte ha för högt så man kan sätta sig på kanten.

Ev. Höga lemmar om de går att fästa fort

Verktygslåda (lådan glider runt på flaket idag)

Lysrör

lösa verktyg

skärmar

Fraktar ofta lätta stora saker (kartonger) och vill ha möjlighet att spänna fast enkelt i de fall då hög lämm inte sitter på flaket. V40 lastspännen (påminde om bilbälte) nämdes som exempel. Denna lösning hade en utdragningspunkt men flera infästningsmöjligheter.

Gärna möjligt att täcka för med pressening om det går fort

Generella åsikter om prototyp:
Såg bra ut.

bra med låga lämmar

lite rädda för att den ska välta

automatisk handbroms uppskattade

vill ha två säten

vill kunna hänga stegen bak.

köra i 45km/h

styrning trög

Bromsning vid gasavdrag var nytt för en del inom gruppen

Grupp preferenser

- Vad har ni för arbetsuppgifter?

  Fastighetsskötsel på Chalmers campus, tilldelat geografiskt ansvarsområde.

- Vem kör? Baserat på erfarenhet?

  De som har längre till sina arbetsområden (1km max) åker ofta istället för att gå.

- Arbetar ni i grupp eller enskilt?

  Oftast 2-3 personer, men enskilt händer också

Arbetstyp

- Arbetspassens längd och frekvens av fordons användning

Fordonen körs korta perioder och står parkerat medans arbete pågår, uppskattningsvi kanske 45 min aktiv körning.

- Vilka typer av fordon har ni på området?

Personbilar och flakmopeder (el)

Nordsjö elmoped

tungstyrda

Låg flaklämm

Kort tröskel runt flak, styret bakom upplevdes inte som om det hjälpte till att hålla last kvar vid acceleration.

Lätt att se om last åkte av då flaket är framför föraren.

- Vad är de olika fordonens huvuduppgift?

Nordsjö: enskild persontranport, skjuts på flak (kort sträcka), transport av diverse grejjer (svårspecificierat men mer volym än vikt såsom paket/kartong), viss elektronik.

Personbil:

Längre sträckor, ev större grejjor och om det inte finns alternativ även till kortare sträckor.

- Hur många åker på fordonet (bara föraren)?

1 sittplats på moped, önskas 2-3

- Mycket transport sker på allmän väg?

Kör både inom campus på gångvägar och vanlig väg.

Förhållande

- Säsongsspecika problem (kallt, varmt, halt, blött)

  Mopeden har dålig drivning i snö

- Hur förvaras fordonen

  Inomhus i garage

- Vilka underlag används fordonen på och är några av dess jobbigare?

  Snö uppförsbacke

- Brukar det vara mycket folk runt omkring fordonet när ni arbetar?

  ja

- Förekommer det att fordonen hanteras på ett mindre säkert sätt?

  Skjuts

- Vid vilka tillfällen väljer ni bort en elmoped.

  När större lastning krävs, fler personer, moped inte finns tillgänglig.

- o Vad väljer ni istället, VARFÖR

Personbil enda alternativet

Behov och utveckling

- Vad tycker ni om möjligheten att ha tak?

Ska vara tak

- o behov av att transportera föremål på taket

I enstaka fall, ofta korta steger (3-4 steg) pga regler kring höghöjdsarbete.

- o väggar?

Allmänna kommentarer om att de gillade den öppna lösningen på prototypen.

- Vad vill ni ha på flaket (kärra)

Stege, verktyg, kartonger

- övringt som ska med:

Pärm

- hur/om vill ni kunna tippa flaket eller fälla väggar

Inget behov av att kunna tippa flaket men att kunna fälla lämmar var önskvärt.

- o varierbar höjd på väggar(flak)?

Ja tack, kombination låg tröskel och högre lämm var intresant. Kravet var att det skulle vara verktygslöst att ta av och på samt lätt.

- speciella infästningar önskemål

Infästningar är nästan ett krav

- Säte önskemål /storlek, nackskydd, Armstöd, värme

Värme!

- o värdering, hur viktigt är ett bra säte

Väldigt korta körsträckor vilket minskar behovet av avancerad ergonomi. Dock skulle inställningsmöjligheter vara användbara då det ofta är samma person som kör fordonet.

- Reglage:

Användarstudie Tidningsutdelning

Största problemet på användarsidan är lokalisering av filialernas bilar. Informella utlåningar sker ofta och utsedd ansvarsperson får sällan vet när utlåningen skett. Ett Excel system finns som ska uppdateras vid utlåning av bilar men detta ses som bökigt och omodernt av användarna och används därför sällan. I dagsläget lokaliseras bilarna genom att "veteraner" inom branschen ringer till varandra och frågar. Detta är både tidskrävande och frustrerande då tidningsutdelare får vänta på sina fordon. Uttrycket " det här företaget gillar Excell och sms" nämndes ett par gånger.

Det viktigaste för att öka tidseffektiviteten vid tidningsutdelningen är tiden mellan lådorna. Lokala filialer finns utplacerade över hela Göteborg för att minska ressträckan till och från utdelningsrutten. Det arbetas aktivt med att minska centralutdelningen ytterligare i framtiden. De lokala filialerna varierar i standard och utrymme. Den som besöktes låg på bottenplan och hade inomhusförvaring av vanliga och trehjuliga utdelnings cyklar. Cyklarna verkade enbart användas av yngre utdelare medans äldre körde bil eller gick med gångvagn (Detta baseras enbart på observationer under de 30-45 min vi var där och fikade). Enligt den ansvarige för filialen var det vanligt att anställda hämtade post med sina egna bilar och sedan körde ut till sitt område där de delade ut tidningar till fots.

Tidningsutdelaren som observerades var ett jourbud. Det innebär att han tar och kör rundor där ordinarie utdelare är sjuk eller har semester. I första hand försöker filialansvarig att ersätta den sjuke med en annan lokal utdelare men om inte detta går så kör jourlinjen. Jouren arbetar kl 22(01)-08 men ordinarie bud/personal kör

mellan kl 03-06. Kör en vecka är ledig en vecka "den veckan man jobbar så är det bara jobb".

Nedan presenteras viktiga punkter som dök upp under postutdelningen:

- Jourbud ska klara alla typer av utdelningsrundor (gång, cykel och bil) och måste därför ha plats för lastvagn i bilen.
- De höjer upp stolen till max läge för att nå ut genom fönstret.
- Sträcker sig frekvent ut genom fönstret för att nå till brevlåda. Om det är för långt öppnar de dörren och svänger sig ut med överkroppen mot fönsteröppningen.
- Att gå ur fordonet för att nå brevlådan ses som onödigt och undviks så långt det går.
- Fordonen körs långa sträckor med ena hjulparet uppe på trottoaren.
- Använder 1:an och 2:ans växel och styr med en hand på ratten.
- Innerbelysningen upplevdes ibland som störande (ingen arbetsbelysning på fordonet).
- Många brevlådor är svåra att se vilket gör att många backningar krävs på varje runda (ordinarie bud har större möjlighet att memorera brevlådeplaceringar)
- Sidobelysning gör det betydligt enklare att lokalisera brevlådor.
- Körlistor levereras i pappersformat och dagliga uppdateringar görs via ett separat papper som knippsas ihop med den ordinarie körschemat.
- Körlistan uppdateras varje vecka.
- Många vändpunkter är så smala att garageuppfarter fåranvändas för att vända.
- En liten bil skulle vara smidigare att använda speciellt ett fordon med kort nos som gör det möjligt att komma nära brevlådor.
- En rymlig förarhytt är viktigt för att kunna sortera upp tidningar i olika högar innan utdelning.
- En del använder ovansidan av instrumentpanelen för att sortera tidningar medans andra föredrar hyllan som finns i taket.
- På vintern kör de flesta med värmen på max och vindrutan nedrullad.
- De är positiva till ett större öppningsbart fönster men är lite oroliga över vad det skulle innebära vintertid.
- Är positivt inställda till en lägre placerad innerbelysning.
- Använde penna för att sätt fast papper på instrumentbräda men tar upp den i handen för att läsa.
- Slänger skräp i fotutrymmet för bakre passagerarsäte.
- Tar upp nästa tidning i handen vid föregående brevlåda och kör med den fastklämd mot ratten
- Vissa bud håller koll på hur bra andra kört samma runda.
- Finns en del problem med punkteringar men det beror ofta på att buden "tar" trottoaren från fel vinkel (45 grader).
- Kör lite fortare på ordinarie distrikt.
- Blir kall om fingrarna på vintern, får dra in armen och värma emellanåt.
- Gps placerad i högra fönster hörnet (vid backspegel).
- Tiotal tidningssorter (titlar) som max.
- Baksäte används ibland när det är mycket post men undviks om det går.

Appendix 4

Need Analysis

	Specification	Comment	Source	Weight: Logistic	Worker	Purpose	Actual weight Logistic	Actual weight Worker
Please note that the weight in this analysis only regards the user experience/satisfaction and not technical functionality		The weight in each sub category is only in relation to the words in the same sub category, the actual weight are then calculated based on the "budget" of that specific purpose						
Design purpose	comfort		purpose weight	40	20	comfort		
Protect driver from rain		Vissa användare kopplar ihop detta med en framruta som är placerad nära föraren. Användare är i de flesta fall klädda för långa arbetspass ute och därför skyddade mot kyla.	Old Msc, Parkförvaltningen, Posten, VTD, Ö. kyrkogårdsförvaltningen, V. kyrkogårdsförvaltningen, Real estate concern Guldheden	4	4	comfort	2,5558	1,905

The full analysis containing 100-200 identified needs is not disclosed due to confidentiality reasons. Please contact Nimbell AB for a complete list.

Appendix 5

Checklist of product development statements

Main Category	Sub category	project phase	Description	comment	Reference
	subkategorier Market need, Problem statement, Concept,	Analysis and preStudymAn USm user study IGm Idea generation			Education Limited Holland, S., Gaston, K. and Gromes, J. (2000) Succes factors for cross-functional teamwork in new product development. International Journal of Marketing Reviews, 2(3), pp. 231-257.
Ergonomi		IG, KD	Minimize vibrations	hand/arm 2.5m/s^2 Body: 0.5m/s^2	Wiklander, Bergquist. (2008). (p.29) The re-design of an electrical distribution moped
		KD, Co	Ensure that access holes necessary for service and repair are sufficiently sized	Make sure that the size is adapted to the clothing that the user wears. Also test if blind access is sufficient or if the user need to have a clear line of sight.	j. a. taylor B2 e7
			Design based on physical characteristics	The product should be adapted to the largest possible user number within the TARGET GROUP.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd. London.
	seating design		try to let the seat to adjust automatically to every users specific features	check the ending of this TED talk to get inspirations: http://www.stumbleupon.com/su/video/1qpITe	http://www.stumbleupon.com/su/video/1qpITe
Sustainability					
	Lifecykle	PI	Identify the most energy demanding life phase of the product	Material production, Manufacturing, Product Usage and delivery, Disposal. Measure in CO2 or energy.	Lecture: Material selection in industrial design
	Lifecykle	AN	Estimate the product lifetime	Don't design for failure on specific parts but instead look at the whole product and let material choices depend on it.	
	Sustainable packaging	MP	Minimize packaging material		j. a. taylor C2 e2
	Sustainable packaging	KD	Use recyclable or biodegradable materials		j. a. taylor C2 e2
	Disposal	KD, Mp	Simplify the process of reusing parts	Reusing parts is far better then simply reusing material.	
	Disposal	KD, MP	Enable disassembly with simple tools	Increase modularity and use design for maintainability as a guide.	
	Disposal	KD	Make it possible to disassemble into single material pieces	Use non permanent fasteners. Avoid molden in metal components, exotic material blends, composites, several colours and metal plating of plastic.	
	Disposal	MP	Use material codes when necessary	Ex. plastic codes	
	Cradle to Cradle	An	Get free of known culprits	the known flaws are the easiest to improve	
	Cradle to Cradle	An, Mp	Perform an LCA (life cycle analysis)	List of relevant energy and material inputs and environmental releases. Evaluate the impact.	
Manufacturing					
	All manufacturing	KD, MP	Check material availability and cost		j. a. taylor f2 e2
	All manufacturing	KD	Check production volumes	Make sure that the local production plants and their capacity is taken into consideration. Ex. vac form tool $1500 and injection moulding tool $75,000	j. a. taylor f2 e2
	All manufacturing	KD	Size or weight limitations		j. a. taylor f2 e2
	All manufacturing	KD	Necessary strength	type and size of the applied load on the part.	j. a. taylor f2 e2
	All manufacturing	KD, MP	Surface requirements	Min and max finish that can be produced	j. a. taylor f2 e2
	All manufacturing	KD	Radius requirements	Min and max differs between different techniques	
	Design for assembly	KD	Parts must be designed to consistently orient themselves when fed into a process.		Bergquist, Wiklander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Product design must avoid parts which can become tangled, wedged or disoriented.	Avoid holes and tabs and designed "closed" parts. This type of design will allow the use of automation in parts handling and assembly such as vibratory bowls, tubes, magazines, etc.	Bergquist, Wiklander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Part design should incorporate symmetry around both axes of insertion wherever possible.	Where parts cannot be symmetrical, the asymmetry should be emphasized to assure correct insertion or easily identifiable feature should be provided.	Bergquist, Wiklander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	With hidden features that require a particular orientation, provide an external feature or guide surface to correctly orient the part.		Bergquist, Wiklander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Guide surfaces should be provided to facilitate insertion.		Bergquist, Wiklander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Parts should be designed with surfaces so that they can be easily grasped, placed and fixtured.	Ideally this means flat, parallel surfaces that would allow a part to picked-up by a person or a gripper with a pick and place robot and then easily fixtured.	Bergquist, Wiklander. The re-design of an electrical distribution moped 2010
	Design for assembly	KD	Avoid parts with sharp edges, burrs or points.	These parts can injure workers or customers, they require more careful handling, they can damage product finishes, and they may be more susceptible to damage themselves if the sharp edge is an intended feature.	Bergquist, Wiklander. The re-design of an electrical distribution moped 2010
		MP, PI	Design the work station area to minimize the distance to access and move a part.		Bergquist, Wiklander. The re-design of an electrical distribution moped 2010
Material					
	Design in wood	MP	Use grain orientation to achieve strength in desired direction.		j. a. taylor
	Design in wood	MP	Select radial cuts of timber instead of tangential cuts to reduce distortion.	Radial: from the middle to the edge	
	Design in wood	KD, MP	Hide end grain where possible		
	All materials	KD, EV	Operating temperatures	Check both short term and long term temperature span. Don't forget transportation environment.	j. a. taylor f2 e2
	All materials	KD, EV	Exposure to liquids	Water, solvents and chemicals.	j. a. taylor f2 e2
	All materials	KD	Electrical properties		j. a. taylor f2 e2
	All materials	KD	Thermal properties		j. a. taylor f2 e2
	All materials	KD, EV	Surface requirements		j. a. taylor f2 e2
	All materials	KD	Check Eco-properties	Production energy , Carbon emissions, Recycleability. Becomes more important when most energy is spent in material production.	Lecture: Material selection in industrial design
	All materials	KD, Co	Its hard to compare technical data (material properties) between material groups	The technique to measure theses numbers are different because of practical reasons. It is very hard to bend a brittle material for instance. Material groups: Metals, Polymers, Elastomers, Ceramics, Glasses and Hybrids	Ashby, M. F. (2011). Materials Selection in Mechanical Design -4th ed. Kidlington: Elsevier.

	Quality impression	KD, DK,	Account for ageing of the material	"whilst some metals and woods acquire an attractive patina over time, in general, polymers do not age gracefully". "Inconsistencies indicative of hand finishing are also valued by consumers and may encourage the formation of emotionalattachments."	Crilly et al. Seeing things: consumer responses to the visual domain in product design (2004)Design Centre, Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK
	Material selection	Kd, Co	Identify the function	What does the component do (in mechanical terms)?	Ashby, M. F. (2011). Materials Selection in Mechanical Design -4th ed. Kidlington: Elsevier.
	Material selection	Kd, Co	Identify the constraints	What conditions must be met (both non-negotiable and negotiable)? Ex: stiffnes, strength and cost.	Ashby, M. F. (2011). Materials Selection in Mechanical Design -4th ed. Kidlington: Elsevier.
	Material selection	Kd, Co	Identify the objectives	What is to be maximized or minimized? The optimization criteria. Ex. minimize weight, minimize cost, maximize performance	Ashby, M. F. (2011). Materials Selection in Mechanical Design -4th ed. Kidlington: Elsevier.
	Material selection	Kd, Co	Identify free variables	What parameters of the problem is the designer free to change? Ex. Material, cross section, thickness	Ashby, M. F. (2011). Materials Selection in Mechanical Design -4th ed. Kidlington: Elsevier.
		Kd, Co	Find material indices that optimizes given objective	limited by constrains	Ashby, M. F. (2011). Materials Selection in Mechanical Design -4th ed. Kidlington: Elsevier.
Project management					
	Risk management	PL	Rank the risks	Identify the probability, impact and hideability of the identified risks.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Risk management	PL	Appoint risk owners	Identifying a risk is not enough, that the risk is continually monitored is ensured by appointing a risk owner.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Project Definition	PL	Identify and manage stakeholder	Who decides if the project is a success? Find out what they need and expect from the project. Divide them in process and result affected parties. Deal with them based on interest in the project and power to influence it. Se the stakeholders as assets rather then watchdogs. Try to anticipate what information they need and when they need it.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Project Definition	PL	Identify the mission statement (core strategy) of the company that owns the project.	Make sure that the project is inline with the mission statement.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Project Definition	PL	Identify the focus of the project	Look on Time, Cost and Performance to know which ones that are critical for the project. Ex. the olympics would be time critical, a scholarship funded science project would be cost critical and the international space station would be performance critical.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Project Definition	PL	Identify the activities that the project consists of	Activities can be identified through a Work Breakdown Structure (WBS). This is usually done in the head of the project leader in smaller projects but it is a good idea to write them down in larger projects.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Project Planning	PL	Estimate the time to perform the activities	Time estimates can be based on previous project, estimation on individual activities by those who shall perform them or by estimating the main phases of a project. Understand the consequences of chances in those estimates.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Project Planning	PL	Identify fixed obstacles	What lies outside of the project groups control? Ex. important dates that can't be moved, resources that needs to be shared with others.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Project Definition	PL	Identify activity dependencies	Can activities be performed in parallel or are they dependant on other activities that need to start or finish first. Use a network diagram to visualise it.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
		AN	Perform a sanity check	Divide the need specification into several categories based on how essential they are to the product	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Design brief	PI, AN	Identify the project owner and decision maker		Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Design brief	PI, AN	Specify the product	Permits, offers, prevents, alleviates, overcomes, improves or enables	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Design brief	PL	Identify the reason for the product development	Redesign, new market, new innovation or to comply with user demand.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Design brief	AN	Identify the primary and secondary functions of the product.	This tells you what demands to comply with and which to maximize.	Maylor, H. (2010) Project management. 4th edition. Essex: Pearson Education Limited
	Design brief	PI, AN	Determine how refined the products on the market are.	Where on the S-curve is the current products? New or old market?	Industriell ekonomi nämtins nämtino
	Design brief	PL	Adapt product to current and past brand- product range	Achieving a strong relation between products includes more then simply slapping on a logo. The designer need to be aware of which products it should relate to from day one. Look at brand recognition for more info.	
	Design brief	PL	Determine the need for modular elements in the design.	Will there be different versions of the product now or in the future?	j. a. taylor
	Design brief	An, Us	Determine the main user segment.	Each segment should be clearly identifiable. Gender, interests, lifestyle and life-phase, housing, aspirations, and outlook could be examples of identifiers.	ertrepenörskapskursen på Lindholmen
	Design brief	An, Us	Determine the buyer	The purchaser and the buyer may be two different persons in larger organisation.	j. a. taylor
	Design brief	An, Ev	Specify the selling points of the product	QFD, are a possible way	j. a. taylor
	Design brief	An, CO, Mo	Estimate the retail price or production cost of the product		i. a. taylor
	design brief	PL, ID, KD	Account for the 80/20 effect	This effects states that 20% of the system/product causes 80% of the effect or use. Find and prioritize these important part of the product.	Universal principles of design, Lindwell et.al
		PI, Mp	Specify a launch date for the product	This could be the date that the product should be available for customers or the date when it need to go into production.	
Brand recognition					
	Analysis	US	Evaluate the suggested core values on the customers and verify that they are accurate	Usually three core values	Youghurt projektet (hur vi kom på den sjlliva)
	Analysis	US, DK	If possible: make sure the product fits to the brand recognition in all aspects of the PPE-framework	Do They recognise it, what makes them? Does it have the right comprehensions, associations etc.	Anders Warell lecture, Formidentity.
	Analysis	An	Identify dimensions for positioning against other brands	What values do you want to reflect? What is it you want to sel yourselves apart from? Are there any holes in the market today?	Market part of the qfd matrix

	analysis	An	Find brand and segment typical features	Use the DFA, Design formal analysis by warell. Ex. of features: Rechargeable batteries with built-in charge indicator, tactile TPE handgrips, dark metallic grey bodies with yellow controls, similar sculptural body forms, a consistent style of applied graphics, and controls that have a similar 'feel'..	Anders Warell PhdThesis
	styling	ID, KD, DK	Incorporate identity of the product in many different layers,	Whole gestalt (car outline) , general form elements (volvo shoulder) - detailed form elements (curvatures and details) and brand recognition elements (emblem)	Anders Warell PhdThesis
	Evaluation	KD, DK	check of what emotions the produce evokes	such as sad vs happy, bored, surprised. Does them correlate with the core values	Anders Warell Lecture: Form identity
	Styling	DK	When using color (as brand identifier) consider environment and lighting of the environment the product is used, bought showed etc.	"a combination of colours is better able to preserve colour identity intact in different environments"."	Crilly et al. Seeing things: consumer response to the visual domain in product design (2004)Design Centre, Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK
User centered design					
	User demands	IG, KD, Ev, US	Check if previously gathered userdemands are up to date and appropriate		
	user demands	PL, US	Does the project have the appropriate usercentered strategy	for the customer, by the costomer or with the customer (for the consumer does only find needs from users, By the consumer is very risky, With the consumer is "designing alongside" using focus groups, leaduser, etc.	Course compendium: user centered design
	user demands	US, IG, KD	think of the kano-model when finding user demands, and evaluting solutions	By observations during use you may see if the user have found a way to solve usage problem or If they even have further developed the product by them selves	http://www.betterproductdesign.net/tools/definition/kano.html
	interview technique	US,	Think of using probing during a interview	During deep interviews its nessesary to use probing, asking for instance, "why", and "how" on users statements	Course compendium: user centered design
	interview technique	US,	Write down the unsaid	Keep notes on emotion and hunches that occur during the interview as well what is actually said.	Interview Technique Lecture Nova 100
	user demands	US, IG, KD	Think of the different user selection theories and which to chose	Critical user: please them and you please all, Often refered to as the "wealed users" Representative users: Statistical or theoretical-(by some criterias) Lead users: The proffesionals which have the most input on deeper demands and insight	course compendium: user centered design Lead user: von Hippel E. (1988): Sources of Innovation. Oxford University Press, New York.
	user demands	US	Most user demands are found after 15 interviews	Theory suggest that between 10-20 users the data becomes saturated	Griffin A. & Hauser J. R. (1991): The Voice of the Customer. Marketing Science, Vol. 12., No.1, Winter 1991, p. 2-27
	user demands	US	Mix observation meathods, interviews, and contect visits to find most user demands	Contect visits means visit and study the environment the product is used, procesed, sold etc.	Course compendium: user centered design
	interview technique	US	Some kind of stimuli should be used to trigger the dialogue with the user.	Images, models, renderings,	Course compendium: user centered design
	Evaluation	US, DK, KD	Test if the koncept/product have appropriate cognetive, affective and behavior responce	By cognetive test. Usability but also the aestetic communication and symbolic communication. Affect- what does it trigger: surprice, interest etc. Behaviour- Doest they whant to approach, pick up, avoid?	Crilly et al. Seeing things: consumer response to the visual domain in product design (2004)Design Centre, Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK
		DK	Evaluate features in terms of use-Cost vs use-benefit.	"Do not make design decisions based on cost parameters alone without due consideration of the benefits realized from interactions." New features not used by some users give only costs and should be hidden. Also stripping functions may lessen benefits for other users.	Universal principles of design, Lindwell et.al
Usability (user centered?)					
	General	KD, DK	Account for the Aestethic-usability effect.	It has been shown from several studies that aestetics are important for percieved usability. People are more forgiving for flaws when the product looks good and a good looking product are more accepted then a actual good product. Also the aestetics impression from the first use effects the long term useage of the product.	Universal principles of design, Lindwell et.al
		ID, KD, DK	Design each function with good affordance	The physical properties of the object/function should correspond with its intended use. A good affordance means that a doorhandle shows it is supposed to be griped and have a good grip, also it should be shaped so its easy to turn.	Universal principles of design, Lindwell et.al
		KD	Account for the users previous habits. Compatibility	The user should be able to reconnect to the execution of similar tasks. Be aware of the extra information needed when this isn't the case.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD	Use conventions as much as possible	"conventions can be useful in visually communicating correct operation and confusion may arise if designers do not adhere to them"	Crilly et al. Seeing things: consumer response to the visual domain in product design (2004)Design Centre, Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK
		KD	Account for cultural differences.	Be aware of the market that the product is intended for. Does red really stand for danger?	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
	user demands	KD, US, ID	Design for the feeble.	Designing for a user group with higher requirements than the average customer increases the potential user base.Also reduces the social stigma around using an "aid".	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD	Design for the colourblind.	Make sure that the messages are not dependent on colour alone. Even people with good colour vision has poor colour recognition ±30° from the resting sight line. Use flashing lights with 3-5 repetitions per second as warning indicators.	j. a. taylor
		EV	Evaluate the lighting that the product is used in.	Examples of light needed: watchmaking 2000 lux, jewellery 1300 lux, tailoring by hand 900 lux, dressing 750 lux and machining 400 lux	j. a. taylor
		EV,	Adapt fonts and symbol sizes	Character height should be based on the expected viewing distance. 0.5m -> 2.5mm, 0.5-1 -> 4.5mm, 1-2m -> 9mm, 2-4m -> 18mm, 4-6m 30mm.	j. a. taylor
		KD, EV	Incorporate Guessability	Reduces the cost (time) when a product is used for the first time. The effectiveness, efficiency and satisfaction with which a specified user can complete specified tasks with a particular product for the first time. Especially important on equipment that is rarely used.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD, EV	Incorporate Learnability	The effectiveness, efficiency and satisfaction with which specified users can achieve a competent level of performance on specified tasks with a product, having already completed those tasks once previously. One way to achieve it is to implement a backbone logic that is repeated.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD, EV	Account for "Experienced user performance"	The effectiveness, efficiency and satisfaction with which specified experienced users can achieve specified tasks with a particular product. Important when the product is used in a repetitive manner over longer periods.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD, EV	Account for "Re-usability"	The effectiveness efficiency and satisfaction with which specified users can achieve specified tasks with a particular product after a comparatively long period away from these tasks. Very important for products that have a long learning curve.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.

		KD, EV	Consideration of the users resources	The users resources should not at any one time be overloaded. The chosen method of operation should take into account the present requirements on the user's resources during the interaction	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD, EV	Incorporate feedback	The user should always be able to understand the connection between action and consequence.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD, EV	Enable error prevention and recovery	Design the product in such a manner that the possibility or error is minimized and error recovery is easy and fast. Some means: Good Affordances, Reversibility of Actions, Safety Nets, Confirmation, Warnings and Help	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		EV	Measure Usability	Effectivity: how well the task is solved. Efficiency: how much the time and effort deviates from the optimum, error frequency and mental load to solve the task. Comfort: how they percieve the product during and after a task.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD, EV	Enable user control	Design the product in such a manner that the user has control over performance and settings.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
			Visual clarity	Information presented should be easy and fast for the user to comprehend.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
			Clear usage design cues. Explicitness	Active areas on the product should be distinct so it is clear to the user how it is intended to be used. This is also true for controls and displays.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD, EV	Interface functions used by less than 5% of the users should be hidden	guideline used by google. Connected with the principle of Progressive disclosure	google
			Design based on attitudes	Is there a preference for a certain type of solutions within the target group?	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
			Design based on special knowledge	Does the target group possess knowledge that separates them from the norm?	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
		KD,	Use "chunking" when presenting information	Group information into chunks makes it easier to grasp, find, process and remember. For instance a number 123-45 67 89 instead of 1234567890 or by using subcatagories like the catagories in this list	Universal principles of design, Lindvall et.al
		KD, Dt	Demand confirmations before users can performs critical tasks	I computers as a "are you shure" dialogue. BUT in products as well as tape-stickers with warning symbols to, having to do the procedure twice in order to activate.	Universal principles of design, Lindvall et.al
		KD, Dt	Account for Fitts law	Objects that needs to be handled quickly should be placed close by and be big, objects that are rare and should be used with caution should be placed away and be small	Universal principles of design, Lindvall et.al
		KD	Make sure the design follows the users "mental model"	If there is a standard mental model for how something works, try to design leveraging that model. When this is not possible, (e.g., when the system is new and novel), create an interaction experience that draws from common mental models as much as possible, such as the desktop metaphor for computers.	Universal principles of design, Lindvall et.al
		KD	Consider the use of "modes" in interaction design	Modes changes the interaction and layout after what task that should be made. I.e. Painting mode vs 3d mode in alias.	
	screen User interface	KD, Ev	Principles for good navigation design A site/ui must:	Let me know where I am at all times Clearly differentiate hyperlinks from content Let me know clearly where I can go from here Let me see where I've already been Make it obvious what to do to get somewhere Indicate what clicking a link will do	http://www.webdesignfromscratch.com/website-architecture/navigation/
Cognitive ergonomics					
	Interface	KD	Most used first	Information, settings and functions should be prioritized based on use frequency and importance If it isn't possibly to access everything with the same ease. No controls or displays should be positioned should be positioned outside of the "head and eye motion" fields and should be concentrated to the "eye motion" field.	Jordan P.W. An Introduction to Usability. Taylor & Francis Ltd, London.
	Interface	KD	Remove unnecessary clutter	Keep the logo away from the interface area, don't label obvious controls, group similar controls, keep warning or status lights to a minimum. Ensure consistency, uniformity and avoid the unexpected.	
	Interface	KD	Position controls so that the user doesn't block important information when used	A recommendations is too keep controls related to displays at the bottom or right side of that display. These recommendations are based on a user operating with the right hand and need to be re-evaluated if this isn't the case.	j. a. taylor
	Interface	KD	Check that the controls offer the precision required	This is usually a compromise between accuracy and time to adjust.	j. a. taylor
	Interface	KD	Check that information is conveyed in the most efficient way	1. Numerical indicators for situations where the absolute value is necessary and previous data is unnecessary. 2. Use analogue display where the indication of trend is more important. Also weigh in the fact that some people are used to a certain type (preconditioned). 3.A fixed scale promotes instant readings while a moving scale (bathroom scale) need to be interpreted. 4. Arrange grouped meters so that they look similar when they show normal values.	j. a. taylor
	Interface	KD	Check that the symbols used can be interpreted by the user	Use the international set of symbols shown in BS ISO 7000 and IEC 60417	j. a. taylor
	Interface	KD	Check that the user gets sufficient feedback on actions taken		
	Interface	KD	Check that the buttons are of appropriate size and has enough spacing	Spacing may need to be larger if two adjacent button should be operated simultaneously.	
	Interface	KD	Account for hicks law	The more options a user have, the longer will the time be until action.	Universal principles of design, Lindvall et.al

				Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout. 2 Enable frequent users to use shortcuts. As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviations, function keys, hidden commands, and macro facilities are very helpful to an expert user. 3 Offer informative feedback. For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial. 4 Design dialog to yield closure. Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions. 5 Offer simple error handling. As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error. 6 Permit easy reversal of actions. This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions. 7 Support internal locus of control. Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders. 8 Reduce short-term memory load. The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes.	
	Interface	KD	use shneidermans eight golden rules of interface design		Designing the User Interface by Ben Shneiderman.
	Interface through screen	KD	Ensure good contrast between data and background while minimizing glare	One way to control this is through ambient lighting in the room. Also avoid positioning lights directly above the head of the operator.	Ergonomikurskoken
	Interface through screen	KD	If colour is used to convey meaning then use no more then five colours.	Use strong colours for accents only and use colours that are understood by the user group.	j. a. taylor
	Interface through screen	KD	All screens and menus should be named		j. a. taylor
	Interface through screen	KD	Avoid large menus (above 20 items)	Use submenys instead.	j. a. taylor
	Interface through screen	KD	Check that the user always has the full range of options (menus) available to them	Global options should be visible (file, edit, view osv)	j. a. taylor
	Interface through screen	KD	Allow expert user to override the "newb" mode	This can be done through advanced options, fast command or command prompt. Avoid the "newb" mode is the complexity of the program doesn't require it.	j. a. taylor
	Interface through screen	KD	Determine critical commands and question if the user really wants to perform that specific action		j. a. taylor
Grafisk design			http://www.jamiewieck.com/visual-essays/the-50-things-every-graphic-design-student-should-know/		
CMF					
		KD, Co	Always strive for equal thickness when designing cast products.		Material libraren
		KD, Co	Always name the parts in an assembly.		
		KD, Co	Have a structure for naming files		
		Dk, KD	When showing early concepts avoid photorealism	The higher realism the harder to go beyond the established design. Also flaws not as accepted. The designes intention are better represented with low photorealism	
Idea Generation					
		IG	Ask why features are there	Do this both with connecting products, old products and the design brief.	
		IG	Kill your darlings	Be aware of the fact that that everyone in the development group has favourites. Acknowledge that they exist and dig a bit deeper to understand why that is the case.	
		IG	Search for similarities elsewhere	Isolating the core problem and finding the same problem in other places creates opportunities for solution transfers.	Vangundy, A. (1988) Techniques of Structured Problem Solving. Springer
		IG	Plan the brainstorming (workshop, focus group brainstorming)	Use people with different background and let them think of the problem beforehand. Document the result so you can go back to it after. Contain criticism in the first half and mix ideas that are created. Select ideas based on potential.	
		IG	One sketch per paper	Use A5 paper size too keep the sketch time down on each idea. Using single papers makes it easier to organize and discuss ideas. -Put the best on a wall	
		IG	Warp Ideas	Transform ideas based on themes such as specific proportion, maximize specific function, mechanic constrins, material feature etc. This may gather ideas that are otherwise ignored.	
		IG	Use osborns creative thinking list		http://www.edu.helsinki.fi/malu/kirjasto/infor_osborn.ev.gif
Form design					

	graphical design	DK, IG, Ev	on page layout: Use a harmonius design that follows a given canon, i.e van der graaf canon		http://retinart.net/graphic-design/secret-law-of-page-harmony/
	perception	ID KD DK	Make sure the form communicate appropriate messages in all aspects in PPE-framework	Impression Appreciation Emotion Recognition Comprehension Association	Anders Warell PhdThesis
	perception	ID KD DK	You should make a targetgroup analysis based on the PPE-framework towards the produce		
	Aesthetics	ID KD DK	The complexity of a design is most pleasing when not to complex or simple		Anders Warell PhdThesis
	Aesthetics	ID KD DK	Try to build a good syntax between different form elements	Form syntax: Arrangement and connections between forms	Anders Warell PhdThesis
	Perception	ID KD DK	Think of the tacit, constelutive and functional form message in every design level. From element to total shape	Tacit: based on other forms by association (kitch, cat-like) Constelutive: by its own shape (round, soft) Functional: Based on attribute and function (Carry load, withstand force)	Anders Warell PhdThesis
	Perception	ID KD DK	Design for a product experience in all the three levels of user experience. Account for which perceptions they make	observer, user and owner	Anders Warell PhdThesis Hauhrer, Gerhard (2004). Design basics – from ideas to products. Zürich: Verlag Niggli AG.
	Perception	DK	make shure there are minimum incoherence between identification modes	"incoherence between identification modes may convey non-genuine perception" Modes: recognition, comprehension, association	Anders Warell lecture: form identity
	Perception	DK	Try to use multi-modal identifiers	Such as sound, smell etc. Less risk of imitation and a stronger identifier = gives more meaning	Anders Warell lecture: form identity
	Good design	DK	A high degree of organisation corresponds to the lines of 'good design'	- that, which within a spectrum of stimuli, represents the simplest, best ordered, and hence 'information-poorest' design (polyhedrons and derived forms, including cubic forms)	Anders Warell Lecture: Bodies and surfaces
	Good design	DK	Try to use variations in basic patterns	Variations in basic patterns are well suited to enhance 'syntactic expressive power', increase the abundance of forms, and extend the 'aesthetic information'	Advanced form course
	Perception	DK	When designing towards a specific intention or want a special expression think of what changes that message gets during the communication chain	think of from the source (designers with intensions) trough the transmitter (product) in an channel (environment) to a reciever (senses) and finally the destination (coonitive, affective, behaviour response) Does it have the same message?	Crilly et al. Seeing things: consumer response to the visual domain in product design (2004)Design Centre, Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK
	Costumer satisfaction	DK, KD	The product should be self-expressive	By design qualities the product should "differentiate the consumer from those that surround them" and "symbolise the person's unique identity"	Crilly et al. Seeing things: consumer response to the visual domain in product design (2004)Design Centre, Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK
	Good design	DK	A design should booth be stereotypical and novel	"Whilst typicality and novelty might appear to be mutually exclusive qualities, consumers often express a preference for products that appear to offer an optimalcombination of both aspects"	Crilly et al. Seeing things: consumer response to the visual domain in product design (2004)Design Centre, Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK
	Perception	DK, Kd	Find a archetype and design after that theme	Consider archetypal themes and forms in all aspects of a design-from form and function to name and brand. Since archetypes influence perception on an unconscious and primarily affective level,	Universal principles of design, Lidwell et.al
	Good design	DK	Design principle: try to make a product that is as advanced yet acceptable as possible	A scientific explination on the qualiys of novelty. It states that new and exiting things overcomes boredom and draws attension. However only to the level that it stays trustworthy	Paul Hekkert. Design Aesthetics: Principles of Pleasure in Design. Department of Industrial Design Delft University of Technology. The Netherlands
	Good design	DK	A design should use metaphors	"Drawing upon imagery from externalsources may give the product a more descriptive appearance and assist the user in their proces of interpretation,"	Crilly et al. Seeing things: consumer response to the visual domain in product design (2004)Design Centre, Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK
	good design	DK	Avoid Clishes	When too many products are seen to use the same visualreferences, such products may be interpreted as cliche's. For instance, phone design to similar to the old iphone, the metallic frame and black surrounding a screen have become a cliche	Crilly et al. Seeing things: consumer response to the visual domain in product design (2004)Design Centre, Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK
	Good design	DK	Make sure normal users are able to receive desired form communications such as metaphors, references and associations	Different persons have different sensitivity and experinces that makes it hard to receive the designers intended form communications. Does the users have the right pre-knowledge, preference of archetype, complexity borderline. Otherwise the "perfect complexity" may be chaos and desired metaphors etc. lost	Heikert. et.al Product aesthetics. 2008
	Good design	DK	Use Powerful gestalts both to enhance grouping and understanding, but also for beauty	Gestalt theorists states that we want to find meaning and connection that is derived from our survivalist nature. When such connections are made sensorial pleasure are created (beauty)	Paul Hekkert. Design Aesthetics: Principles of Pleasure in Design. Department of Industrial Design Delft University of Technology. The Netherlands
	Good design	DK	Design principle: Try to accomplish "Unity in variety"	This is one aesthetic gestalt principle. There is a clear neurophysiological advantage for making connections and thus applying this leads to sensorial delight or beauty	Paul Hekkert. Design Aesthetics: Principles of Pleasure in Design. Department of Industrial Design Delft University of Technology. The Netherlands
	Good design	DK	Design principle: A solution that generate maximum effect from minimal means appear beautiful	Look for inspiration in the nature. Generally natural forms that maximizes efficiency on minimum means such as vortexes, raindrops, streamlined, bee-wax patterns are universally beautiful according to Heikert	Paul Hekkert. Design Aesthetics: Principles of Pleasure in Design. Department of Industrial Design Delft University of Technology. The Netherlands
	Good design	DK	Design principle: use "Consistency of impressions"	Heikert states that "we tend to prefer products that convey similar messages to all our senses" which means that leather should sound, feel and smell like leather. etc. - All desired expressions and theire concequences in the design should apply to all senses. (avoid poor imitations)	Paul Hekkert. Design Aesthetics: Principles of Pleasure in Design. Department of Industrial Design Delft University of Technology. The Netherlands
	Good design	DK	Use a design language that uses elements that support navigation and identification.	Gestalt theorists states that we want to find meaning and connection that is derived from our survivalist nature. When such connections are made sensorial pleasure are created (beauty) Heikert describe it like finishing a puzzle for the brain.	Paul Hekkert. Design Aesthetics: Principles of Pleasure in Design. Department of Industrial Design Delft University of Technology. The Netherlands

	Good design	Dk	Every functional element should be design as a metafor for a reconizable object that handles a similar task	These kind of functional connecting metafors gives meaning and creadability to the object, also methafors are supposed to have a aesthetic quality as well. For instance Philips espresso machine shaped like a servant holding a plate.	Paul Hekkert. Design Aesthetics: Principles of Pleasure in Design. Department of Industrial Design Delft University of Technology. The Netherlands
	Good design	DK	Account for "cultural form" (also sub culture)	Nostalgia and certain form language effects the products attractiveness and differs between cultures, also different cultures and sub cultures have different preferences of what is a appropriate complexity level	Exploring Types and Characteristics of Product Forms Wen-chih Chang 1, Tyan-Yu Wu 2,
	Good design	DK	"Use good proportions" where possible	Studies have shown that proportions around the golden section are preferred	Hekkert, et.al Product aesthetics, 2008
		DK	Account for balance in a design/balanced distribution	Studies have shown that non trained persons prefer balanced compositions in paintings and products, that dont tilt or fall over or have unbalanced distribution of elements	Hekkert, et.al Product aesthetics, 2008
		DK	Use symmetry where possible	Symmetry especially in faces are a sign of good genes in humans and in product design it is supposed to be preferred and raise the quality feel of a product, also to interpret a symmetrical object is easier for the observer as they only have to focus on half of it	Hekkert, et.al Product aesthetics, 2008
			create gestalts in negative space	A similarity of beauty in many cultures are bandpatterns where the negative space is equally powerful gestalt as the pattern, this is considered universal beauty	Hekkert, et.al Product aesthetics, 2008
	Aesthetics	DK	Make systematic variations of your designs to find the best proportions	By making rapid prototyping, transformations in cad or Photoshop variations of sketches. Also possible to make morphings between form concepts	Hekkert, et.al Product aesthetics, 2008
	Gestalt	DK	If you want a powerful gestalt, human shapes such as the eye-spot, the hip curve and the cheek curve are universally especially powerful	the eye spot (pupil surrounded by white) is genetically something we spot from camouflage. also sexual curves, or human curves are especially easy to connect to.	Peter D. Slabbing, Creating a Real Meeting of Cultures and Media in the Art and Design Curriculum through the Identification of Universals of Aesthetic Behaviour
			Account for the waist to hip ratio	Human prefers shapes with a waist thinner than the hip. The prefferd ratios are for men 0.9 and women 0.7, Use this when designing hip shaped objects.	Universal principles of design, Lindwell et.al
	Gestalt	DK, US, IG	Account for conflicts between gestalts, and gestalt criteria	There are three typs of conflicts: 1. both are active in the same time. 2: one wins. Here they are some hiranchy. good continuation and rule of experience are high ordered whilst rule of proximity are the lowers. 3: The conflict nullifies all rules, or you cannot see which is active.	
	Gestalt	DK	Consider baby-face bias	When designing something with a face-structure. Consider baby-face bias to find the appropriate expression. A baby face shape are genetically found and have round features large eyes, small noses, high foreheads, short chins, and lighter hair are perceived as babylike. attributes: naive, helplessness, honesty, and innocence.	Universal principles of design, Lindwell et.al
		DK	Consider masculine/feminine face structures	Same as above but gives corresponding expression based on masculine/feminine	
	Color	DK	Make shure the object colors correspond to the intended expressions	For instance: unsaturated colors are connected to professionalism and efficiency.	Universal principles of design, Lindwell et.al
	Color	DK	Use aesthetic color combinations	The web software Kuler can help you with this	Universal principles of design, Lindwell et.al
	Perception	DK, KD	Design elements that needs attention threatening	"People are born with automatic visual detection mechanisms for evolutionarily threatening stimuli, such as snakes. These threatening stimuli are detected more quickly than nonthreatening stimuli"	Universal principles of design, Lindwell et.al

Appendix 6

Vehicle accessories

[illegible]	Lagavelik fyrkiten	lagavelik pelo	standard-baksa (fastlåst)	Standard (låst)	[illegible]	[illegible]
[illegible]						
Flak	hårt stängt skåpflak. låsbart	kapellflak kring ram	Tippningsbart med löstagbara/fällbar_bak lämmar	mdf platta moterad chassi+avtagbara lemmar (ej fällbara)	[extra stort flak.] [L-format flak.] [extrahöga lämmar.] [Kapell/lastskydd]	[nullgardinskapell på spår på B-stolparna.] [sektionsavdelare på flaket]
Hyttinredning	Fasta dörrar	Kapell dörrar	tak, skyddsgaller bakruta	låg ruta + infästning + skyddbåge bak	vindspoiler fram	[fasta dörrar.] [Kapelldörrar]
Takmarkeringar	[sido Ljusramp] Extra ljus	inget	takräcke	inget	(Keps) [saftblandare] [ljusramp]	Brand-skylt (som på taxi)(enbart tak)[usramp bak]
Instrumentpanel/hyllplats	[Hållighet i panelen med plan bordsyta som sträcker sig ut][belysningsslingor] [pappershållarklämma]	Hållighet i panelen med plan bordsyta som sträcker sig ut	[låsräcke handtag] [pappershållarklämma]	öppet handskfack	Lucka till handskfack låsbart	[vridbar bordsyta] [avlastningsyta bakom ruta på huv]
Innerlak	[skärmbar belysning] [radio]	Fast belysning	Belysning	inget	[fläkt] [radio]	[gummispändband rämsor längst taket]
värme	Värmepaket inbyggt. färdiga kanaler för varmluft. Stolsvärme+rygg	extern gasolvärme	Defroster] [stolsvärme]	Defroster om tak		[Gasoldriven infravärme]
passagerarsäte, stolplats	[bra lastytymme]	bra lastytymme	fällbart säte	säte	flak	[box med väderskydd för passagerarplats]
Passagerarsäte, bortplats	[fritt utrymme][första hjälpen]	[fritt utrymme] [första hjälpen]	ej aktuellt	ej aktuellt		[möjlighet för hyllplan vilka medföljer]
Skidfästanordning	Jättebrasiol] [höjd+längdjustering]	[Bra stol diagonaljustering]	[Bra stol diagonaljustering]	billigt säte/soffa	nimbell_sittunderlag	[Regnskydd för säten, sadelskydd] [förvaring för sittunderlag]
Front	grillskydd	inget	grillskydd	inget	Extra lampor att fästa i grillskydd	
Standard val:						
Dödmansgrepps stol som endast kapar gas-möjligheten						
Ljudindikation för tändning						
Axelstöd brevid förare						
bälte						
Instegshandtag vid tak/A-stolpe						
(keps)						
fönstermaskot krok + nimbellmaskot	brand reminder					
Igf skylt						
Flaskhållare	kan byggas ihop (fyrkantig?)					
termoshållare	kan byggas ihop (fyrkantig?)					
mugghållare	kan byggas ihop (fyrkantig?)					
elutag i hytt						
Batteriindikator						
Räkneverk för antal körtimmar						
Rimliga tillval:						
gummerade kontaktytor i hytten						
värmeplatta för batteriet när det laddas vintertid	logestik främst					
Avrinningshål i durkplåt för smältvatten och is	ev lösning: sträckmetall					
dockbar flakförlängning som bär på dragkrok	vältrisk?					
Gallervägg bak mellan last och förarplats	möjliggör massor med dockningsmöjligheter					
lucka i flak för serviceverktyg						