A NEW CAR BODY DESIGN FOR CARICE

N.A. Kodde
September 2014
OPM-1231
University of Twente
Industrial Design Engineering
Design & Styling

MASTER'S ASSIGNMENT

A NEW CAR BODY DESIGN FOR CARICE

N.A. Kodde
September 2014
OPM-1231
University of Twente
Industrial Design Engineering | Design & Styling

Supervisors:

Prof.dr.ir. A.O. Eger (University of Twente)
MSc. M.P.J. Zwart (University of Twente)
Ir. E.J. Oude Luttikhuis (University of Twente)
Ir. R. Holleman (Carice)

FOREWORD

The development of a car is not an easy task, especially for a small company like Carice. Still they were able to follow their dream and build something quite special. During this project I learned a lot about designing and all the other aspects that came along with this project. I want to thank my supervisors for their continuing support and enthusiasm that always helped me go on in order to make things better.

Here it is, the result of research, questioning, designing, redesigning and the endless process of trying to make things better. I cannot wait to see this result in real life and I hope that it will give people the smile on their face that we intended to give them.

Annet Kodde

TABLE OF CONTENTS

SYNOPSIS

WHAT IS THE ASSIGNMENT ABOUT?

SUMMARY

WHAT IS THE ASSIGNMENT ABOUT?

This master's assignment is about the design of a plastic body for Carice, the MK2, an electric cabriolet for two persons. This new body fits the chassis of the current car, the MK1. First of all, the profile of the company and the matching characteristics are investigated. Then car design theories and the influence of shapes and colours on the perception of design are examined. After that, the requirements, wishes and legislation for the new design are determined. Based on this research a new car design is proposed. The design of an optional rooftop and more efficient production methods are also considered. The final result is a body design that can be produced in a large production amount after a couple of technical changes. The rooftops are only worked out conceptual, since the main focus is on the body design.

SAMENVATTING

WAT BESLAAT DE OPDRACHT?

Deze afstudeeropdracht beslaat het ontwerp van een kunststof body voor Carice, de MK2, een elektrische tweezits-cabriolet. De nieuwe variant body sluit aan bij het huidige chassis van de MK1. Allereerst wordt gekeken naar het profiel van het bedrijf en welke karakteristieken hierbij horen. Vervolgens wordt ingegaan op de theorie van het ontwerpen van auto's en welke invloed vormen en kleuren hebben op de perceptie van design. Daarna spitst het onderzoek zich toe op de eisen en wensen en de regelgeving voor het nieuwe ontwerp. Uiteindelijk wordt op basis van dit onderzoek een nieuw ontwerp auto voorgesteld. Hierbij wordt het ontwerp van een dak en het overgaan op meer efficiënte productiemethoden meegenomen. Het eindresultaat is het ontwerp van een body die met enige aanpassingen in het productieproces in grote oplage zou kunnen worden geproduceerd. Het ontwerp van de daken is alleen conceptueel uitgewerkt, omdat de focus op het design van de body ligt.

Photo Carice

DESCRIPTION OF THE ASSIGNMENT

WHAT ARE THE MAIN RESEARCH QUESTIONS WITHIN THIS ASSIGNMENT?

The main goal of this master's assignment is:

- THE DESIGN OF A NEW CAR BODY FOR CARICE

This survey is divided into four phases with the following global research questions:

PART 1 | BACKGROUND OF THE COMPANY AND ITS PRODUCT

- What are the characteristics of Carice and their product, the MK1?	1.1-1.2
- How can the target group be defined?	1.3
- Who are the competitors of Carice?	1.4
- How should Carice develop in the future?	1.4-1.5

PART 2 | DESIGN AND EMOTION ANALYSES

- What are the effects of certain design characteristics on perceptions?	2.1-2.3
- What perceptions does the MK1 evoke?	2.4
- What kind of design would fit the target groups?	2.5

PART 3 | REQUIREMENTS AND WISHES FOR THE MK2

- What are the requirements and wishes from a user perspective?	3.1
- What are the requirements and wishes from Carice perspective?	3.1
- What are the legal requirements?	3.2
- What are the technical constraints?	3.3

PART 4 | BODY DESIGN

- What are possible design sketches of the MK2?	4.1-4.3
- What are the main concepts for a new car body?	4.4-4.5
- What is the development of the final concept into a final design?	4.6-4.8
- What are the specifications of the final design of the MK2?	4.8-4.11
- What is the development of the rooftop designs?	4.10-4.11
- How can the designs be produced and how much will it cost?	4.11
- How is the final design linked to phase 1 -3?	4.1-4.11
- What are recommendations for Carice?	4.12

The final result of this research is survey of the company Carice and their product, a car design analysis and finally a body design that can be produced after the necessary technical changes to the 3D model.

THE DESIGN APPROACH

WHAT IS THE APPROACH FOR DESIGNING THE NEW CAR BODY?

INTRODUCTION

Since designing a car is a complex task, much is written about the best way to do it. Macey and Wardle (Macey, 2008) gave a clear view on all the steps that should be taken in this process and in which order. These steps can be found in Appendix A.1. First of all, the functional objectives have to be determined. This will give a loose idea of the car concept and packaging and will drive the architecture. Then, the size and proportions are defined, these are derived from the functional objectives. For this new car body design, the current chassis will be used. This gives a lot of technical constraints. Most key target dimensions are determined: length, width, wheelbase, tires and ground clearance. Almost the whole interior constrains are specified: occupant dimensions and position, interior, power train packaging, suspension and chassis. After these specifications the body can be designed. The style and type of construction should be determined. These have to be based on analysis of i.a. the purpose, target group, company, costs, and functions. In this phase many concepts are made and some of them are worked out into detail. Finally one of the concepts will be chosen and fully defined. This phase starts with appealing drawings and ends with a 3D model. This 3D model can be further developed so all technical details are elaborated. To give a better understanding of the shape, a 3D model can be made, printed or modelled of clay.
The steps taken in this process are therefore generally the following:

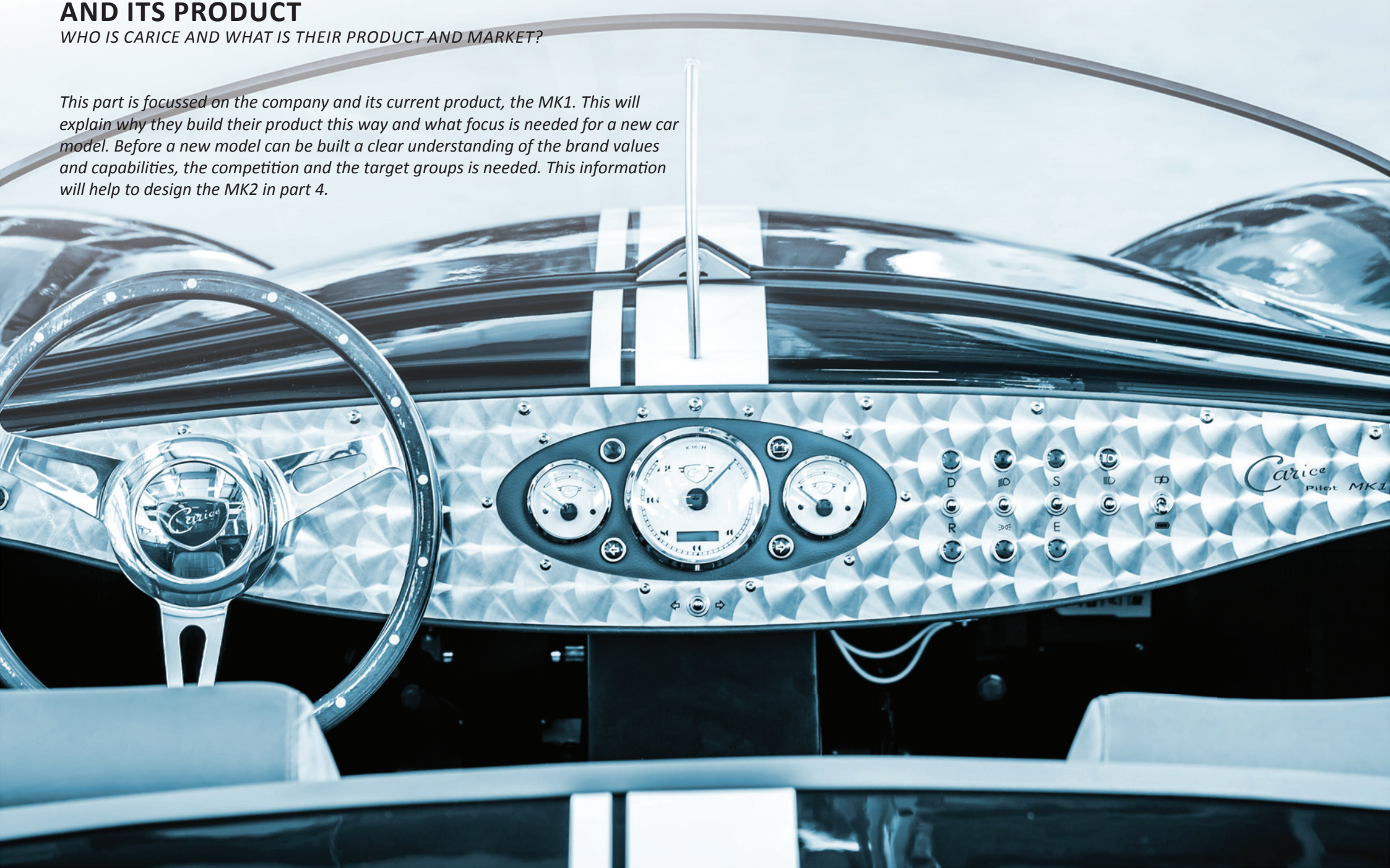
- *Company characteristics, target groups and market environment*
- *Style characteristics company and target groups*
- *Requirements and legislation*
- *Measurements and following constraints*
    - *Chassis parts, position steering wheel, seats*
    - *Position drivers height, posture and lateral location (H-point)*
    - *Position cargo space*
    - *Size and position wheels and wheelbase*
    - *Key hard points (lights; window; height nose, roof and back and door step)*
    - *Safety constraints*
- *General sketches and global designs for possible directions*
- *Final concept direction sketches for the body, considering the way of entering the car*
- *Shape and position of grille, lighting, mirrors, license plates and roll cage.*
- *Final concept 3D model*
- *Final 3D printed model*

It must be noted that the design was made in a very iterative process. For example, the design of the lighting caused changes to the design of the car. All the elements influenced the design of other elements. It is tried to give a clear and comprehensive view on the design process as far as possible.

PART 1 | BACKGROUND OF THE COMPANY AND ITS PRODUCT

WHO IS CARICE AND WHAT IS THEIR PRODUCT AND MARKET?

This part is focussed on the company and its current product, the MK1. This will explain why they build their product this way and what focus is needed for a new car model. Before a new model can be built a clear understanding of the brand values and capabilities, the competition and the target groups is needed. This information will help to design the MK2 in part 4.



1.1 | COMPANY & BACKGROUND

WHO IS CARICE AND WHAT ARE THE PROS AND CONS OF THE COMPANY?

1.1.1 | CARICE THE COMPANY

Carice is a young start-up in Delft that is developing an electric two seat cabriolet with a sportive and classic look (Holleman, 2013). Carice started to develop motorised quadricycles in 2010. Mostly because of a rising demand for electric vehicles she started to develop an electric car in 2012: the MK1. The company wanted to broaden their focus in order to get rid of a 'motorised quadricycle for youth' image. With this electric car a whole new target group was obtained and this would give Carice a totally different image. This had two important consequences, namely a rise in the selling price and a higher demand for different technical specifications. Carice is focussed on a niche in the automotive market. For big companies this is not attractive because of high developing costs and small sales. For small companies the high developing costs and strict legislations are big disadvantages.

1.2 | CARICE: THE CAR

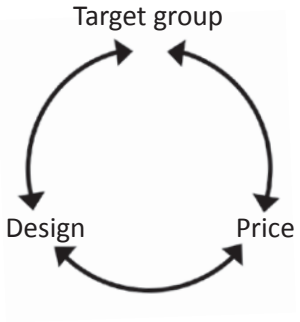
WHO IS CARICE PRODUCT AND WHAT ARE THE PROS AND CONS OF IT?

1.2.1 | PRODUCT SPECIFICATIONS

Photos Carice

1.2.2 | DEFINING A SCOPE

As will become clear in this survey, three elements are of big influence on each other: price, target group and design.
Since Carice is in the starting phase of building cars, they are still searching for the right combination of these elements. In this project it is tried to define this combination as best and well founded as possible. The following analysis will help define these key elements, however, the future will show whether or not they will have to be adjusted.



1.2.3 | PRODUCT SWOT ANALYSIS

STRENGTHS PRODUCT

- Design
Handmade and exclusive i.a. because of the proportions and the simple and classic appearance
- Car performance
Light-weighted, low centre of gravity, high torsion stiffness, independent springs
- Electric
Less environmental impact, quiet
- Low weight
Weight of 300 kg causes a low use of energy
- Easy in maintenance
Polyester body, electric motor
- Low cost of ownership
Few maintenance and less added taxes
- Financial benefits for companies and the self-employed.
- Limited edition of 45 km/h
Youth above 16 years old are allowed to drive this car
- Maximum speed of 120 km/h
For 'normal' cars this is low, but compared to other electric cars this suffices.
- Action radius of 70 or 200 km
This action radius depends on the battery pack. Most of the time people will drive short distances.
- Range extender
Action radius will be increased, but it also increases the price. The sound of this engine can be adjusted which will add up to the driving pleasure.

WEAKNESSES PRODUCT

- No rooftop
No protection from rain and wind
- Charging costs time
Charging takes two hours, which is long compared to filling up a tank
- Only two seats available
- Relatively little comfort
Little cargo space, low entry, much air flow due to the low window
- High price
€22.000 is a lot of money for just another car
- Not widely known
The product is in the start-up phase and the company does not use a dealer network. Therefore sales are low and this will affect the price negatively. Benefit is that there is no loss of money in the margin.

OPPORTUNITIES PRODUCT

- Luggage space / rack / windscreen wiper / belts / mirror inside
- Rooftop
- Increase of the market for electric cars

THREATS PRODUCT

- Car is not suitable for foreign countries (road condition) yet, this might cost a lot of adjustments to the car
- The price can be too high, so consumers expect it to be more luxurious
- The price can also be too low, so consumers do not see it as an exclusive item, which should be a unique selling point

CONCLUSION

This SWOT analysis makes clear that Carice already has a special and well performing product. This can be improved by decreasing price and adding extra comfort, like a rooftop.
Earlier market and company investigations based on interviews with the company, experts and potential customers showed that Carice can position itself best with emphasis on the following strengths (Suijkerbuijk, 2013):

- A unique and exclusive look
- 100% electric, with a range extender option for a longer action radius
- Sportive and comfortable road holding
- Luggage space
- Limited edition with a limitation of 45 km/h
- Optional rooftop for largely protection from rain
- Price of about €22.000 exclusive VAT depending on the model

1.2.4 | BRAND IDENTITY PRISM

In short we will describe the identity of this Carice Car in an identity prism (Kapferer, 2008). The power of this diagram is that it shows very briefly the core elements of the brand. These elements define Carice and the most important things they stand for now and should stand for in the future. The following chapter about design and emotion shows that congruence of values between products will strengthen the brand. ■

Photo Carice

BRAND IDENTITY MODEL

Picture of the recipient

externalisation

CAPABILITIES
Small classic shaped cabriolet
Joyful design
Simplicity (few dashboard elements etc.)
Selling about eight cars a year (starting phase)

INTERNAL CULTURE & VALUES
Quality
Driving pleasure / fun
Good relationship with the owners

NOBLE PURPOSE
Electric driving is innovative
and environmentally friendly

PERSONALITY
Exclusive
Sportive
Classic touch
Joyful

SHARED VALUES & COMMUNITY
Driving is pleasure.
Tough guys can stand unconvenience in order to drive exclusive and adventurous.
Rich people / gadget car

ASPIRATIONAL SELF-IMAGE
Rich / sportive /
youthful / innovative

internalisation

Picture of the sender

1.3 | TARGET GROUPS

WHAT ARE THE TARGET GROUPS OF THE MK1 AND MK2?

1.3.1 | INTRODUCTION

Four target groups and their characteristics are established by conversations with R. Holleman, N. van Dril and their network. These target groups are all on the Dutch market for now, but can be expanded to other markets in the further. For all target groups applies that mainly the men will be attracted.

- Rich youth in the age of 16 - 25
- Rich members of the general public (35-65 years old)
- Car lovers
- Companies and self-employed

1.3.2 | RICH YOUTH IN THE AGE OF 16 - 25

Youth in the age of 16 and older can drive in a limited edition car. This car is bought by their parents, however, they choose the car. This target group likes modern goods and things that make them look special.

CHARACTERISTICS:
- The car price does not bother the youth very much, because their parents pay
- The car must look fancy, modern, fast, sportive and maybe even a little bit adventurous
- The car does not have to be very handy in use, young people are quite flexible

Collage Rich youth in the age of 16-25

1.3.3 | RICH MEMBERS OF THE GENERAL PUBLIC IN THE AGE AROUND 35 - 60 YEARS

This group contains mostly men in the age around 35 - 60 years. The car is suitable for home-work traffic, however, it will be used mostly for pleasure. The focus of this group is mostly to have an extra, special and exclusive car. The top of the rich people will have more expensive second cars, for them this car would be an extra toy or gadget. This target group has jobs in big companies like Ernst & Young and might be a member of the Quote 500. They are the early adopters, and dislike mainstream products. These people want to be seen as strong and healthy people that can bear little discomfort of the car. People with 'new money' can be part of this target group. Members of this group might buy this car for their kids as a present. For this target group the car can be an impulse purchase.

CHARACTERISTICS:
- The car is special and meant for show of and pleasure. It is a second car, a gadget.
- The car is fancy and sportive.
- Quality is important, but the car can be a little uncomfortable.

Collage Rich members of the general public in the age around 35-60

1.3.4 | CAR LOVERS

These are mostly rich people that are focused on having a special edition car. This group mostly have good knowledge of cars. They dislike mainstream and love classic and vintage. They love cars of all periods that became iconic and most of the time they have more than one of these cars in their possession. This group is very conscious of their goods and the appearance of it. People with 'old money' can be part of this target group. This group is a little more well considered than the previous target group and takes its time to make a decision.

CHARACTERISTICS:
- The car is an object to love and learn and talk about
- These people know a lot about other cars and all the characteristics of this car and other ones
- The car must be special
- The car does not have to very handy in use, pleasure is reached by owning and driving
- This group likes classic and vintage

Collage Car lovers

1.3.5 | COMPANIES AND SELF-EMPLOYED

Companies that want a special electric car for marketing use or short distances. An electric car can have fiscal benefits, for example tax deduction and deductions because of environmental reasons or subsidies can be reached. Therefore the costs for the car are significantly reduced. The actual design of the car is less important than the fact that the concept is striking, exclusive and innovative.

CHARACTERISTICS:
- The car must look special and be an eye-catcher
- The car can be used as a marketing instrument
- The electric component is important, this is new and shows environmental awareness

Collage Companies and self-employed

1.3.6 | MAIN TARGET GROUP

Based on earlier investigations, current customers, meetings with R. Holleman, N. van Dril and advice of marketing specialists in the car branch, the second target group is seen as the most important: rich people focussed on an having an exclusive car. Sell a car that is exclusive. In some way this car is a car that nobody wants, it cannot withstand rain in a perfect manner, it is small and it is expensive. However, somehow these arguments may not count at the moment of purchase. Rich people are willing to compensate on price when it comes to exclusivity because it gives them an image of being special. Marketing specialist F. Colthoff, who has much experience in the automotive branch, stated the price can be three times higher to give the car an even more exclusive character. This would result in a price of about €60.000 excl. VAT. That this target group is the main group for Carice does not mean that the other target groups are not interesting. Carice is selling only a few cars at the moment and buyers fall into all these four categories. The future will tell which group will be the most profitable. At this moment these rich people are seen as the most profitable target group, but it is tried to make a design that fits all the four groups. Important for all these target groups is that they have money and like to have a car that is special and no one else has. In *chapter 2.5 | Target group focussed design* these targets groups will be discussed into further detail. ■

1.4 | CAR LAUNCH & COMPETITION

HOW CAN THE MK1 BE LAUNCHED AND WHAT IS COMPETITION FOR CARICE?

1.4.1 | CAR LAUNCH OPTIONS

At the start of this assignment the car was not officially launched into the market yet. Many options to this were investigated by Carice. For example the option to put the product as a kit car on the market. However, looking at all the skills involved with the assembling process this is not seen as a good option for now. Customizers with trouble in the assembling process can cause harm to the image of Carice, because people will associate poorly assembled cars with Carice. Producing a kit car can be an option in the future, as well as building a hydrogen car.
Other options are selling the car on rental base. However, this gives a small income at short term when money for production is needed and is more time consuming than selling a car at once. Carice chose for a simple but solid solution which generates a big income at once. The company is not open for other selling options at this time, but it the future these might be good strategies. Carice proceeds their selling possibilities with cautions because they want to establish an exclusive and sportive image. This strategy will be pursued with the new car model, the MK2.

Carice chose to launch their car on a big classic car event in Apeldoorn in 2014. Their cooperation with Vredestein helped to give them publicity and broaden their network. Since the car is launched the papers and internet took out the news very fast and Carice can now be seen on car websites all over the world. The car can be used for marketing campaigns, especially in this early phase. This will generate publicity which increases sales.

1.4.2 | SALES AND PRICING

At this moment a sale of about 5 to 15 models per year is aspired. In recent years the prototypes were sold and the model has been developed further. In this development phase the costs were very high due to investments. Costs will decrease by increasing production amounts, because materials can be bought in larger quantities or costs for a mould can be spread. So the preproduction models are mostly meant as an investment. Suppliers will decrease their prices when they want to invest in Carice too. The following table shows a rough calculation of the car models based on an edition of 10 cars and including investment costs, but it does not include costs for assembling and any profit. This calculation gives a rough idea of the costs made in this early stage.

COST CALCULATION PREPRODUCTION MODEL (EDITION OF 10 CARS)			
PART	COST CALCULATION	COSTS	
Body parts (hand-lay-up method)	Includes mold investments	€ 10.000,00	
Accessories outside		€ 1.300,00	
Accessories interior		€ 1.300,00	
Chassis		€ 9.500,00	
Assembling	No man hours included	€ 0,00	Bill of materials
Extra costs		€ 12.000,00	€ 31.100,00
Margin	No profit included	€ 0,00	
Total excl. VAT		**€ 34.100,00**	**(Excl. range extender)**
Total incl. VAT		**€ 41.261,00**	

Table with cost calculations preproduction model

In this early phase the car models were sold without profit. Later on in this survey a more detailed version of the cost estimation will be given. Carice first wants to know the price they can sell their car for. Then a rough estimation of the total costs of manufacturing (within a higher production) will be made and finally the profit can be determined.

Suijkerbuijk investigated price strategies for Carice by interviewing potential buyers and marketing experts. Carice can place the car on the market using three strategies (Suijkerbuijk, 2013). First of all, with the *penetration strategy*, the car costs about €17.000 exclusive VAT. Sales will be bigger, however there is a low profit. Secondly the *fair pricing strategy*, the car cost about €22.000 exclusive VAT. Sales will decrease a little, however most people will see this price as quite fair for an exclusive

car. Within this strategy it is easy for Carice to sell cars a little cheaper or more expensive, depending the model. The third option is the *skimming strategy*, the car will cost about €30.000 exclusive VAT. Only the real innovators or rich people will be buyers. The profit is high, however the sales are small. Based on the target groups, production costs and predicted sales the fair pricing strategy fits best. Carice will launch the car for €22.000 exclusive VAT. The company has to sell at least seven cars in the first year and around twenty in the second year to be profitable. This makes it hard to estimate how big the target group is and how many sales can be made. It is hard to compare this car with other cars, since there are only a few brands that have a comparable product.

1.4.3 | COMPETITORS

There is much competition in the area of driving electric, having a low price and being exclusive. However, no competitor has combined all these qualities in the same way as Carice. Carice's selling points are its exclusivity, electric power and the fact that the cars are made by handcraft which are brought together for only €22.000. Competitors offer options like rooftops, luggage space or a higher action radius. Prices of these extended versions are higher of course.
A Dutch car brand is Burton that makes cars for a price between €11.000 and €25.000 for a complete version. The company was able to sell over 400 cars a year in 2005. This car is different because it will mostly be bought as a kit car. The appearance of the car is classic and the target group can be compared to those of Carice and therefore this car looks most like Carice. Many other car producers offer electric cars, however these can be seen as more mainstream designs. ■

	CARICE	BURTON ELECTRIC	TESLA ROADSTER	RENAULT TWIZY
Range / speed	140 km / 120km/h	140 / 120 km/h	390 / 200 km/h	100 km / 45 km/h
Appearance / exclusivity	High	High	High	Medium
Price	€22,000	€38,000	€99,000	€7000
Practical use / rooftop	Low	Low	High	Medium
Market / target group	Exclusivity	Exclusivity	Exclusivity / praktical	Practical



1.5 | THE FUTURE OF THE CAR

HOW SHOULD THE COMPANY DEVELOP IN THE FUTURE?

1.5.1 | A NEW CAR MODEL

According to Carice this electric cabriolet will be an addition in the automotive world of today. Advantages are the electric power and low weight of only 300 kg. This results in a relatively low environmental impact compared to other cars. The fact that the car is handmade and quite small gives the car a special and exclusive appearance. However, this makes the car also less safe. The MK1 has no rooftop which is a big disadvantage in case of bad weather.
Carice wants to give her current car a design upgrade and develop a new body. She already has several requirements for the next car model. Carice is searching for an exclusive, sportive and sturdy design that fits the target group. The company has developed a lightweight and strong steel plated chassis. This chassis will also be used in the next car, so the body must fit these measurements. The current body is made of polyester and produced using the hand lay-up method, which is quite time consuming. A requirement is to design a body that can be made by an optimal production process. The type of the production process will have influence on which shapes are possible.
Assembling the car is also taking a lot of time, which should be reduced in a new model. The MK1 consists of a nose, back, and middle part and also four door parts. These parts must all be assembled together and carefully aligned with each other. This aligning is very time-consuming. In order to solve this problem there are two possible solutions. The body can be made out of one part as far as possible, which results in less body parts that should be aligned. The door can be taken out of the car and replaced by a low doorstep. Another solution would be to create a framework in which the body parts can be easily connected. Optimizing the assembling process will reduce costs enormously.
The next car model should have an optional rooftop that protects from rain. This can be an internal or external solution, as long as it has good usability properties, looks good and has a suitable price. Passengers can sit mostly dry, however a little bit of damp should be tolerated, since this is an exclusive sport car. At this moment Carice sells a few cars a year. The company wants to slowly expand the production and finally sell in large amounts. Therefore the production method has to change and become less time consuming and expensive. A new car model can help expanding the company in the future.

1.5.2 | REASONS FOR A NEW DESIGN

Carice wants to innovate and produce a new car model. The design style can be slightly different, but the chassis will be the same.

ARGUMENTS FOR A NEW MODEL
- Today's body exists of seven parts that need to be assembled and aligned. This is very time-consuming and expensive. A new model can be made out of less and bigger parts or assembled in another way. The door can be replaced with a low doorstep, so a part less needs to be aligned. The seams can also be placed in a more effective manner.
- Carice wants to focus on a wider target group with a new design of the body. At this moment the car is sportive and classic. The style can become more modern and sturdy to fit the present generation and make the car more exclusive.
- Carice wants to develop and show a dynamic and innovative character. The company wants to show it can do more than this one car and widen her assortment.
- Carice should establish a solid brand image by offering a well fitting assortment.

ARGUMENTS AGAINST A NEW MODEL
- Developments cost a lot
- Carice does not sell large amounts of cars yet and should first focus on selling more of the MK1.

Photo Carice

1.5.3 | BACKGROUND INFORMATION ABOUT ELECTRIC DRIVING DEVELOPMENTS

On an international level many electric cars are developed. Car developers are experimenting with creating a hybrid or 100% electric car. Since foreign countries invest much money in these developments, The Netherlands want to participate and innovate as well. A survey group came up with the next vision on the future (D-insert: Dutch innovation centre for electric road transport, 2011):

"ELEKTRISCH RIJDEN IN 2020
In 2020 moet de grootschalige invoering van elektrisch rijden leiden tot een aanzienlijke verbetering van de leefkwaliteit in Nederland, in het bijzonder in het binnenstedelijke klimaat. Het gaat hier om verbetering van de luchtkwaliteit (reductie van fijnstof en NOx) en een reductie van de geluidsoverlast van voertuigen, vooral in de binnensteden. Daarnaast draagt de grootschalige invoering van elektrisch rijden bij aan de reductie van de (lokale) uitstoot van CO2. In 2020 heeft Nederland daarmee een van de efficiëntste, schoonste en veiligste vervoerssystemen in Europa. Het grootschalige gebruik van elektrische voertuigen in combinatie met de beschikbaarheid van intelligente elektriciteitsnetten biedt Nederland na 2020 een buffercapaciteit in de energie-infrastructuur en daarmee de mogelijkheid tot verdere verduurzaming van de energievoorziening. De fluctuerende productie van zonne- en windenergie kan met deze buffercapaciteit opgevangen worden en laat daarmee opschaling van deze productie toe. Dit maakt het mogelijk om de afhankelijkheid van energielevering uit instabiele buitenlanden verder te verminderen. De invoering van elektrisch rijden in Nederland heeft er ook toe geleid dat het Nederlandse bedrijfsleven economische groei heeft gerealiseerd door innovatieve product/dienst combinaties te ontwikkelen en deze succesvol op de markt te zetten."

The government stimulates the development of electric cars by establishing a Formula E-team that needs to stimulate and catalyze the electric market. Taxes for electric cars are very favourable to stimulate companies to buy electric vehicles. The right electric infrastructure is crucial in these developments and has a big effect on Carice. Carice fits in this picture of innovating electric cars and can give the market a positive image and stimulation. On the other hand, the developments of other parties on electric driving will help Carice selling their cars. A good electric infrastructure takes away the range anxiety, the anxiety to be out of energy. In short Carice wants to offer a sturdy, exclusive and environmental friendly alternative compared to other cars. ■

Electric driving (Photo: www.lichtbrenger-webshop.nl)

PART 2 | DESIGN AND EMOTION ANALYSIS

WHAT ARE THE EFFECTS OF CERTAIN SHAPES ON PERCEPTIONS AND HOW CAN THEY BE USED IN DESIGNING A CAR BODY?

In the previous part Carice and the MK1 was analysed. This part focuses on emotions in car design. Shapes, proportions and many other product characteristics influence the way a person perceives something. This part helps to understand how Carice can use these design theories in their products and make a fitting design that is focussed on the target groups. It helps to guide the design process of the MK2 and let this design fit with the findings in the first part.

2.1 | IMPORTANCE OF EMOTION IN DESIGN

Why is it important to investigate what effect shapes have on humans?

2.1.1 | INTRODUCTION

This chapter will go further into detail about emotion in car design. In what way does the design play a role and what effect does it have on the consumers' perception? The first focus is on brand awareness and product aesthetics in a more general way. Then the effects of design in the automotive branch are discussed on a more detailed level. This explains the connection between a car's design and its target group. Every topic in this chapter is applied to the case of Carice. How can this car brand use all these theories in their marketing and design?

2.1.2 | BRAND AWARENESS

The following knowledge is based on information based on a paper about the effects of brand awareness on consumer decision making (Macdonald & Sharp, 2000). Brand awareness is a very important term for a company. It reveals the way a consumer perceives a brand and its products. In order to become a strong, stable and focussed company the brand and the products should fit the target group. Consumers choose a certain product because of the design characteristics, but also because they have prior knowledge of the brand. When dealing with a product in an unknown category the consumer will be inclined to choose a product with a familiar brand name and brand image. A consumer stays quite loyal to a product and is sometimes even willing to choose for familiarity even when quality is less compared to the competitor. This brand loyalty has decreased over the years because of market expanding. The market is filled with many competitors, which makes differences between products smaller. The growing amount of producers makes it easy for a consumer to find an alternative. Because of the high competition most companies really try to distinguish themselves by their visual design characteristics. These design elements should always fit and stimulate the brand image. Graphic design elements also support the brand awareness. A brand is more recognisable when it has a good logo and a corporate identity that is distinguishing, consequent and uniform as well. Design changes will always influence the brand awareness and therefore should be made in a way that the brand stands out in a good way and at the same time remains recognisable .

- Carice is a new brand and therefore consumers do not have prior knowledge of the car. Consumers will not choose this car because of the brand awareness they already have, but because of the design and product characteristics when they first see the car. This means that Carice have to put much effort in being distinctive in order to stand out amongst the competition. All marketing elements have to communicate the same message that is focussed on a clear target group. At the same time the MK1 and the MK2 should not differ too much. All the designs should together strengthen the Carice brand. These brand characteristics are defined in the brand identity prism in Chapter 1.2 | Carice: The car.

Apple is a typical example of a brand with many different products, but at the same time it is always very recognisable by its simple and rounded shapes.

2.1.3 | IMPORTANCE OF PRODUCT AESTHETICS

The visual design characteristics are extremely important for a product. An investigation made by Audi shows that the choice for a certain car is affected by the design for 60% (Kreuzbauer & Malter, 2005). According to Brunel and Kumar (Brunel, 2006) the perceptions of the consumers are influenced by the product aesthetics in the following dimensions: distinction, perception and connection.

DISTINCTION

First of all, the design can help a brand to stand out and distinguish itself from competitors. A brand also has to be very careful with their whole product range. Products that are visually very much alike may lead to a misinterpretation of the product and the brand (Keaveney, Herrmann, Befurt, & Landwehr, 2012). It leaves the consumers with a insecure feeling about what products is best. Products within a brand have to be dissimilar as well, so the added value of different products are communicated clear. So a product has to be dissimilar enough to the competitor and the rest of the product range, but at the same time all the products of a certain brand have to be a unity. BMW uses the kidney shaped grille as an iconic element in their cars. But creating iconic elements can be quite difficult, because they are mostly not reduced to a single element, but also build up by line geometry, geometric principles and relationships between bodies and lines (Kreuzbauer & Malter, 2005).

The BMW grille is an excellent example of a design element that makes the brand recognisable while the products still can be different.

- The new car model for Carice can be different from the MK1, however in a way these models have to be recognisable as belonging to the same brand. There are some elements that can be made iconic for Carice. For example the race lines on top of the car (that actually covers a seam line), the proportions of the car (the new body will be built on top of the same chassis), round characteristics (front and back lines) and the overall simplicity of the car design. Carice could also use a certain colour arrangement in their cars (always three colours for the body, race lines, interior and seats). Some accessories in the car can be the same in all the models (mirrors / lights / tires / dashboard / buttons).

PERCEPTION

Secondly the visual design influences the perception, comprehension and evaluation of a product. This means that a product is valued by the frame of reference of the consumer. This frame of reference or in other words scheme of congruence contains the cognitive knowledge of the consumer. Experiences in the past with other products and values composed by other designs affect the way someone perceives a new product. These perceptions are mostly influenced by the cultural background (Crilly, Moultrie, & Clarkson, 2004), but also by demographic characteristics like age, class or gender (Demirbilek & Sener, 2003). The scheme of congruence is very important for car producers. A car producer has knowledge about her target groups and therefore knows which things are important for them, for example high status, luxury or much money. These characteristics fits the consumers scheme of a high class car. A producer will always try to make the car look like it has the same values as the consumer. For example, a car for high class people has to look luxurious, qualitative and reliable. It is best if the consumer feels a higher level of congruence between the car and the conceptual scheme of the type of the car.

Products that are saved in the frame of reference as very violent and dangerous or very friendly.

- The concept of the Carice car is new for the consumer: an electric cabriolet with small proportions. However, the style of the car refers to cars made years ago, like the classic Porsche 356, Midget and Healey. It has a classic wink that consumers will recognise. Consumers will put this car in their scheme of reference around classic, electric, handmade cars and cabriolets. Cars in these categories usually have less comfort, are smaller and have a more distinctive design. However, the car can be put into another reference scheme if characteristics of luxury, comfort and safety are added. Carice has to be very careful with creating such an image, because consumers will expect more and they should not become disappointed. In the end the car is simple, handmade and not that luxurious, although quite expensive. Characteristics of modernity and very high quality will let people compare this car to other modern cars. It is better to focus on the exclusive, innovative and sportive character of the car. Less comfort and small proportions refers to these keywords and help to place the car in the right scheme of reference. It might be a hard job for Carice to connect the classic and innovative characteristics, since they are placed in quite different schemes of reference.

CONNECTION

Third, the emotional connection between a product and its owner is affected by the aesthetics of a design. This connection is strengthened when the design of the product corresponds to the personality characteristics and identity of the consumer (Govers, Pascalle, & Mugge, 2004). When consumers recognise characteristics of themselves in a product they will evaluate it as more familiar and they are more willing to bind to the product and form some sort of a relationship. People are for example much more careful when it comes their own car than someone else's car.

Diesel makes designs of perfume bottle that refer to a strong man's hand in order to strengthen the relationship of the owner and his product.

- Creating an emotional connection is important for Carice. This car is part of the luxury segment and therefore it will be bought as an extra, maybe even an impulse purchase. The following paragraphs will explain more in detail how emotions can be included in the car design. An emotional connection is also stimulated by personal communication of the car seller, so a connection with the brand is made. ■

2.2 | DESIGN MEANING

What different meanings of design can be described?

2.2.1 | AFFECTIVE MEANING

The following paragraphs will explain how affective meaning can be translated into product design.
Affection is a term used to describe emotions, feelings and moods (Crilly et al., 2004). Products evoke emotions by a consumer and these reactions or perceptions are described as affective meanings. As mentioned before these perceptions are highly affected by culture, but also by demographic elements. However, a survey showed that certain values overcome the cultural reference frame (Sonja Windhager et al., 2012). There are different methods to measure the design perceptions and translate them into words; they will be explained shortly.

For example, one can order affective meaning by linking semantic differentials to the following dimensions: evaluation, potency and activity (Osgood, May, & Miron, 1975). The semantic differentials are made of bipolar sets of adjectives. They correspond to the dimensions bad-good, weak-strong or passive-active. All the design values will be categorised and valued in these dimensions. Rating a product or product range with many semantic differentials will finally give a good value of the evaluation, potency and activity of a product.

Another way to 'measure' design characteristics is by looking at the lines, points and shapes itself. These investigations are more focussed on why people feel certain emotions by looking at specific design elements. Not only static characteristics can be investigated, but also movements. In most situations a comparison between shapes and humans can be made, it seems that people value products in a way that they value people.

Van Rompay (Rompay, 2008) showed four different categories for affective meanings that designers can use to create affective products: symbolic, sensory, anthropomorphic and movement. These four categories will be explained in the following paragraphs.

2.2.2 | AFFECTIVE MEANING | SYMBOLIC MEANING

Symbolic meaning is added when a product fits in a certain scheme or frame of reference. These references can contain visual and spatial characteristics. These symbolic meanings can be indicated by words, for example dominance or safety. The term *enclosure* is a visual and spatial characteristic that comes along with safety. A coffee maker that leans forward can refer to this term enclosure and therefore gives a feeling of safety.
Demirbileks survey (Demirbilek & Sener, 2003) showed that consumers perceive sharp, pointing, downwards V-shaped elements and extreme changes in line directions as dangerous. Rounded and fluent curved shapes were valued as nice and more convenient. Designers can translate these characteristics directly into a product when they know what it should evoke.

People will associated this Lamborghini Sexto with danger and aggression because of the extreme sharp downward lines.

- The following items fit the Carice brand image: balance between friendly and serious, sportive, innovative and open. The many rounded lines make the car very friendly, the look of the front will mostly determine the final expression. Sportsmanship is created by the low body, horizontal lines and race lines. Openness is reached by the fact that it is a cabriolet and elements in the car are not enclosed.

2.2.3 | AFFECTIVE MEANING | SENSORY MEANING

Materials have their own colours, reflections, textures, weight, temperature and sounds. All these sensory meanings evoke certain emotions by people. The sound of plastic cutlery on plastic plates has a cheap connotation. The cheap materials, low weight and simple graphics enhance these feelings. Sensory meaning in cars is very important because it attributes to the total impression and feeling of the product. Producers give for example much attention to the balance between hardness and suspension in a chair. The softer the chair the more the driver will feel pulled back when starting up, this enhances the feeling of driving fast. Another example is the design of a door handle. The sound and force used to close a car door has

influence on whether the user perceives the car as safe or luxurious. Colours are very important for a design, since colour and shape are the first attributes someone perceives. All colours have their own meaning, red for example is more aggressive, whereas blue is neutral and calm. Colours can be divided into two main groups: warm (exciting) and cool (calming). Warm colours are red, pink, yellow, gold and orange. Cool colours are blue, green, turquoise and silver. Other colours are neutral (unifying), like brown, beige, gray, black and white. The theory of colours is very extensive, so only some global meanings will be stated here.

COLOURS

Colour meanings are culturally bound, however, the following characteristics are applicable for most people (ColorMatters, 2014a), (Scott-Kemmis, 2014b).

Red: extreme, passion, love, seduction, violence, danger, anger and adventure. This colour is very striking.

Orange: vibrant, hot, healthy, fruity, engaging, adventure, warmth and energy. Orange is a very positive colour, although it lacks it bit seriousness. In the 70's it was very groovy and it looked cheap.

Yellow: luminous, happiness, optimism, creativity, spring, but also egoism, poison and illness. Depending on the context this colour is either very optimistic and bright or pointing at a poisoned situation.

Pink: girly, active, extravert. Pink is striking colour that will always be strongly associated with girls.

Purple: fantasy, royalty, creativity, mystery, magic and nobility.

Blue: natural, cold, wet, trust, dignity, intelligence, authority, spiritual, sportive and loyal. Almost everyone likes blue as it is very neutral and trustworthy.

Green: nature, accessible, peaceful, calm and health. Green is mostly perceived as very calm and neutral.

Brown: nature, serious, boring, old, stability, trustworthy and calm. Brown is quite neutral and most of the time it makes designs more serious.

Black: serious, dark, secretive and stylish.

White: clean, sportive, light weighted, pure and innocence.

Jaguar E-type

Bright colours are more youthful and striking and dark colours more serious and stylish. The picture shows an orange car within a brown environment. This gives it a vintage and classic look. The total looks quite neutral, although the car itself is very warm and striking.

- The next Carice car model will have a range extender. This motor will cause a sound that will enhance the feeling of driving fast. The material of the car however is plastic, that can give a cheap, weak but lightweight impression. A strong colour combined with race lines gives a sportive perception. In chapter 4.11 some examples of a new car model with different colour combinations are given. Colours can mach a target group by matching other items they use, like furniture or cloths. They can also match values or a certain style of the Carice customers, for example luxury, youthfulness, vintage and sportsmanship. It depends on the customer and the purpose of use what colour is most appropriate.

2.2.4 | AFFECTIVE MEANING | ANTHROPOMORPHIC MEANING

WHAT IS ANTHROPOMORPHISM AND ZOOMORPHISM?

Another word for anthropomorphism is humanoid. It denotes the way humans are able to recognise human characteristics in objects or animals (Aggarwal & McGill, 2007). A designer can make an object more anthropomorphic by adding shapes that refer to the human body and especially the human face. This will give the product character and personality which are evaluated as human characters. Consumers will link human emotions to the design and therefore the designers are able to make a design that fits the aimed emotion of the target group. Products that are humanized seems to be stronger candidates for a long term relationship with the consumer (Aggarwal & McGill, 2007). After an period of intense use of a product a human is more likely to see and treat a product as a human. Research showed that people often apply social norms of reciprocity in the interactions with their computers (Moon, 2000).

Designers usually make designs partly anthropomorphic, which means that the product has humanoid characteristics but is not seen as human. Attribution of the human characteristics is mostly unconscious. Instead of humanoid the design can also be zoomorphistic, in that case characteristics of animals are used to enhance emotions. Zoomorphism can be very close to anthropomorphism but is more on the safe site. This is because no social norms come along that can have negative associations.

These domestic product strongly refer to living creatures.

ANTHROPOMORPHISM IN CARS

Attributing characteristics of living creatures to cars is very common and seen in examples like the 'Snoek' or 'Duck'. Sometimes an association is given by only using a certain name to the product, but not specifically its visual characteristics. A Dodge Viper for example does not really look like a snake, although it appears quite poisonous. Anthropomorphism in cars is mostly seen in the front of the car, that looks like a human or animal face. Surveys showed that experts in the area of cars used the same neurological area's in the brain when recognising cars as when they used to recognise a face (Gauthier, Skudlarski, Gore, & Anderson, 2000).

Examples of cars that refer to behaviour of animals or have faces referring to living creatures.

Cars are memorised componential (Barsalou, 1999), which means that a car is largely recognised by the sum of all its part characteristics. Important elements in the front of the car are the air intake (mouth), grille (nose), head lights (eyes) and mirrors (ears). The elements itself link to specific emotions, however, the proportions and positions are also of high influence. All these transitions are perceived as if it were elements in the face of a living creature. In Western countries the emphasis of facial emotions is on the shape of the mouth, so this makes the air intakes and the grille a very important design element (Keaveney et al., 2012). Culture influences the way a car face is perceived, however some reviews were interculturally consistent. An intercultural survey about car faces showed that people have similar ideas about proportions when it comes to maturity, gender and dominance (Sonja Windhager et al., 2012).

CAR FACES AND DRIVER EMOTIONS

Car faces and other anthropomorphic elements can be linked to the driver emotions. Windhager showed that the characteristics of the drivers and their cars have great similarities (S. Windhager et al., 2008). People will recognise anthropomorphic elements more quickly when the emotions of the object are similar to their own emotions or emotions they are primed with (Aggarwal & McGill, 2007). People also become more attached to products when the personality is similar to their own (Govers et al., 2004). A product shows the world what kind of person the owner is and therefore it gains more symbolic meaning to the consumer. The design appearance of the car mostly fits the character of its driver. It can also fit to things that the driver wants to be associated with, translated into body language or characteristics of humans or animals. For example the sprint of a panther can be translated into design lines in the sides of the body and the line of the back of the car can refer to the back of this black animal. The driver may like this because he somehow wants to associate himself with characteristics like speed, strength and confidence. This attachment to the product can happen unconsciously.

Expression of humans of animals can be translated into car design.

- The MK1ice car is seen as quite cute. It has for example big headlights, which associates with the proportions in a baby face. Some people like this very friendly appearance, but others are looking for a more serious and mature version. A more comprehensive analysis of the Carice car from an anthropomorphic point is given in the chapter 2.4 Analysis of the MK1.

2.2.5 | AFFECTIVE MEANING | MOVEMENT MEANING

Meanings by movements and actions are based on how a product is acting. Many products evoke some sort of natural movement or action only by looking at it. For example the feeling that the door opens to the inside or outside of a building

is guided by the design of the door handle. So will the height of a car influences the way people perceive a car as reliable or exiting. The design refers to a certain movement, that in turn is linked to a certain emotion. Van Rompay showed that fast and strong movements are linked to anger but sorrow or happiness goes along with calm and weak movements (Rompay, 2008).

- The door of the next Carice car model will be probably be different from the MK1. It is important to create a design that makes some sort of natural movement of how to enter the car. When the car has a rooftop it should be clear to know how to open it and how to enter the car.

2.2.6 | DESIGN FOR A TARGET GROUP

The previous findings show that the aesthetics of the car are very important because they provoke emotions that a consumer wants to be associated with. Good knowledge of the target group and the brand gives insight in which emotions should be aroused. A clear picture of the target group is indispensable for establishing a relation between the consumers and their products. Research showed that incorporating the image of the target consumer will provide the designer with essential embodied constraints during the design process (Kreuzbauer & Malter, 2005). Without an image of the target consumer used during the design process the final designs were evaluated as more original, however less useful and less appealing to the target group.

By looking at these wing doors one knows how it will behave.

The following paragraphs show more specific information about which shapes evoke which emotions. This information is given point by point as much as possible to give a good summary that can be used for designing or evaluating a new car design. ■

2.3 | ANTHROPOMORPHISM

WHAT ARE THE RULES OF ANTHROPOMORPHISM?

2.3.1 | ANTHROPOMORPHIC DESIGN GUIDE LINES

The previous chapter mentioned the affective meaning anthropomorphism. Since it has big influence on the perception of a car this chapter will give some more detailed information about it.
The following rules are explained in the Next nature book (Sterling & Kevin, 2012) and function as guide lines for anthropomorphic design. Because the rules are quite clear and simple they will not be further explained.

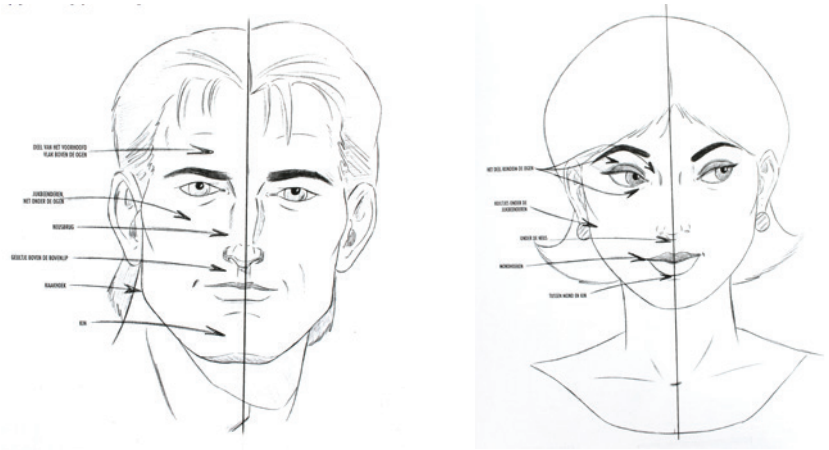
1: Any Association that Can be Made, Will be Made
2: Different People Anthropomorphize Differently
3: Keep it ASS: Abstract, Simple and Subtle
4: Complex Products Tend to Be Anthropomorphized
5: Consider Zoomorphism as an Alternative
6: Meet People's Expectations
7: Respect Social Standards
8: Use Human Ethics
9: Be Aware of the Ecosystem You're Invading
10: Enhance Human Experience, Don't Replace It
11: Don't Use Anthropomorphism if it Does Not Serve Any Purpose

2.3.2 | PROPORTIONS, POSITIONS AND SHAPES IN HUMAN FACES

The following comparisons show what effect differences in proportions and shapes have on whether someone perceives a person as male, female, or childish. This theory can be easily translated into transportation design.

PROPORTIONS MAN VERSUS WOMAN

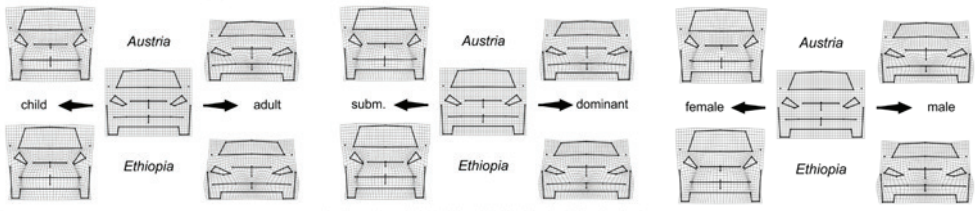
The picture shows what differences a feminine face has compared to a male face. The face of women are more rounded and smaller below. Eyes and lips of women are bigger and show similarity to proportions in baby faces. The chin, cheekbones, eyebrows and lips of men are wider and have more angular shapes.



Example of the differences between a male and a female face.

Windhager (Sonja Windhager et al., 2012) showed in her intercultural investigation the following conclusions about masculine and feminine car design:

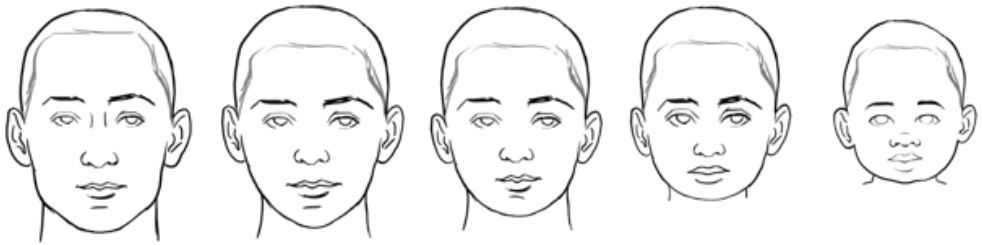
- Vertical stretching in cars have low attributed maturity and dominance and high femininity
- A relatively larger windshield has low attributed maturity and dominance and high femininity
- Relatively smaller windshield led to associations of adultness, maleness and dominance
- The grille becomes relatively wider and taller with increasing attributed age, maleness and dominance.
- The additional air-intake became wider and thinner with increasing attributed maturity, masculinity and dominance.
- The headlights were extended laterally and were more slit-like in the estimated geometry of a vehicle with an adult, male, dominant appearance.



Matrix of car faces.

PROPORTIONS OLD VERSUS YOUNG

The picture shows that proportions are the most important characteristic for a young versus old face. All elements in a baby face are big and they are positioned in the middle of the face close to each other. When someone grows older the lines in a face will change. Young faces have rounded and spherical faces. Older faces are bigger and more angular, the space between the elements is bigger.



Example of a male face over time. Shapes, proportions and positions change.

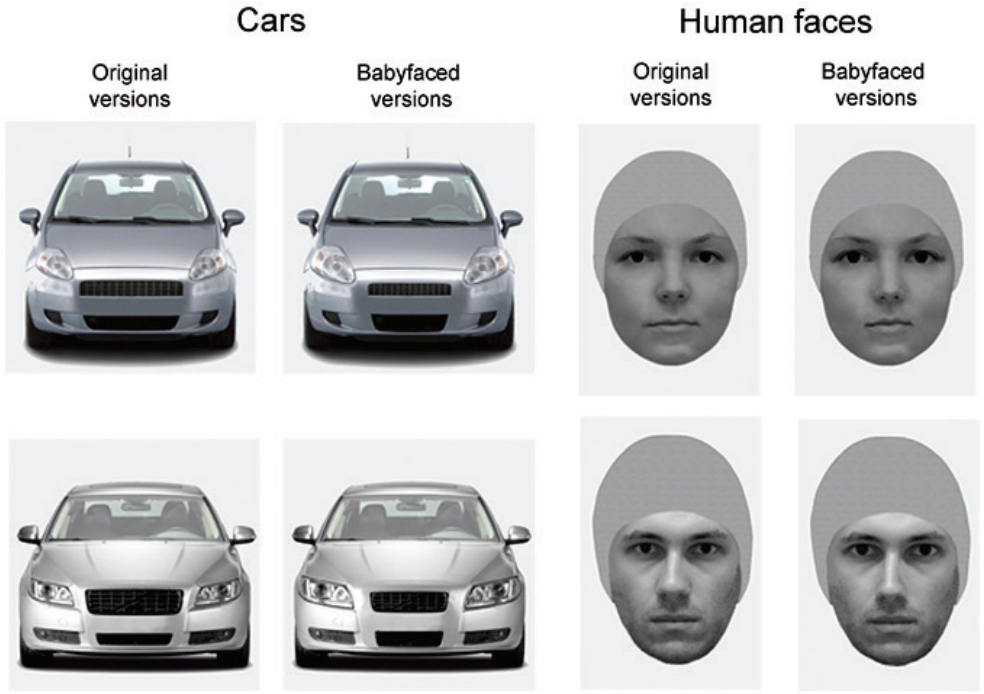
Windhager (Sonja Windhager et al., 2012) showed in her intercultural investigation the following conclusions about mature and childlike car design:

- The extreme upper and lower edges of the headlights were close to the middle of the car in a vehicle that was likely to be rated as childlike, feminine and submissive.
- Other surveys showed that a large forehead compared to a short lower face and large eyes leads to increased babyishness attributions and perceived need for protective aid in humans.

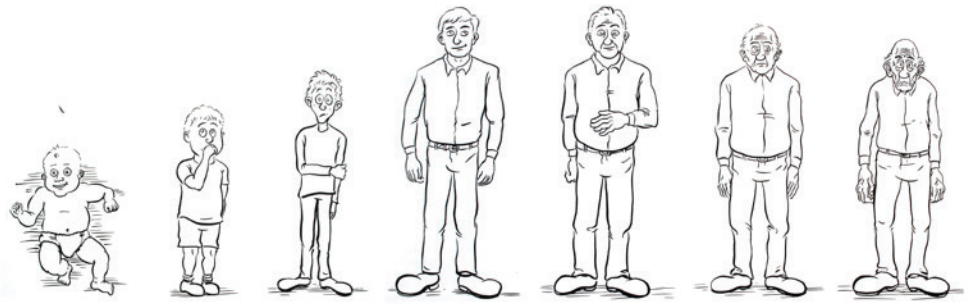
Research also showed that car design based on baby faces were perceived as cuter that original stimuli and it elicited larger activations of the smiling muscles (Miesler, Leder, & Herrmann, 2011). This however does not imply anything about whether someone judge the car as attractive.

ATTITUDE OF YOUNG VERSUS OLD

The attitude of a middle age man is confident which is seen by his straight, wide and angular posture. The look is right ahead and because of the shape of the eyebrows and mouth confident.



Car designs translated into designs with a more babyish appearance.

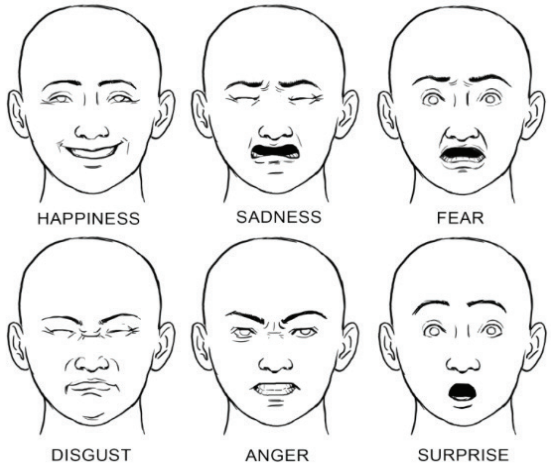


Example of a male body over time.

FACIAL EMOTIONS

The picture is very simple and therefore gives a good representation of how the shape of the eyes, eyebrows and mouth cause all these different emotions.

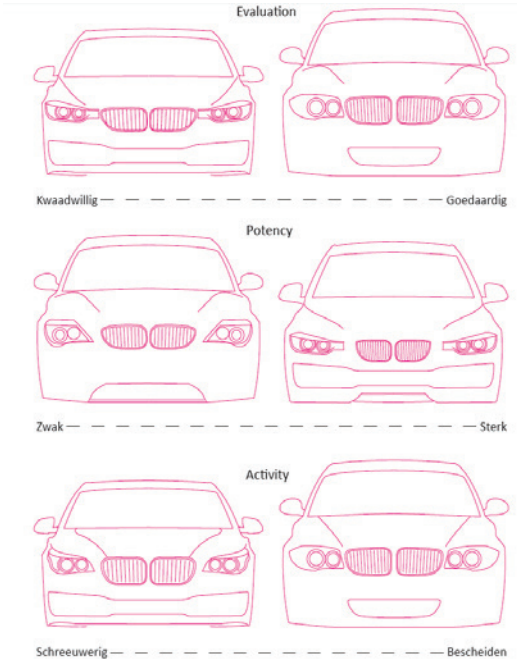
The following graph shows contrary emotions, the simple reproduction of emotions showed before can be easily recognised. The shape of the headlights, grill and bonnet lines give the car a face with an emotion.



Simple reproduction of emotions.

Zaw (Zaw, 2013) has investigated the influence of BMW design on the perception, taking into account three dimensions: evaluation, potency and activity. These are some conclusions:

- Malevolent, strong and blatant designs look busy compared to good, weak and modest designs. This is because the elements are positioned closer to each other.
- The designs of grilles in cars did not have much influence on how the emotion of the car was rated. This is probably because the nose in a face has not much influence on the expression. However, it can strengthen emotions evoked by other parts of the car. The design of the grille is an important part in creating brand awareness. A unique grille design makes the brand of the car recognisable.
- Car faces are seen componential. This means that the sum of all elements does not necessarily have to carry out the same emotion as the overall expression of the car. However, it does guide the design process in a certain direction.
- The air intakes have big influence on the emotion of the car and is the clearly



Comparison BMW cars: Extreme reproduction of a compilation of elements according to the categories.

assessed part of the car. If it is rated as malevolent, most people will see it as malevolent.
- For the dimension evaluation (good / malevolent), the design of the head lights and air intakes are most important.
- For the dimension potency (weak / strong), the design of the bonnet and the head lights are most important.

In Appendix B.1 some detailed pictures of BMW car elements and the fitting perceptions are shown.

2.3.3 | CONCLUSION

The previous paragraphs showed how lines, shapes and proportions have effect on perceptions. In the following chapters these theories will be applied to the Carice model and target group. What perceptions are needed? This analysis of design and perception will help to guide the design process and use shapes and lines that will evoke a perception that fits the target group. In the design part of this survey will be looked back at these findings. ■

2.4 | ANALYSIS OF THE MK1

What perceptions does the MK1 evoke?

2.4.1 | THE MK1

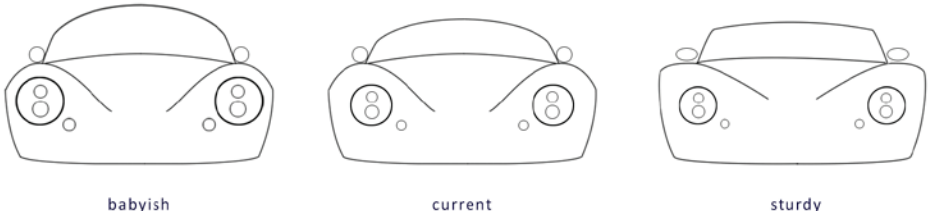
Bugattig dashboard.

Dashboard MK1.

2.4.2 | DESIGN AND EMOTIONS OF THE FRONT

The previous chapters showed the effect of certain lines and proportions on how people perceive products. With this theories the MK1 is analysed. How do people perceive this MK1 and why? The picture displays an abstracted version of the MK1. Also a babyish and a sturdy version are drawn in order to show the effect of certain lines and proportions.

- Because of the big, round, head lights the car looks very friendly; the rounded ‘eyebrows’ strengthens this effect. In the baby version these head lights are enlarged and elements are positioned closer to each other. In the sturdy version the head lights are much smaller and positioned far from side edges. Also the ‘eyebrows’ are drawn severe.
- In the current version the windshield is quite low, which gives the car a relative masculine and mature look. In the baby version the windshield is higher and more rounded. In the sturdy version however, this windshield is low and angular.
- The side mirrors are rounded which enhance friendly appearance. The sturdy version shows that wide side mirrors optically widens the car and make it more masculine.
- The more angular shapes, the more the car becomes masculine, mature and dominant.
- The lack of a grill makes the car face look more neutral. In the new model a grill will be added which will have big effect on the car appearance.
- The big and striking headlights, rounded forms and proportions make the front of the car a little bit look like a surprised childish face.
- The ‘eyebrows’ in the front and the square forms have lines of an angry face. These lines are more subtle than the headlights and therefore have less effect on the perception.

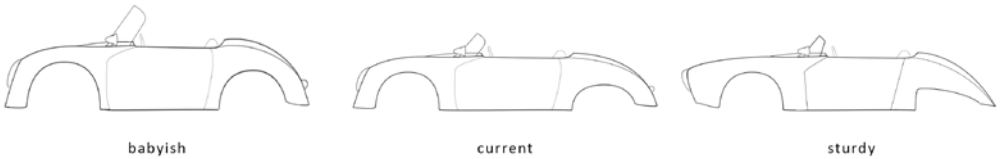


Car design of Carice turned into a babyish, the current and a sturdy version.

2.4.3 | DESIGN AND EMOTIONS OF THE SIDE

- The lower the car, the more sportive and fast it looks.
- The relatively bigger the elements, like the windshield, the more babyish and feminine the car will look.
- The sturdy versions shows that angular and accented horizontal lines shapes make the car look more mature and aggressive. Rounded shapes in the front and back of the MK1 give the car a friendly appearance.

Examples of emotions seen in the Carice car.



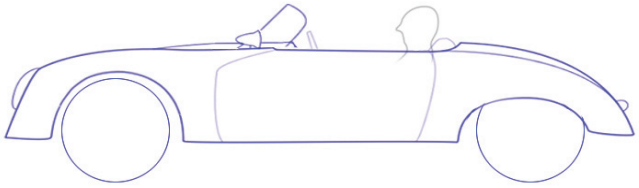
Car design of Carice turned into a babyish, the current and a sturdy version.

- The short wheel base makes the car tiny and therefore the driver will look bigger. This makes the car more childish. It is best to let the car be bigger and optical longer. The following graphs show the difference of proportion in the Carice car and in a car that is perceived as modern and sturdy (Chevrolette Stingray). These proportions are translated into the Carice design to show the effect of size and wheelbase. A wider wheelbase and higher waist line make the car more mature and sturdy. In a small car a person looks very big, this has a childish effect on the appearance. In this case that does not necessarily have to be negative, since the car is sort of a toy car and made to be special.

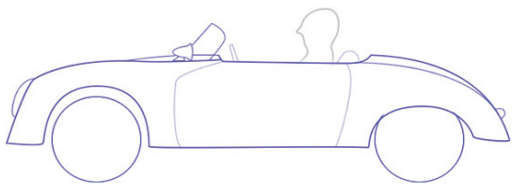
2.4.4 | DESIGN AND EMOTIONS OF THE TOTAL APPEARANCE

- Brand awareness is created by the simple and clean design and the logo up front.
- Because the car is electric it makes no motor sounds. The sound of soft swishing and screeching tires while braking give sensory meaning to the car. The range extender does make noise. The hardness of this sound can be adjusted so it will influence the perception of speed.
- Other sensory meaning can be given by colour. The customer can choose these colour combinations themselves.

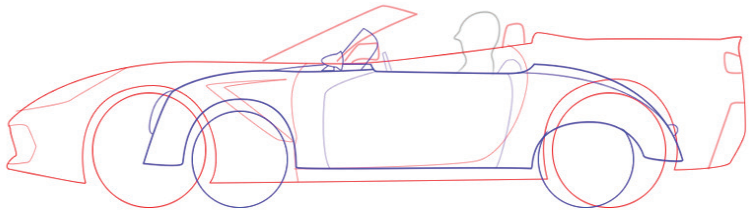
The overall look of this car model is very friendly. The new model has to contain more elements of sturdiness, sportsmanship and masculinity in order to fit the target groups. ■



A version of the MK1 with extended wheel base.



A current version of the MK1.



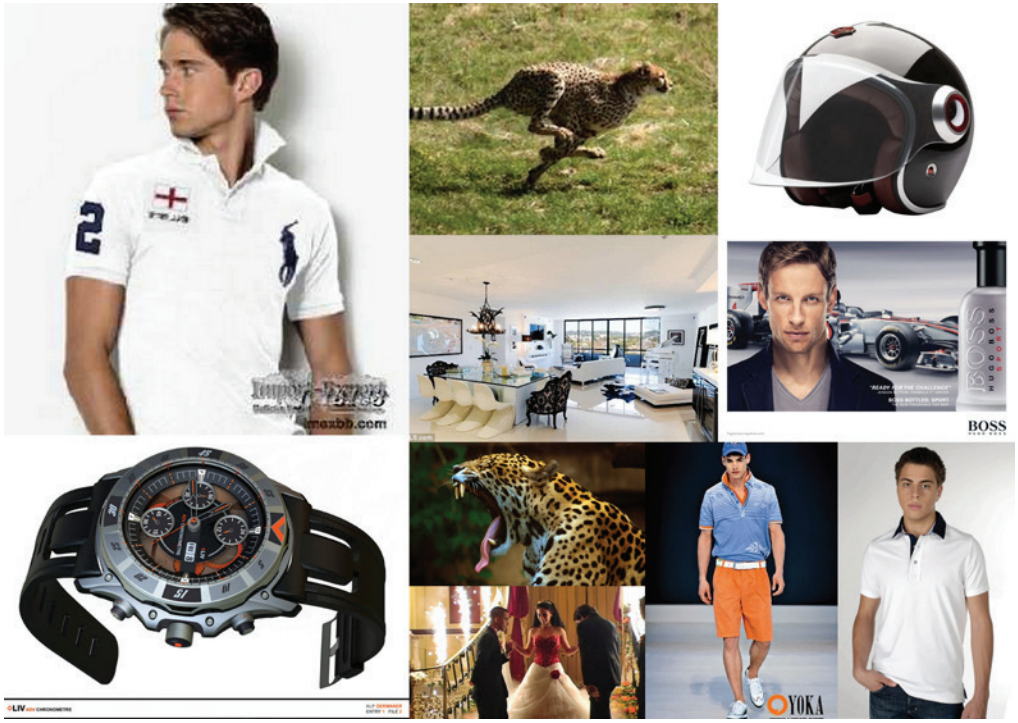
The MK1 compared to the proportions of Chevrolette Stingray.

2.5 | TARGET GROUP FOCUSSED DESIGN

WHAT ARE DESIGN CHARACTERISTICS FOR THE TARGET GROUPS?

2.5.1 | Target groups

The first chapters explained how Carice and its car can be defined. Then an analysis of design and emotion was given. As was stated in the chapter about design meaning it is very important to have a target group focussed design. In chapter 1.3 | Target groups the four target groups were already described. This chapter will give a detailed version of the target groups. The characteristics of the following target groups are established by conversations with R. Holleman, N. van Dril and their network. These target groups are all on the Dutch market for now, but can be expanded to other markets in the future. For all target groups applies that mainly the men will be attracted.



Collage Rich youth in the age of 16 25 years.

2.5.2 | RICH YOUTH IN THE AGE OF 16 - 25 YEARS

PERSONA: LESLEY WESTERVLIER

Lesley is a sparky and quite brilliant kid. He loves music and learned to play piano and electric guitar himself. Tonight he is off for his weekly hockey training. It is the last day on his mountain bike, tomorrow he will be sixteen and able to ride his first car. He has already made promises to his friends to pick them up on the way to school. Awesome, he can't wait to show them his new fancy looking car.

CHARACTERISTICS:

- The car price does not bother for the youth, however is does for their parents
- The car must look fancy, modern, fast, sportive and maybe even a little bit adventurous
- The car does not have to be very handy in use, young people are quite flexible

DESIGN CHARACTERISTICS

- Sturdy design, hard and clear lines
- Aggressive, self confident
- Plain colours, metal elements

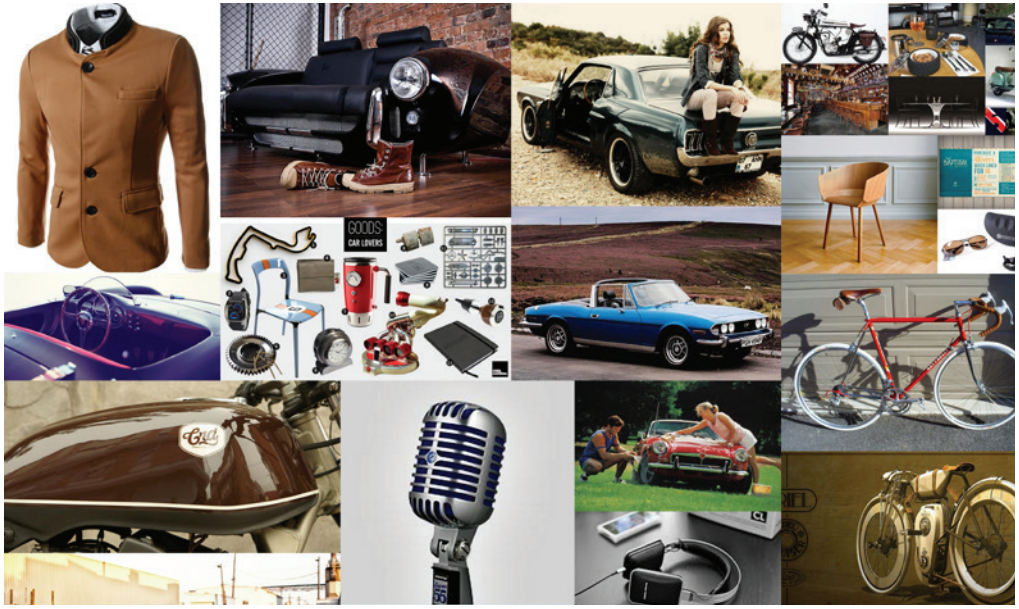
2.5.3 | RICH MEMBERS OF THE GENERAL PUBLIC IN THE AGE AROUND 35 - 60 YEARS

Collage Rich members of the general public in the age around 35 - 60 years..

PERSONA: ALBERT VAN DER VELDE
On this monday morning sir Van der Velde woke up early. He drinks a strong espresso and quickly scans the NRC Handelsblad for some interesting new facts. With a professional swing he puts on his tailor made jacket. His BMW will bring him to places real people make some serious money.
At seven thirty he is on his way to the Ernst & Young headquarters to prepare a business meeting. Last Saturday he played golf and drank some port with one of his colleagues. In the evening he went with his beautiful wife to a concert in De Nieuwe Kerk in Den Haag. He enjoys these little pleasures in life, but he also loves his job.

CHARACTERISTICS:
- Men in the age of 35 -60 years
- The car is special and meant for show of and pleasure. It is a second car, a gadget.
- The car is fancy and sportive.
- Quality is important, but the car can be a little uncomfortable.

DESIGN CHARACTERISTICS
- Basic shapes with hard, strong lines
- Self confident, open, strong, sportive
- Plain colours, metal elements



Collage Car lovers.

2.5.4 | CAR LOVERS

PERSONA: OLIVIER VAN HÖVELL
Olivier van Hövell has past his fifties, but is still a very brisk man to see. He has always lived in Kralingen and is a beloved member of the Kralinger Pin Club, which he joins every Wednesday. Using his vintage bike he is on his way to the local patisserie for a delicacy of excellent quality. Today he will discuss politics with one of the aldermen, a good friend from the old days. Olivier likes to discover new innovations but cherish the good old ones.

CHARACTERISTICS:
- The car is an object to love and learn and talk about
- These people know a lot about other cars and all the characteristics of this car and other ones
- These people love iconic, classic cars
- The car must be special, maybe even stand for something
- The car does not have to very handy in use, pleasure is reached by owning and driving

DESIGN CHARACTERISTICS
- Plain flat surfaces with many metal elements
- Simple rounded shapes with ornaments
- Self confident, modest, friendly
- Dark, brown, strong pastel colours

2.5.5 | COMPANIES AND SELF-EMPLOYED

PERSONA: MARTIN DE WITTE
Martin de Lange is head of the marketing department and today they brainstorm about new possibilities for attractive publicity. Martin is a real business man, to the point, gentle and well considered. Image is an important term for his company that is a specialist in delivering products on demand. Therefore Martin is always seeking for new innovations and interesting developments. Creating opportunities is what he is made for.

CHARACTERISTICS:
- The car must look special and be an eye catcher
- The car can be used as an marketing instrument

- The electric component is important, this is new and shows environmental awareness
- This car has fiscal benefits

DESIGN CHARACTERISTICS
- Striking design
- Open, friendly, joy
- Plain striking colours combined with stickers

Collage Companies and self-employed.

2.5.6 | MAIN TARGET GROUP

As was stated in chapter 1.3 | Target groups, the main target group will be the rich people focussed on having an exclusive car. These rich people are seen as the most profitable target group, but it is tried to make a design that fits all the four groups. Important for all these target groups is that they have money and like to have a car that is special and no else has.

The analyses of the MK1 show that it is a very friendly and classic car. Looking at the target group, this design fits the car lovers best. The other groups like a less classic, more sturdy and strong design. Therefore the new model will be a combination of both. An exclusive classic design with a more aggressive and strong appearance. How this is reached will be discussed after the design phase. ■

PART 3 | REQUIREMENTS

WHAT ARE THE REQUIREMENTS AND CONSTRAINTS FOR THE MK2?
WHAT LEGISLATION SHOULD BE TAKEN INTO ACCOUNT?

The previous two parts showed what product is needed and what perceptions fit this product. This part focuses on the requirements, legislation and constraints for the MK2. All these conditions will be brought together in part 4, were the design process of the MK will be explained.

3.1 | REQUIREMENTS FROM A USER AND COMPANY POINT OF VIEW

WHAT ARE THE REQUIREMENTS, WISHES AND CONSTRAINTS FOR THE MK2?

3.1.1 | INTRODUCTION

The next car model of Carice will be quite similar to the MK1 when it comes to functionality. The most important new functionalities for the user are the optional rooftop and changes in entry, for example using a low doorstep. Important changes for the company are the production and assembling methods. The requirements over here are focussed on a new design of the body.

3.1.2 | WHAT ARE THE REQUIREMENTS AND WISHES FROM A USERS PERSPECTIVE?

USER REQUIREMENTS | NON- FUNCTIONAL
- Exclusive and unique body
- Not too expensive, max. of €30.000 excl. VAT

USABILITY REQUIREMENTS
- Safety
- Good road holding
- Easy to enter
- Good view
- Easy to store and clean
- An optional roof system must be easy and safe in use

3.1.3 | WHAT ARE THE REQUIREMENTS AND WISHES OF CARICE?

SYSTEM REQUIREMENTS | FUNCTIONAL
- The body must fit the current chassis
- Body can be easily assembled, assembly time is reduced by ~20%
- Optional door, that does not have to be lined out with the body
    - Enough space for the legs to enter the car, in all positions of the chair
    - Body may not be damaged while entering (for example by leaning on the back of the car while entering)
- The body must be light weighted, total weight of the car must be less than 350 kg
- Low material and production costs (without looking cheap; amount of 100-1000)
- Measurements that fit 95% of men in the age of 16 - 65 years
- Body provides enough space for the wheels to move (wheel size is 560 mm diameter)
- Body provides enough space for a range extender
- Body provides cooling for a range extender
- Luggage space for approximately one weekend bag
- Roll bars should be attached to provide safety and safety perception and perhaps attachments points for a rooftop and seat belts
- All obligated accessories can be attached (licence plates, mirrors, seat belts, reflectors, wipers and lights)
- All obligated accessories have to be standardized designs
- Dashboard design has to stay the same as the current design

- Optional roof system that protects from rain
    - Rooftop can be easily assembled, with a maximum time of 30 minutes
    - Rooftop does not cost much, with a maximum amount of €1500 excl. VAT
    - Rooftop is at least 5 cm above the head of 95% of men in the age of 16 - 65
    - Rooftop may not obstruct a clear view on the road

The car does not necessarily have to be very handy (while entering / raining) or pretty, because it is an exclusive car and it is acceptable to make some effort to be able to use it.

DESIGN & IMAGE REQUIREMENTS
- Sturdy, sportive, contemporary
- Exclusive, unique
- The design has a little classic touch
- The design contributes to the image of Carice
- Looks also good with a person sitting in the car
- Looks also good when loaded
- Safety perception
- Quality

WISHES
- Foam space or side bar as safety barrier
- The body must have a low doorstep, in order to make doors unnecessary
- Production method is suitable for a higher number of cars (1000)
- Wind deflector that makes driving more comfortable

3.2 | LEGISLATION IN SHORT

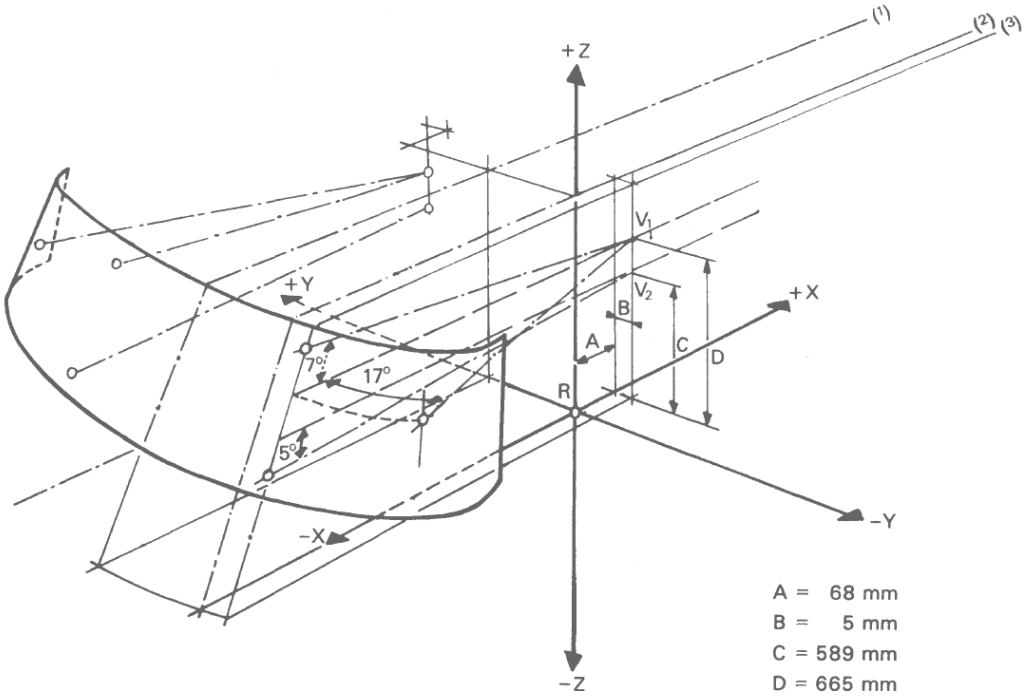
WHAT ARE CONSTRAINTS FROM THE DUTCH GOVERNMENT?

3.2.1 | LEGISLATION

The following is a brief summary of the most important Dutch legislation for cars.

- The car may not have sharp edges
- The car must have a certain approach angle
- At least two mirrors are obligated (two outside or one right outside and one inside mirror)
- A rear licence plate is obligated
- A windshield spray and wash system is obligated in case of a window with rooftop
- Certain obligated sightlines are applied to a window with rooftop
- De-icing and demisting system is obligated in case of a window with rooftop
- High beam, low beam, indicator lights, hazard lights, brake lights, front position light and tail light are obligated
- License plate lighting and reflector at the back are obligated
- All the obligated car elements must be positioned on a certain height, distance and angle

This legislation is based on requirements listed by the RDW (RDW, 2009). The product is categorized in the category L7e. Further legislation can be found in Appendix C | Part 3 | Legislation and is stated at the design parts of this survey.



3.3 | CONSTRAINTS BECAUSE OF THE CHASSIS

WHAT ARE CONSTRAINS FOR THE MK2 BECAUSE OF THE CHASSIS?

Side view chassis

3.3.1 | MEASUREMENTS OF THE CHASSIS

The following graphs show the main dimensions.
Very important are the height of the chassis, the wheelbase and the position of the driver. The wheelbase is a little short compared to other cars. To maintain a fast and sportive look, Carice has positioned the driver as close to the ground as possible. The person in the car has the measurements of a 95-percentile male positioned in the most backwards position of the chair. The legislation will be checked by the RDW with a dummy. Obligated sightlines and measurements are based on the position of this dummy (the H-point). The position of the interior and most of the elements in it will be the same in the next version of the car. The shape of the window however may vary. ■

Side view chassis

Top view chassis

Top view chassis

PART 4 | DESIGN PROCESS

WHAT WAS THE DESIGN PROCESS?
WHAT WILL BE THE NEW BODY DESIGN FOR CARICE?

The previous parts showed the background, constraints and design possibilities for the MK2. All this information will be combined in this part. This part shows the design process of the body for the MK2 and the optional rooftops. It also gives a recapitulation on the previous parts and shows the final results.

4.1 | DESIGN DIRECTION

WHAT IS THE CAR BODY DESIGN FOCUS?

4.1.1 | INTRODUCTION

This chapter is a very short recap of the previous chapters and helps to get the right focus for a new body design that is the main task of this master's assignment.

4.1.2 | MAIN REQUIREMENTS

- Body can be easily assembled
- The body must fit the current chassis
- Measurements that fit 95% of men in the age of 16 - 65 years
- Space for a range extender and luggage space for one sporting bag
- All obligated accessories are standardized and can be attached
- Optional roof system can fit the body
- Production method is preferably suitable for a higher number (100-1000) of cars and has low costs
- Maximum price of €30.000 excl. VAT

4.1.3 | KEYWORDS CARICE MK2

- Simplicity
- Driving pleasure
- Exclusive
- Sportive
- Innovative (electric)
- Classic touch
- Sturdy
- Friendly, but more aggressive than the MK1
- Adventurous
- Quality

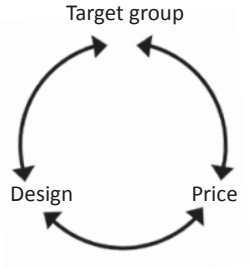
4.1.4 | TARGET GROUP

The two main target groups are these and they have in short these characteristics:

RICH MEMBERS OF THE GENERAL PUBLIC IN THE AGE AROUND 35 - 65 YEARS
- The car is special and meant for show of and pleasure. It is a second car, a gadget.
- The car is fancy and sportive.
- Quality is important, but the car may be a little uncomfortable.

CAR LOVERS
- The car is an object to love, learn and talk about.
- These people know a lot about other cars and all the characteristics of this car and other ones.
- The car must be special.
- The car does not have to very handy in use, pleasure is reached by owning and driving.
- This group likes classic and vintage.

4.1.5 | PRICE / DESIGN / TARGET GROUP



As mentioned in the first chapter the graph shows that the price, target group and design focus have big influence on each other. In the previous chapters it is tried to describe each term as far as possible, however, Carice is still searching for the right mix. The next version of a car must have the best tuned mix of them three, so they will guide choices in the design process and strengthen each other. This means each design aspect is described as detailed as possible, but sometimes Carice will just follow their intuition when choices for a new model have to be made.

4.1.6 | DESIGN APPROACHES

The following design approaches are used in this project:
- Target group focussed / keyword and inspiration collage driven
- Panel opinion / company based
- Technical driven
- Anthropomorphic point of view

The design for the new body will be mainly based on the target group, opinion of the company and will be technical driven. The design can then be evaluated from an anthropomorphic point of view, what will verify whether the design fits the company and target groups.

4.1.7 | STYLE PLACEMENT

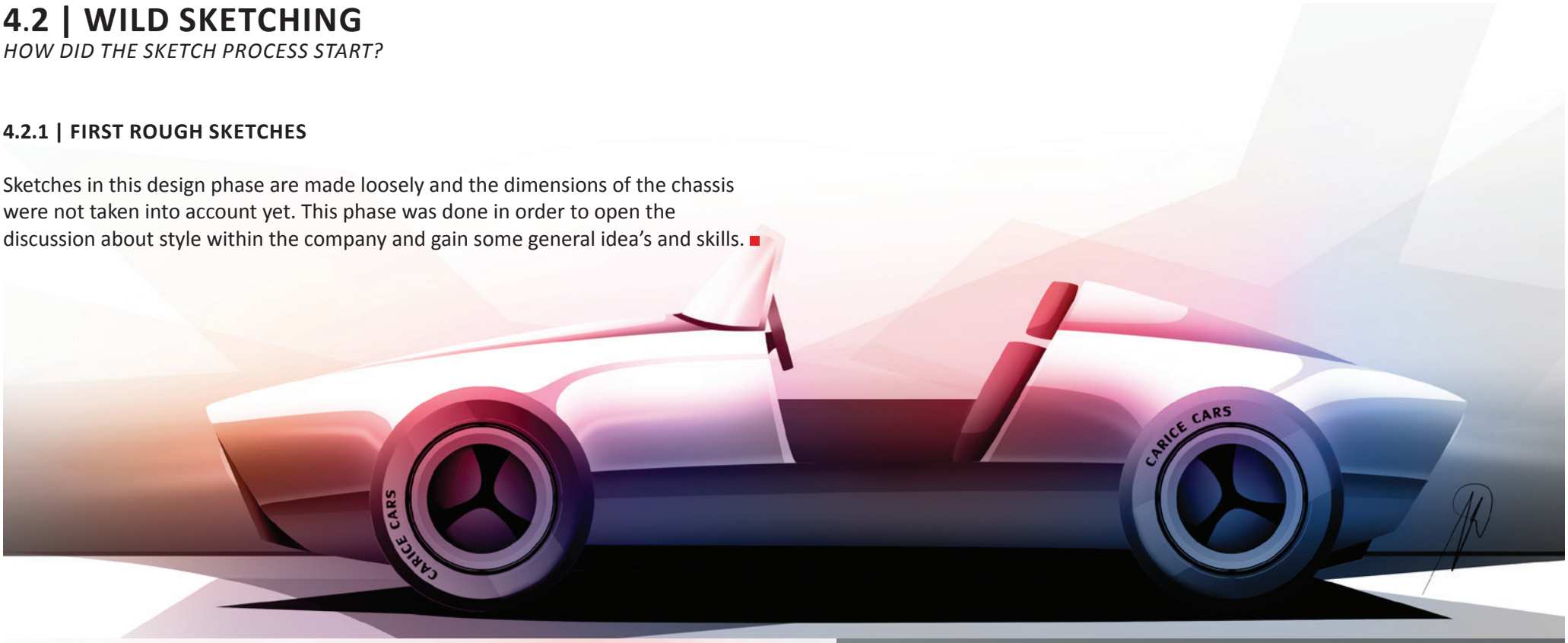
The following diagram shows four core words: classic, modern, round and square. Of course cars can be qualified into many categories, for example building year, without doors, cabriolet etc. However, these four categories give a rough classification of car styles. The circle shows the design area in which Carice wants to see their new car design. A modern car with a classic touch. This description fits the target groups, although it depends on the details how well it will fit them. ■

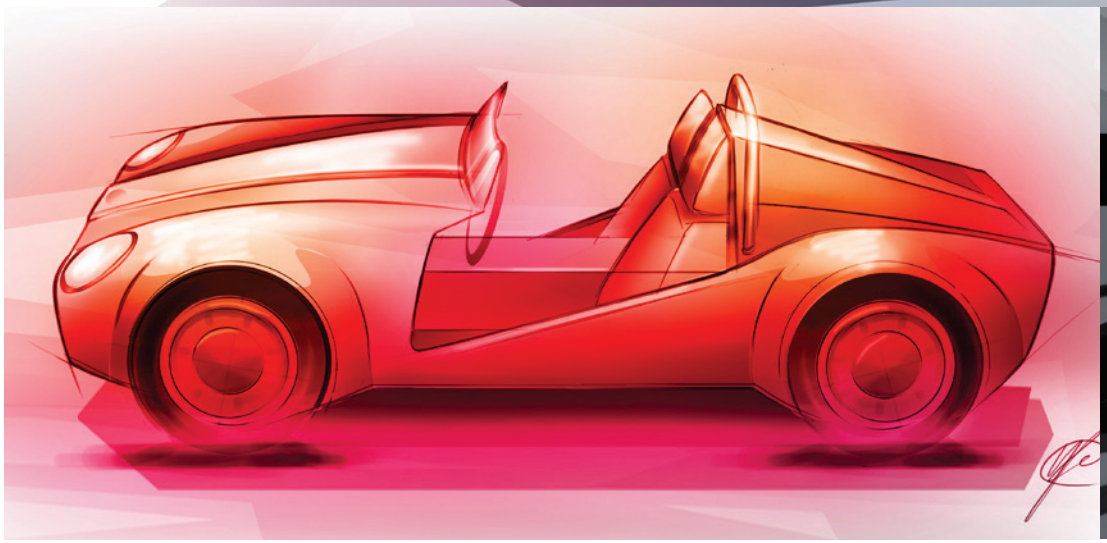
4.2 | WILD SKETCHING

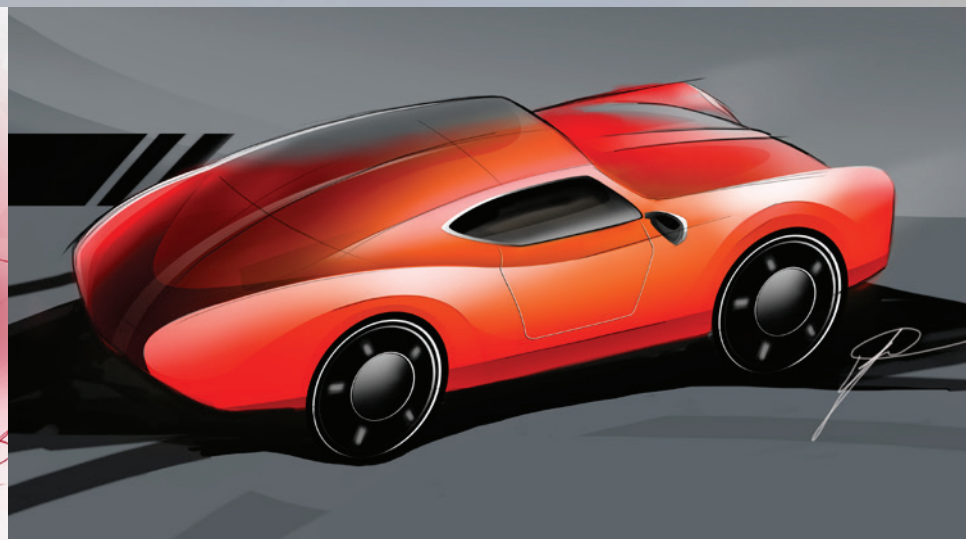
HOW DID THE SKETCH PROCESS START?

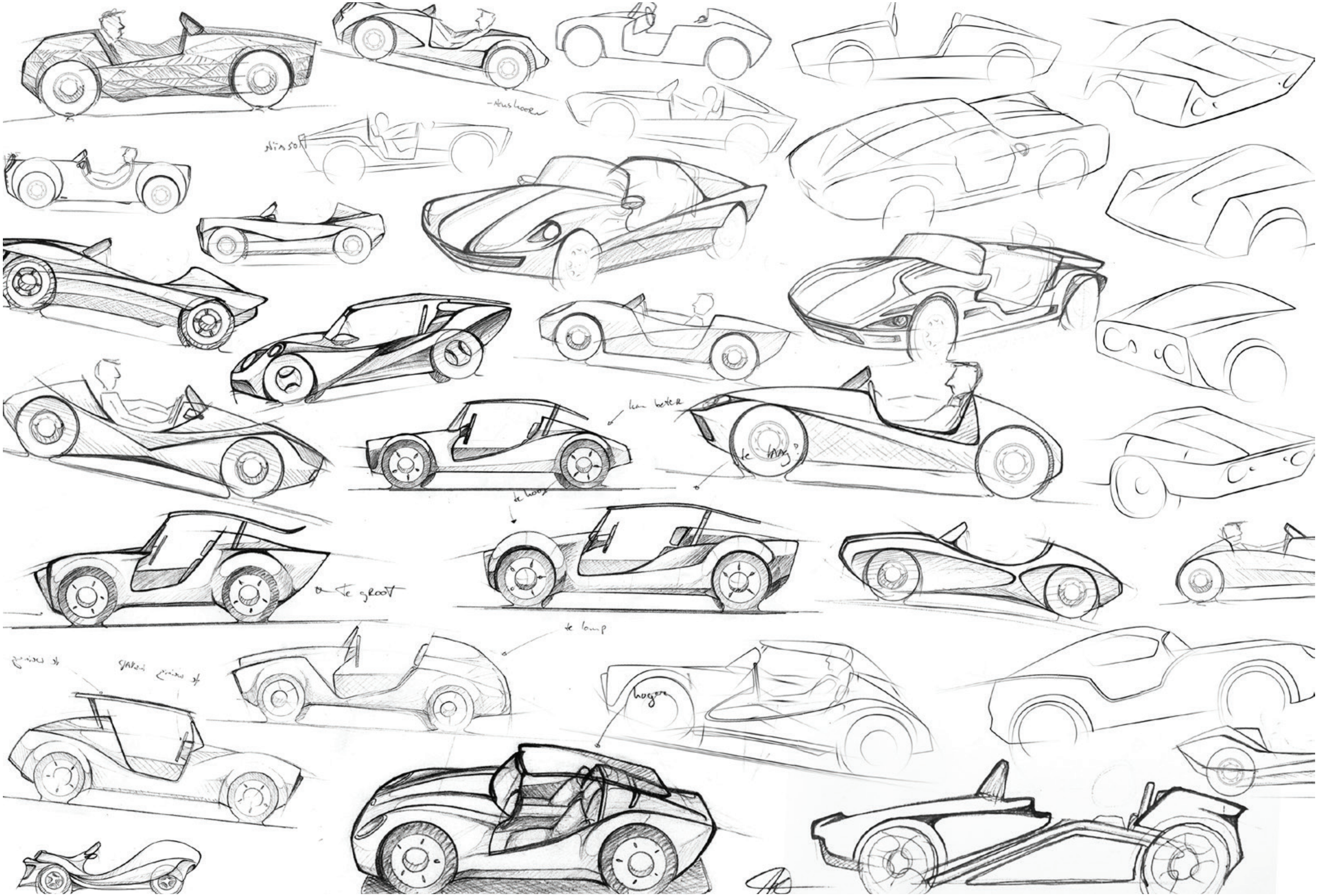
4.2.1 | FIRST ROUGH SKETCHES

Sketches in this design phase are made loosely and the dimensions of the chassis were not taken into account yet. This phase was done in order to open the discussion about style within the company and gain some general idea's and skills.








kan beter
te groot
te lomp
hoger

4.3 | SPECIFIC SKETCHING

WHAT SKETCHES ARE MADE WITH WHAT SPECIFIC FOCUS?

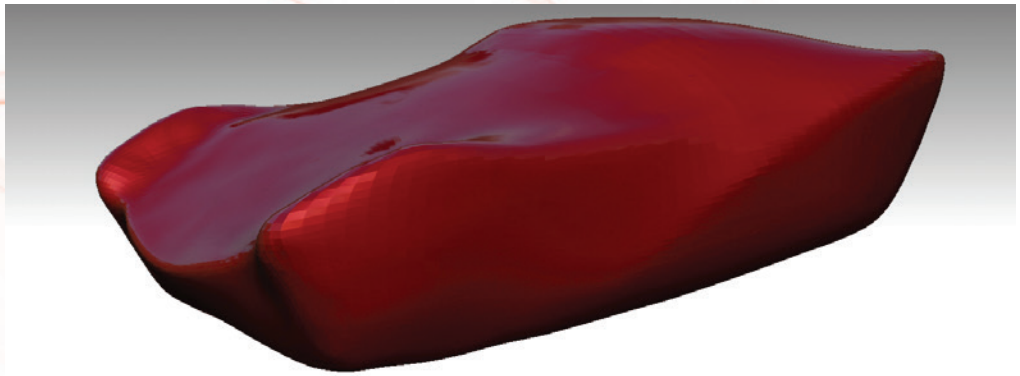
4.3.1 | CREATIVE TOOLS

Different methods for designing were used in order to stimulate the creative process: free sketching by hand, sketching digital, scaling of current car models, free modelling (Z-Brush), rough modelling (SolidWorks), programs that generate random shapes and curves and finally a lot of inspirational pictures. Some examples are given below to show the design process. Not all the sketches are included in this report for the benefit of the readability.

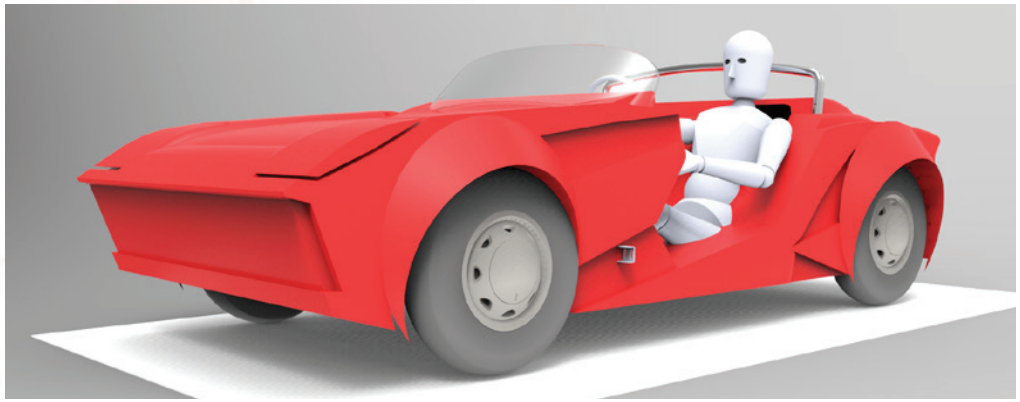
4.3.2 | SKETCHES

The designs are divided into two main focuses: modern and classic. Various sketches are made within these themes. Yet, they are still applicable to the sportive, little classic and exclusive character of Carice and based on the current chassis. These two focus points were chosen based on the analysis made earlier and on conversations with the company. These focuses are still very global, but since Carice does not have a narrow view on what kind of car is best for them, it gives them an idea of the possibilities and sorts the options roughly. This also makes is easier to tell what kind of design would fit the target groups.
In order to use the right dimensions and save time, renders of the chassis were used as an under layer. The following pages show sketches and inspiration.

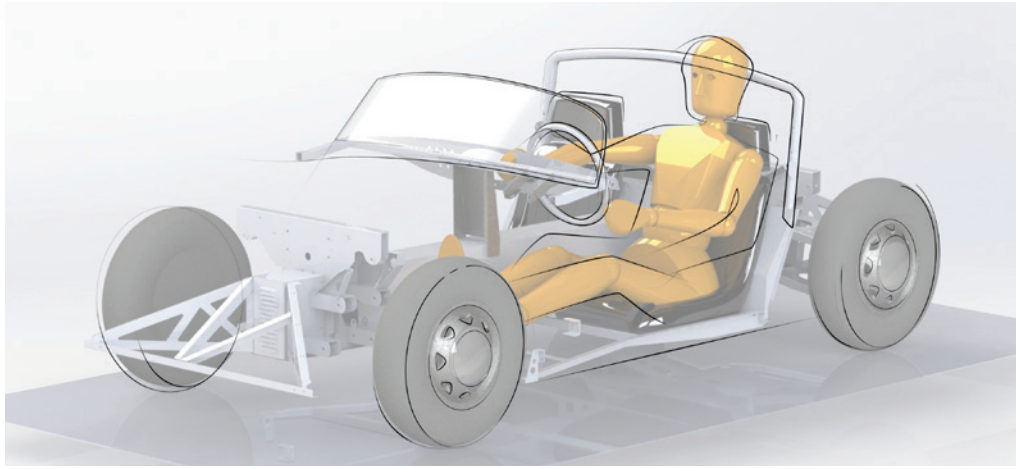
Example of Sculptris Free modelling for inspiration



Example of Z-Brush free modelling for inspiration



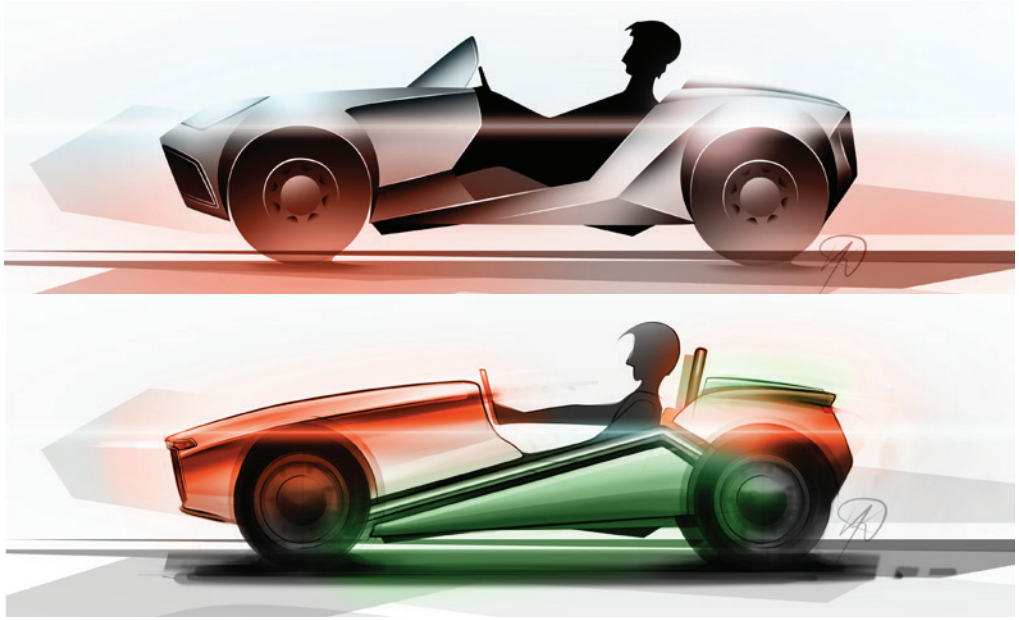
Example of rough SolidWorks model



Example of Render used as sketch under layer

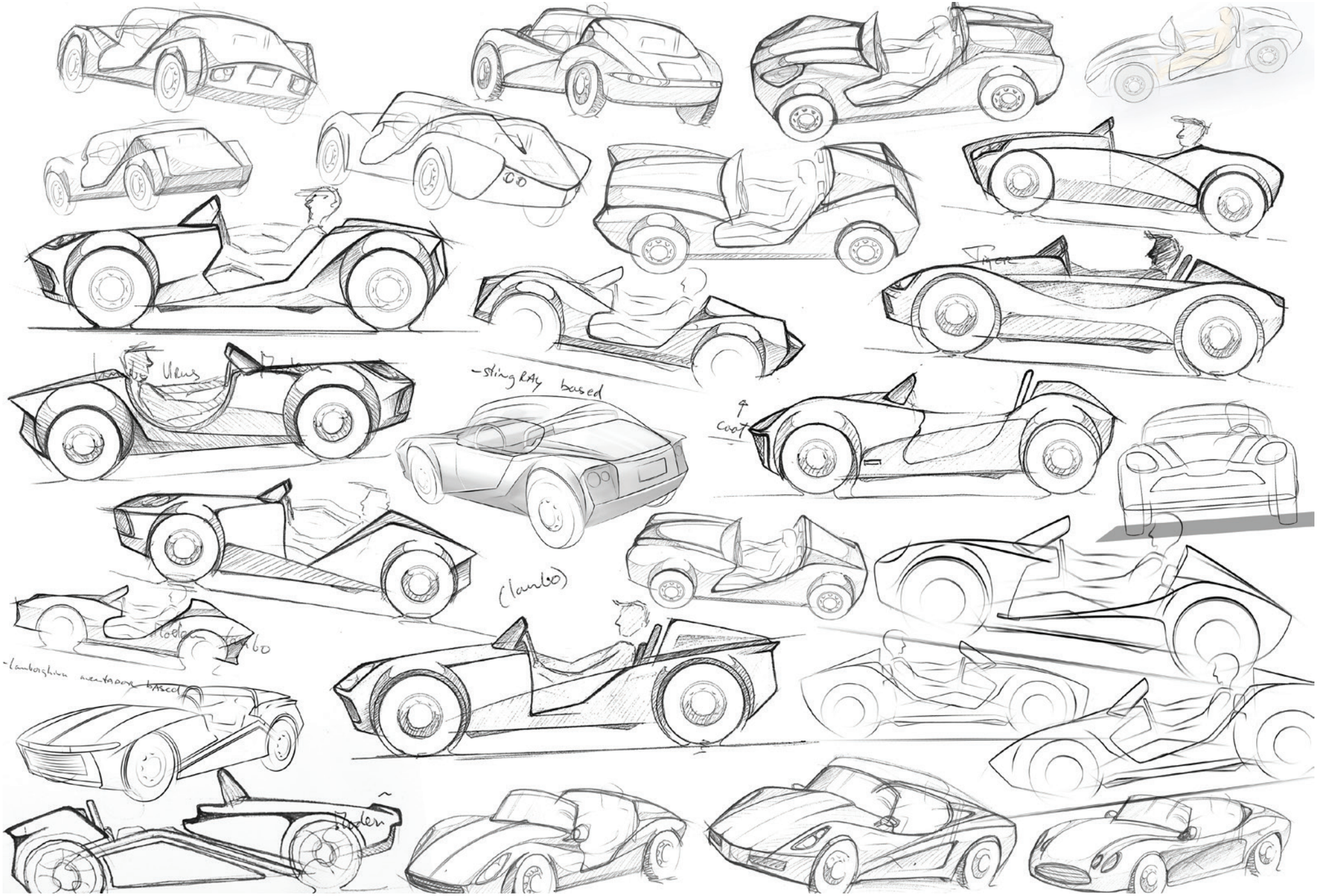
4.3.3 | MODERN

The following sketches were based on modern and sturdy car design.



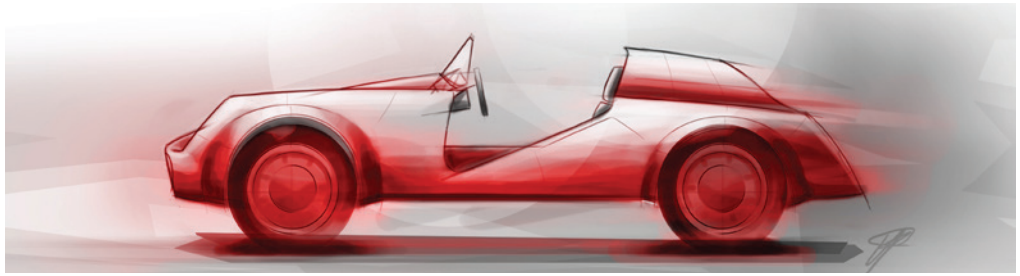
Chapter 2.2 and 2.3 explained that these characteristics make a design more sturdy. In chapter 2.5 is explained what kind of design fits the target groups. The following graphs are examples of cars that would fit them. However, the MK2 should be designed less modern and aggressive.

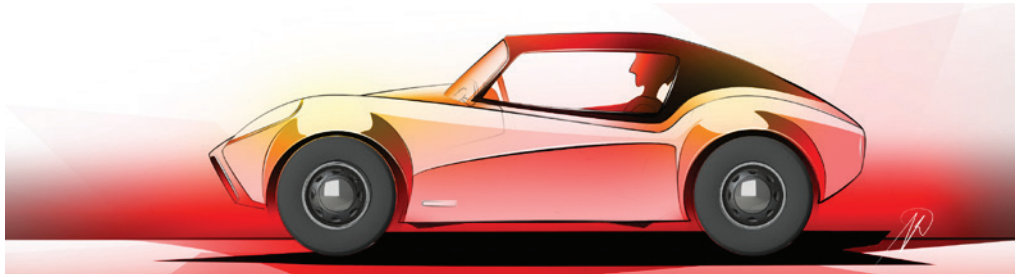
Modern


-sting RAY based
(lambo)

4.3.4 | CLASSIC

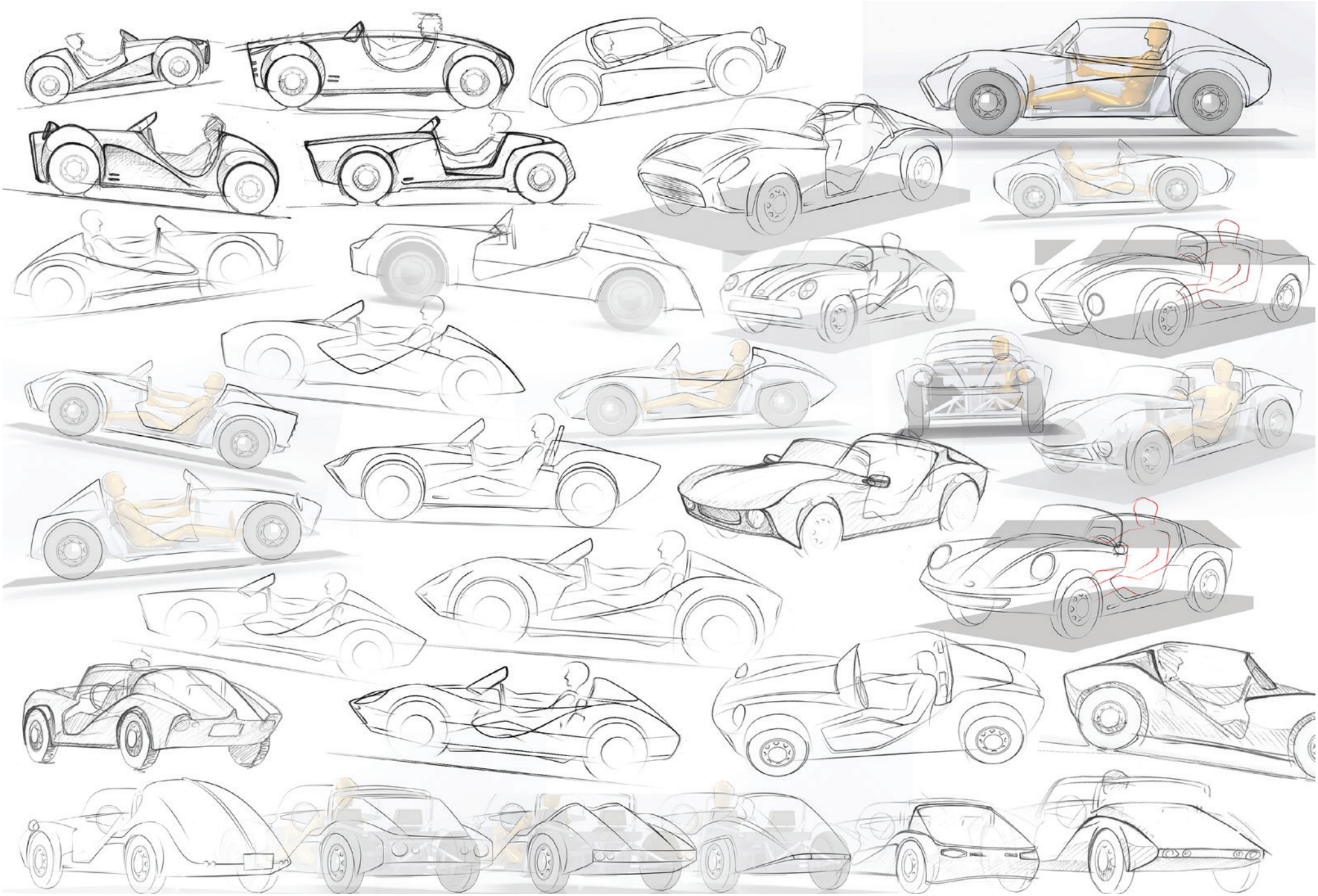
The following sketches were based on classic car design.





The chapters 2.2 - 2.4 explained that these characteristics make a design more friendly and classic. The following examples of cars are inspiration for the MK2 sketches, however the MK2 should be designed less friendly and classic than the MK1.

Classic

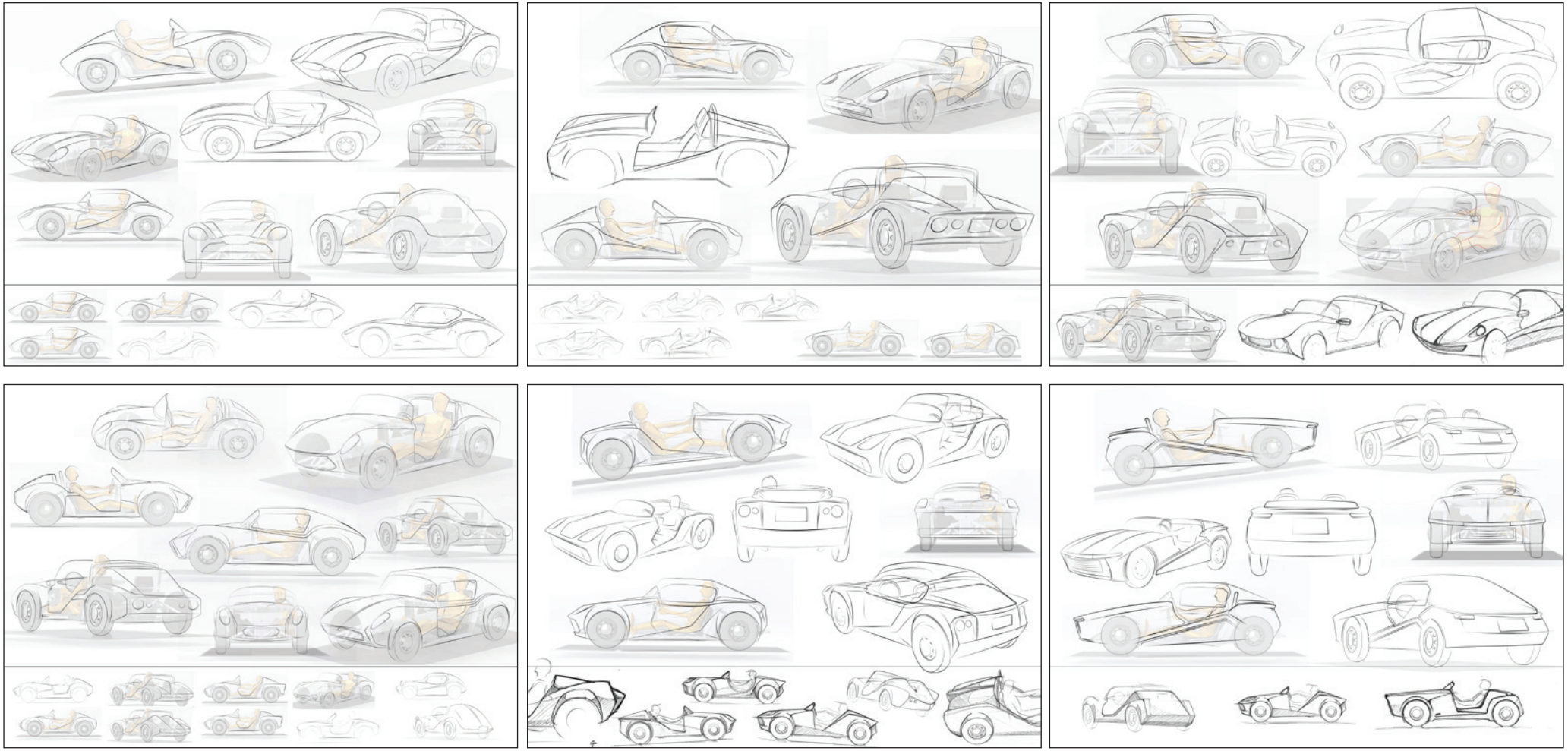


4.3.5 | FOUR CONCEPTS

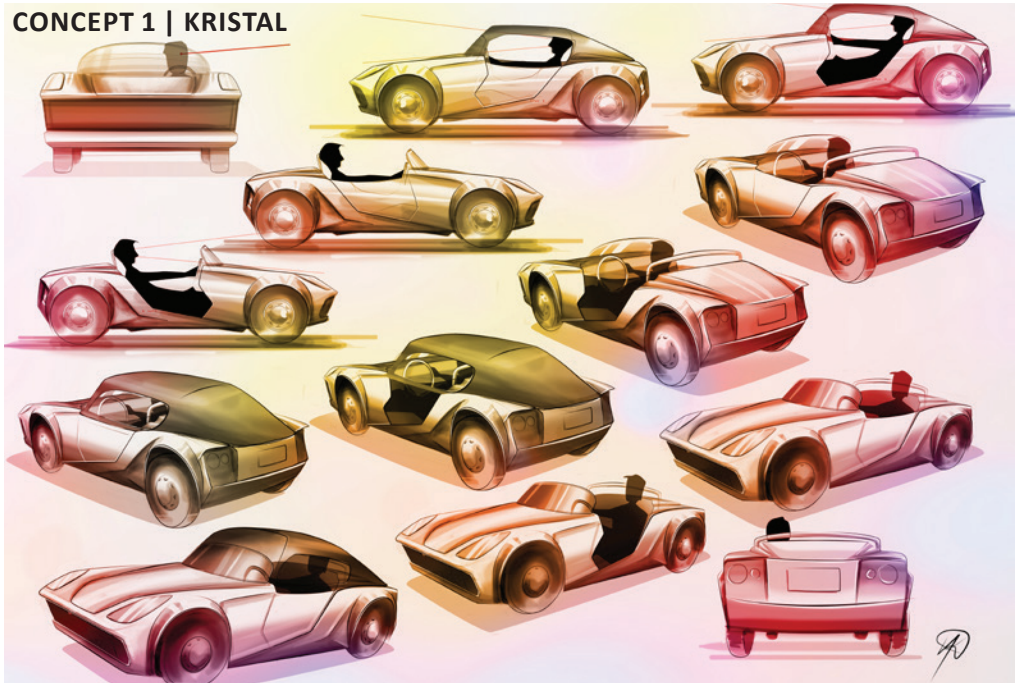
In this first phase there was a classic and a modern focus. Within these keywords many different cars were drawn which were eventually evaluated by the company. The company, customers and car lovers were asked to point out which designs were best for the Carice MK2. The fitting within Carice and her target groups, the appearance and technical possibilities were most important in this phase. After consultation finally six groups of sketches were derived to be further elaborated. In Appendix D.1 enlarged versions of these drawings are shown.

Because some designs looked a bit like each other is was finally decided to leave out two of them. Four final designs were chosen to be worked out to the same level of detail. Concepts can be classified as: very modern, very classic, combination between modern and classic and very technical handy. The arguments pro and con for these design are stated in the following chapter.

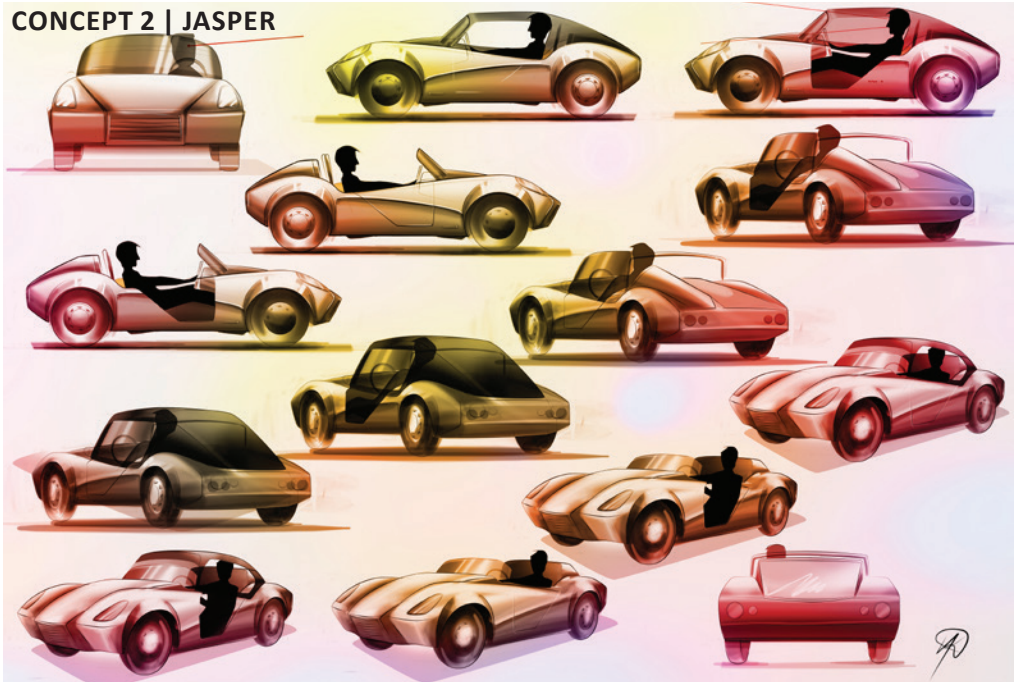
Chapter 2.2 and 2.3 showed the effect of lines and proportions on the perception and these theories are used in designing the car. ■



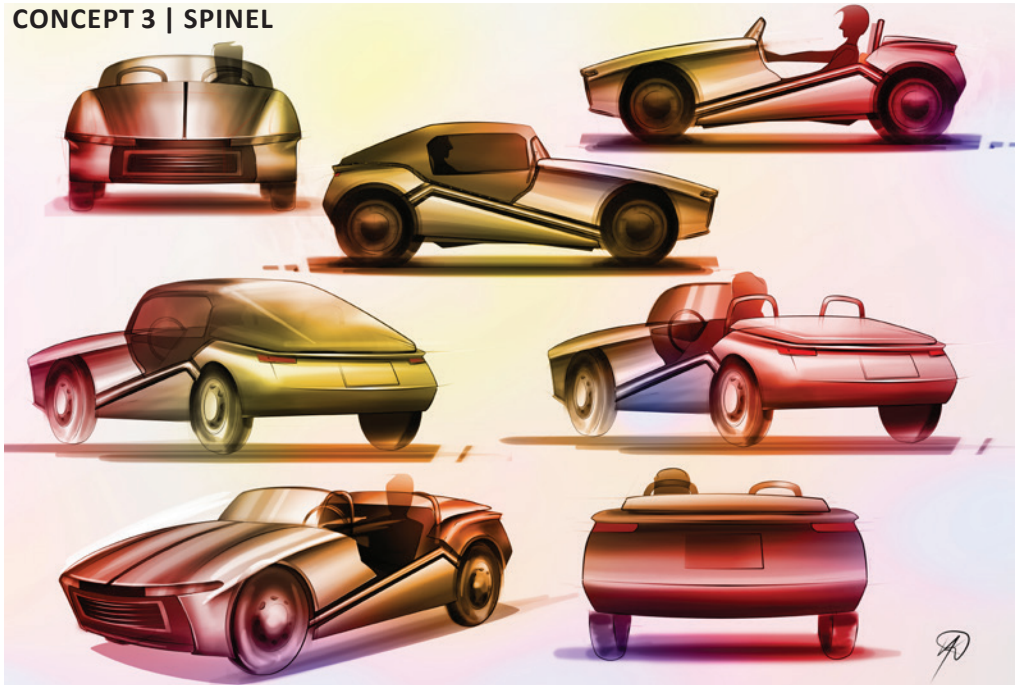
CONCEPT 1 | KRISTAL



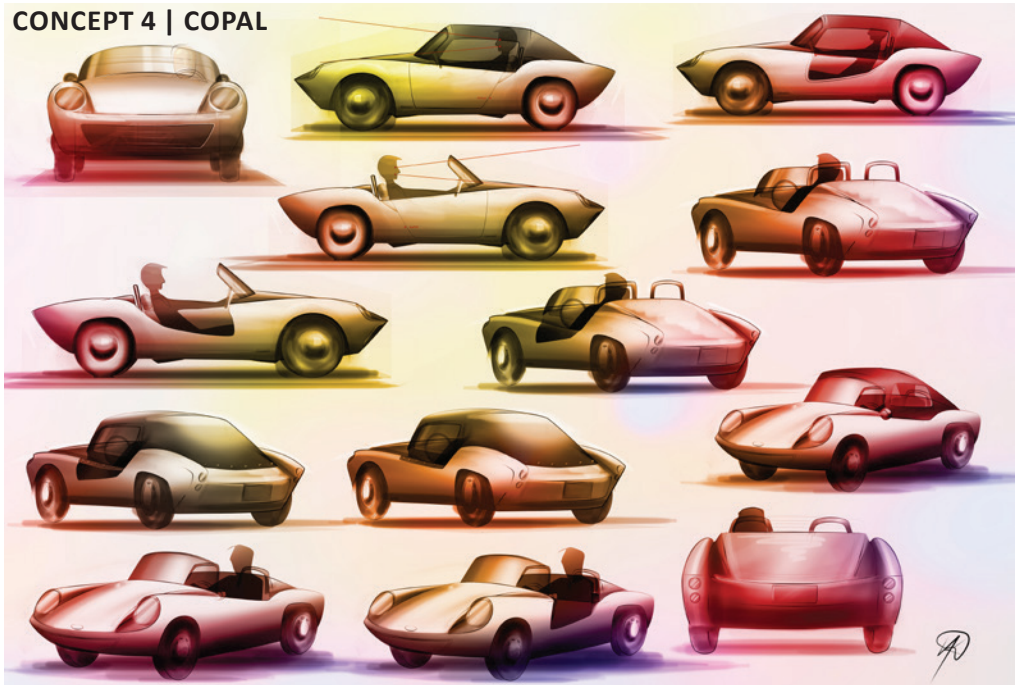
CONCEPT 2 | JASPER



CONCEPT 3 | SPINEL



CONCEPT 4 | COPAL



4.4 | FOUR FINAL CONCEPT DIRECTIONS

WHICH MAIN CONCEPT DIRECTIONS CAN BE DERIVED FROM THE SKETCHING PROCESS?

4.4.1 | FOUR CONCEPTS

Arguments and opinions about these concepts are stated in order to make the right choice for a final design focus. These arguments are based on the opinions of the designer, company, customers, car lovers and analysis of the MK1 and the requirements for the new body design.

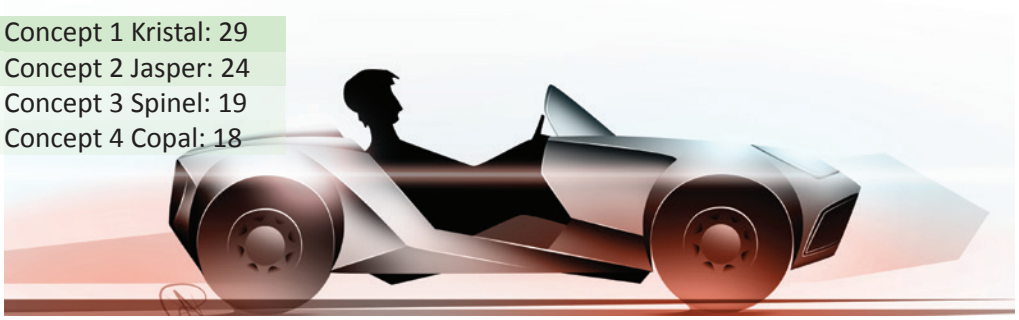
The opinions gave a rating that is included in Appendix D.2. Also a group of not directly related people is asked to give their opinion. All the concepts were also examined via an interview for a more in depth opinion. The outcomes of the interviews are included in the arguments stated at the concepts. (The names of the concepts are randomly chosen jewels.)

RELATED PEOPLE
In total an amount of 90 were divided among the following concepts.

Concept 1 Kristal: 27
Concept 2 Jasper: 31
Concept 3 Spinel: 14
Concept 4 Copal: 18

NON DIRECTLY RELATED PEOPLE
In total an amount of 90 were divided among the following concepts.

Concept 1 Kristal: 29
Concept 2 Jasper: 24
Concept 3 Spinel: 19
Concept 4 Copal: 18



4.4.2 | CONCEPT 1 | KRISTAL

DESIGN ANALYSIS
The sharp lines make the design aggressive, strong and confident. Lines in the side view are sharp and go down in the front to enhance an effect of dynamics and speed. The fact that the back is short enhances this effect. The grill is very big and wide, together with the big and squared head lights this look like a face of someone that shows his teeth. The lights at the back are less aggressive, for they are disclosed in the body what makes the design more subtle. The rooftop is in line with the back what makes it a fluent design. The overall design of the body is sturdy and masculin.

ARGUMENTS PRO
- Short back side
- High waist line (prevent Mickey Mouse effect)
- Sturdy, sportive and modern appearance
- Model without a door looks good

ARGUMENTS CON
- Too sturdy and modern for Carice
- A very modern appearance makes the car mainstream instead of exclusive

4.4.3 | CONCEPT 2 | JASPER

DESIGN ANALYSIS
The design looks classic and dynamic because of the waving side line and the fluent line of the rooftop. The front of the car looks classic because it is very clearly divided into three parts. The sharp fall at the back of the side line could be an abstract reflection of a hip joint of a horse, which make the part look stronger. The front of the sight line has an enclosing movement as if it wants to grab something. At front the car appears angry due to the negative line in the bonnet, squared head lights and grill. The raise in the body of the back looks like it wants to push the driver, which enhances the effect of speed. The low very end of the back of the car looks like it is descended, which gives the car a slow appearance at that side.

ARGUMENTS PRO
- Fluent and subtle side view
- Fluent and special back ‘head restraint’
- Good balance between classic and modern design,

not mainstream design
- Seems to fit within the Carice brand

ARGUMENTS CON
- Simple and flat end at the back
- Door gap does not fit the total design

4.4.4 | CONCEPT 3 | SPINEL

DESIGN ANALYSIS
The lights are small and look like squeezed eyes. The front of the car is quite simple and flat. Therefore the front of the car does not reveal much emotions, which makes it a bit inscrutable. The body parts at the front partly enclose the grill. This does not add up to an open character. The short back and the optical long front of the car enhance an effect of speed from side perspective. However, the back of the car is flat and a bit simple and clumsy, which gives the car a slower appearance. The side bar gives the design a strong appearance and makes it look like a terrain car.

ARGUMENTS PRO
- Looks good without a door
- Sturdy and exclusive appearance
- Nice front and side view
- Easy to produce and assemble
- Side bar provides extra safety

ARGUMENTS CON
- Simple and flat end of the back
- Looks too much applicable for rough terrain
- Little too futuristic

4.4.5 | CONCEPT 4 | COPAL

DESIGN ANALYSIS
The front of the car is very classic due to the recessed and round head lights. The rounded side and front of the car and the lack of strong lines make it appear very soft, weak and friendly. The curved shape of the front, the grill and the lights make it look like a laughing face. Lines in the side of the car are very horizontal what makes the car a little slow. The downside of the front and back is very small and goes almost directly upwards, this gives the side view an instable appearance.

ARGUMENTS PRO
- The classic appearance fits the MK1

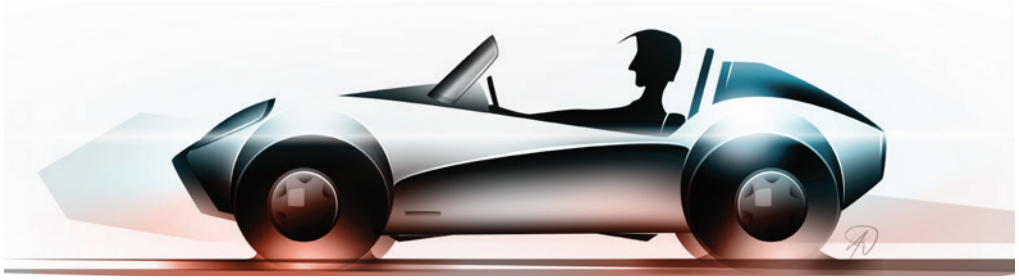
ARGUMENTS CON
- A bit too much classic, not special
- Too basic design, little boring, weak and friendly character

4.4.6 | GENERAL FEEDBACK

- A rooftop should not be big
- A high back makes the design of a rooftop more subtle
- A short back looks nice
- A low front looks nice and gives the car a higher speed appearance
- Exclusive design means an extreme design, not everyone has to like it and it must not become mainstream
- Try to catch the attention with a brightly coloured design, but also manufacture a more standard version
- Too modern makes a small car a bit of a want-to-be-cool car, do not try to be a competitor of current modern cars, but make the small design of the car a strenght

4.4.7 | CONCLUSION

Based on the ratings, interviews and on judgment of the company the second concept Jasper is chosen as the best. It seems to fit in the brand of Carice with its combination of classic and modern design elements and the concept looks special. These were the main arguments since exclusivity is the main keyword to attract the target group. However, the first concept Kristal was also rated quite high, especially by younger people. The appearance seems too modern for Carice, however, it might give the brand an extra sportive image. In order to choose the right type of car those two are both globally worked out in 3D so a better funded choice can be made. ■



4.8 | CHOICES FOR THE ACCESSORIES
WHAT ACCESSORIES SHOULD BE PLACED IN THE CAR?

4.8.1 | INDICATOR LIGHTS

LEGISLATION
All lights have to be E-marked , which means they can be used on cars within Europe. The LEP lampen (Lucas electrics products) will be used.

SPECIFICATIONS
Diameter: 80 mm
Height: 60 mm
Costs: ~€12

Position of the indicator lights.

PLACING
The lights are placed on a raised edge on the body what makes it easier to assemble.

4.8.2 | LICENSE PLATE POSITION / LICENSE PLATE LIGHTING

LEGISLATION
Only one back licence plate is obligated, see Appendix C.1 and C.9.

SPECIFICATIONS
Width: 520 mm
Height: 110 mm
Costs: License plate: ~€15 - €20. License plate lighting: ~€7.

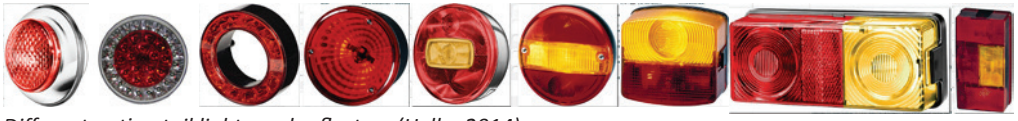
Configurations of the license plate.

PLACING
License plate lighting is placed above the license plate in the body so the light will shine downwards. A space of 30 mm and a radius big enough to let the body come out of the mould is used. Because of the clear borders around the plate it is easier to position the plate on the body.

4.8.3 | TAIL LIGHTS AND REFLECTORS

LEGISLATION
Legislation about the tail lights can be found in Appendix C.11. Legislation about reflectors can be found in Appendix C.12. Reflectors have to be non triangular and like the tail lights placed at a certain height and distance.

OPTIONS



Different option tail lights and reflectors (Hella, 2014).

Since the whole design of the car is rounded, a squared light is not suitable. It is chosen to use a light unit that is combined with a reflector, this will reduce assemble time and makes the back of the car look more clean. The following configurations were made. The other light is the same indicator light as in at the front.
The first design looks best and gives the car a very classic appearance.

Configurations of the back lights.

SPECIFICATIONS
Diameter: 80 mm
Height: 60 mm
Costs: ~ €15

PLACING
Like the indicator lights the back lights are positioned on a raised edge what will make positioning easier.

Configurations of the back lights.

4.8.4 | OUTSIDE MIRRORS

LEGISLATION

Mirrors have to be attached in such a way that certain sightlines are applicable. See Appendix C.14 for the legislation. It is also obligated to have one rear view mirror and inside mirror or two rear view mirrors when there is no inside mirror.

OPTIONS

Mirror options (Automotive, 2014).

The Tex classic Torpedo Racing mirror is chosen for its classic appearance and fits the period of the cars that were inspiration. It also looks fast and solid, which fits the overall design of the car. Downside of the mirror is that it is small and therefore less functional than 'normal modern' side mirrors.

SPECIFICATIONS

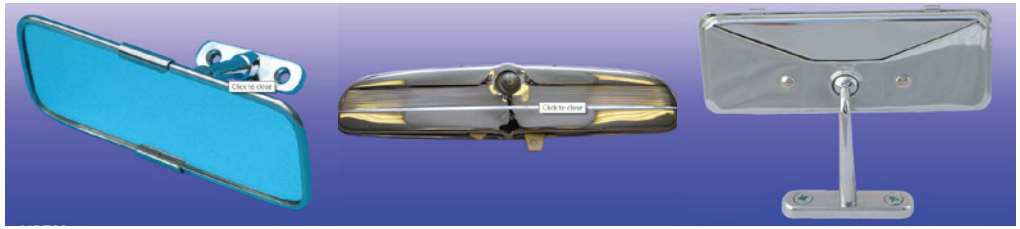
Glass Diameter: 95mm
Base Dimensions: 95mm x 30mm (maximum)
Hole Centres 50mm
Costs: ~ €25

PLACING

After placing, the mirrors are rotatable in order to meet the requirements for the sightlines. Like the lights the mirrors are also placed on a flat border in the body.

Render of the mirrors.

4.8.5 | INSIDE MIRROR



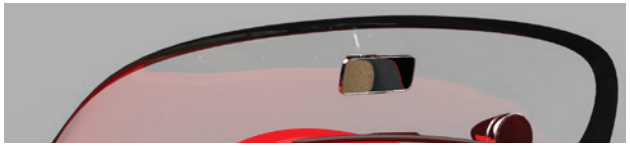
Mirror options (Automotive, 2014).

OPTIONS

The Tex MDT02 Dash top mirror is chosen for its classic and simple shapes and it is the biggest version of this selection.

SPECIFICATIONS

Head: 155mm x 63mm
Overall height 90mm
Costs: ~30 euro



Render of the inside mirror.

4.8.6 | DASHBOARD SIZE

DESIGN

The MK1 and configuration of the dashboard will also be used in the new model. However, due to a higher body the back plate needed to be raised a little.

Dashboard render.

PRODUCTION
The dashboard can be laser cut out of stainless brushed steel. All the buttons are standard items that can be easily assembled into the dashboard. The dashboard in this new model is bigger than in the MK1, however this has only little effect on the price. The dashboard needed to be bigger so the front body part would be smaller and could be made out of one part.

SPECIFICATIONS
Width: 1200 mm
Height: 200 mm
Costs: ~€80


Example of wipers (Spares, 2014)

4.8.7 | WIPERS

OPTION
Costs: ~ €200

4.8.8 | LUGGAGE SPACE

DESIGN
Since there is not much space in the back of the car the luggage space will be big enough for just one sporting back. It is made by two extra body parts and optional for customers.

SPECIFICATIONS
Width: 600 mm
Height: 300 mm
Length: 300 mm
Costs: ~€100

Luggage panel

PRODUCTION
The luggage space will be made by extra moulds for the tub and the cover. An extra bent edge keeps the body parts together and adds strength. The cover will be attached with simple hinges and finished with rubber strips.

4.8.9 | ROLL BARS

OPTIONS
Because of the two curved bumps at the back, one big roll bar will not look well, although it is a cheaper option. Two nicely curved roll bars will be attached. These will provide support while entering the car and optional seatbelts can be attached to it. The roll bars are little less high than for a 95% man in straight position. However, at an accident a person will automatically make himself small and the roll bars will provide enough safety.

SPECIFICATIONS
Width: 415 mm
Height: 200 mm
Thickness: 30 mm
Costs: €75 / piece

PRODUCTION
A metal tube must be bent and chromed.

The rollbars and seats fit nicely together.

4.8.10 | SEATS

OPTIONS

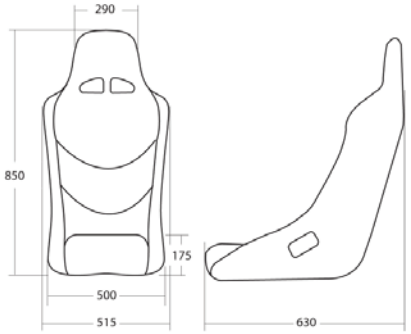
Seat options (http://www.cobraseats.com/clubman).

In order to maintain a more sportive and modern look the seats are different from the MK1. The Cobra Clubman sport seats seem to fit well in the car and its colours can be customized. These seats are also bigger than in the MK1, which is fine since the body is higher and this will give more comfort. A requirement was that the top of the seat is rounded in order to fit in the design of the body. The seat is placed at the same position and same angle so their position have no influence on the sight lines.

SPECIFICATIONS
Costs: ~€300 / chair

PLACING

4.8.11 | HUBCAPS



The driver fits nicely into the car because of the seat design.

Placement of the seat in the interior.

OPTIONS
The following 13 inch hubcaps were selected. The same tires as in the MK1 will be used.
The first option seems to fit the design best for it

Mirror options (Automotive, 2014).

looks modern and sportive, but because of the many thin spokes also a bit more classic.

SPECIFICATIONS
Costs: ~€ 35 / hubcap

Render of the hubcaps.

4.8.12 | OPTIONAL ADDITIONS

SEAT BELTS
In the MK1 no seat belts are attached, this should be done in the next model to provide more safety. Side effect of driving a small and exclusive car is that people will drive more carefully and are therefore more safe already. The seat belts will be connected to the roll bars.

BUMPER
A bumper can prevent damage on the plastic body and offers crease space. A metal bumper is quite labour intensive to make yourself and therefore expensive. Finding an appropriate standard part that fits the right measurements is also quite difficult and a constant long term supply is not guaranteed. A rubber strip is a cheap and simple alternative, however it less strong and does not add up to the sturdy and modern look of the car. A plastic bumper is the third option. However, this requires an extra mall which is very expensive. Mounting the bumper directly behind or underneath the body is also an option of realising impact protection without compromising the vehicles appearance. Bumper options can be investigated further in the future.

WIND DEFLECTOR
A wind deflector can be attached at the back of the car behind the head of the passengers. This will prevent the air flow from going directly into the car. The model has a little gap between the head restraints were this wind deflector can be placed. Downside is that it cannot be a standard design due to geometry, so this will cost relatively much. Because of these downsides and the fact that the body is already quite high no wind deflector is chosen. ■

Final car model render.

4.9 | OVERVIEW OF THE MODEL AND ACCESSORIES

4.9.1 | THE FINAL DESIGN WITH ALL ACCESSORIES

This chapter shows the model with all the accessories and gives a small summary on how the car is perceived and why it fits the target group.

Final car model renders of the model without door.

Final car model renders of the model without door.

Final car model renders of the model with door.

4.9.1| COLOURS AND STICKERS

The colours of the car can be customized, as well as the stickers or optional wrapping. For this model long horizontal stripes are used to enhance the length effect (see chapter 2.2). The stripes are placed in the middle, otherwise they would interfere with the head restraints at the back. In Appendix D.4 the other sticker options and colour options can be found. There is also the option of a wrapping that can cover the seams and make the car real special or usable for marketing purposes.

To get the attention of the target groups the colour schemes must fit their preferences and purpose of use. This can be done by taking a look at colour combinations in products they use. A vintage look fits with the classic appearance of the car and adds style to the design. Vintage colours are mostly pastel colours with a lower saturation and lower brightness. The darker the colour the more serious it will appear. Intense and bright colours grab attention. Most of the time

Colour combinations give the car a total different appearance..

the show room models are coloured in a way that they grab attention, but the more standard coloured versions are the ones sold. The following pictures show possible combinations of car that probably would fit a certain target group. In reality it is possible that people choose a very different car than one would expect. Chapter 2.2.3 explained some colour theories that can be used when choosing the colours of a new model.

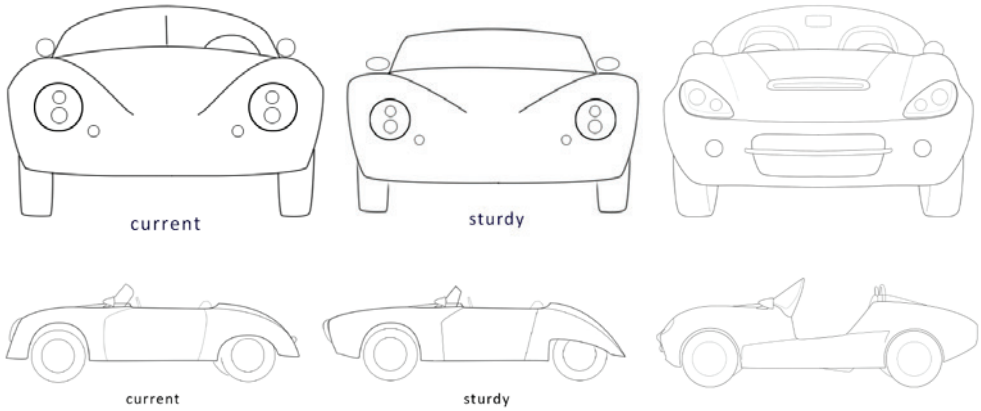
This car looks trustworthy, open, friendly, vintage and has colours of old race cars, this would fit the target group Car lovers.

This car looks serious and trustworthy and would fit the target group Rich people (35-65).

Dark makes the car serious and stylish, this would for example fit Youth or Rich people (35-65).

The colour green reminds of the environmental friendly character of the car, is open and it would be appropiate for Marketeers.

Without stripes the car looks even more serious and normal. It is possible that people perceive stripes as overdone and too striking.



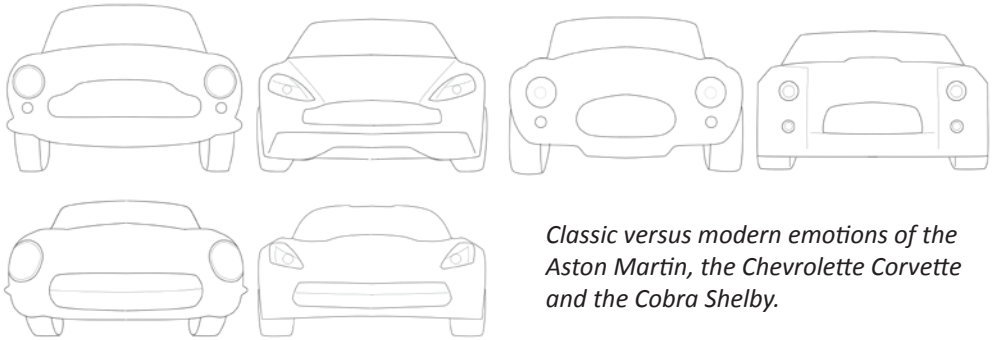
Comparisons between the MK1, sturdy version of the MK1 and the MK2

The pictures show the MK1, a more sturdy version of the MK1 and finally the MK2. The MK2 is a combination of classic and modern design for it has a combination of squared and rounded lines. The headlines and grill give the car a serious, neutral face. These perceptions are based on the theories explained in chapter 2.2.4 and 2.3

Without the stripes the car looks more tranquil and less striking.

4.11.2 | ANALYSIS OF THE NEW MODEL

In chapter 2.4 the MK1 is analysed. This chapter is focussed on the design of the MK2 and the differences between this model and the previous one. In phase 1 and 2 it was stated that a more sturdy version of a car would fit the target group better. A comparison between classic cars and their modern design is made and the following picture (see chapter 4.7) shows that modern versions have a more serious face, more squared lines and look lower, but wider.



Classic versus modern emotions of the Aston Martin, the Chevrolette Corvette and the Cobra Shelby.

Comparisons between a face and the front of the MK2, it shows the same lines used for the expression.

Chapter 2.5 went deeper into the characteristics of the target groups. Important characteristics were: confident, sportive, exclusive, open, strong, striking, adventurous. The lines of the doorstep have the same direction of a confident person, and an open attitude that leans back a little (see the graph next page). The following graph shows how the upward lines in the design make it look open. But the driver is embodied by the window and head restraints, this gives also a feeling of being enclosed. The fact that it is hard to step into the car shows that the driver should be able to do so and must be a bit sportive and adventurous.

The lines of the doorstep are confident and open.

Confident attitude.

Extended version of the MK2: enlarged wheelbase and wheels.

An often heard comment is the wheel base and proportions of the car. Since these are so small the car can look a bit like a toy car. To make the car more serious and sturdy the wheelbase can be enlarged. This will also enlarge the safety perception and luggage space. The following graph shows the effect on a bigger wheelbase. It however makes the car look less like the MK1 and as stated in chapter 2.1.2 it is important that all the products together should strengthen the brand and therefore should not differ too much. Chapter 2.1.3 mentioned that some elements can be made iconic for Carice. For example the race lines on top of the car, the proportions of the car, round characteristics and the overall simplicity of the car design. Carice could also use a certain colour arrangement in their cars (always three colours for the body, race lines, interior and seats). Some accessories in the car can be the same in all the models (mirrors / lights / tires / dashboard / buttons). These options were included in the MK2 design.

One of the hardest parts of this assignment was to design a car body with a sturdy appearance on a small wheelbase. The graph at the right shows a model with an extended wheelbase and bigger wheels. These changes make the car appear more sportive and sturdy and it also reduces the Mickey Mouse effect, since the driver is relatively less big. In Appendix D.7 more renders of this model can be found.

4.11.3 | OPINIONS OF PEOPLE

The perception of the designs were questioned via an online survey. The design of the MK1 and MK2 were compared, also the version of the MK2 with door was compared to the one without door. Furthermore questions about the general expression and expected target group were asked. Appendix D.8 shows the results of this survey.

Extended version of the MK2: enlarged wheelbase and wheels.

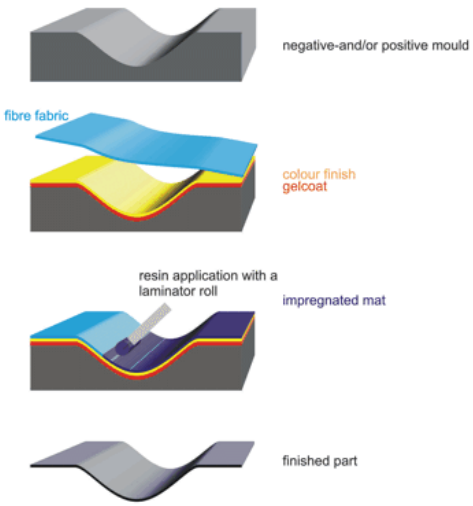
The MK1 was mostly perceived as classic and friendly. The MK2 was mostly perceived as sturdy and sportive. The MK2 was compared with the MK1 and seen as more modern, more sturdy, more robust, more like today's cars, more sportive, more present, more mature, more trendy. Most people though that the target group would probably would be men in the age of 30-60 who have money and like sportive and exclusive cars. The perception of the MK2 in general was quite various. The front was seen as modern as well as very rounded. The back was seen as very special as well as very pointed and big. Most people perceive the car as trendy, funny, simple, modern, nicely detailed, and youthful. Most of the perceptions are surprisingly much the same as formulated in the target group description (chapter 2.5), the design analysis (chapter 2.4 / 4.11) and meet the design requirements (chapter 3.1). ■

4. 9 | PRODUCTION, ASSEMBLING AND COSTS

HOW CAN THE BODY OF THE MK2 BE PRODUCED AND ASSEMBLED AND WHAT ARE THE COSTS?

4.9.1| PREPRODUCTION MODELS.

The car is designed for higher production amounts, however first of all a preproduction model needs to be made. This is done using the hand lay-up method. A mould is made by a milling machine. Impregnated mats are placed on a layer of gel coat within the mould. Finally the body parts can be pulled out. Since the parts are made of polyester they can bend a little, what makes it easier to release them from the mould.
This production method is very labour intensive and therefore expensive, but perfect for the first models.



Hand lay-up method.

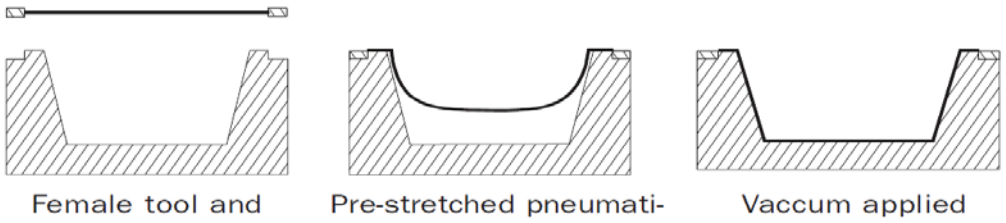
The costs for this method is an estimation based on the MK1 preproduction models. Before the MK2 can go into mass production it needs to be further developed. The quality of the moulds for the MK2 can be relatively low since it will be used for a small amount of cars. The labour costs for a preproduction model are quite high, since the car parts are not fully optimized and require more assembling time. The table shows the estimation for the preproduction model of the MK1. The costs of the preproduction models of the MK2 will be less high since Carice has more expertise and a better network of suppliers.

4.9.2| PRODUCTION NEW MODEL

The vacuum form method is applicable for bigger production amounts. A sheet of material is pulled in a mould and than a vacuum is created. After that the material is cooled and finished. There are many sorts of vacuum forming and the most suitable option have to be found in cooperation with experts. The type of mould depends on the amount of cars produced. A wooden mould could be very suitable for 50 cars. An aluminium mould would have a longer life time and would require less finishing.

COST CALCULATION PREPRODUCTION MODEL MK1 (EDITION OF 10 CARS)			
PART	COST CALCULATION	COSTS	
Body parts (hand-lay-up method)	Includes mold investments	€ 10.000,00	
Accessories outside		€ 1.300,00	
Accessories interior		€ 1.300,00	
Chassis		€ 9.500,00	
Assembling	No man hours included	€ 0,00	Bill of materials
Extra costs		€ 12.000,00	€ 31.100,00
Margin	No profit included	€ 0,00	
Total excl. VAT		**€ 34.100,00**	**(Excl. range extender)**
Total incl. VAT		**€ 41.261,00**	

Rought calculation of the preeproductionmodels, this is an investment period without profit.



Vacuum forming (female model).

This is only one example of all the things need to be taken into attention. A survey of these options is presented to Carice, but not included in this report. Carice will use a ‘female’ or ‘negative’ model ‘, since the surface finish of the outside have to be best. The vacuum form method is very applicable for the model since it is less labour intensive and cheaper when used within bigger production amounts. Since PE cannot be vacuum formed, ABS seems an appropiate material for the MK2 body.

Vacuum forming (female model).

Render of the pieces of the body that need to be vacuum formed.

4.10 | ROOFTOP PROCESS

WHAT ARE CONCEPTS FOR AN OPTIONAL ROOFTOP?

4.10.1 | INTRODUCTION

This chapter focuses on the conptual design of the optional rooftops. Three concepts are shown and globally elaborated. Carice can choose to develop and produce one or more of these concepts and consumers can choose which option they like most.

4.10.2 | REQUIREMENTS

- The window must be strong enough to carry the load
- The window must contain a rain channel
    - So no water will enter the car via the window
    - This should not be seen at front when no rooftop is attached
- The rooftop should be easily attachable to the body
- It should be possible to enter the car when a rooftop is attached
- The rooftop can be stored easily
- The driver must contain a good look at the road

4.10.3 | POSSIBLE SOLUTIONS IN OTHER CARS

There are two main categories of solutions for a rooftop: one that partly covers the rain and one that is totally rain closed. Six options are named with the main arguments pro and con.

PARTLY COVERING

- Targa top (hard part combined with hardtop or soft top)
+ Middle panel is easily attachable
- Requires a permanent hardtop body part on the back of the car

Porsche targa rooftop.

- Small hardtop (swinging hardtop part)
+ Very cheap
- Not a very elegant

Locost rooftop.

- Small soft top
+ Cheap, easy and elegant

TOTAL COVER (RAIN CLOSED)

- Hardtop with wing doors
+ Fully rain closed and fancy appearance
- Complex and most expensive solution

- Soft top with doors
+ Fully rain closed and relatively easy to produce
- Little harder to find a construction that provides an easy entrance of the car

- Targa top with wing doors or soft top parts that swing
+ Solid and middle panel is easily attachable
- Requires a permanent hardtop body part on the back of the car

Burton softtop roof.

Burton hardtop roof.

Lotus softtop roof.

Donkervoort rooftop.

THREE MAIN CONCEPTS

Based on consultation with Carice, three concepts were chosen to be further elaborated: Hardtop (rain closed), small hardtop (partly covering) and a small soft top (partly covering). Carice can decide to produce all of them or produce on request of the customer.

Three main concepts to be further collaborated.

4.11 | FINAL DESIGN OF THE BODY AND ROOFTOP

WHAT ARE THE CHOICES FOR THE CONSUMER AND HOW ARE THEY PERCEIVED?

4.12 | CONCLUSION & RECOMMENDATIONS

WHAT IS THE REFLECTION ON THIS PROJECT AND HOW SHOULD CARICE

5 | REFERENCES

Aggarwal, P., & McGill, A. L. (2007). Is That Car Smiling at Me? Schema Congruity as a Basis for Evaluating Anthropomorphized Products. *Journal of Consumer Research, 34*(4), 468-479.

Automotive, T. (2014). http://www.texautomotive.com/.

Barsalou, L. W. (1999). Perceptual symbol systems. . *Behavioral and Brain Sciences, 22*(4), 577-660.

Brunel, F. F. (2006). Design and the Big Five: Linking Visual Product Aesthetics to Product Personality. *Advances in Consumer Research, 34*, 238-239.

ColorMatters. (2014a). *http://www.colormatters.com/*

Company, B. C. (2009). https://www.youtube.com/watch?v=brqKmC_3xOQ.

Crilly, N., Moultrie, J., & Clarkson, P. J. (2004). Seeing things: consumer response to the visual domain in product design. *Design Studies, 25*(6), 547-577. doi: http://dx.doi.org/10.1016/j.destud.2004.03.001

D-insert: Dutch innovation centre for electric road transport. (2011). Verkenning elektrisch rijden 1-51.

Demirbilek, O., & Sener, B. (2003). Product design, semantics and emotional response. *Ergonomics, 46*(13-14), 1346-1360.

Europese Gemeenschappen. (1977). Richtlijn van de raad betreffende de onderlinge aanpassing van de wetgeving der Lid-Staten inzake het zichtveld van de bestuurder van motorvoertuigen. *Publikatieblad van de Europese Gemeenschappen, CELEX-31977L0649-NL*, 1-22.

Gauthier, I., Skudlarski, P., Gore, J. C., & Anderson, A. W. (2000). Expertise for cars and birds recruits brain areas involved in face recognition. *Nature Neuroscience, 3*(2), 191-197.

Gemeenschappen, E. (1992). Approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers | 70/156/EEC. 1-67.

Govers, Pascalle, C. M., & Mugge, R. (2004). 'I Love My Jeep, Because Its Tough Like Me': The Effect of Product-Personality Congruence on Product Attachment. *Proceedings of the Fourth International Conference on Design and Emotion*.

Hella. (2014). http://www.hella.com/.

Holleman, R. (2013). Carice.

Kapferer, J. N. (2008). The New Strategic Brand Management. *Kogan Page Publishers*, 1-560.

Keaveney, S. M., Herrmann, A., Befurt, R., & Landwehr, J. R. (2012). The eyes have it: How a car's face influences consumer categorization and evaluation of product line extensions. *Psychology and Marketing, 29*(1), 36-51.

Kreuzbauer, R., & Malter, A. J. (2005). Embodied Cognition and New Product Design: Changing Product Form to Influence Brand Categorization. *Product Development & Management Association, 22*, 165–176.

Macdonald, E. K., & Sharp, B. M. (2000). Brand Awareness Effects on Consumer Decision Making for a Common, Repeat Purchase Product: A Replication. *Journal of Business Research, 48*, 5–15.

Macey, S. W., Geoff. (2008). H-point, The fundamentals of car design & packaging. 1-224.

Miesler, L., Leder, H., & Herrmann, A. (2011). Isn't It Cute: An Evolutionary Perspective of Baby-Schema Effects in Visual Product Designs. *International journal of design, 5*(3).

Moon, Y. (2000). Intimate exchanges: Using computers to elicit self-disclosure from consumers. *Journal of Consumer Research, 26*(4), 323-339.

Osgood, C., May, W. H., & Miron, M. S. (1975). Cross-Cultural Universals of Affective Meaning. *University of Illinois Press*.

RDW. (2009). INDIVIDUELE GOEDKEURING 2-3 WIELERS.

Rompay, T. J. L. v. (2008). Product expression-13. Bridging the gap between the symbolic and the concrete. *Elsevier Ltd.*, 333-351.

Scott-Kemmis. (2014b). *http://www.empower-yourself-with-color-psychology.com/meaning-of-colors.html*.

Spares, E. (2014). http://www.europaspares.com/complete-wiper-motor-kit.html.

Sterling, B., & Kevin, K. (2012). The Next Nature Book. 472.

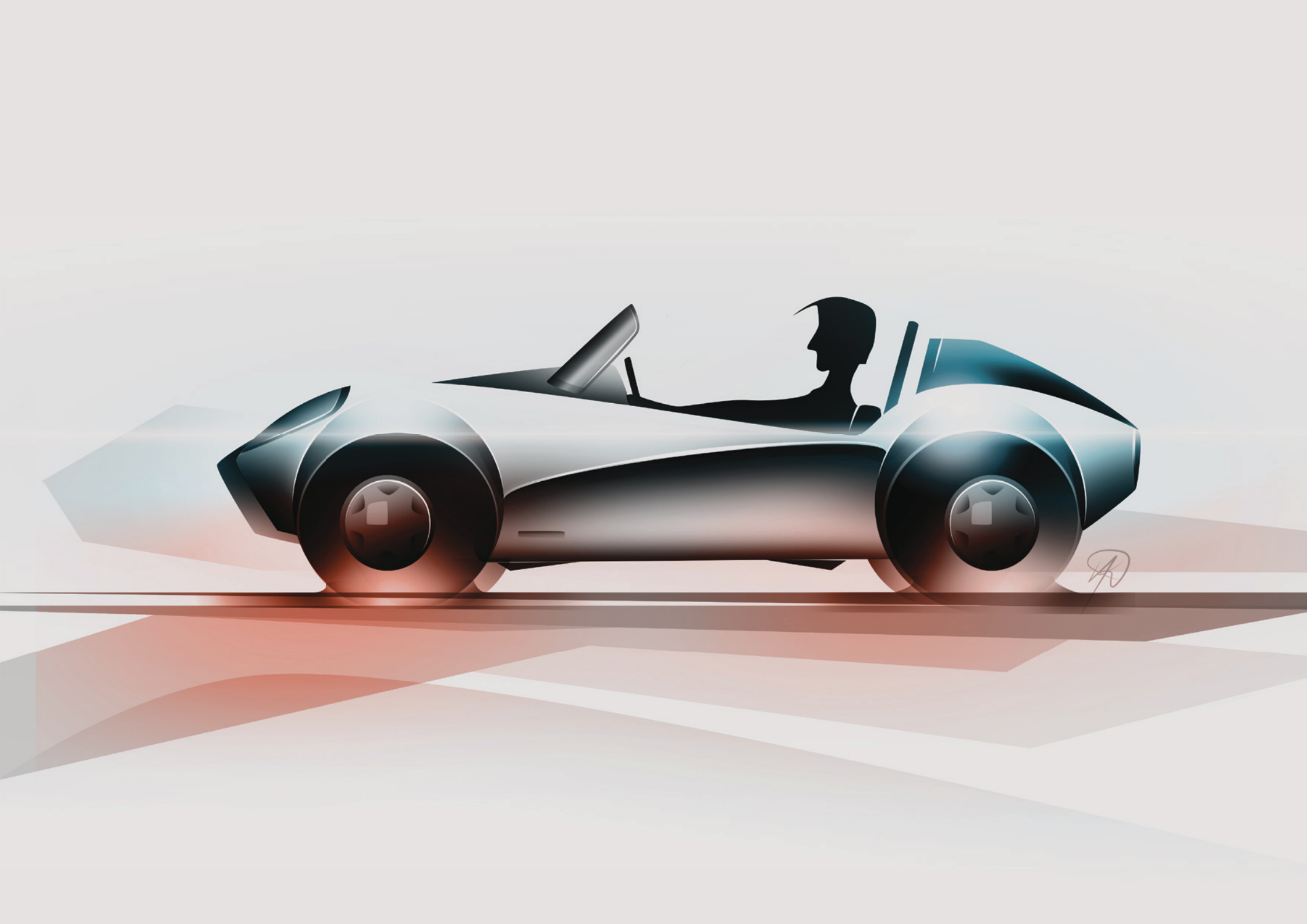
Suijkerbuijk, L. (2013). De lancering van een nieuwe elektrische auto. *Bachelor assignment*, 1-38.

Windhager, S., Bookstein, F. L., Grammer, K., Oberzaucher, E., Said, H., Slice, D. E., Schaefer, K. (2012). "Cars have their own faces": cross-cultural ratings of car shapes in biological (stereotypical) terms. *Evolution and Human Behavior, 33*(2), 109-120. doi: 10.1016/j.evolhumbehav.2011.06.003

Windhager, S., Slice, D. E., Schaefer, K., Oberzaucher, E., Thorstensen, T., & Grammer, K. (2008). Face to face: The perception of automotive designs. *Human Nature, 19*(4), 331-346.

Zaw, T. J. (2013). Relating Shapes to Emotions: Laying the First Steps Towards a New Branding Tool. BMW Antropomorfisme. *Bachelor assignment UTwente*, 1-75.

PART 5 | APPENDIX



APPENDIX A | PART 1 | BACKGROUND OF THE COMPANY AND PRODUCT

A.1 |STEPS FOR A NEW CAR DESIGN BY MACEY AND WARDLE

Source: (Macey, 2008)

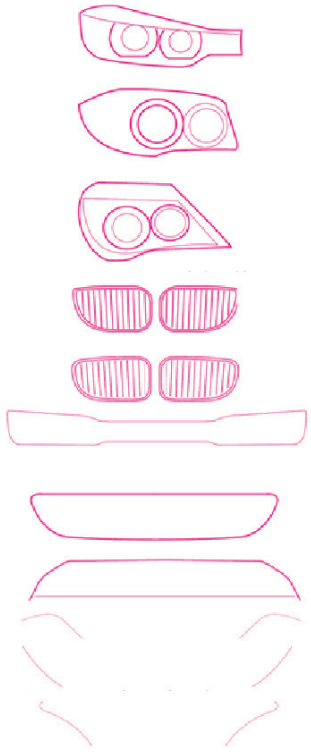
1) Functional objectives. Set out some clear functional objectives for the three entities: customers. brand and market environment.
2) Package ideation. Loosely sketch some basic package concepts based on the functional objectives which drive the architecture.
3) Size and proportions /benchmarking. Choose a direction from the package ideation sketches and establish the size and proportion of that concept. Look again at the functional objectives to see which key dimensions deserve the most focus. Establish some key target dimensions: length, width, height, wheelbase, tires and ground clearance.
4) Occupant packaging. Establish some key target dimensions for each row of occupants.
5) Interior and cargo. Set up the interior environment around the occupants.
6) Powertrain packaging. Select and lay out the propulsion system.
7) Wheels & tires. Establish the wheel and tire sizes for your project and position them in the package. Confirm wheelbase, track, turn circle.
8) Suspension and chassis.
9) Body and exterior features. Determine the body style for your concept and choose a type of construction. Think about the following before making these decisions: The vehicle's purpose and function, annual sales volumes, weight targets, cost, investment, paint, durability, towing capacity, closures and load-carrying capacity.
10) Create a package logic drawing. Compile the information gathered In the previous nine exercises and clearly communicate the package with a clean and graphically appealing drawing.
After all these steps a model can be created, a digital 3d model or a clay model.

APPENDIX B | PART 2 | DESIGN & EMOTION ANALYSIS

B.1 | COMPARISON OF BMW CAR FACES

Zaw (Zaw, 2013) have investigated the influence of BMW design on the perception, taken into account three dimensions: evaluation, potency and activity. These are some conclusions:

- For the dimension activity (blatant / modest) the design of the air intakes were most important.
- Head lights with downwards lines, as well as intern lines that cut the lights are seen as malevolent, strong and blatant.
- Head lights with round lights, without intern lines are judged as good, weak and modest.
- Head lights with a horizontal line show a neutral expression.
- Grilles with horizontal lines, sharp corners are evaluated as malevolent, strong and blatant.
- Grilles with downwards lines from middle to the sides and curved corners are seen as good and modest.
- Sharp and narrow air intakes are judged as malevolent, strong and blatant. This effect is strengthen when the air intakes is narrowed in the middle.
- Rounded air intakes with a wider top are seen as good and modest.
- Air intakes with a smaller top line are seen as weak or negative.
- Upwards shaped curves in the bonnet have a positive expression.
- Downwards shaped curves provoke a strong negative emotion. This effect is emphasised by sharp corners in the lines.



APPENDIX C | PART 3 | LEGISLATION

Based on requirements listed by the RDW (RDW, 2009). The product falls in the category L7e.

C.1 | LICENSE PLATE

Source: (RDW, 2009)

Aan richtlijn 93/94/EEG is voldaan indien de plaats voor de bevestiging van de achterste kentekenplaat voldoet aan de technische eisen van richtlijn 93/94/EEG.

In richtlijn 93/94/EEG staat:
"Afmetingen
De afmetingen van de plaats voor de montage van de achterste kentekenplaat van motorvoertuigen zijn als volgt:
1.3. Driewielers met een maximumvermogen van meer dan 15 kW, lichte vierwielers met carrosserie en andere vierwielers dan lichte vierwielers met carrosserie.
1.3.1. De voorschriften voor personenauto's zijn van toepassing (Richtlijn 70/222/EEG).
Algemene plaatsing
2.1. De plaats voor de montage van de achterste kentekenplaat moet zich aan de achterzijde van het voertuig bevinden, zodanig dat:
2.1.1. de plaat geplaatst kan worden tussen de langsvlakken die gaan door de punten waar het voertuig het breedst is.
Helling
3.1. De achterste kentekenplaat:
3.1.1. moet loodrecht staan op het middenlangsvlak van het voertuig;
3.1.2. mag een helling van ten hoogste 30° ten opzichte van de verticaal hebben wanneer het voertuig niet beladen is, indien de van het kenteken voorziene zijde naar boven gekeerd is;
3.1.3. mag een helling van ten hoogste 15° ten opzichte van de verticaal hebben wanneer het voertuig niet beladen is, indien de van het kenteken voorziene zijde naar beneden gekeerd is;
Maximum hoogte
4.1. Geen enkel punt van de plaats voor de montage van de kentekenplaat mag zich op een hoogte van meer dan 1,50 m boven het wegdek bevinden wanneer het voertuig niet beladen is.
Minimum hoogte
5.1. Geen enkel punt van de plaats voor de montage van de kentekenplaat mag zich op een hoogte van minder dan 0,20 m of de straal van het wiel, indien deze minder bedraagt dan 0,20 m, boven het wegdek bevinden wanneer het voertuig niet beladen is.
Geometrische zichtbaarheid
6.1. De plaats voor de montage van de kentekenplaat moet zichtbaar zijn binnen een ruimte die wordt begrensd door twee tweevlakshoeken: één met een horizontale ribbe en bepaald door twee vlakken die door de boven- en onderrand van de plaats voor de montage van de plaat gaan en onder de in figuur 1 aangegeven hoeken ten opzichte van de horizontaal staan; de andere met een vrijwel verticale ribbe en bepaald door twee vlakken die door de zijranden van de plaat gaan en die onder de in figuur 2 aangegeven hoeken ten opzichte van het middenlangsvlak staan.

C.2 | OBLIGATED AND OPTIONAL LIGHTING

Source: (RDW, 2009)

Schema aanwezige verplichte, facultatieve en verboden verlichting
Bron: 93/92/EEG-2000/73/EG

Some lights can be combined which means that it is the same lighting unit. Other ligths can be build together which means they are placed next to each other.

Verlichtings- en lichtsignaal-inrichtingen	L6e	L7e
Grootlicht	facultatief	verplicht
Dimlicht	verplicht	verplicht
Mistvoorlicht	facultatief	facultatief
Achteruitrijlicht	facultatief	facultatief
Richtingaanwijzer	verplicht (1)	verplicht
Waarschuwings-knipperlicht	facultatief	verplicht
Stoplicht (remlicht)	verplicht	verplicht
Achterkenteken-plaatverlichting	facultatief	verplicht
Breedtelicht (stadslicht)	verplicht	verplicht
Achterlicht	verplicht	verplicht
Mistachterlicht	facultatief	facultatief
Niet-driehoekige achterretroreflector	verplicht	verplicht
Niet-driehoekige voorretroreflector	verboden	verboden
Niet-driehoekige zijretroreflector	facultatief	facultatief
Pedaalretrorefelectoren	verplicht(4)	verboden

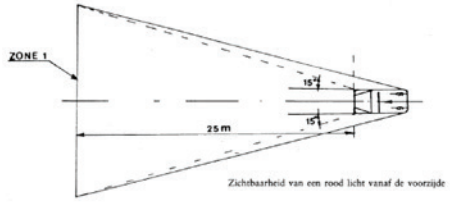
C.3 | GENERAL LIGHTING LEGISLATION

Source: (RDW, 2009)

ALGEMENE VOORSCHRIFTEN
Bron: 93/92/EEG-2000/73/EG

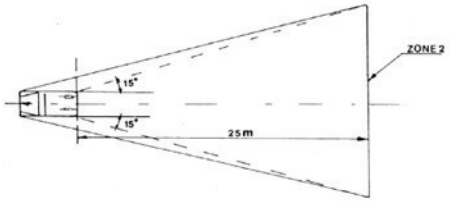
1. De verlichtings- en lichtsignaalinrichtingen moeten zo zijn aangebracht dat zij onder normale gebruiksomstandigheden en ondanks de trillingen waaraan zij kunnen zijn blootgesteld de voorgeschreven kenmerken behouden, en dat het voertuig blijft voldoen aan de voorschriften van deze richtlijn. In het bijzonder moet een onopzettelijk veroorzaakte ontregeling van de lichten uitgesloten zijn.
2. De lichten moeten zo zijn aangebracht dat een juiste instelling van de stand gemakkelijk uitvoerbaar is.
3. Voor alle lichtsignaalinrichtingen moet de referentieas van het op het voertuig aangebrachte licht loodrecht staan op het middenlangsvlak van het voertuig bij zijretroreflectoren en evenwijdig zijn aan dit vlak voor alle andere signaalinrichtingen. Voor alle richtingen is een tolerantie van ± 3° toegestaan. Indien door de fabrikant bijzondere aanwijzingen voor de installatie zijn gegeven, moeten ook deze in acht worden genomen.
4. Behoudens bijzondere voorschriften worden de hoogte en de instelling van de lichten gecontroleerd bij een onbelast voertuig dat op een plat horizontaal vlak rust met het middenlangsvlak verticaal en zijn stuurstang of stuurwiel in de stand van recht vooruitrijden, De bandenspanning moet de spanning zijn die door de fabrikant is voorgeschreven voor de voorgeschreven bijzondere belastingsomstandigheden.
5. Behoudens bijzondere voorschriften moeten de lichten die een stel vormen en dezelfde functie hebben:
5.1. symmetrisch ten opzichte van het middenlangsvlak zijn aangebracht;

5.2. symmetrisch ten opzichte van elkaar en ten opzichte van het middenlangsvlak zijn;
5.3. aan dezelfde colorimetrische voorschriften voldoen;
5.4. dezelfde nominale fotometrische kenmerken bezitten.
6. Behoudens bijzondere voorschriften mogen lichten met verschillende functies afzonderlijk of gegroepeerd, gecombineerd of samengebouwd in een zelfde inrichting voorkomen, mits al deze lichten voldoen aan de desbetreffende voorschriften.
7. De maximumhoogte boven het wegdek wordt gemeten vanaf het hoogste punt van het lichtdoorlatende gedeelte en de minimumhoogte vanaf het laagste punt. Bij de dimlichten wordt de minimumhoogte boven het wegdek gemeten vanaf de onderrand van de lens of van de reflector, indien deze hoger is.
8. Behoudens bijzondere voorschriften mag geen enkel licht knipperen, behalve de richtingaanwijzers en het waarschuwingsknipperlicht.
9. Geen enkel rood licht mag vanaf de voorzijde zichtbaar zijn en geen enkel wit licht vanaf de achterzijde, met uitzondering van het achteruitrijlicht, indien het voertuig daarvan aan de achterzijde is voorzien. Dit wordt als volgt gecontroleerd (zie de tekeningen naar gelang van het type twee- of driewielig voertuig in de aanhangsels 1 van de bijlagen II tot en met VI):
9.1. voor de zichtbaarheid van een rood licht vanaf de voorzijde: een rood licht mag niet rechtstreeks zichtbaar zijn voor een waarnemer die zich verplaatst in zone 1 van een dwarsvlak dat zich op 25 meter voor de totale lengte bevindt;
9.2. voor de zichtbaarheid van een wit licht vanaf de achterzijde: een wit licht mag niet rechtstreeks zichtbaar zijn voor een waarnemer die zich verplaatst in zone 2 van een dwarsvlak dat zich op 25 meter achter de totale lengte bevindt;
9.3. in hun respectieve vlakken worden de door het oog van de waarnemer bestreken zones 1 en 2 begrensd:
9.3.1. in de hoogte door twee horizontale vlakken respectievelijk op 1 m en op 2,20 m boven de grond;
9.3.2. in de breedte door twee verticale vlakken die respectievelijk naar voren en naar achteren een hoek van 15° naar buiten vormen met het middenlangsvlak van het voertuig. In deze vlakken liggen respectievelijk de verticale snijlijnen van de verticale vlakken die evenwijdig aan het middenlangsvlak van het voertuig lopen en de totale breedte begrenzen met de dwarsvlakken die de totale lengte van het voertuig begrenzen.
10. De schakelingen van de elektrische installatie moeten zodanig zijn dat de breedtelichten of, indien er geen breedtelichten aanwezig zijn, de dimlichten, de achterlichten en de achterkentekenplaatverlichting slechts tegelijkertijd kunnen worden ontstoken en gedoofd.
11. Behoudens bijzondere voorschriften moeten de schakelingen van de elektrische installatie zodanig zijn dat het groot licht, het dimlicht en het mistlicht slechts kunnen worden ontstoken als de in punt 10 vermelde lichten eveneens branden. Deze voorwaarde geldt echter niet voor groot licht of dimlicht wanneer dit wordt gebruikt voor lichtsignalen die worden gegeven door het met korte tussenpozen ontsteken en doven van het dimlicht of door het met korte tussenpozen ontsteken van het groot licht, dan wel door het met korte tussenpozen afwisselend.



Zichtbaarheid van een rood licht vanaf de voorzijde

Figuur 1



Zichtbaarheid van een wit licht vanaf de achterzijde

C.4 | HIGH BEAM (GROOT LICHT)

Source: (RDW, 2009)

Bijzondere installatievoorschriften grootlicht
Bron: 93/92/EEG-2000/73/EG

13 Kleur
wit
6.1.3. Plaats
6.1.3.1. In de breedterichting:
- een afzonderlijk groot licht mag boven, onder of naast een ander voorlicht worden geïnstalleerd; indien het ene licht zich boven het andere bevindt, moet het referentiepunt van het groot licht zich in het middenlangsvlak van het voertuig bevinden; indien de lichten naast elkaar geplaatst zijn, moeten hun referentiepunten symmetrisch ten opzichte van het middenlangsvlak van het voertuig zijn;
- een met een ander voorlicht samengebouwd groot licht moet zo zijn geïnstalleerd dat het referentiepunt daarvan zich in het middenlangsvlak van het voertuig bevindt; indien het voertuig echter tevens is voorzien van een afzonderlijk dimlicht dat naast het groot licht is geïnstalleerd, moeten hun referentiepunten symmetrisch ten opzichte van het middenlangsvlak van het voertuig zijn;
- twee grote lichten, waarvan een of beide met een ander voorlicht is (zijn) samengebouwd, moeten zo zijn geïnstalleerd dat hun referentiepunten symmetrisch ten opzichte van het middenlangsvlak van het voertuig zijn.
6.1.3.2. In de lengterichting:
aan de voorzijde van het voertuig. Aan deze eis wordt geacht te zijn voldaan, indien de bestuurder noch rechtstreeks noch indirect via de achteruitkijkspiegels en/of andere lichtweerkaatsende oppervlakken van het voertuig hinder ondervindt van het uitgestraalde licht.
6.1.3.3. Bij een afzonderlijk groot licht mag de afstand tussen de rand van het lichtdoorlatende gedeelte daarvan en de rand van dat van het dimlicht in geen geval meer dan 200 mm bedragen per stel lichten.
6.1.4. Geometrische zichtbaarheid
De zichtbaarheid van het lichtdoorlatende gedeelte, ook in velden die niet verlicht lijken vanuit de betreffende waarnemingsrichting, moet gewaarborgd zijn binnen een divergerende ruimte die begrensd wordt door beschrijvende lijnen die uitgaan van de gehele omtrek van het lichtdoorlatende gedeelte en die een hoek van minstens 5° maken met de referentieas van het koplicht. Als oorsprong van de geometrische zichtbaarheidshoeken moet worden beschouwd de omtrek van de projectie van het lichtdoorlatende gedeelte op een dwarsvlak dat raakt aan het voorste gedeelte van de lens van het groot licht.
6.1.5. Richting:
naar voren. Mag draaien naar gelang van de draaiing van de stuurinrichting.
6.1.6. Mag gegroepeerd zijn met het dimlicht en de overige voorlichten.
6.1.7. Mag niet gecombineerd zijn met een ander licht.
6.1.8. Mag samengebouwd zijn:
6.1.8.1. met het dimlicht;
6.1.8.2. met het breedtelicht;
6.1.8.3. met het mistvoorlicht.
6.1.9. Elektrische schakeling
Het ontsteken van de lichten voor groot licht moet gelijktijdig plaatsvinden.
Bij de overgang van gedimde lichtbundels naar ongedimde lichtbundels is het ontsteken van alle lichten voor groot licht vereist. Bij de overgang van ongedimde lichtbundels naar gedimde lichtbundels moeten

alle lichten voor groot licht gelijktijdig worden gedoofd. Het dimlicht mag tegelijk met het groot licht blijven branden.

C.5 | LOW BEAM (DIMLICHT)

Source: (RDW, 2009)

Bijzondere installatievoorschriften dimlicht
Bron: 93/92/EEG-2000/73/EG

"6.2 DIMLICHT
6.2.1. Aantal:
één of twee. Voor driewielers, waarvan de grootste breedte meer dan 1 300 mm bedraagt, zijn echter twee dimlichten vereist.
13 Kleur
wit
6.2.3. Plaats
6.2.3.1. In de breedterichting:
- een afzonderlijk dimlicht mag boven, onder of naast een andere voorlicht worden geïnstalleerd; indien het ene licht zich boven het andere bevindt, moet het referentiepunt van het dimlicht zich bevinden in het middenlangsvlak van het voertuig; indien de lichten naast elkaar geplaatst zijn, moeten hun referentiepunten symmetrisch ten opzichte van het middenlangsvlak zijn;
- een met een ander voorlicht samengebouwd dimlicht moet zo zijn geïnstalleerd dat zijn referentiepunt zich in het middenlangsvlak van bevindt; indien echter tevens is voorzien van een afzonderlijk groot licht dat naast het dimlicht is geïnstalleerd, moeten hun referentiepunten symmetrisch ten opzichte van het middenlangsvlak van zijn.
- twee dimlichten, waarvan een of beide samengebouwd is (zijn) met een ander voorlicht, moeten zo zijn geïnstalleerd dat hun referentiepunten symmetrisch zijn ten opzichte van het middenlangsvlak van het voertuig.
Indien een voertuig twee dimlichten heeft:
- mogen de randen van de lichtdoorlatende gedeelten die het verst van het middenlangsvlak van het voertuig zijn verwijderd, zich op niet meer dan 400 mm van het punt van de grootste breedte van het voertuig bevinden;
- moeten de binnenranden van de lichtdoorlatende gedeelten zich op een afstand van minstens 500 mm bevinden. Deze afstand mag worden verminderd tot 400 mm indien de grootste breedte van het voertuig minder dan 1300 mm bedraagt.
6.2.3.2. In de hoogterichting:
minimaal 500 mm, maximaal 1 200 mm boven het wegdek.
6.2.3.3. In de lengterichting:
aan de voorzijde van het voertuig. Aan deze eis wordt geacht te zijn voldaan, indien de bestuurder noch rechtstreeks noch indirect via de achteruitkijkspiegels en/of andere lichtweerkaatsende oppervlakken van het voertuig hinder ondervindt van het uitgestraalde licht.
6.2.4. Geometrische zichtbaarheid
Deze wordt bepaald door de hoeken a en b zoals aangeven in de algemene bepalingen onder 10:
a = 15° naar boven en 10° naar beneden;
b= 45° links en 45° rechts, indien er één enkel dimlicht is;
45° naar buiten en 10° naar binnen, indien er twee dimlichten zijn.
Plaatdelen of andere uitrustingsstukken in de buurt van het koplicht mogen geen nevenwerkingen veroorzaken die hinder opleveren voor andere weggebruikers.
6.2.5. Richting:
naar voren.
Mag draaien naar gelang van de draaiing van stuurinrichting. De verticale helling van de dimlichtbundels moet tussen -;0,5 % en -;2,5 % blijven, tenzij er een externe regelinrichting is geïnstalleerd.
6.2.6. Mag gegroepeerd zijn met het groot licht en de overige voorlichten.
6.2.7. Mag niet gecombineerd zijn met een ander licht.
6.2.8. Mag samengebouwd zijn met het groot licht en de overige voorlichten.
6.2.9. Elektrische schakeling
Met het bedieningsorgaan voor de overschakeling op dimlicht moet tegelijkertijd het groot licht kunnen worden gedoofd, terwijl het dimlicht tegelijk met het groot licht mag aanblijven.
6.2.10. Inschakelverklikkerlicht:
facultatief. Niet-knipperend groen signaleringslampje."

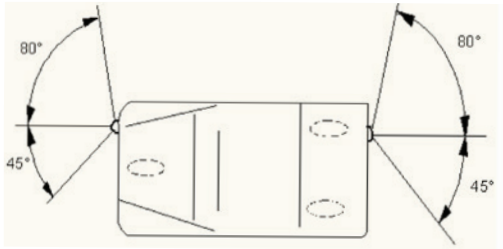
C.6 | INDICATOR (RICHTINGAANWIJZER)

Source: (RDW, 2009)

Bijzondere installatievoorschriften richtingaanwijzers
Bron: 93/92/EEG-2000/73/EG

6.3.1. Aantal:
twee aan elke kant.
13 Kleur
ambergeel
6.3.2. Installatieschema:
twee voorrichtingaanwijzers en twee achterrichtingaanwijzers.
6.3.3. Plaats
6.3.3.1. In de breedterichting:
- de randen van de lichtdoorlatende gedeelten die het verst van het middenlangsvlak van het voertuig zijn verwijderd mogen zich op niet meer dan 400 mm van het punt van de grootste breedte van het voertuig bevinden;
- de binnenranden van de lichtdoorlatende gedeelten moeten zich op een afstand van minstens 500 mm bevinden;
- tussen de lichtdoorlatende gedeelten van de richtingaanwijzers en van de dimlichten die zich het dichtstbij bevinden moet er een onderlinge minimumafstand zijn van:
- 75 mm indien de richtingaanwijzer een minimale lichtsterkte heeft van 90 cd;
- 40 mm indien de richtingaanwijzer een minimale lichtsterkte heeft van 175 cd;
- 20 mm indien de richtingaanwijzer een minimale lichtsterkte heeft van 250 cd;
- kleiner of gelijk aan 20 mm indien de richtingaanwijzer een minimale lichtsterkte heeft van 400 cd.
6.3.3.2. In de hoogterichting:
minimaal 350 mm, maximaal 1 500 mm boven het wegdek.
6.3.4. Geometrische zichtbaarheid
Horizontale hoeken:

Verticale hoeken: 15° boven en onder het horizontale vlak.
De verticale hoek onder het horizontale vlak mag echter tot 5° zijn verkleind, indien de hoogte van de lichten minder dan 750 mm bedraagt.



6.3.5. Richting
De voorrichtingaanwijzers mogen draaien naar gelang van de draaiing van de stuurinrichting.
6.3.6. Mogen gegroepeerd zijn met een of meer lichten.
6.3.7. Mogen niet gecombineerd zijn met een ander licht.
6.3.8. Mogen niet samengebouwd zijn met een ander licht.
6.3.9. Elektrische schakeling
Het inschakelen van de richtingaanwijzers moet onafhankelijk van de ontsteking van de andere lichten gebeuren. Alle richtingaanwijzers die zich aan dezelfde zijde van het voertuig bevinden worden met dezelfde schakelaar bediend.
6.3.10. Verklikkersignaal voor de werking:
facultatief. Het kan optisch en/of akoestisch zijn. Een optisch signaal moet groen zijn en knipperen; het moet onder alle normale rijomstandigheden zichtbaar zijn; het moet uitgaan of aanblijven zonder te knipperen of een duidelijk waarneembare frequentiewijziging vertonen, indien een van de richtingaanwijzers niet goed functioneert. Een akoestisch signaal moet duidelijk hoorbaar zijn en in dezelfde omstandigheden functioneren als het optische signaal.
6.3.11. Overige voorschriften
Bij meting van de hieronder vermelde kenmerken mag de stroomgenerator uitsluitend belast zijn met de voeding van de circuits die nodig zijn voor de werking van de motor en de verlichtingsinrichtingen.
6.3.11.1. Na inschakeling van het lichtsignaal moet het licht binnen een seconde aangaan en binnen anderhalve seconde voor de eerste maal uitgaan.
6.3.11.2. Bij alle voertuigen met richtingaanwijzers die op gelijkstroomwerken moet:
de knipperfrequentie van het licht 90 ± 30 perioden per minuut bedragen;
het knipperen van de richtingaanwijzers die zich aan dezelfde zijde van het voertuig bevinden met dezelfde frequentie en in fase gebeuren.
6.3.11.3. Wanneer, bij voertuigen waarvan de richtingaanwijzers op wisselstroom werken het toerental van de motor ligt tussen de 50 en 100 % van het met de maximumsnelheid van het voertuig overeenkomende toerental:
moet de knipperfrequentie van het licht 90 ± 30 perioden per minuut bedragen;
mag het knipperen van de richtingaanwijzers die zich aan dezelfde zijde van het voertuig bevinden gelijktijdig of afwisselend gebeuren. De voorlichten mogen niet vanaf de achterzijde zichtbaar zijn en de achterlichten mogen niet vanaf de voorzijde zichtbaar zijn binnen de in aanhangsel 1 gedefinieerde zones.
6.3.11.4. Wanneer, bij voertuigen waarvan de richtingaanwijzers op wisselstroom werken, het motortoerental ligt tussen het door de constructeur opgegeven stationaire toerental en 50 % van het toerental bij maximumsnelheid van het voertuig:
. moet de knipperfrequentie van het licht liggen tussen 90 + 30 en 90 - 45 perioden per minuut;
mag het knipperen van de richtingaanwijzers die zich aan dezelfde zijde van het voertuig bevinden gelijktijdig of afwisselend gebeuren. De voorlichten mogen niet vanaf de achterzijde zichtbaar zijn en de achterlichten mogen niet vanaf de voorzijde zichtbaar zijn binnen de in aanhangsel 1 gedefinieerde zones.
6.3.11.5. Wanneer een richtingaanwijzer door een andere oorzaak dan kortsluiting defect is, moet het andere knipperlicht blijven knipperen of ontstoken blijven, maar in dat geval mag de frequentie afwijken van die welke is voorgeschreven.”

C.7 | HAZARD LIGHTS (WAARSCHUWINGSKNIPPERLICHT)

Same as indicator lights.

C.8 | BRAKE LIGHTS (STOPLICHT)

Source: (RDW, 2009)

Bijzondere installatievoorschriften stoplicht
Bron: 93/92/EEG-2000/73/EG

6.4.1. Aantal:
één of twee.
Voor driewielers met een grootste breedte van meer dan 1 300 mm zijn echter twee stoplichten vereist.
13 Kleur
rood
6.4.3. Plaats
6.4.3.1. In de breedterichting:
indien er één enkel stoplicht is, moet het referentiepunt
zich bevinden in het middenlangsvlak van het voertuig; indien er twee stoplichten zijn, moeten deze symmetrisch ten opzichte van het middenlangsvlak zijn.
Bij voertuigen met twee achterwielen moet de afstand tussen beide lichten minstens 600 mm bedragen. Deze afstand mag zijn verkleind tot 400 mm, indien het voertuig nergens breder is dan 1300 mm.
6.4.3.2. In de hoogterichting:
minimaal 250 mm, maximaal 1500 mm boven het wegdek.
6.4.3.3. In de lengterichting:
aan de achterzijde van het voertuig.
6.4.4. Geometrische zichtbaarheid
Horizontale hoek: 45° links en 45° rechts.
Verticale hoek: 15° boven en onder het horizontale vlak. De verticale hoek onder het horizontale vlak mag echter zijn verkleind tot 5°, indien de hoogte van het licht minder dan 750 mm bedraagt.
6.4.5. Richting:
naar achteren.
6.4.6. Mag gegroepeerd zijn met een of meer andere lichten aan de achterzijde.
6.4.7. Mag niet gecombineerd zijn met een ander licht.
6.4.8. Mag samengebouwd zijn met het achterlicht.
6.4.9. Elektrische schakeling:
moet gaan branden, wanneer ten minste een van de bedrijfsremmen wordt bediend.
6.4.10. Inschakelverklikkerlicht:
verboden”

C.9 | LICENSE PLATE LIGHTING BACK SIDE

Source: (RDW, 2009)

Bijzondere installatievoorschriften achterkentekenplaatverlichting
Bron: 93/92/EEG-2000/73/EG

6.11.1. Aantal:
één.
De inrichting kan bestaan uit verschillende optische elementen die ertoe bestemd zijn de plaats van de plaat te verlichten.
13 Kleur
Wit
6.11.3 Plaats
In de breedterichting:
Zodanig dat de inrichting de voor de kentekenplaat bestemde plaats verlicht
In de hoogterichting:
Zodanig dat de inrichting de voor de kentekenplaat bestemde plaats verlicht
In de lengterichting:
Zodanig dat de inrichting de voor de kentekenplaat bestemde plaats verlicht
Richting
6.11.6. Mag met een of meer lichten aan de achterzijde zijn gegroepeerd.
6.11.7. Mag gecombineerd zijn met het achterlicht.
6.11.8. Mag niet zijn samengebouwd met een ander licht.

C.10 | FRONT POSITION LIGHT (BREEDTELICHT OF STADSLICHT)

Source: (RDW, 2009)

Bijzondere installatievoorschriften breedtelicht
Bron: 93/92/EEG-2000/73/EG

13 Kleur
wit.
6.5.3. Plaats
6.5.3.1. In de breedterichting:
- een breedtelicht mag boven, onder of naast een ander voorlicht worden geïnstalleerd; indien het ene licht zich boven het andere bevindt, moet het referentiepunt van het breedtelicht zich in het middenlangsvlak van het voertuig bevinden; indien de lichten naast elkaar geplaatst zijn, moeten de referentiepunten symmetrisch ten opzichte van het middenlangsvlak van het voertuig zijn;
- een met een ander voorlicht samengebouwd breedtelicht moet zo zijn geïnstalleerd dat zijn referentiepunt zich in het middenlangsvlak van het voertuig bevindt;
- indien er twee breedtelichten zijn, waarvan een of beide samengebouwd is (zijn) met een ander voorlicht, moeten deze zo zijn geïnstalleerd dat hun referentiepunten symmetrisch ten opzichte van het middenlangsvlak van het voertuig zijn.
Indien een voertuig twee dimlichten heeft:
- mogen de randen van de lichtdoorlatende gedeelten die het verst van het middenlangsvlak van het voertuig zijn verwijderd, zich op niet meer dan 400 mm van het punt van de grootste breedte van het voertuig bevinden;
- moeten de binnenranden van de lichtdoorlatende gedeelten zich op minstens 500 mm afstand bevinden. Deze afstand mag tot 400 mm zijn verkleind, indien het voertuig nergens breder is dan 1 300 mm.
6.5.3.2. In de hoogterichting:
minimaal 350 mm, maximaal 1200 mm boven het wegdek.
6.5.4. Geometrische zichtbaarheid
Horizontale hoek: 80° links en 80° rechts, indien er één enkel breedtelicht is; 80° naar buiten en 45° naar binnen, indien er twee breedtelichten zijn. Verticale hoek: 15° boven en onder het horizontale vlak. De verticale hoek onder het horizontale vlak mag evenwel zijn verkleind tot 5°, indien de hoogte van het licht minder dan 750 mm bedraagt.
6.5.5. Richting:
naar voren. Mag draaien naar gelang van de draaiing van de stuurinrichting.
6.5.6. Mag gegroepeerd zijn met elk ander voorlicht.
6.5.7. Mag samengebouwd zijn met elk ander voorlicht.

C.11 | TAIL LIGHT (ACHTERLICHT)

Source: (RDW, 2009)

Bijzondere installatievoorschriften achterlicht
Bron: 93/92/EEG-2000/73/EG

6.6.1. Aantal:
één of twee. Voor driewielers met een grootste breedte van meer dan 1 300 mm zijn echter twee achterlichten vereist.
13 Kleur
rood.
6.6.3. Plaats
6.6.3.1. In de breedterichting:
indien er één enkel achterlicht is moet het referentiepunt zich in het middenlangsvlak van het voertuig bevinden; indien er twee achterlichten zijn, moeten de referentiepunten symmetrisch ten opzichte van het middenlangsvlak van het voertuig zijn. Bij voertuigen met twee achterwielen moet de afstand tussen beide lichten minstens 600 mm zijn. Deze afstand mag zijn verkleind tot 400 mm, indien het voertuig nergens breder is dan 1300 mm.
6.6.3.2. In de hoogterichting:
minimaal 250 mm, maximaal 1500 mm boven het wegdek.
6.6.3.3. In de lengterichting:
aan de achterzijde van het voertuig.
6.6.4. Geometrische zichtbaarheid
Horizontale hoek: 80° links en 80° rechts, indien er één enkel achterlicht is; 80° naar buiten en 45° naar binnen, indien er twee achterlichten zijn. Verticale hoek: 15° boven en onder het horizontale vlak. De verticale hoek onder het horizontale vlak mag echter tot 5° zijn verkleind, indien de hoogte van het licht minder dan 750 mm bedraagt.
6.6.5. Richting:
naar achteren.
6.6.6. Mag gegroepeerd zijn met ieder ander licht aan de achterzijde.
6.6.7. Mag gecombineerd zijn met de achterkentekenplaatverlichting.
6.6.8. Mag samengebouwd zijn met het stoplicht of de niet-driehoekige achterretroreflector, of met

beide, dan wel met het mistachterlicht.
6.6.9. Elektrische schakeling:
geen bijzondere bepalingen.
6.6.10. Inschakelverklikkerlicht:
facultatief. De functie

C.12 | RETRO REFLECTOR NON TRIANGULAR (NIET DRIEHOEKIGE ACHTERREFLECTOR)

Source: (RDW, 2009)

Bijzondere installatievoorschriften niet driehoekige achterretroreflector
Bron: 93/92/EEG-2000/73/EG

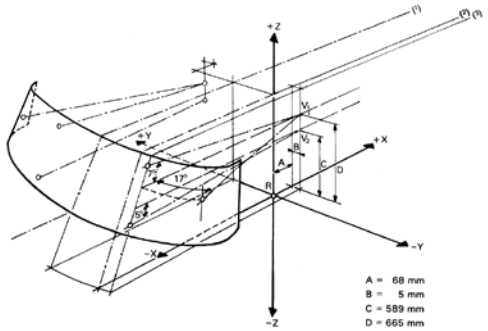
13 Kleur
rood
6.12.3. Plaats
6.12.3.1. In de breedterichting:
indien er één enkele retroreflector is, moet het referentiepunt zich in het middenlangsvlak van het voertuig bevinden; indien er twee retroreflectoren zijn, moeten deze symmetrisch ten opzichte van het middenlangsvlak van het voertuig zijn. Indien een voertuig twee achterretroreflectoren heeft, mogen de randen van het lichtdoorlatende gedeelte die het verst van het middenlangsvlak van het voertuig verwijderd zijn zich niet verder dan 400 mm van het buitenste deel van het voertuig bevinden. De binnenranden van de retroreflectoren moeten zich op een afstand van minstens 500 mm bevinden. Deze afstand mag zijn verkleind tot 400 mm, indien het voertuig nergens breder is dan 1 300 mm.
6.12.3.2. In de hoogterichting:
minimaal 250 mm, maximaal 900 mm boven het wegdek.
6.12.3.3. In de lengterichting:
aan de achterzijde van het voertuig.
6.12.4. Geometrische zichtbaarheid
Horizontale hoeken: 30° links en 30° rechts.
Verticale hoeken: 15° boven en onder het horizontale vlak.
De verticale hoek onder het horizontale vlak mag echter zijn verkleind tot 5°, indien de hoogte van de retroreflector minder dan 750 mm bedraagt.
6.12.5. Richting:
naar achteren.
6.12.6. Mag gegroepeerd zijn met ieder ander licht.
6.12.7. Overige voorschriften:
het lichtdoorlatende gedeelte van de retroreflector mag bepaalde delen gemeen hebben met dat van elk ander rood licht aan de achterzijde."

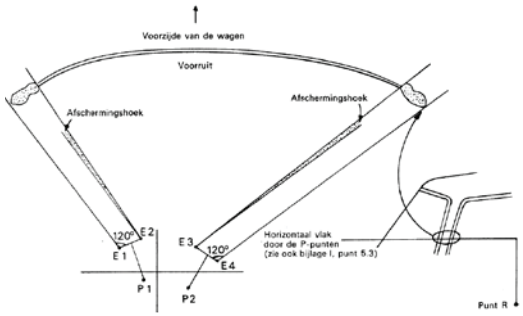
C.13 | SIGHTLINES

Source: (Europese Gemeenschappen, 1977)

The following graphs show the obligated sightlines (Europese Gemeenschappen, 1977). These lines are based on the H, V, R and P points, which are based on measurements of the current chassis and chair position.

A car with a (optional) rooftop should have a window which satisfies these sightlines. When the car does not have a roof a windshield can be used, which can therefore be smaller.





1) Correction because of the angle of the chair
30 degrees -> correction: +43 mm in X direction and -14 mm in Z direction
2) Determine R-point, which is the H-point (axis of the hip) in most backward chair position.
Distance middle of the back wheel to R-point: 650 mm
Distance ground to R-point: 350 mm
3) Determine V-point

Punt V	X	Y	Z
V_1	68 mm	— 5 mm	665 mm
V_2	68 mm	— 5 mm	589 mm

Total of V-point with corrections.

Punt v	X	Y	Z
V1 (corrected)	68+43=111	-5	665-14=651
V2 (corrected)	68+43=111	-5	589-14=575

The total of the R-points, V-points and obligated angles form the sightlines.

C.14 | SIDE MIRRORS

Source: (RDW, 2009)

Bijzondere installatievoorschriften achterlicht
Bron: 97/24/EG-2006/27/EG
Plaats
1.1. Achteruitkijkspiegels moeten zo bevestigd zijn dat zij in normale rijomstandigheden goed vast blijven zitten.
1.2. Bij voertuigen zonder carrosserie moet(en) de achteruitkijkspiegel(s) zodanig worden gemonteerd of ingesteld dat de afstand van het midden van het naar buiten toe spiegelend oppervlak tot het middenlangsvlak van het voertuig minstens 280 mm bedraagt. Voor de meting moet het stuur in de stand blijven die overeenkomt met verplaatsing van het voertuig in rechte lijn en moet(en) de achteruitkijkspiegel(s) in de normale gebruiksstand worden gezet.
1.3. Achteruitkijkspiegels moeten zodanig zijn geplaatst dat de bestuurder, in normale houding achter het stuur, de weg achter en naast het voertuig duidelijk kan overzien.

1.4. Buitenspiegels moeten zichtbaar zijn door het gedeelte van de voorruit dat door de ruitenwisser wordt bestreken, of door de zijruiten.
1.5. (....)
1.6. De voor de zijde van de bestuurder voorgeschreven buitenspiegel moet zodanig zijn aangebracht dat de hoek tussen het verticale vlak door de lengte-as van het voertuig en het verticale vlak door het midden van de spiegel en door het midden van het 65 mm lange lijnstuk dat de oogpunten van de stuurder verbindt, niet groter is dan 55.
1.7. Buitenspiegels mogen niet aanzienlijk verder buiten het profiel van het voertuig uitsteken dan noodzakelijk is om de in punt 4 omschreven gezichtsvelden te verkrijgen.
1.8. Indien de onderkant van een buitenspiegel zich bij een voertuig, waarvan de belasting overeenkomt met de technisch toelaatbare massa, op minder dan 2 m boven de grond bevindt, mag deze spiegel niet verder dan 0,20 m uitsteken buiten de uiterste breedte van het voertuig gemeten zonder achteruitkijkspiegel.
1.9. Onder de in de punten 1.7 en 1.8 vermelde omstandigheden mogen de maximaal toegestane breedten van de voertuigen door de achteruitkijkspiegels worden overschreden.
Aantal
2.2. Verplicht minimumaantal achteruitkijkspiegels bij voertuigen met carrosserie
Bromfiets op 3 wielen (met inbegrip van lichte vierwielers) en driewieler
1(1)
1 indien een binnenspiegel aanwezig;
2 indien geen binnenspiegel aanwezig
(1) De binnenspiegel is niet vereist indien niet aan de in onderstaand punt 4.1 bedoelde zichtbaarheidsvoorwaarden kan worden voldaan. In dat geval zijn twee buitenspiegels verplicht, de een links en de ander rechts aan het voertuig.
2.3. Wanneer het voertuig slechts ,,één buitenspiegel heeft, moet deze op de linkerkant van het voertuig worden gemonteerd in lidstaten met rechts verkeer en op de rechterkant van het voertuig in lidstaten met links verkeer.

C.15 | WINDOW

Source: (RDW, 2009)

Ruiten, ruitenwissers, ruitensproeiers en ontdooiings- en ontwasemingsinrichtingen, van bromfietsen op drie wielen, driewielers en vierwielers met carrosserie
Bron: 97/24/EG

1. Het materiaal van de ruiten van het voertuig bestaat uit gehard of gelaagd glas, of kunststof, dat bij breuk minder kans geeft op ernstige verwondingen dan bij breuk van gewoon glas. Dit wordt vastgesteld door middel van visuele controle. Bij een fabrieksmatig vervaardigd voertuig wordt geacht hieraan te zijn voldaan; indien noodzakelijk wordt er een nader onderzoek ingesteld.
2. De lichtdoorlaatbaarheid van de voorruit en de ruiten van de voorste portieren gelegen voor de oogpunten van de bestuurder mag niet minder bedragen dan 75% respectievelijk 70%. Dit wordt gecontroleerd met een lichtdoorlaatbaarheidsmeter.
3. Voor wat betreft de voorruit en de ruiten van de voorste portieren gelegen voor de oogpunten van de bestuurder mag er geen beeldvertekening optreden. Dit wordt vastgesteld door middel van visuele controle.
4. Voor wat betreft de achterruit mag er geen beeldvertekening optreden indien geen rechterbuitenspiegel is gemonteerd. Dit wordt vastgesteld door middel van visuele controle.
5. Een voertuig met een voorruit moet zijn voorzien van een geschikte ruitensproei- en ruitenwisinrichting en een geschikte ontdooiings- en ontwasemingsinrichting. Dit wordt vastgesteld door middel van visuele controle. Stel vast of de inrichting warme lucht op de voorruit blaast dan wel op andere wijze de voorruit verwarmt.

C.16 | Sharp edges
Source: (RDW, 2009)

Scherpe uitwendige delen
Bron: 97/24/EG-2006/27/EG

Wijze van keuren individuele goedkeuring:
Aan richtlijn 97/24/EG is voldaan indien het voertuig, voor wat betreft scherpe uitwendige delen, voldoet aan de technische eisen van richtlijn 97/24/EG, hoofdstuk 3.
Dit wordt vastgesteld door middel van visuele controle. Indien de RDW het noodzakelijk acht wordt er volgens de richtlijn gemeten en getest.

Samenvatting:
In richtlijn 97/24/EG worden eisen gesteld aan scherpe uitwendige delen van een voertuig. Deze richtlijn schrijft voor op welke wijze het voertuig moet worden getest indien visuele controle niet volstaat. De test kan op het RDW testcentrum worden uitgevoerd. Samengevat beschrijft de richtlijn een test waarbij het beproevingstoestel (bol) langs het voertuig wordt bewogen. De specifieke testvoorwaarden zijn te vinden in de richtlijn.

C.17 | APPROACH ANGLE

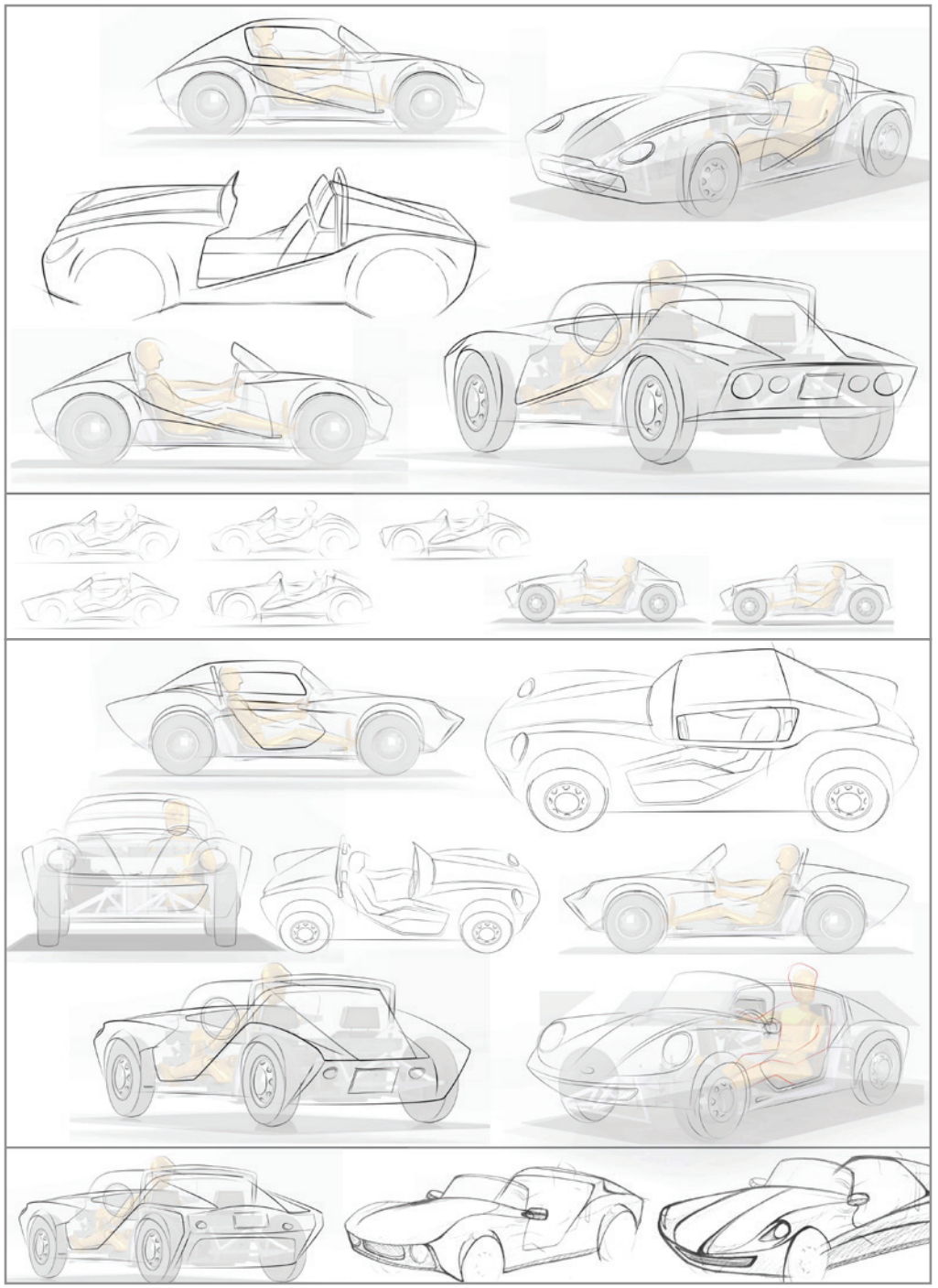
Source: (Gemeenschappen, 1992)

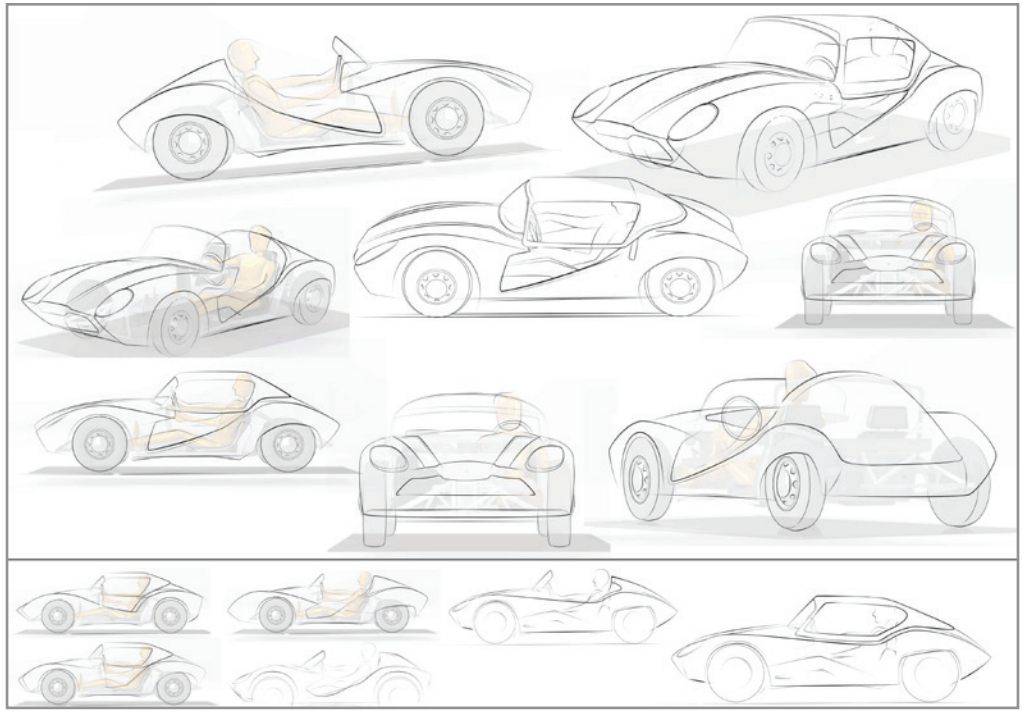
4.5.1. ‘Approach angle’ means the maximum angle between the ground plane and planes tangential to the tyres of the front wheels, under a static load, such that no point of the vehicle ahead of the front axle is situated below these planes and no rigid part of the vehicle, with the exception of any steps, is situated below these planes.
Approach angle with a 20% gradient from mid axis is obligated for M vehicles.

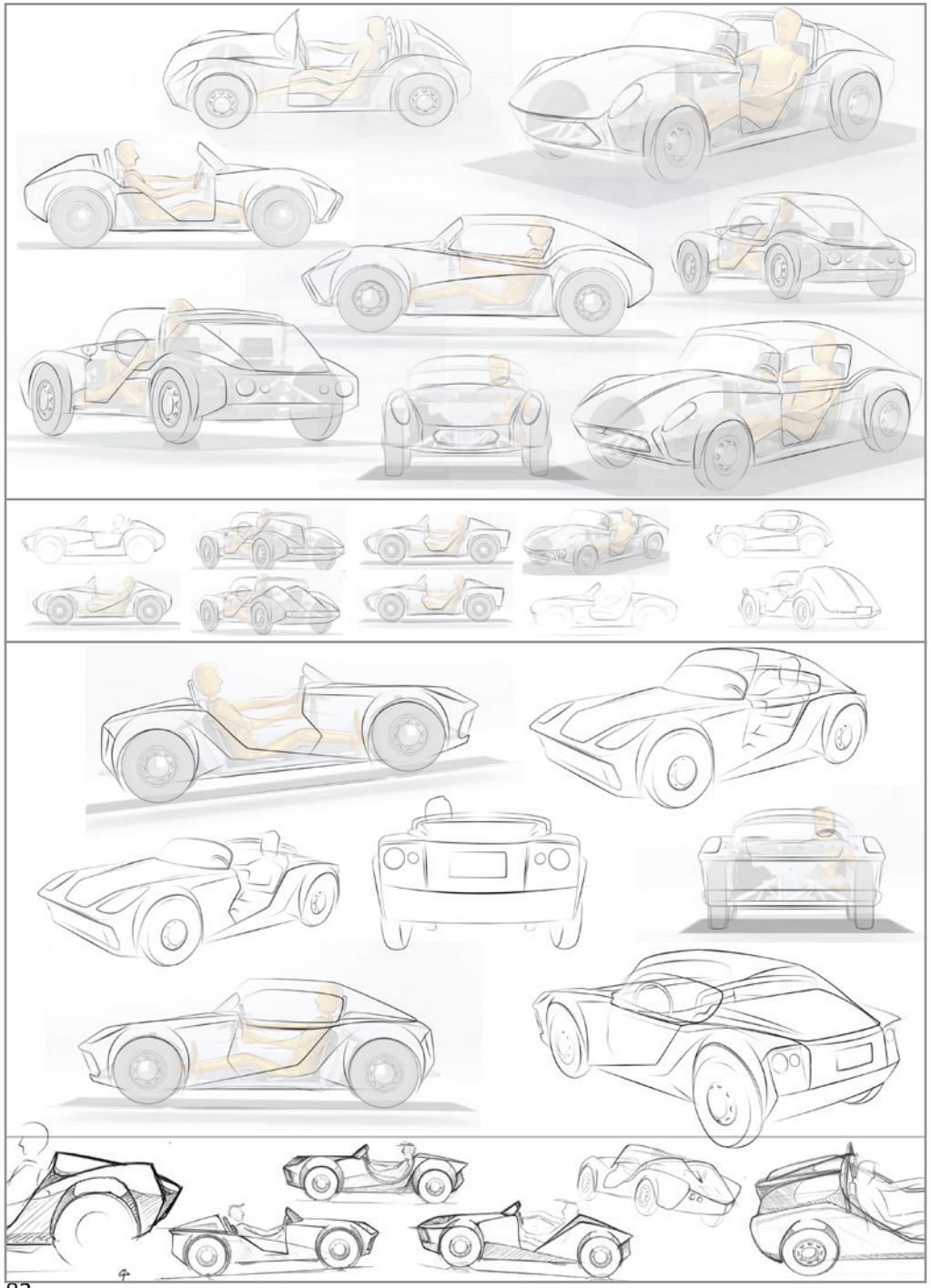
APPENDIX D | PART 4 | DESIGN PROCESS

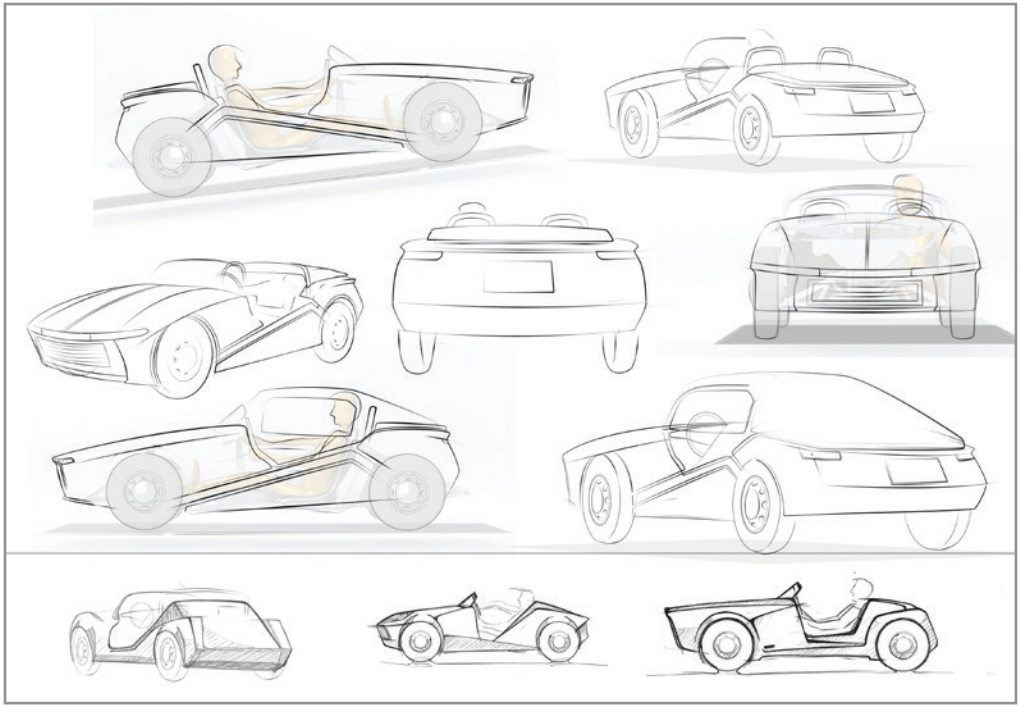
D.1 | 6 CONCEPT DIRECTIONS, OF WHOM THE 4 FINAL DESIGNS ARE DERIVED.

Why are these specific sketches chosen to be further developed? As stated in the report the company, customers and car lovers were asked to point out which designs were best for the new Carice. The fitting within Carice and her target groups, the appearance and technical possibilities were most important in this phase. Some of these design are a good combination between classic and modern, what fits the target group (1/2). Some were very classic (4). Some very modern and sturdy (3/5/6). And some were very handy to produce (6). Within all these categories sketches were arranged and reviewed and finally these 6 were selected.









D.2 | 4 FINAL CONCEPT DIRECTIONS EVALUATION

	Concept 1	Concept 2	Concept 3	Concept 4	
Related					
Person 1	4	1	2	3	
Person 2	2	4	1	3	
Person 3	2	4	1	3	
Person 4	3	4	1	2	
Person 5	3	4	1	2	
Person 6	4	2	3	1	
Person 7	3	4	2	1	
Person 8	3	4	1	2	
Person 9	3	4	2	1	Total:
	27	31	14	18	90
Unrelated					
Person 1	4	2	3	1	
Person 2	4	3	2	1	
Person 3	4	2	3	1	
Person 4	4	2	3	1	
Person 5	4	3	1	2	
Person 6	1	3	2	4	
Person 7	2	3	1	4	
Person 8	2	4	1	3	
Person 9	4	2	3	1	Total:
	29	24	19	18	90

D.3 | FRONT LIGHTING

Combinations of headlights and gril
3D models of headlights