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[VENTUS : an everyday lightweight sports car for the next generation]

[2013/14 Nils Blum]

ABSTRACT

This applied design research project was conducted to fulfil a Master of Design specializing in Transport Design, at the Massey University's Auckland School of Design and The School of Design Wellington.

The aim of this project was to develop a sports car for the next generation of customers that believe in a sustainable lifestyle and trend in society. In order to save resources while simultaneously offering an agile and exciting performance with less energy required, the project focuses on how a sports car can visually communicate a lightweight sensibility. This idea aims to not only make a car look lighter, but also to make it lighter in order to be more efficient and sustainable.

Through design and research processes this project outlines how a sports car that follows a lightweight philosophy could determine its design, and therefore offer new opportunities and layouts when it comes to automotive developments.

This sports car development aims to offer an attractive choice for the sports car driver that enjoys driving but also cares for the environment, and therefore wants to express his way of life through his choice of car.

This project ventures to create a suitably sporty user experience, as is expected from sports cars, while using less energy, power and resources, in order to be intelligently sustainable.

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1.0 INTRODUCTION

The aim of this research and design project was to design a sports car that caters for a current trend in society and the car industry. A new mode of thinking emerged; people want a car that follows a sustainable and eco friendly philosophy, along with traditional sportive characteristics.

"The right Tool for the right job"

"Towards 2020 stiff new fuel efficiency legislation, urban parking shortages, and the growing public concern about our environment will finally see growing numbers of one - seat, one plus one – seat, and one plus two – seat cars that will be freeway capable,
rewarding to drive, comfortable, and highly fuel efficient"

Rubinyi & Wardle. (2013). "*The Car in 2035 – Mobility planning for the near future*". Page84

A car of this type will not endeavor to be an eco-vehicle, but will rather embody an intelligently designed, lightweight sports car. It will achieve the same amount of enjoyment and thrill when driving as current models, but will not waste or use as much fuel and energy due to an intelligently designed construction and power concept.

Many sports cars have different characteristics, depending on how much sportiness is desired and how much usability is needed. Most sports cars rely on an excessive amount of power and fuel, which they seem to express visually in their design characteristics.

INTRODUCTION

This car will focus on an intelligent use of lightweight and sustainable (regenerative) materials to reduce weight and save fuel, but still offer the everyday usability.

The main characteristics and design will be determined by the use of new materials that save weight and add performance. They will lead into a new age where performance goes hand in hand with sustainability.

This project aims to design a lean and agile car that utilizes its advance weight saving technology to achieve its performance attributes, as opposed to using an excessive amount of materials and resources, effectively encouraging brutal power plants to prosper.

Combining efficiency and sportiness generates great potential when the focus of the development is on saving weight in order to increase performance and save fuel. (Rubinyi & Wardle, 2013)

By using new technologies, which include power train concepts; new opportunities in terms of ergonomics and layouts emerge. This enables new performance characteristics and demonstrates a sustainable sporty driving experience, which makes a car like this attractive to the modern customers worldwide.

This document will explain the background research involved in this project; how society is slowly starting to see the environment differently and how it should adapt its transportation manners accordingly.

It also outlines the cultural aspects surrounding sports cars, how they are developed and designed using research, tests, explorations and conclusions.

2.0 BACKGROUND

2.1 Sports Cars

Sports Car Definition:

"The main objectives for this segment are high performance and exotic design uncompromising power trains, body structures, suspension, tires aerodynamics and a low centre of gravity are priorities. The occupant environment is minimized and cargo space is generally compromised. Customers of extreme, high performance sports cars are usually affluent enthusiasts..."

Macey & Wardle. (2008). *H-Point; The fundamentals of car design & packaging.* Page: 52

The field of sports cars has a long tradition in the history of car manufacturing and is as old as the car itself.

When the first cars where produced, people strove to modify them, drive them faster than originally designed, and exercise their knowledge of modern engineering to achieve the best possible results.

Brands were competing in which of their cars would set new records on race tracks and whose model would be the most powerful. This constant search for perfection in motorsport, heavily influenced the technology, innovation and design of modern cars.

Figure001
"Sports Car Influence Relations"

Figure002
"Modern Gran Turismo, Aston Martin Vanquish"

Figure003
"Modern Super Car, McLaren P1"

Knowledge gained on the racetrack was put straight into production models and still is.

Many people drive their sports cars to work daily, and enjoy driving their car in a more recreational way in the weekend, by going on short trips or just to drive around. This way of connecting both elements through one great design, is often the key to the best sports car designs there are.

There are certain levels and degrees of sports cars; depending on how much performance is wanted in conjunction with everyday usability.

We therefore decide between these main sports car categories:

Gran Turismo
Hyper Car
Super Car
Race/Road Car
Kit Car
Roadster
Modified Car

One main aspect that constantly pushed designs in sports cars to make them go faster, as opposed to other aspects, was the element of increasing the power output of the vehicle. The idea of saving weight was often a secondary part of the design, because the technology was not yet advanced enough to cater to both. But nevertheless the idea of saving weight has become very important in motorsport in recent decades.

There has always been an active exchange of design and construction developments between motorsport and common car design. Some of the most iconic sports cars of all time have their origins in motorsport.

2.2 Eco Trend in Society

Recent years have shown that there is an emerging trend in the worldwide car society, which focuses on saving fuel and resources, instead of wasting them. All major car brands set their goals in saving resources and developing new types of power concepts for their vehicles. The main types of these are either hybrids, hydrogen powered, full electric powered or small fuel saving combustion engine powered vehicles.

"If gasoline is $8 per gallon, why don't we buy a small, four seat cars with a 1.8 litre engine that will carry the kids to school and perhaps return 35 mpg on the commute to and from work instead of the 15 mpg that the SUV would achieve?"

Rubinyi & Wardle. (2013). "*The Car in 2035 – Mobility planning for the near future*". Page84

Many people think that this trend only focuses on the average commuter car or small city vehicle. The truth is that nearly all big brands and high end sports car manufacturers are starting to develop concepts for their sports cars that satisfy this trend.

This is because the car brands nowadays want to demonstrate that they care for the environment, by offering more "eco-friendly" vehicles in their model line up. This eco image is really important for car brands, as many of their customers appreciate nature and therefore do not want to be seen in "wasteful" vehicle.

Brands like Toyota or VW offer a fuel saving or Hybrid version for their complete model line-up.

"Volkswagen, Europe's biggest carmaker, outlined ambitious plans to offer as many as 40 electric or hybrid vehicles, betting buyers will have enough confidence in performance to shift to low-emissions cars.

VW will produce 14 models with alternative drive by next year, and will widen the lineup should demand increase"

Chief Executive Officer Martin Winterkorn said at the International Motor Show in Frankfurt

Maier, Tommaso & Rauwald. (2013). "VW *weighs 40 low-emission cars as Frankfurt goes green*",

Figure004
"IAA 2012 World Green Car 2012-Mercedes E250 BlueTec Presentation"

Figure005
"Volkswagen Jetta Hybrid"

Figure006
"Ford V8 Supercar J. McIntyre 2012"

Figure007
"Toyota Hybrid Model Lineup"

This trend however has not reached all places in the world equally. The main customer groups in many countries still believe in absolute power figures, when it comes to sporty vehicles. This thinking is still visible in Australia and New Zealand, where the market for big engine vehicles, like V8's or larger is still one of the most prominent. The idea beyond this thinking relates to notions of status, where a bigger engine represents a higher status than the small, cheap to run motor. But the question is, what is the need for a high powered, fuel wasting sports car, that reaches top performance figures; if there are speed limits in place, which limit the cars abilities anyway? Therefore it was worth considering how to create the same experience but on a smaller scale in terms of performance, which would fit into our modern societies better than many of the current developments.

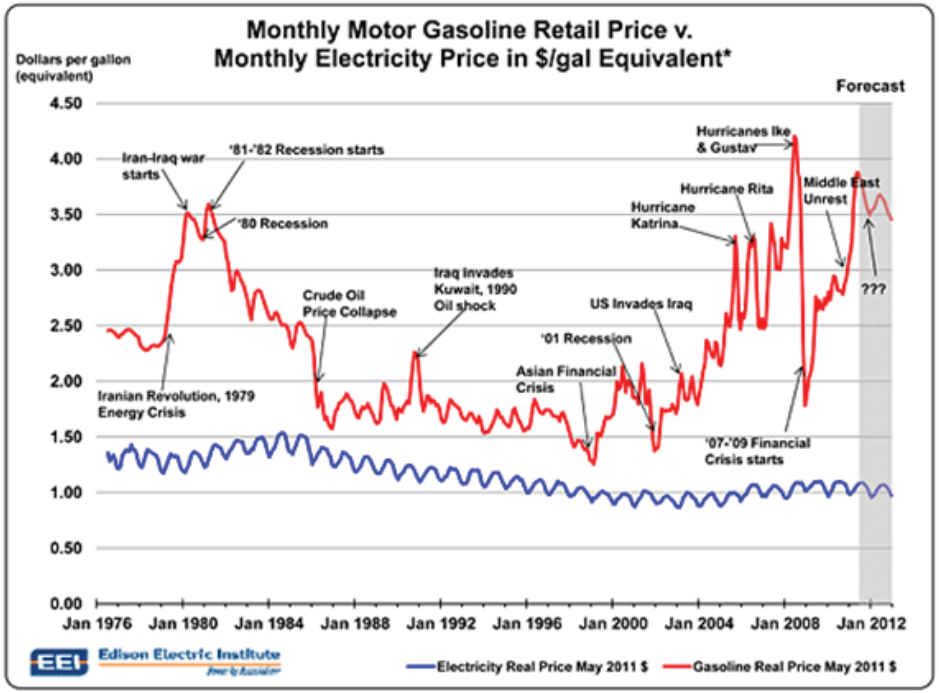

Figure008
"Monthly Gas Price US vs. Monthly Electricity Price US"
Wisconsin Public Service 2012

Source:
http://www.wisconsinpublicservice.com/environment/images/electric_vehicles/electric_vehicles_rate_options_gasvselec.gif

Despite this the demand for fuel saving vehicles is growing by the day; this is due to the increase in fuel prices and the pollution of our air, seen in many mega cities around the globe. Particularly people in western countries, like in Europe or in certain parts of the USA, are starting to put their environment before pure power output figures in cars. (Rubinyi & Wardle, 2013)

This development goes beyond cars and other forms of transport. It starts with people demanding clean, green energy and therefore switching into regenerative energy solutions like solar panels for their homes. Show LA example. (DiBenedetto, 2013)

Another indicator of people showing interest for their environment regarding the daily shopping is the ever growing demand for organic food and environmentally friendly grown food of all kinds.

People are realizing that they have to think about their type of consumerism, in order to keep their environmental foot print smaller. (Rubinyi & Wardle, 2013)

Sports cars in particular carry the image of a resource wasting lifestyle. Therefore it is important to offer an alternative to the past generations of sports cars that only had the improvement of power and speed exclusivity in mind, as opposed to fuel efficiency and intelligent, sporty driving.

Figure009
"Los Angeles Solar Panels Installation"

Figure010
"Tesla Model S Las Vegas 2013"

Figure011
"Audi A3 E-Tron 2013"

2.3 The EV & Hybrid Movement

In the last decade the once exclusive club of hybrid and electric vehicles, has spread out to the masses. More and more people choose to drive a hybrid vehicle, if not fully electric.

"In 2012 – 2015...Technological factors that will impact cars over the next three years will include the mainstream introduction of plug-in, parallel hybrid vehicles, such as the Toyota Prius. In addition, there will be more plug-in series hybrids similar in concept to the Chevy Volt."

Rubinyi & Wardle. (2013). "*The Car in 2035 – Mobility planning for the near future*". Page 80

Taxi and public service vehicle fleets all over the world choose Hybrid vehicles for their daily service. This is not just to save fuel and money, but to increase the air quality in many cities. Cities like New York have Hybrid Only Policies for their taxi fleets to improve the living quality of the city. (King, 2013) This is also for the city to be seen supporting the current trend of environmentally aware vehicles, which reflects well on the city's image.

Many people, particularly those that are aware of current trends and live an environmentally aware lifestyle, choose these kinds of vehicles to demonstrate their way of thinking and position towards a better world of transportation.

Many people think that it is "In" or "Cool" to drive a Hybrid or Electric car nowadays instead of driving a wasteful big engine vehicle, which was the car to drive twenty years ago and earlier if you wanted to be top class. (Rubinyi & Wardle, 2013)

"The Hybrid is poised for a boost. Demand for fuel from India, China, and developing countries will cause the price of gasoline to increase dramatically"

Rubinyi & Wardle. (2013). "*The Car in 2035 – Mobility planning for the near future*". Page 94

Figure012
"2013 Volvo XC60 Plug In Hybrid"

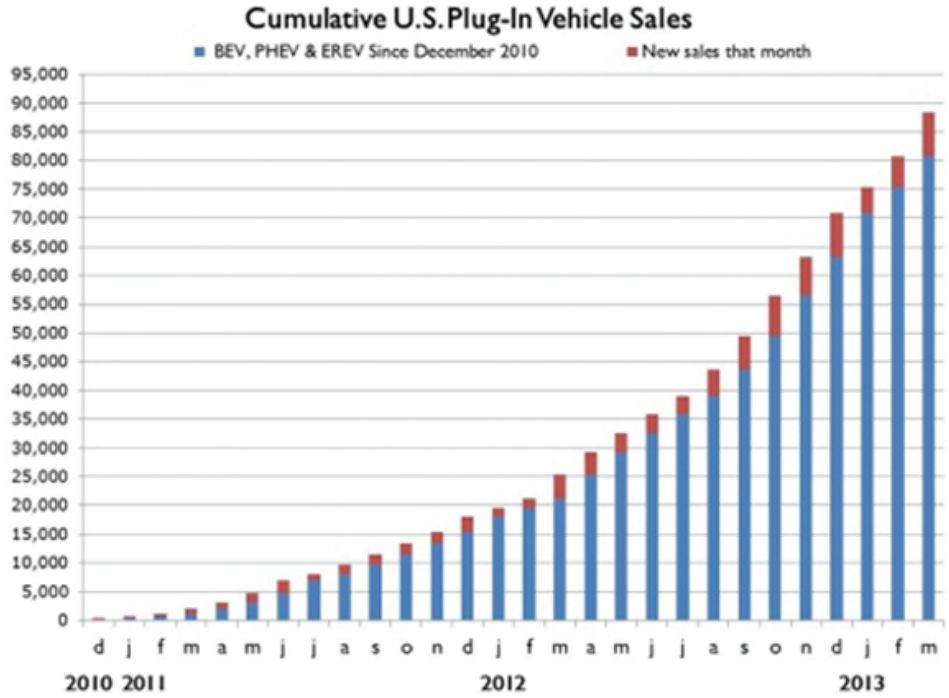

Figure013
"U.S. Plug In Vehicle Sales 2010 - 2013"

Source: http://evworld.com/press/edta_phev_sales_graph2013.png

Figure014
"California Clean Vehicle Designation Sticker"

The sale numbers of Toyota, Chevrolet and Honda in their segment of Hybrid vehicles for California, clearly indicate that there is a demand for new sustainable vehicle concepts, and that this segment is no longer a niche product, as it has been in the past. (Rubinyi & Wardle, 2013)

Furthermore it is also important to note that the more radical field of Pure Electric vehicles is growing by the month, with new sales records for Tesla Motors every month in California and worldwide. (Rogowsky, 2013)

Figure015
"Tesla Model S 2014"

Figure016
"Ford Escape Hybrid - Los Angeles Surf Lifeguard Fleet"

3.0 RESEARCH QUESTIONS

3.1 Main Research Questions:

How will a lightweight sports car that combines the ideas of everyday usability, resource saving and a great driving experience look?

How will the lightweight construction aspects determine the design features of the sports car?

What new chances does a new/modern lightweight construction offer for the design of the cars exterior and interior?

3.2 Sub Research Questions:

In order to research and answer the lead research questions, several sub-questions were formed to investigate certain aspects of the complex issue. Later on specific research methods were determined to answer these sub-questions

What material can be used to save weight and support the notion of sustainability?

How does the interior concept change/look when applying new technologies in terms of power, performance and lightweight techniques?

Is there the potential in the current market for this design concept?

What new technologies in terms of engines and power concepts can be used to gain maximum performance and driving pleasure, while saving fuel and energy?

Is the green/eco friendly trend strong enough to support a car like this?

Is the current layout of sports cars still effective/appropriate for this type of concept?

Which specific consumer groups would be interested in this sort of car?

For what purposes would the car be used daily and what does that mean for a car like this? What would be the daily usage patterns for this car?

What design principles are suitable to improve the design of the concept?

How much power is enough to create a sporty driving experience? What sensations and performance attributes create such an experience best?

3.3 Objectives

In addition to the research questions, objectives were created that would guide the projects research processes.

Objetcive1:

Review existing sports car models that relate to the topic, in regards to ergonomics, performance and design and connect it to the ideas relevant for this sports car project. In order to understand the current market and standards in this industry, use the information to place and develop the project.

Objective2:

Review literature and lectures in relation to design, construction and market predictions in order to make the project feasible; and develop a current understanding of the relevant topics. Use this theoretical knowledge to inform the design and research processes.

Objective3:

Obtain an understanding of current trends in society in regards to sustainability, new green technologies and environmental standards that relate to modern transportation. Utilise this information to shape the research process in working towards the development of the projects aim.

Objective4:

Define the aspect of being an "Everyday Usable" car, and which characteristics represent this term.

Objective5:

Identify the idea of lightweight, its characteristics in automotive design and external fields. Additionally identify how to express this idea in a certain form through the use of new materials and production techniques.

4.0 METHODOLOGY

For the research process, different types of approaches have been used to -

- **Inform**
- **Understand**
- **Evaluate**

- The relevant topics and areas for this project.

For the understanding of this topic it was imperative to analyze Literature Reviews, which included books, articles, publications and magazines. With the help of these critical outlets it was possible to attain an in depth understanding of the relevant background and specific research areas.

After collecting this information it was possible to evaluate the relevant areas in order to draw conclusions, identify user groups, place the project in the market, define the project more in depth and start to develop the first suitable ideas.

With this knowledge it was possible to take the next step and work more directly towards the final design solution.

To further explore and understand the design and related research processes, different approaches were used, which included:

- **Test Rig Building:** To understand and develop the right ergonomic concept for the interior of the vehicle

- **Expert & User Interviews/Talks:** To identify the right user types, needs and wants; to gain professional knowledge about relevant topics and areas

- **Product Testing/Reviews:** To understand the development of a car in depth, with all its functions and components, to determine the right setup for this project in comparison to current solutions

- **Case Studies:** To understand the specific models and their philosophy; To gain knowledge about specific market details in order to place the car in the right market and to study the aesthetics of current models.

- **Design Experiments:** To find the right aesthetic ideas and to create the targeted design language

- **Model Making:** To understand the design ideas in a three dimensional shape

- **Sketching:** To generate and develop design ideas and the character of the car

- **Clay Modelling:** To work in depth on design ideas, evaluate them and understand design decisions in order to reach a realistic solution

- **CAD Modelling:** To refine the design, test ergonomic concepts and transform the selected design into a more realistic solution

These processes aimed to tackle this design and the research processes as it worked towards the final outcome.

5.0 LITERATURE REVIEW

To gain pertinent information and understand the relevant topics and area for this project I focussed a big part of my research process on Literature Reviews.

Figure017
"Success Models from Past and Present in the U.S."

5.1 Sports Car - User Experience

The user experience of sports cars is one of the main contributing factors that create the legendary image of a sports car. The thrill and excitement of driving a sports car are some of the most important associations that make the sports car a status symbol.

The overall question is: Why do I need to drive a sports car, instead of other more practical solutions, that cost less money and are easier to drive?

A sports car communicates the desire to distinguish oneself from others, which is natural habit or desire. A sports car expresses a certain kind of lifestyle, which is a dream that many people work to achieve. The excitement and thrill in driving one, often outweighs the negative side effects or costs, and also motivates the owner to keep and invest in the vehicle. To drive a sports also shows a certain type of status, which is less or more important to the user.
(Rubinyi &Wardle, 2013)

It is therefore important to capture and identify this essence for the user experience of the car, in order to make it desirable to own.

By driving a sports car the owner is communicating something to the audience, which could be perceived either negatively or positively.

This could either fall into the category of showing off their status and wealth or showing that driving is more than just getting from A to B for them. This communication or expression of certain things depends often on the type, brand and model that is chosen.

Ferrari

Figure018
"2014 Ferrari - LaFerrari"

Is:

• Loud, aggressive, red traditional colour, centre of attention

Communicates:

• Wealth, status, jetset lifestyle, above all wasteful

Porsche

Figure019
"2013 Porsche 911 Carrera"

Is:

• Sportive, icon, more subtle, a mix of everyday life and race track excitement

Communicates:

• Sporty, understatement but also a form of status, sense of style

Some of the classical features and characteristics can be found on nearly all sports cars, however some models communicate these features more subtly and uniquely than others.

5.2 The Market Situation

Many European and other Western car manufactures have struggled in recent years to reach enough sale numbers in classic car countries like Europe, USA and Japan. This is due to the financial crisis and income deficits for the middle classes in these countries.

"The reasons for this decline in annual model volumes (U.S. & Europe) can be summarized as more car makers, making more models, chasing the same number of buyers"

Rubinyi & Wardle. (2013). "*The Car in 2035 – Mobility planning for the near future*". Page 110

The numbers of cars being sold, in Europe especially, are declining every year. Brands have to offer great deals and packages to attract their customers. A big problem for brands in Europe is also, that the car is losing its significance as a prestige and status symbols.

The majority of younger customers in countries in the EU and USA do not think that they need a car for transport or as a symbol of prestige. This attitude has significantly changed in the past ten to fifteen years. This is due to the car being seen more as a problem for pollution and traffic congestion, than as a desired object for the young forward thinking clientele. (Rubinyi & Wardle, 2013)

Nevertheless it remains stable in the upper car market, and younger, wealthier people are still interested in spending their money on a car, particularly sports cars. For this specific user group the car still represents a status symbol, in contrast to the masses of young people. When considering this demographic in conjunction with the current trend development that focusses more on environmentally friendly ideas, it is important to offer an option for this thinking.

Figure020
"Renault Production Yard full of cars without owners. March 2013"

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"If current trends continue, today's emerging young generations will have much less interest in cars as principal expression of themselves. They will see the cars mostly as utility devices"

Rubinyi & Wardle. (2013). "*The Car in 2035 – Mobility planning for the near future*". Page 85

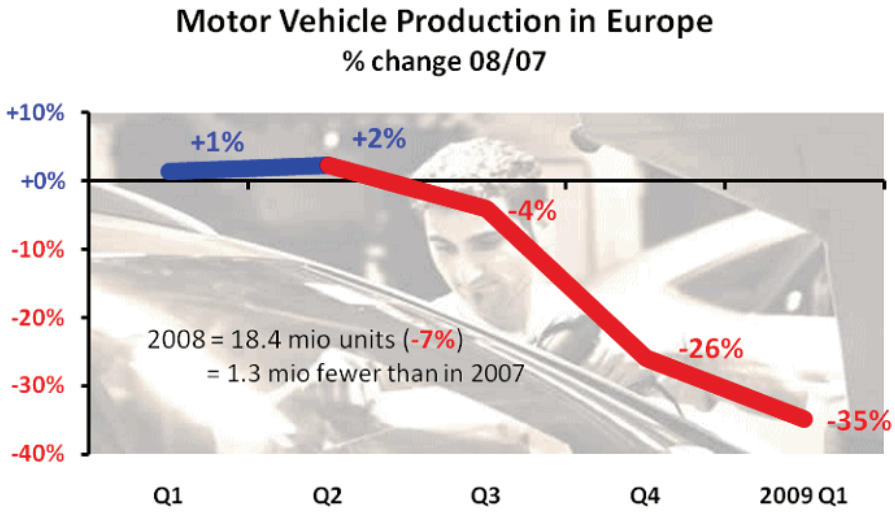


Figure021
"European Vehicle Production Decline 2007 -08"

Figure022
"Car as a Status Symbol in 1980's for the young - Opel Manta"

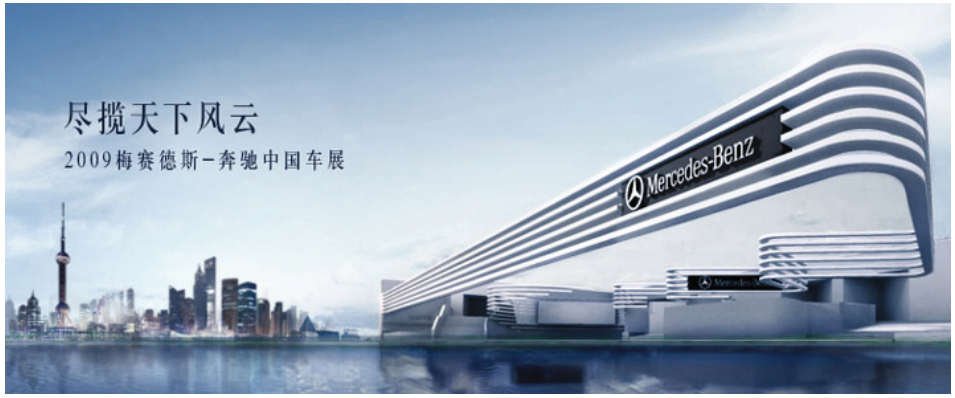


Figure023
"Mercedes Benz Dealership Shanghai Opening Banner 2009"

It is interesting to see that in contrast to Countries in the EU or USA, people in countries like China or India still believe that the car is still one of the most important things to have. (Rubinyi &Wardle, 2013)

This is a natural process, as the people in these markets have not had the chance to own their own vehicle before. The young clientele in these countries in particular, demand a huge range of vehicles, and chiefly upper market vehicles, depending on their financial status. (Rubinyi &Wardle, 2013)

Figure024
"Success Model BMW 5 Series in China"

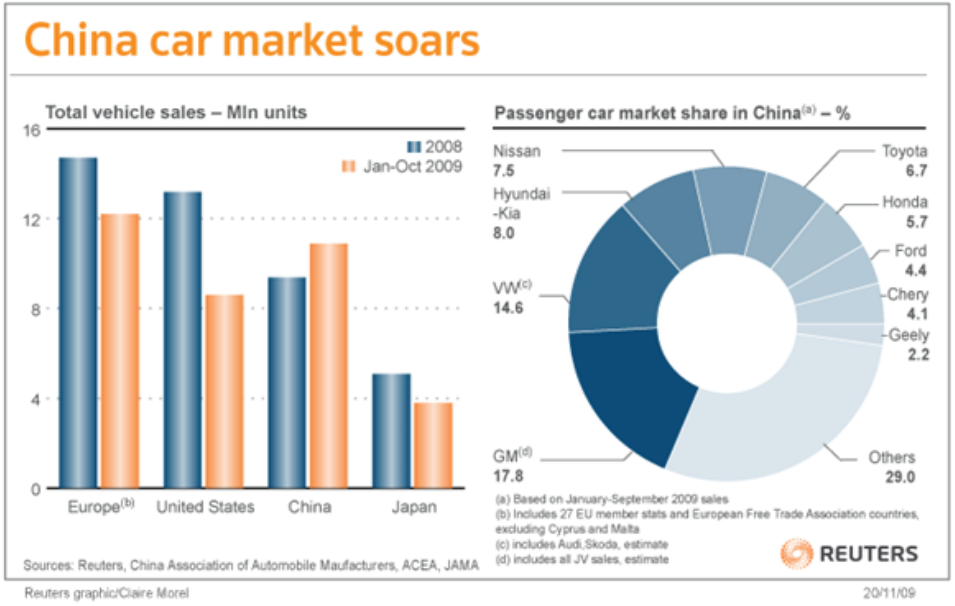


Figure025
"China Vehicle Market Sales 2009 "

Source: http://static5.businessinsider.com/image/4d1a35064bd7c8e263080000/chart-car-sales-2.gif

Interestingly, in emerging countries like China, the government is releasing more and more laws to improve the air quality, and is subsidizing electric cars (up to 60,000 Yuan = 10,000 $U.S.) in order to increase the amount of cleaner cars. This is due to bad air quality in cities like Beijing, Shanghai or New Delhi. Countries like China invest a huge amount of money into the development of batteries and electric cars, to improve and update their vehicle fleets in the cities. (Cho, 2013)

Therefore these markets are also worth considering for this project, as it is a sports car for the upper market range and therefore available for customers that have a stronger financial background. These customers in emerging countries could potentially be younger than in most other countries, due to a comparatively strong young wealth.

It is important to understand that the general attitude towards sustainable cars is not yet as strong as in the traditional markets, and therefore the acceptance of vehicles of this kind will need time to develop. Which makes the prestige symbol of being a sports car more important to traditional markets and a relevant aspect of the final design.

Figure026
"Chinas own electric mainstream car - BYD e6"

The difference between the traditional western markets and the new emerging markets is however, that the customers in the traditional markets have a greater interest in sustainable concepts, especially for cars.

This is due to people's desire to preserve our environment. It is not just "cool" to live a green or more sustainable lifestyle, but people actually care for the environment. This is due to the strong shift in the thinking over recent decades. Nowadays it is more an ethical decision or a conscious well considered act to live a sustainable lifestyle. This can be expressed foremost with the things you eat, where you live and what car you drive. (Rubinyi & Wardle, 2013)

The sales numbers for hybrid cars like the Toyota Prius, Honda Insight or fully electric like the Tesla S have increased heavily in recent years when compared to ten years ago. This also goes back to society trying to care more for their environment, by driving a more environmentally sensible vehicle.

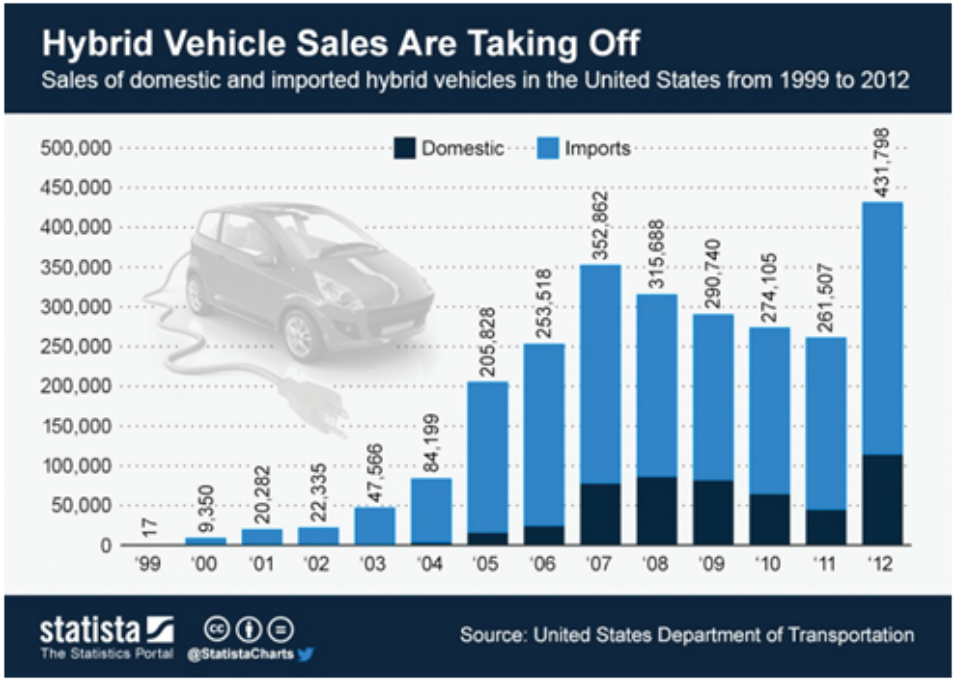


Figure027
"Sales of domestic & imported Hybrid vehicles in the U.S. 1999 - 2012"

Source:
https://d28wbuch0jlv7v.cloudfront.net/images/infografik/normal/ChartOfTheDay_1182_Hybrid_Vehicle_Sales_Are_Taking_Off_n.jpg

5.3 New Materials

"Significant new opportunities to change the appearance of cars will also come from completely new manufacturing paradigms. Components, structures and panels will be manufactured from 100% recyclable or new materials derived from organic, renewable sources that allow industrial-grade performance and accuracy of components"

Rubinyi & Wardle. (2013). "*The Car in 2035 – Mobility planning for the near future*". Page 90

The aspect of saving weight is mainly achieved by using new materials for new applications, where they have been uncommon before. For this project it is important to look at new materials that can be used for the construction of a lightweight sports car.

These materials are often composite materials that have been used successfully in the past for different applications. Carbon Fibres are the most prominent type of these composite materials when it comes to the modern car construction. It has been used as the main material in Formula1 cars for many years and nearly every sports car that has come into the market in recent years has used it, if not fully constructed out of it. (Rubinyi & Wardle, 2013)

Carbon Fibre is extremely light, can be bought in nearly every shape due to modern moulding techniques, and has excellent crash impact absorbing characteristics. It is therefore one of the most favoured material choices in car constructions and developments.

Figure028
"Cotton, Bamboo, Coconut and Hemp Fibres"

Figure029
"BMW i3 CFRP Production in Leipzig, Germany"

Figure030
"BMW i3 Carbon Fibre Production"

Despite this it has not been used in the common car industry in the past, due to the high costs, which relate to the difficult manufacturing process.
However there has been a shift towards carbon fibre and other composite materials in the common car manufacturing in the recent years. This is due to new technologies having been developed, like BMW's patented Carbon Fibre Reinforced Plastic (CFRP) process.

"Use of carbon fiber in a vehicle can appreciably reduce the weight and hence the size of its frame. This will also facilitate designers' and engineers' creativity and allow more in-cabin space for commuters.

The new BMW i3 is made with a carbon fiber that not only reduces weight in the car, but reduces the amount of water and electricity used to make it.... The carbon fibers are woven into carbon fiber fabrics and created into the cockpit of the car."

Pohlmann & Hammond. (2013) *BMW/SGL - Carbon Fibre Reinforced Plastic (CRFP)*

Figure031
"BMW i3"

Figure032
"SIEMENS Logo"

To ensure that the car will have an intelligent and sustainable idea and appearance, it is important to take into consideration current changes in environmental standards. This also includes the use of Carbon fibre materials and its resins.

The recycling of composites is still currently problematic. The fibres and resins themselves are not the problem, it is when they have been joined, that their separation for recycling brings about complications.

The issue is a large quantity of composite waste - as occurs in car manufacturing. Therefore scientists and companies search for recyclable composites, made from natural (or biodegradable) resins and fibres.

SIEMENS and several other partners are working on a process that enables them to recycle carbon fibre in an environmentally friendly way, by not destroying the carbon fibres.

"Using the solvolysis recycling procedure employed by scientists at Siemens Corporate Technology, the resin component is heated under pressure at a temperature of 200 degrees Celsius and converted to low molecular-weight soluble alcohols with the help of water.
No environmentally damaging solvents are used in the process, which also requires much less energy than would be required to manufacture new fibres. The woven fabric recovered from the workpiece retains its shape and its fibers remain intact.
As a result, it can be immediately further processed. The fibers' mechanical properties are also nearly fully retained. As a next step, the researchers are now looking for ways to use the recycled fibers in new types of reshaped workpieces."

SIEMENS GLOBAL.(2013) ***New Technologies Report***

A more natural solution for this problem could be the use of bio fibres and bio resins, which have their origin in nature and are therefore easier and more efficient to recycle. (Rubinyi &Wardle, 2013)

It is therefore important to look into other new types of composite material choices that are often very natural, and have similar if not the same characteristic as current composite materials; e.g. carbon fibre.

These natural fibre reinforced plastics and natural fibre sheets have excellent characteristics in terms of weight and stiffness, and have therefore already been used in the car industry, predominantly in Europe. German Car manufactures increased their use of natural fibres from 15.000t in 1999 to around 30.000t in 2007 (Carus & Gahle 2008), but mostly in places where they are not seen (e.g. isolating parts, dashboard filling, noise cancellation).

Figure033
"Mercedes S-Class W220 Use of Natural Fibres"

Figure034
"Natural Fibre Composite Varieties"

For my project I want to give these materials more prominent places in the car, for example in body panels like front and back bumper or door panels where they are more visible for the audience. This would reflect the sustainable philosophy of this vehicle visually, in a unique way.

Natural fibre composites can be based on different natural growing resources, which could be based on fibre types like: Flax Fibres, Hemp Fibre Sheets, Bamboo Fibres, Coconut Fibre Sheets and Corn Fibre Sheets connected with Bio-Based Thermosetting Resin.

This project would suit the use of rice, coconut, flax or corn fibres, which are made out of the waste product of the actual production of these natural resources. It is important to source the components in a sustainable way, and to avoid harming the environment with more plantations, which take the place of indigenous habitats. This has been seen in the past with the palm plantations in Indonesia and Malaysia, for the production of palm oil.

"More intriguing than improved aerodynamics are the potential weight savings that imperfect surfaces can bring: by creating a part of their rigidity through creases and folds their stiffness can be maintained even as they are manufactured in thinner and thus lighter sheets."

Lynn & Foster Gage.(2010) "Composites, Surfaces, and Software-High Performance Architecture", Page 76

Figure035
"Wheel with Hub Motor on Brabus E500 Hybrid"

5.4 E-Motor & Batteries

There is one integral part of car developments in the recent history that gets more attention than most – The Electric Motor in conjunction with modern Battery Concepts.

Due to the increasing prices and emission problems of fossil fuels, the electric motor seems to be a viable answer to these problems, even though there are trade-offs too. Modern car concepts nearly always feature an electrically powered concept, whether it be purely battery powered or by hydrogen in conjunction with electric motors.

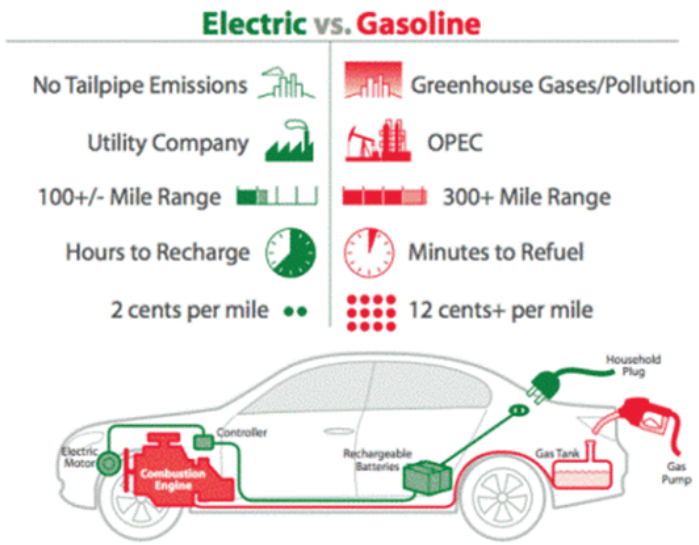


Figure036
"Electric vs Gasoline"

Source:
http://www3.jjc.edu/ftp/wdc11/drucker/assets/gas-electric-v6.gif

The electric motor itself has good power and performance characteristics in comparison to traditional combustion engines. The electric motor has an instant use of the full torque performance, with no warm up period as is necessary from combustion engines.

This is beneficial for a stand still start or in keeping an average speed, which makes them the ideal power source for modern sports cars.

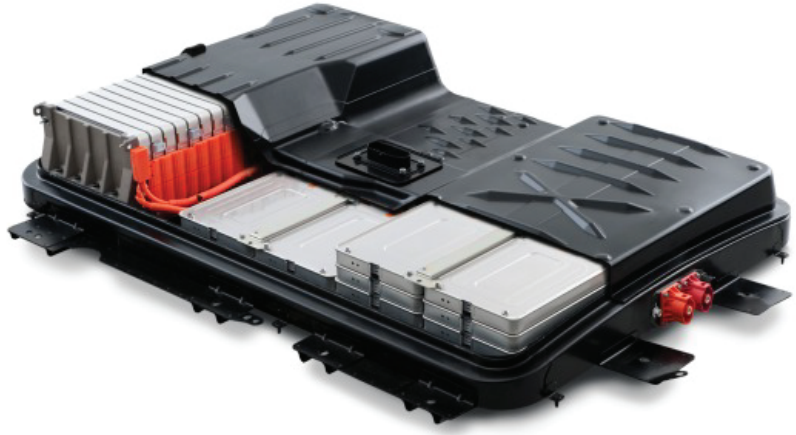


Figure037
"Lithium Ion Battery Unit"

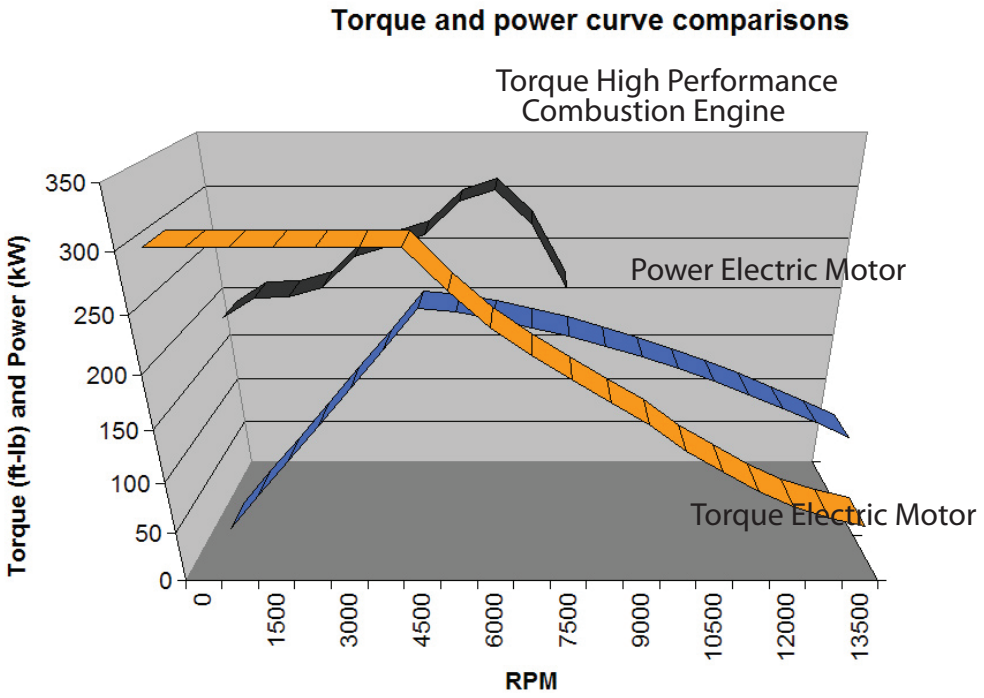


Figure038
"Torque & Power Comparison, Electric Motor vs. Combustion Engine"

Source: http://www.carbibles.com/EV_bible.html

The choice of using an electric drive system for a car saves the need for almost all components of a common combustion engine system. The electric power concept basically only needs the electric motor itself and batteries or a hydrogen system that supplies the electric motors with energy. The part of an engine with all its components or a transmission is not needed. This creates a completely new way of constructing cars, and offers new, more efficient ergonomic concepts.

"From a packaging perspective, electric drives (also Hybrid in a smaller degree) offer tremendous opportunity to design more space efficient vehicles, mainly because the motors are so much smaller than internal combustion engines. The other components that make up the power-train can be distributed throughout the package in remote locations, unlike conventional power-train systems, which linked mechanically..."

Macey & Wardle.(2013). ***The Car in 2035: "Mobility Planning in the near Future". Page: 84***

The Electric movement has one problem though, which inhibits the electric revolution from moving beyond being relatively small on the scale of the common car market – The Batteries.

These types of batteries are mostly lithium ion batteries or the newer lithium air batteries. They are still very limited in storing energy, and therefore limit the km range of electric vehicles. Additionally, they are relatively heavy, easily overheat and do not have a long life expectancy.

"Lithium-air technology has game changing qualities. But the hurdles we need to overcome are significant"

Mueller. (2013, November). ***Chemical Reaktion, Electric & Hybrid: Vehicle Technology International, January 2014,*** **32-40**

Figure039
"Mercedes N1000 Electric Test Model , Battery Change 1972"

Figure040
"Honda C-RVe Concept Car 2010"

Figure041
"Honda C-RVe Concept Car Interior 2010"

5.5 The Hybrid Drive

"Long before 2035, Hybrid Cars won't be referred to as hybrid, but will simply be cars. This process has already begun and will continue through the next few decades."

Page 92, "The Car in 2035 – Mobility planning for the near future"

The Hybrid drive is mainly a combination or symbiosis of a combustion engine or gas turbine and electric motors in conjunction with batteries.

The combustion engine works at a higher speed or in some cases to recharge the batteries, and the electric motors at lower city commuting speed or to support the combustion engine when needed. The batteries will generally be recharged due to friction energy generated by the braking of the car

"With gas prices currently hovering around 4 $US a gallon, Hybrid models are now 3% of the U.S market (around 0.1% before 2003, with launch of the Toyota Prius MK2.)"

Rubinyi & Wardle. (2013). "*The Car in 2035 – Mobility planning for the near future*". Page 92

Figure042
"2013 Toyota Prius Hybrid"

Figure043
"2011 Toyota Camry Hybrid"

The concept of a Hybrid Drive is to date the most well known and common of the new power concepts for the vehicles of the future. Many car manufacturers, mainly from Japan (Toyota Prius, Honda Insight) pushed this system into the markets and offer nearly every model in their line up as a Hybrid version.
Brands from Europe (BMW 3, 5 and 7 Series Hybrid) and America (Chevrolet Impala Hybrid) are catching up fast to offer this alternative power concept choice of vehicle to their customers.

For this project a hybrid system is the most suitable option, as it allows an emphasis on performance as well as being efficient. It is a mix of a parallel hybrid and a series hybrid to deliver the best possible performance characteristics.

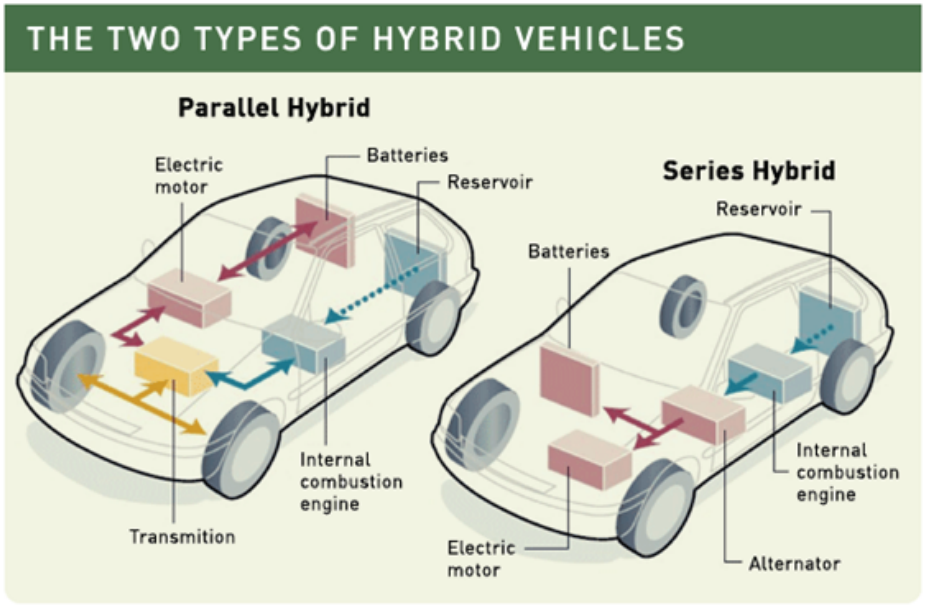


Figure044
"The Two Types of Hybrids"

Source:
http://www.oica.net/wp-content/uploads/2007/07/hybrid-diagram-large.gif

Figure045
"Full Monocoque - Lamborghini Aventador"

Figure046
"Semi Monocoque - McLaren MP12-C"

5.6 Monocoque Construction

Monocoques are structures that support their loads through their external skins. They are also called Unibodies, or the general technique can also be known as structural skin or stressed skin. (Merriam-Webster Dictionary, 2011)

Car manufacturers have developed omnidirectional carbon fiber weaves that apply strength in all directions. This way of carbon fibre manufacturing is mainly used in the construction of monocoques.

Many sports cars over the past few decades have incorporated carbon fibre extensively into their manufacturing process, using it for their monocoque chassis as well as other components (Trzesniowski, 2011)

This sports car would also use a monocoque as its integral construction part. It uses a monocoque, because it offers great stiffness, excellent safety characteristics, good lightweight characteristics and most body panels are attached to it, so they are able to be repaired in case of minor accidents.

The monocoque aspect of this car would be the backbone of the vehicle, being visible from the outside, so that the audience can tell how this vehicle is constructed. Body panels made in a similar way, but being made out of natural fibre composites instead of carbon fibre surround the monocoque structure and create the vehicle as a whole.

To guarantee maximum strength and stiffness of the body of the car, the monocoque would be constructed in the most modern of composite fibre construction. However instead of using carbon fibre as the material the car would use a bio fibre and bio resin as the materials. These are better in terms of recycling, and offer similar characteristics. This could be achieved via modern moulding techniques, to guarantee the most efficient body structure.

5.7 Lightweight

The History of lightweight designs in car developments goes back to the early days of the car itself. There have been many approaches over the years of how to achieve lightweight bodies to predominantly make cars go faster.

The materials varied and became more advanced over time to save weight in order to increase the performance of the vehicle. Starting with wood, steel to aluminium and now with high tech composites, where carbon fibre is the dominating material nowadays.

In earlier days simple and unconventional ideas brought up new ideas. A famous example is the AVUS race of 1932 in Berlin, when Manfred von Brautsch entered the race with his Mercedes Benz SSKL. It had been stripped of his white paint before, in order to pass weight regulations for the race. He later won this race in his bare aluminium skin looking SSKL, which is still known today as the "Silver Arrow". (Schrader, 1987)

More recent examples of new ways of saving weight are the high tech Americas Cup Yachts. In 1987 New Zealand was the first to sail with a full fibre glass boat in the KZ 5. The most recent AC72 multi hull yachts use high tech carbon fibre materials in order to make their boats fly over the water. (Elmer Dewitt, 1986)

In the recent times the idea of lightweight has been most relevant in making cars and other vehicles more efficient. With fuel increasing in price and the exhaust fumes damaging the environment, the race for more efficient vehicles is one of the main targets for future developments.

Composite materials offer the solution for many weight problems, but still have problems with the recycling of the composites end product. Natural bio fibres and resins, as well as new technologies for the recycling of current composites try to solve this important issue.

For this project the idea is to combine both ideals: Efficiency and Performance. This sports car should offer the idea of being sporty and agile, while being efficient and forward thinking. This can be achieved through incorporating lightweight as the core idea for this sports car by using new sustainable composite materials.

Figure047
"1932 AVUS race Berlin"

6.0 USER RESEARCH

6.1 User Analysis

After the research process it was possible to narrow down target users, who would be relevant and could be of interest for this project.

These people could fall into different categories of age, gender or lifestyle background.

The findings were:

Users are predominantly male (3:1).

Sees driving as more than just getting from A to B.

Enjoys the driving experience.

- Has a mid to high income per annum.

- Uses the car daily, but also enjoys driving in general and driving in a sportier manner.

- Lives a modern lifestyle, meaning open for new and sustainable technologies.

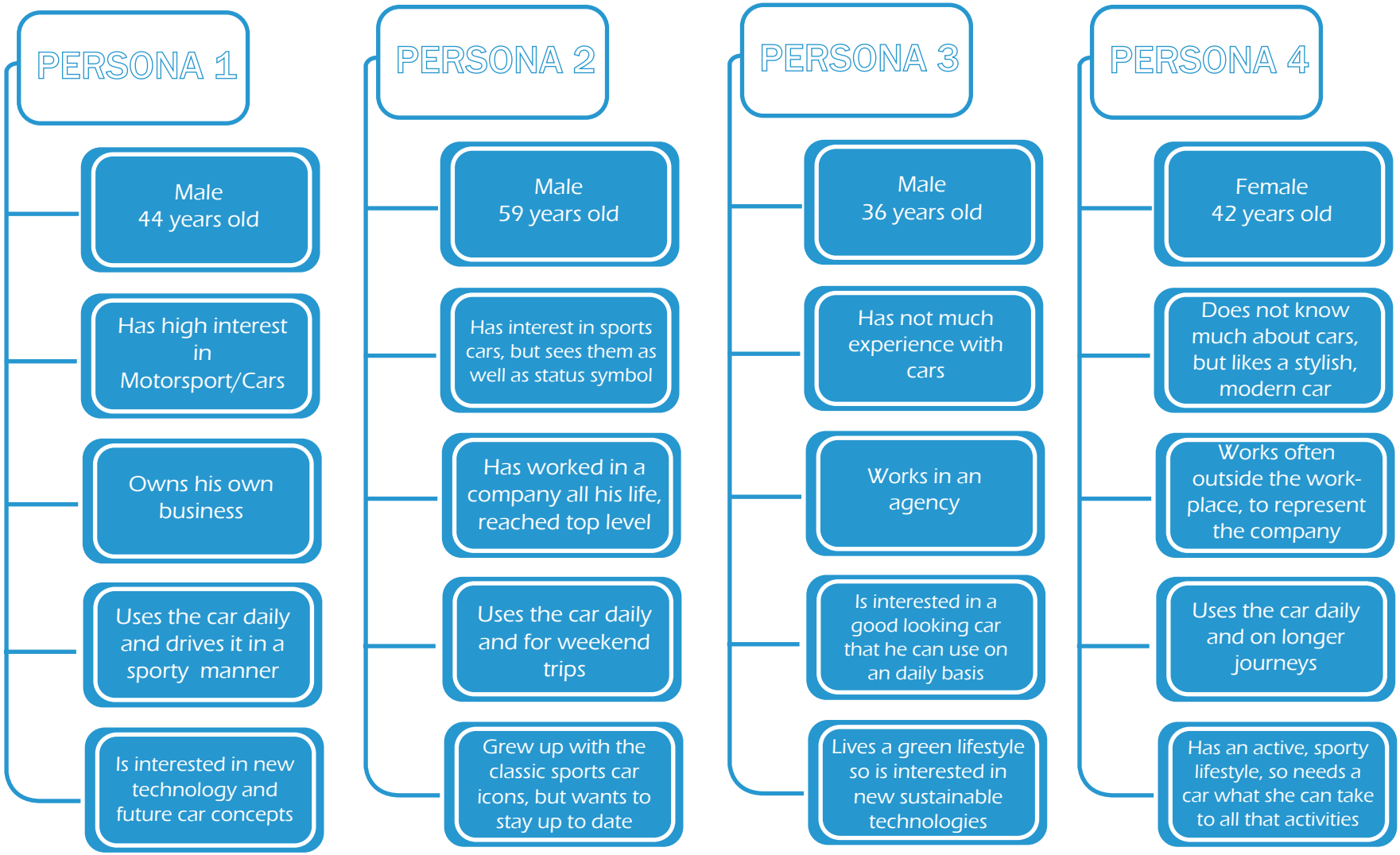
Follows values that have the environment as an integral point, and does therefore care what happens to nature and the environment

- Has an interest in cars, and is up to date with the market, and follows the it with interest (reading magazines, journals, blogs)

- Is concerned about the image a car reflects on its user.

6.2 PERSONA TYPE OVERVIEW

After the first informative interviews and research regarding the users of the sports car it was clear that the following types of personas are relevant and would be of interest for this project:



6.3 Identifying Needs & Wants

To create a suitable sports car specifically for the needs and wants of the targeted user, it was important to recognise what this customer would want in such a car.

To gain this information it was necessary to speak to people that enjoy cars, sporty driving or even use them in motorsport. After having informative interviews with people like Prof. Tony Parker (Hulme Supercar), Eric Thompson (NZ Herald – Drive magazine) and several other people it was possible to create key points that would be important for the project.

Additionally, pre-structured questionnaires (see Appendix) about this topic were created.
For the questionnaires people that fit into the target user groups were chosen and approached.

Demographic:

Male: 28-63 years old (80%), Female: 30-60 years old (20%)

Milieu:

NZ Middle Class, All Living in the Auckland Area

Number of People Interviewed:

30

Some of the important key points identified as desirable for the project were:

- Agile and exciting driving performance/experience
- A lightweight vehicle, that has the characteristics of such a car; reflected in its performance and appearance
- Low seating position
- Tight appearing interior, but with enough space for reasonable transportation of luggage
- Fairly simply orientated interior, but with extras that are seen in other models
- Technical feel of components
- Manual or Sequential Manual transmission available
- Accurate and agile feel for steering
- Engine sound/vibrations of some kind
- Stiff, sporty suspension and chassis, but able to drive in the city as well
- Flat and low bottom floor tray, as is known from kit cars

The questionnaires also showed which features the participants would not necessarily want:

- Pure and raw power would not be essential, but an agile and light free flowing performance would be preferred
- Manual transmission, including clutch not necessary
- Only key interior features needed (aircon, electric windows),
- Not too many luxury features needed

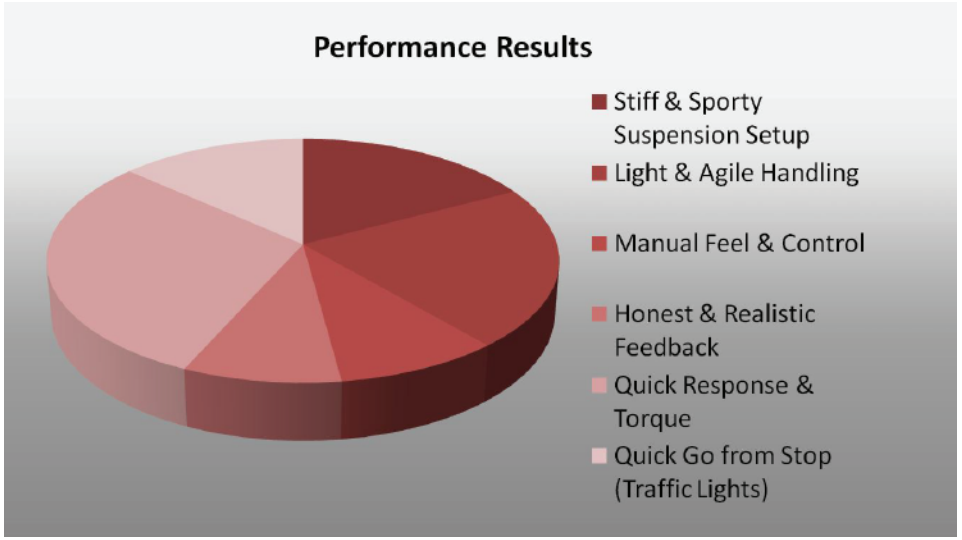


Figure048
"Top Performance Questionnaire Answers"

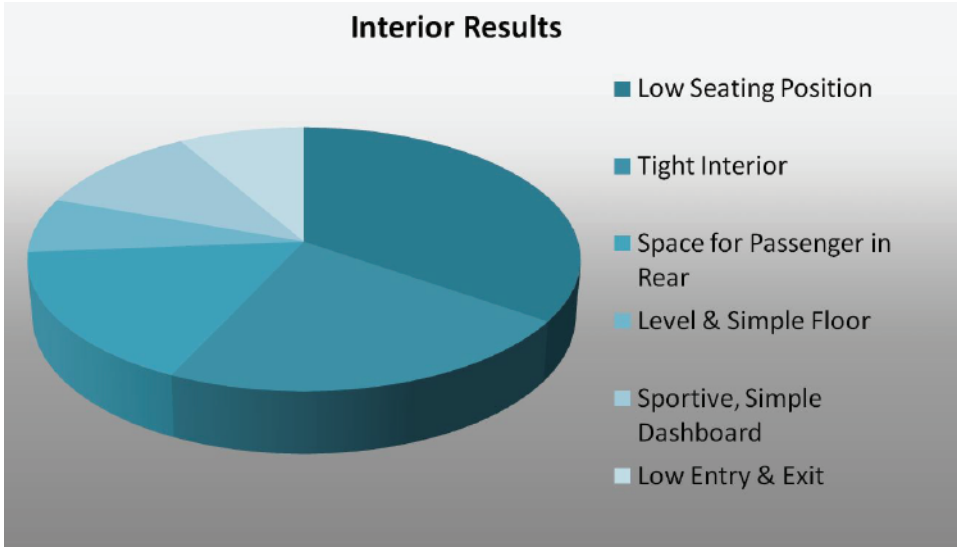


Figure049
"Top Interior Design/Layout Questionnaire Answers"

To gain information about everyday usability and the practicality of the vehicle, I had to focus more on how people would use their car on a daily basis. Where they would use them foremost and how long or often they would drive. I did this by again using the questionnaires to gain information.

Some of the most important key points people mentioned were:

- Most people would use the car on a daily basis by themselves
- They would try to use it for recreational activities, such as going to the beach, shopping, golfing or going to the gym
- Occasionally they would go away for weekend trips or holidays, so they would need some space for luggage
- Many people work in the city, and therefore need to be able to drive the car as comfortably as possible in the city. (Power Steering)
- Most journeys with the vehicle would vary between 20 and 50 km one way and overall about 40 to a 100 km in a day.
- For the most part holiday journeys would not exceed more than 500kms one way

By analyzing this information it became clear that it would be necessary to offer sufficient space for luggage and make the entering and exiting of the vehicle as effortless as possible - despite being a sports car, which usually have a low entry and exit point.

Figure050
"Driving - Stance Nation"

6.4 User Experience

The user experience for this project is very important, being a sports car, which has performance and agility as its main target. It was therefore essential to research a lot into the performance aspects of modern sports cars, and try to identify their key elements such as engine sound & vibration, seating position, torque response or stiffness of suspension setup.

Additionally specialists like Prof. Tony Parker (Hulme Super Car) and Eric Thompson (NZ Herald). provided ample information on what their wants in a car like this would be. With this specific information and the gathered research data it was possible to identify the intended the user experience.

For this car it was important to develop the right amount of thrill when driving the vehicle, in relation to its performance characteristics. Therefore it is the power concept using a hybrid system that is most appropriate for creating this excitement.

It includes:

- quick response,
- agility,
- a lot of torque,
- engine sound if wanted and sporty suspension set up
- saving fuel and resources by using a supportive and intelligent power/motor management.

However in order to create the sporty driving experience it is also important to look into other factors that determine this experience. These factors relate to the data collected from the questionnaires and interviews.

- A low seating position to the ground
- A narrow cabin and tight interior feel
- Enclosing sporty seats that offer the right amount of support when driving fast
- Feeling the road and vibrations that come with it through the steering wheel, while not being irritating
- Focusing on the right amount of information, meaning that the dashboard should be kept simple
- Having good contact to the road through the suspension set up
- A low entering and exiting point/position of the car

Visually the car should express the sports car feel in both its exterior and interior, to create the right feeling for the owner when entering the car and using it. This could be created through a sporty and exciting design, which keeps the efficient and sustainable idea of a lightweight sensibility in mind.

7.0 CASE STUDIES

With the help of case studies it was possible to look in more detail at specific design features and models, in order to apply this specific knowledge to the project.

Figure051
"Case Study Images - Dealerships Auckland"

Figure052
"Case Study Images - PORSCHE 911"

7.1 Bench Marking PORSCHE 911

For this project it was important to look at specific examples of car developments, when it comes to Design, Ergonomics and numbers of sales.

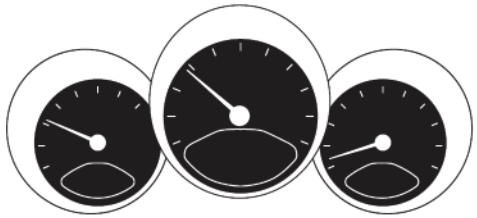
The Porsche 911 (991) was the main benchmark model for this project, and therefore the current version of the 911 Porsche (991) was examined in detail. The Porsche 911 was an invaluable case study because it managed to find the ideal compromise between an agile sports car, and a car which is usable on a daily basis without problems.

The Porsche 911 also sits in the same price range category, has the same performance characteristics, and targets the same user groups as this project's car does.

Figure053
PORSCHE Annual Figures 2011

2011 in figures

Record levels of unit sales, revenue and operating profit



116,978 UNIT SALES (NEW VEHICLES)

10.93 BILLION € REVENUE

2.05 BILLION € OPERATING PROFIT

€ million	31/12/2011	31/12/2010
Assets		
Intangible assets	1,757	1,255
Property, plant and equipment	2,850	2,433
Financial assets	130	141
Leased assets	1,207	1,129
Receivables from financial services	1,207	1,375
Other receivables and assets	9,470	9,599
Income tax assets	39	46
Securities	9	9
Deferred tax assets	283	325
Non-current assets	16,952	16,312
Inventories	1,051	834
Trade receivables	284	242
Receivables from financial services	663	607
Other receivables and assets	1,593	1,108
Income tax assets	42	56
Securities	99	86
Cash and cash equivalents	884	670
Current assets	4,616	3,603
	21,568	19,915
Equity and liabilities		
Subscribed capital	45	45
Capital reserves	5,806	5,806
Retained earnings	1,123	803
Equity	6,974	6,654
Provisions for pensions and similar obligations	990	922
Other provisions	677	605
Deferred tax liabilities	340	269
Financial liabilities	5,679	4,988
Other liabilities	562	400
Income tax liabilities	3	0
Non-current liabilities	8,251	7,184
Income tax provisions	41	30
Other provisions	995	732
Financial liabilities	2,098	3,296
Trade payables	1,032	761
Other liabilities	2,148	1,241
Income tax liabilities	29	17
Current liabilities	6,343	6,077
	21,568	19,915

Source: PORSCHE AG Annual Report 2011

7.2 Market Case Study PORSCHE 911

Porsche has had the highest sales numbers of their vehicle in the company's history for the past two years. Keeping in mind that the world was hit by one global financial crisis after another since 2008, it is very interesting to see and begs the question, how Porsche is reaching these numbers? (Porsche annual Report 2011)

Due to solid sales in the USA and strongly increasing sales mainly in new emerging markets, Porsche had a 20% increase in sales worldwide with approximately 117,000 units sold in 2011. (Porsche annual Report 2011)

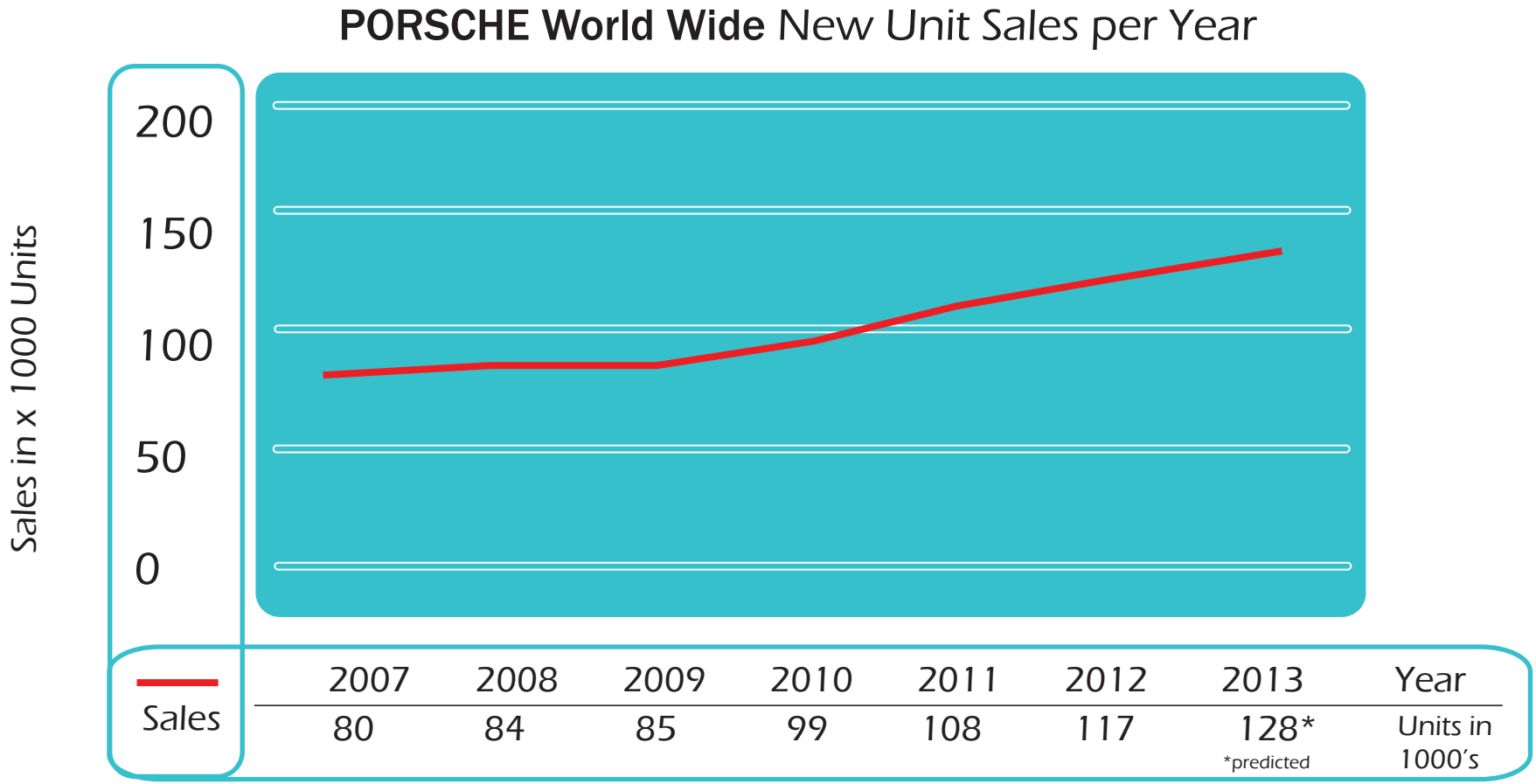
In the first quarter of this year Porsche sold 21% more cars than in the year before, that is a record for Porsche with 14,000 units sold. Trends and numbers like this, suggest that developing new sports car concepts could satisfy the demand for more and new car models of this kind. (Porsche annual Report 2011)

The success of Porsche is a result of excellent performance characteristics and a timeless design. But the image factor of a Porsche is also very important. In comparison to many other sports cars, the Porsche 911 is a vehicle of "understatement", which makes it suitable for this project. It is an understandable status symbol, that does not foremost communicate one's wealth, but a sense of taste and sportiness.

Figure054
"2013 PORSCHE 911 Carerra S (991)"

Sales Chart

Figure055
"2013 PORSCHE Logo"



Source: PORSCHE AG Annual Report 2011

7.3 Additional Model Case Studies

To get an idea of what is on the market in addition to the PORSCHE 911, different models were observed with a particular focus on the interior layouts.

By measuring out dimensions and distances of different key points of the interiors, it was possible to get an overview of the ergonomic factors required to develop a sports car.

The next step was then to visit car dealerships in Auckland that had sports cars on display.

Time was specifically spent at the Continental Car Porsche dealership in Newmarket Auckland and The Continental Prestige Cars Dealership in Newmarket Auckland.

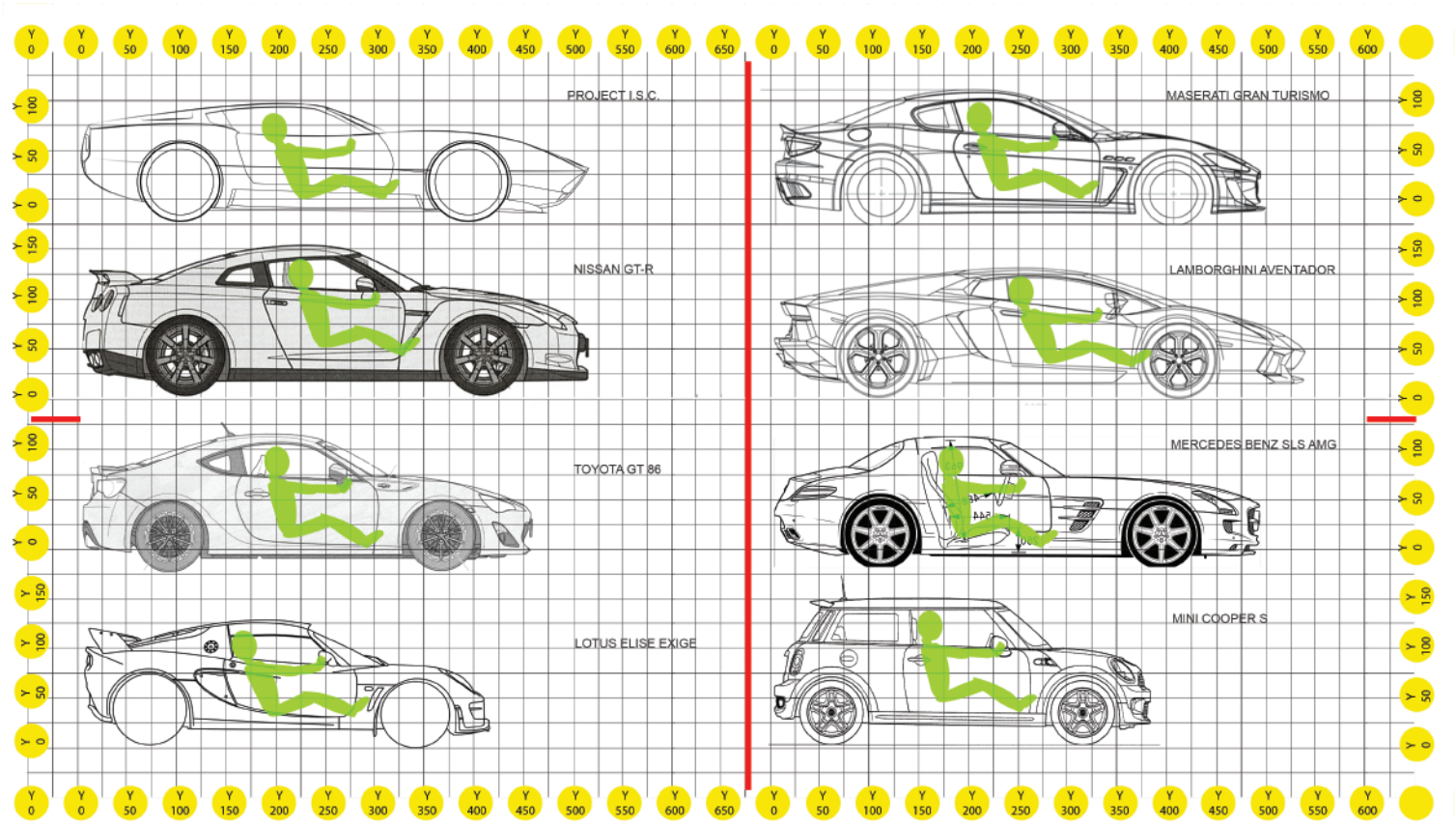


Figure056
"Ergonomic Model Comparison"

Figure057
"Dealership Field Trips, Newmarket, Auckland"

MODEL CASE STUDY

ERGONOMIC DIMENSIONS CHART

These key dimensions are used to develop and set up the size and key attributes of the package. (Appendix for dimension explanation)

Dimensions that were taken included:

Model / Category	MASERATI Gran Turismo	LAMBORGHINI Aventador	FERRARI 599 GTO Fiorano	FERRARI 458 Italia	PORSCHE 911 Carerra	DODGE Viper SRT	LOTUS Evora	McLAREN MP 12 4C	NISSAN GT-R	AUDI R8 V10 +
Effective Headroom F	965	899	945	934	950	955	890	895	960	945
Effective Headroom B	947	/	935	/	938	/	/	/	949	/
Hip Room	1289	1174	1274	1187	1275	1275	1185	1101	1277	1269
Steering Wheel Distance	310	297	300	299	300	330	285	290	320	300
Front Leg Room	90	/	70	/	89	/	/	/	75	/
Rear Leg Room	410	398	410	379	429	390	375	384	412	375
Chair Height (Average)	150	141	146	143	152	154	142	142	151	148
Shoulder Room	1370	1290	1360	1345	1352	1356	1289	1312	1354	1349
Average Cargo Lenght	1300	525	1155	656	782	1278	884	685	1314	747

7.4 Market Placement

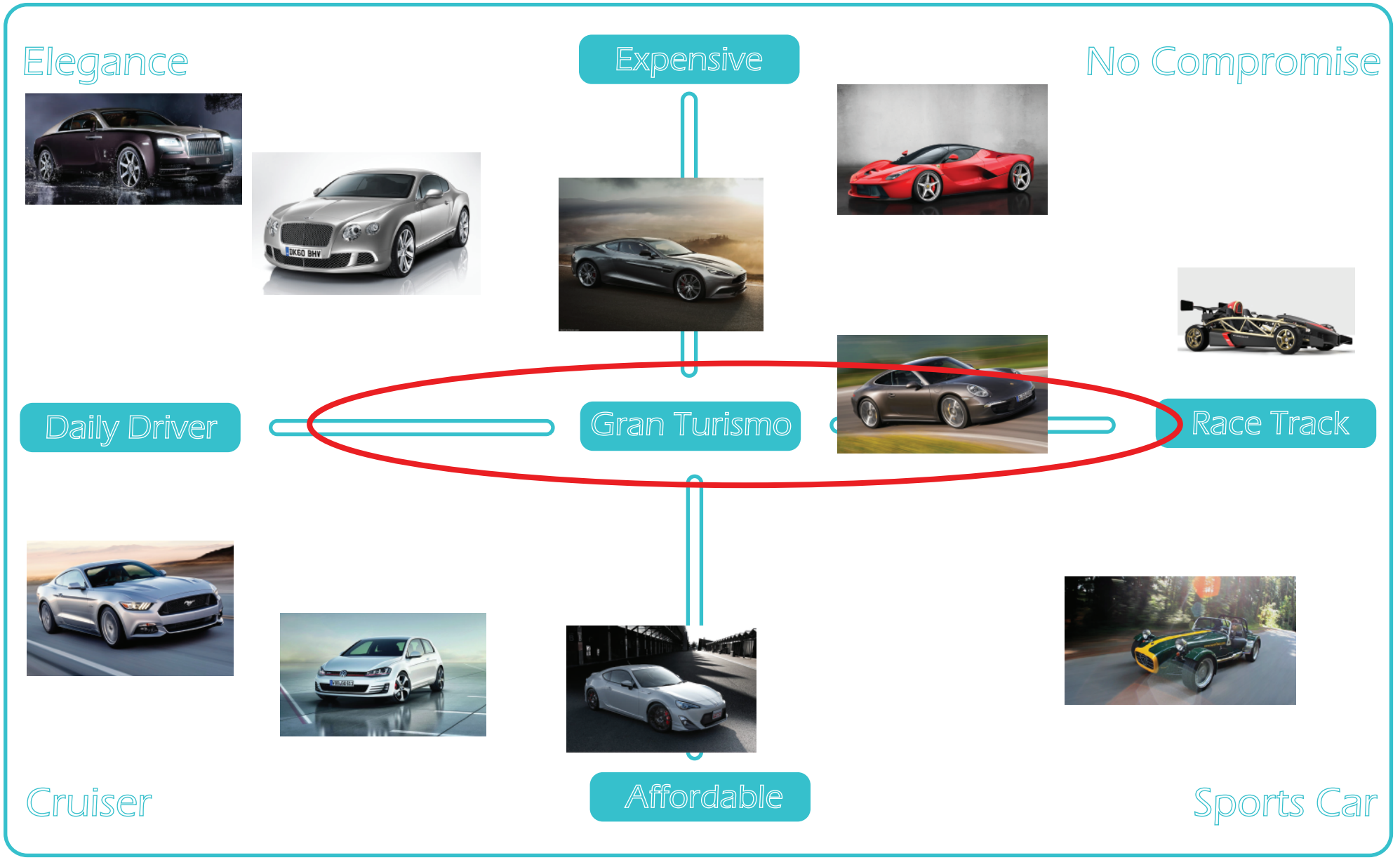


Figure058
"Market Placement Examples"

7.5 Model Comparison

Model	Nissan GT-R	Aston Martin Vanquish	Porsche 911
KW/HP	409/550	421/573	257/350
Top Speed	320 km/h	285 km/h	289 km/h
0-100 Km/h	3.9 sec	4.3 sec	4.8 sec
Weight	1.749 kg	1.739 kg	1.445 kg
Seats	2+2	2+2	2+2
Engine Type	3.8l. V6 TT	6.0l. V12	3.8l. F6
Engine Layout	MF	MF	R
Price (NZ$)	170.000	360.000	245.000

Figure059
"Model Comparison Examples"

Model Comparison Findings

After the process of evaluating the case studies and model comparisons, it was possible to find certain averages and common features in these concepts. This was important for the design process in order to find the right dimensions, features and performance characteristics for this project.

In terms of the case studies, the ergonomic data gathered helped to identify certain key dimensions and features for the ergonomic and visual development of the car.

Previously and during this process it was concluded that the PORSCHE 911 would be the most suitable benchmark for this project. Although it has less Horse Power than many of its rivals, it is still one of the best in its segment due to its intelligent design. It is an excellent example in terms of its relationship between everyday usability and being sporty and practical.

Visually all of the observed cars were of interest to identify modern designs trends and features, such as layering and undercuts in most models. Also the strong lines and folds, seen in the current Lamborghini models were of high interest.
Material choices for the exterior and interior of the studied cars were predominantly expensive modern materials (carbon fibre, leather, and aluminium) that often made up most of the overall composition.

8.0 PACKAGE LAYOUT

To address the key features and characteristics of the car, it was necessary to define what these key ideas were and which would create the car in the most successful way. Design experiments were undertaken, which included different mediums, generally unrelated to car design; and traditional sketching to find the suitable design ideas for the concept.

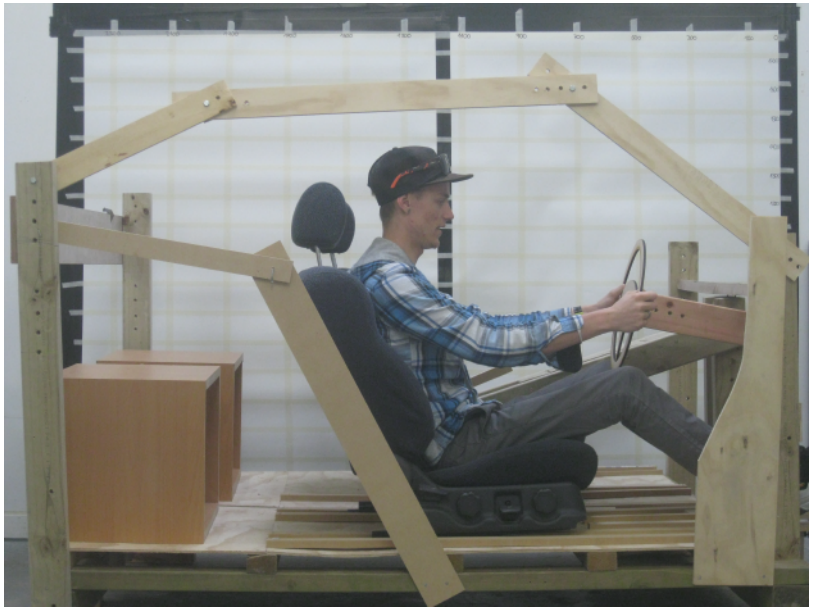


Figure060
"Interior Box - Ergonomic Tests Images"

8.1 Test Interior Box

To gather exact and 1:1 scale ergonomic data and information, a full scale bucket box was built, which would stand in for the interior of my concept car. With this bucket box it was possible to take exact measurements and get a feel for seating positions, steering column position and pedal distances.

It was also possible to look into different ways of placing essential elements like the gear stick, steering column, handbrake and the dashboard line. All of these elements are essential for creating the right interior.

To gather the right ergonomic data with a driver and passenger inside that car, it was important to do experiments with real people. With the help of volunteers it was possible to go through different seating positions and variations of the placement of some of the key elements of the car interior

Figure061
"Interior Box Images"

INTERIOR BUCK TEST BOX

ERGONOMIC DIMENSIONS CHART

Participant / Test Type	MALE 95%	FEMALE 50%	NOTES
Version 1	Moderate	Good	A bit too tight for male, but good for female
Version 2	Uncomfortable	Good	Too tight for male, especially steering distance but good for female
Version 3	Good	Uncomfortable	Comfortable for male, good access to all components, too much effort for female
Version 4	Good	Moderate	Good for both parties, female would prefer a bit more proximity to steering and pedals
Version 5	Good	Good	Good for both parties, good all-rounder for both, could be made a bit tighter for male

Evaluation Key
- Good
- Moderate
- Uncomfortable

	Seat Height	Seat Distance	Steering Distance	Pedal Distance	Passenger Distance
Version 1:	120	320	280	450	145
Version 2:	100	220	190	320	145
Version 3:	180	440	320	550	220
Version 4:	200	420	300	450	160
Version 5:	170	330	310	500	170

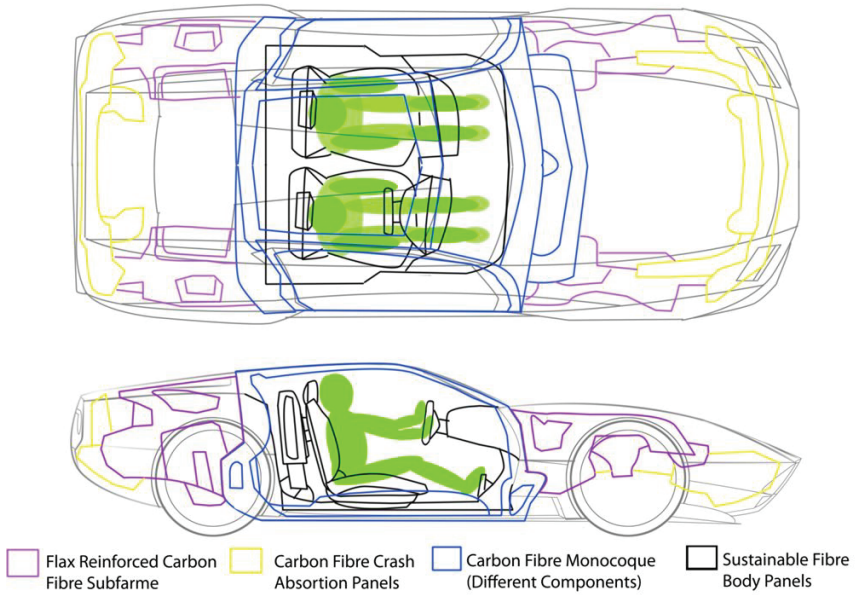


Figure062
"First Material Component Layout Concept"

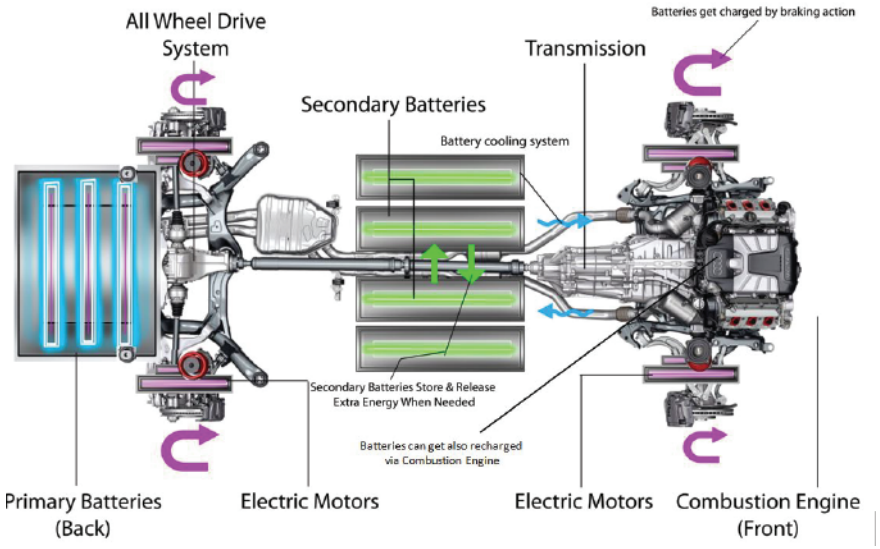


Figure063
"First Powertrain Layout Concept"

8.2 First Package

After evaluating the data from the research process and the bucket box tests, it was possible to create the initial package model, which included all the necessary dimensions.

This package was created in CAD to be as accurate as possible and include all the structural and necessary components. This also made it possible to be very flexible when it came to new layout ideas.

This CAD package model was used as an underlay for sketches to generate side profiles, ensuring the use of the same package concept and dimensions. This package model was also used as the foundations and underlay for the mock up models and clay models that followed.

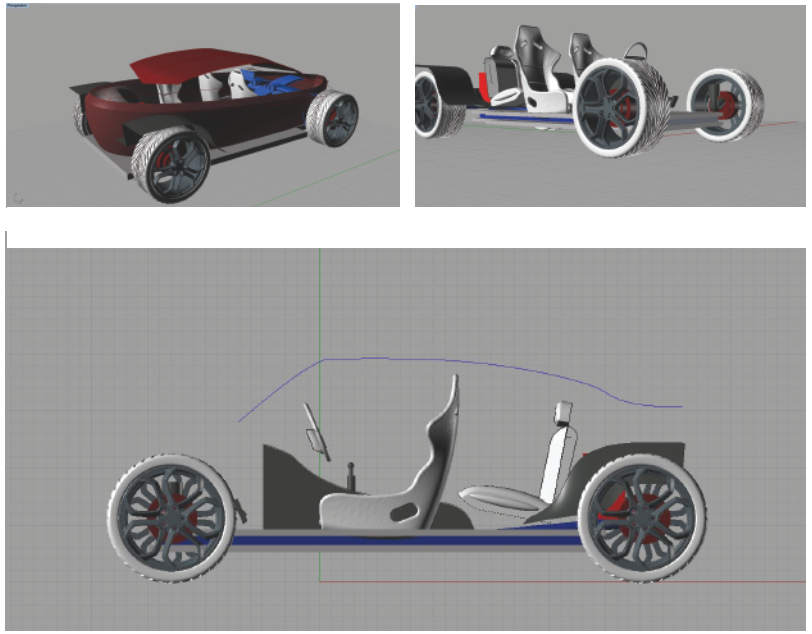
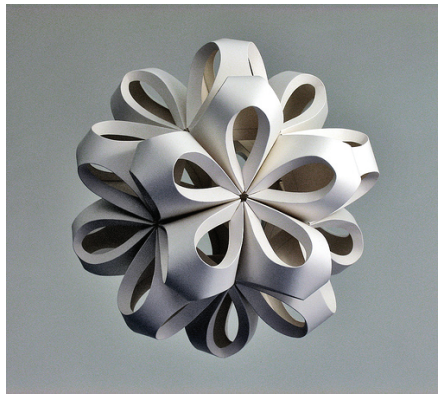


Figure064
"First Package CAD Concept"

9.0 DESIGN INSPIRATION



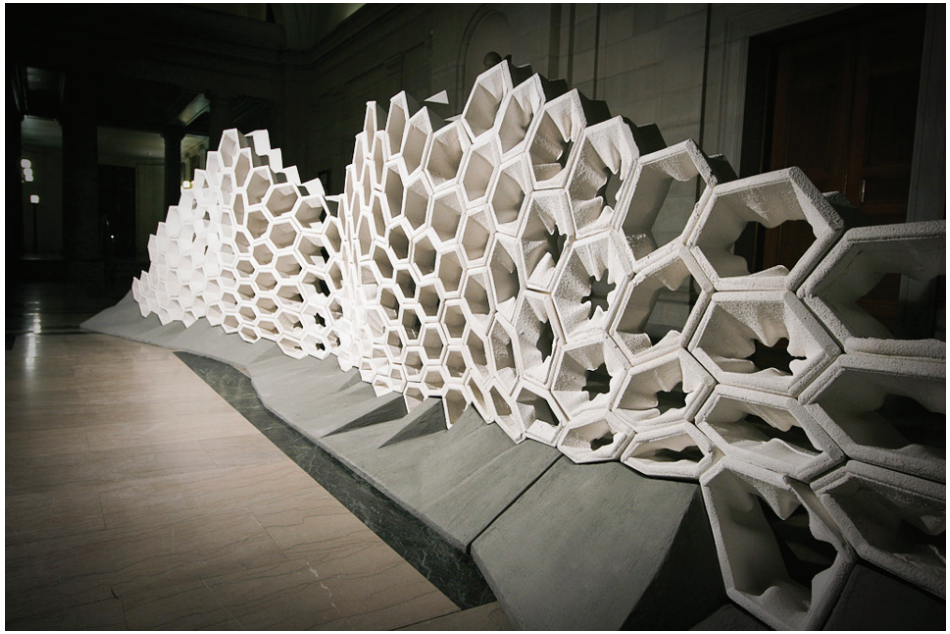


Figure065
"Inspirational Images - Sculptures"

A couple of key areas, which would not generally be associated with cars or other vehicles were vital design inspirations for this project. Firstly the art of sculptures and how their artists have created shapes and forms that look relevant for the key ideas. Often these sculptures represent specific moods or feelings without mentioning anything verbally. These sculptures also inspired different forms or shapes that were later resolved by means of sketching.

Figure066
"Inspirational Images - Nature"

Another big initial influence was the area of nature. Specific areas or species in nature have solved and mastered the ideas of lightweight, transparency and the dynamic in different ways. Nature has different answers to the same problem, and these solutions often come across visually different to others, which were a great source of inspiration.

One specific area that was explored was the great many types of flower petals or blooms. To get an overview of different types and shapes of petals, different species and families of flowers were investigated.

The Botanic Gardens in Auckland, Hamilton and Wellington were also visited to experience some of the species in real life and take pictures.

The petals of flowers create some amazing shapes, the effect of the overlapping of their surfaces was an interesting effect for the design concept. Also the concave and convex shapes of the leaves, which demonstrate a sense of the dynamic, inspired some great ideas for shapes that could be transformed into parts of the sports car. Furthermore the transparency that some of the flower species showed is a characteristic that communicates lightweight in a special way which fit well into the design concepts.

Figure067
"Inspirational Images - Flowers/ Botanic Gardens"

9.1 FLOWER CARS

As a next step, and to come back to my earlier inspirational design research of flower petals, abstract cars that are constructed out of flower petals were created.

These cars have been created in Photoshop and attempt to find and create dynamic shapes and possible patterns or texture for the sports car. These cars aimed to come up with possible new shapes and ideas for the sports car design, concentrating on the inspirational topic of flower leaves and their characteristics.

Car number 2 was the most influential and promising test regarding its proportions and lines. In my view it most effectively captured the essence of the project overall. Elements from this concept were used for the sketching process and strongly influenced the design.

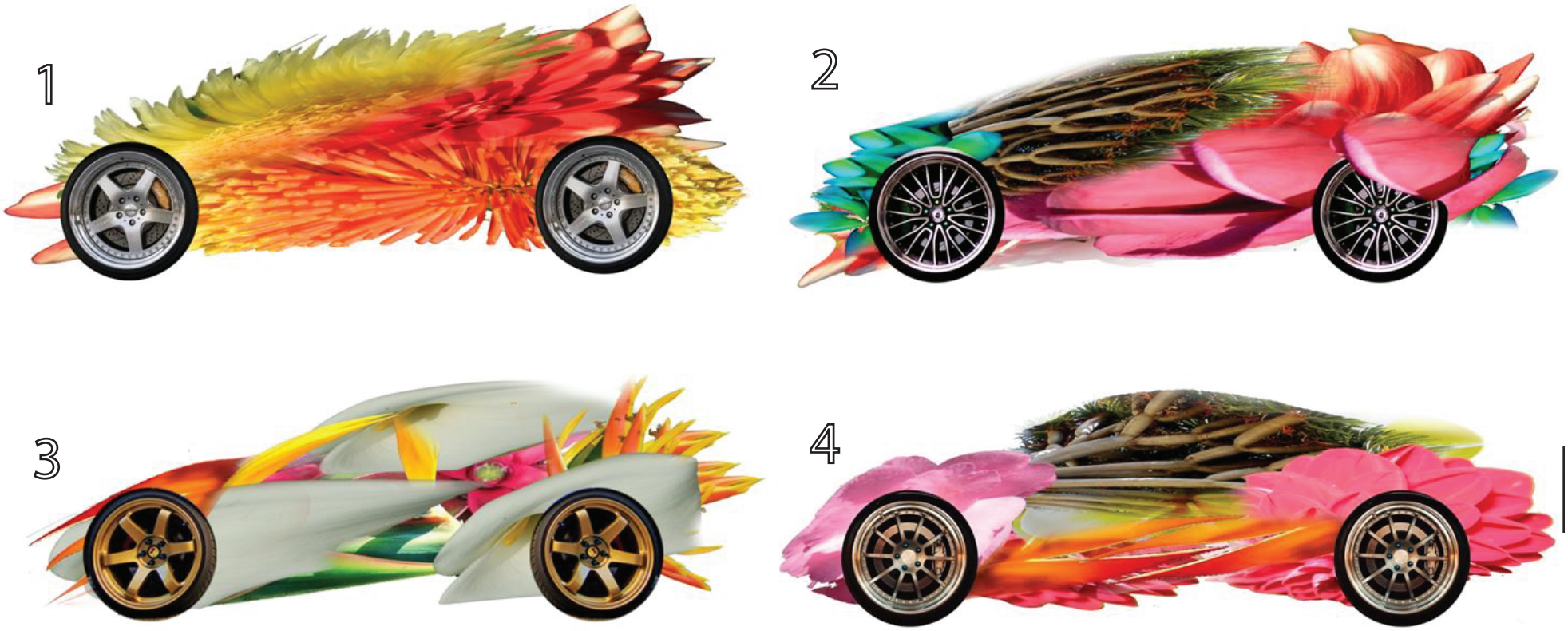
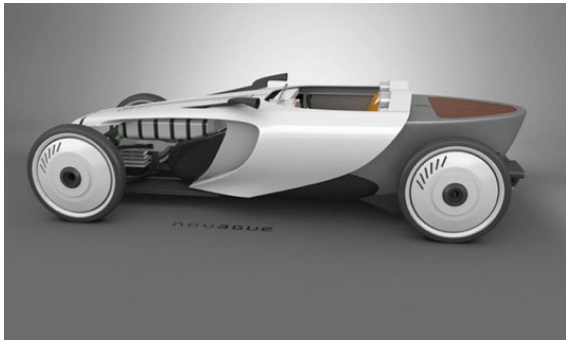


Figure068
"Form Experiments - Flower Cars"

Renault Fly



Novague Eco Car

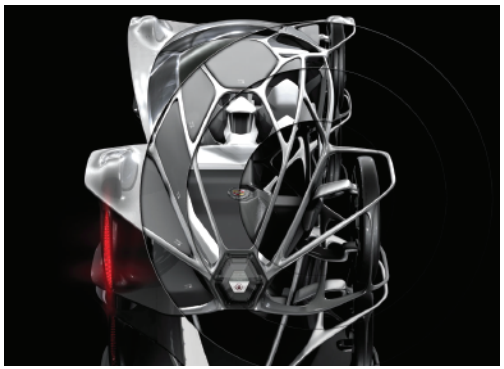
Pininfarina Sergio

Figure069
"Inspirational Images - Concept Cars"

9.2 Concept Vehicles

In additional to earlier forms of inspiration; Naturally the emphasis returned to vehicles. Concept vehicles that communicated lightweight, sustainability and performance were focussed on.

Toyota ME.WE.



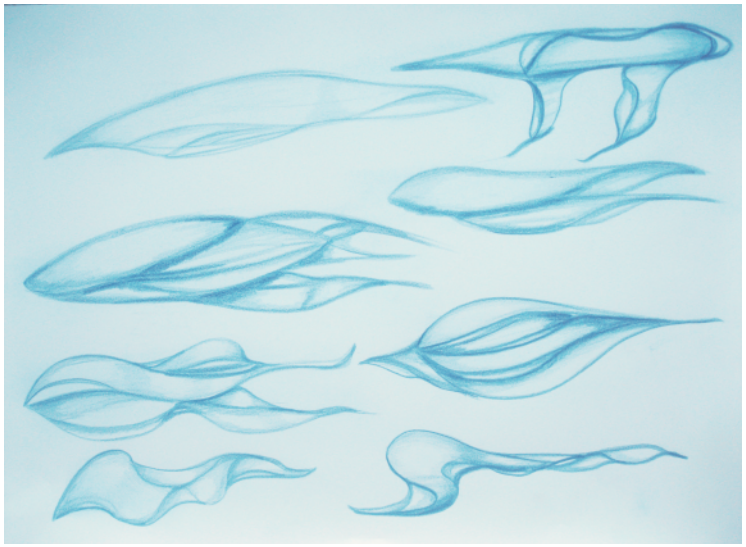
Caddillac Aera

Figure070
"Form Experiments - Fabric Underwater"

9.3 Design Form Experiments

After some first sketching explorations, it was apparent that there were some problems with finding the right design language that would reflect the projects key thoughts. The next step was therefore to do some experiments with other three dimensional media, that also dealt with the notion of the lightweight and the other key design characteristics previously mentioned.

Photos of fabric underwater in a fish tank were taken to demonstrate the felling of floating and transparency. Such experiments were a means of attaining inspiration for new shapes and forms. This also helped in understanding how fabric sheets react when floating. With these pictures it was possible to examine the transparent and floating characteristics and shapes of the fabric, which could then be transformed into design elements of the sports car.



Another type of experiment undertaken was creating sculptures out of plastic sheets. The aim of these sculptures was to find shapes, and create tension in curves which could then be transformed or incorporated into the lines of the car body.

Next a sculpture was created out fabric that had been soaked in pva glue and then dried while draped over a plastic bottle. This exercise was done to get a sense of a floating, transparent object, which could then be used for form studies of the car design language.

These different types of three dimensional experiments provided the information and aesthetics to create abstract drawings that transformed the information directly into the sketching phase. These drawings show some abstract shapes that all stand for light-weight terms such as, dynamic, transparent, and agile.

Figure071
"Form Experiments - Fabric PVA & Inspirational Drawings"

Figure072
"Form Experiments - Plastic"

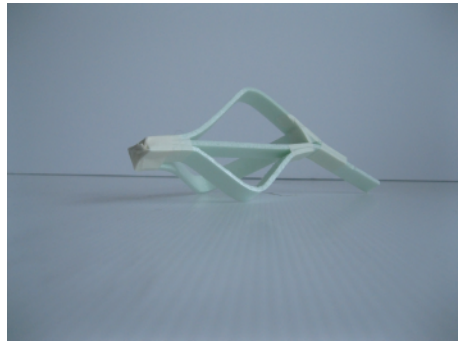


Figure073
"Form Experiments - Foam"

10.0 DESIGN BRIEF

Having finished the research process and evaluated the data and information, key points were created that would be necessary for the design of the sports car. With this key information it was possible to determine what shape the sports car should take, and what the following design processes should focus on.

To summarise this data, the sports car should be:

- Designed to be driven comfortably in the city and excitingly on the race track
- Able to carry a moderate amount of luggage for up 3 passengers
- Express the way of construction through its design language
- Use an exciting design suitable for the sports car character
- Use new sustainable materials to save weight and resources
- Use a modern fuel saving power concept, that develops enough power to deliver the right amount of excitement in driving
- Focus on developing a sporty user experience, which uses less energy to create the same amount of thrill when driving

Figure074
"Brutal Power (Lamborghini Veneo) VS. Lightweight Intelligent (BMW i8)"

10.1 Effective Qualities

For the formal aesthetic language of the car, a couple of key factors that would best describe the vehicle and be reflected in its design were focused on.

Being a sports car, low profile lines, an aggressive or exotic styling and a relatively low ground clearance where obvious key design characteristics. But being a lightweight sports car, several other characteristics had to be considered and included to create the right feel.

People have certain associations and expectations with a light weight sports car that make them different to other sports cars. It is important for a car like this is to reflect its lightweight construction and design visually, meaning that it should not look heavy or wasteful.

"This goes in hand with the resource saving background concept in terms of generating the same amount of performance, but saving fuel and energy by saving weight and material.

"In an effort to save significant weight, new forms of glazing to replace heavy glass will be developed from plastics and polycarbonates....As a secondary benefit, such glazing materials could offer designers greater freedoms to generate more elaborate and sculptural window surfaces. This major effort to reduce energy-sapping weight will also apply to aerodynamics."

Page 87, "The Car in 2035 – Mobility planning for the near future"

To demonstrate the lightweight design of the car visually, it is Important to openly show the construction of the vehicle to the audience, where it would normally be hidden.

This creates an open honest character, that clearly communicates from a distance what class of car it is.

The interesting part of this concept is the balance between the lightweight character of the car which is usually minimal and has limited usability; to an everyday driving practicality.

For this concept it is important to find the right compromise between being an agile lightweight sports car, but still offering a good sense of everyday practicality by not sacrificing those key aspects of the car.

To find the right direction of design a couple of key values and key ingredients were followed that would describe the character of the sports car properly.

Everyone connects specific words, characteristics or images, when thinking of sports cars. In addition to that is the idea of the lightweight, which again is connected to specific visual ideas.

To narrow it down to specific ideas I followed four key words that represent for lightweight in car design and beyond.

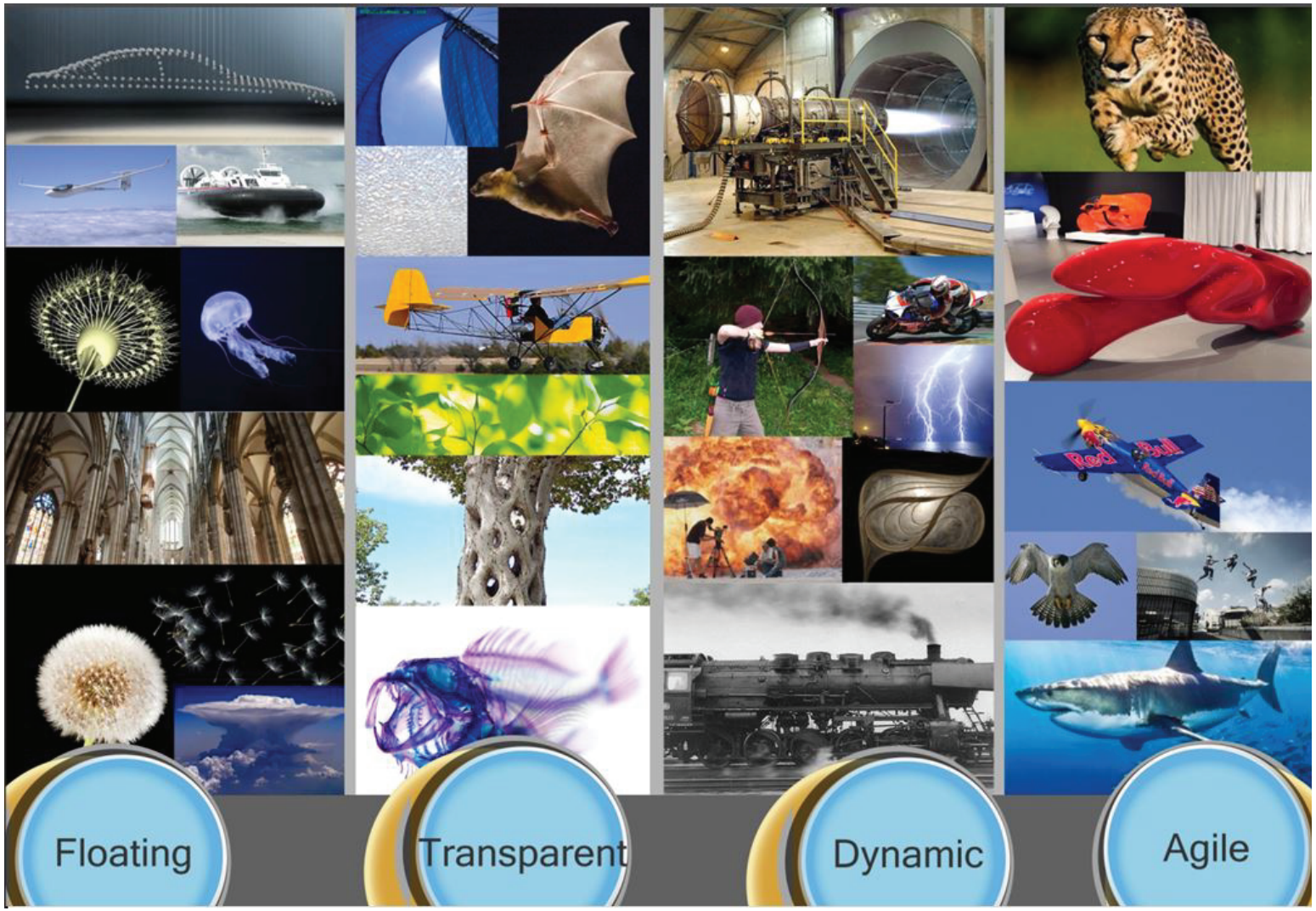


Figure075
"Key Values Image Chart"

11.0 DESIGN PROCESS

For the design process it was important to consider how the car would be constructed and how this construction would influence the design.

Overall the aim was to create a sports car that would adopt a lightweight philosophy to save resources and create the same amount of joy in driving with less energy needed than the majority. These ideas had to relate to the possibility of an everyday usability factor in a visually pleasing way.

For this vehicle finding a balance between "Guilt Free Pleasure" and "Environmental Awareness" was really important. Therefore it is important to develop a way to create this guilt free experience that creates the thrill in driving a sports car, without sacrificing a background in sustainable thinking.

11.1 Sketching 1st Phase

With the design language and form finding experiments finished, it was time to return to sketching out concepts in order to summarize and resolve ideas.

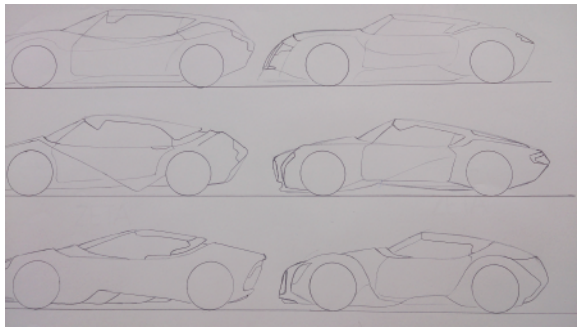
The focus was on generating as many ideas as possible that incorporated the inspiration and findings from earlier in the process.

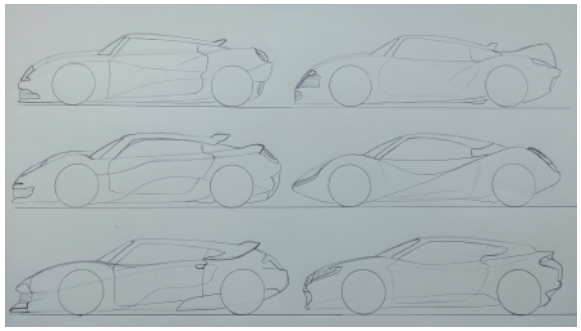
The sketching periods aimed to incorporate the idea of transparency, dynamic and agility into the designs alongside the lightweight construction of the car that was established through the research findings.

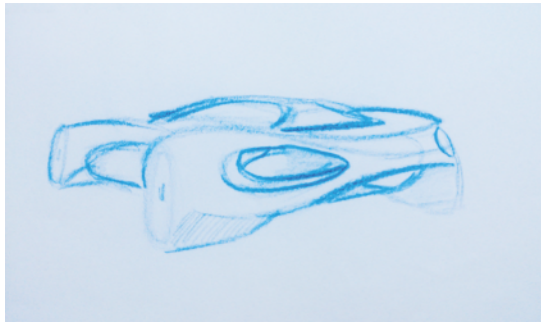
These sketches all try to show different ways of establishing a visual lightweight appearance, through design features such as using glass for transparency, a thin reduced bottom line for the idea of lightweight with less material or a pod like design for the passenger area.

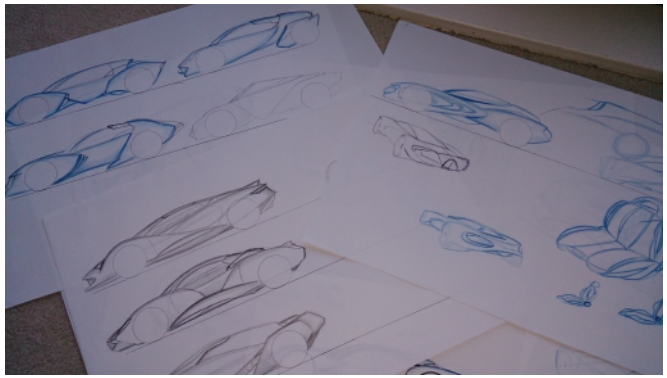
SKETCHING

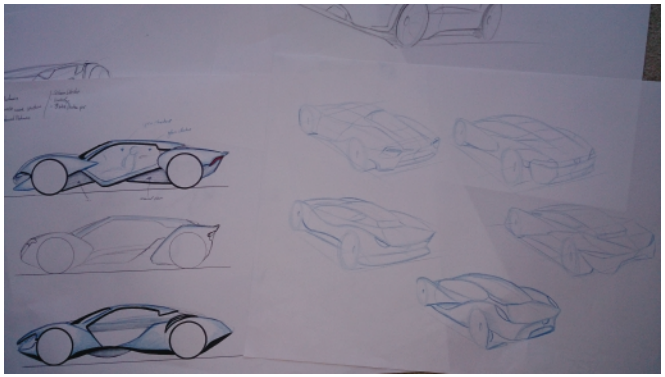
CONCEPT SKETCHES











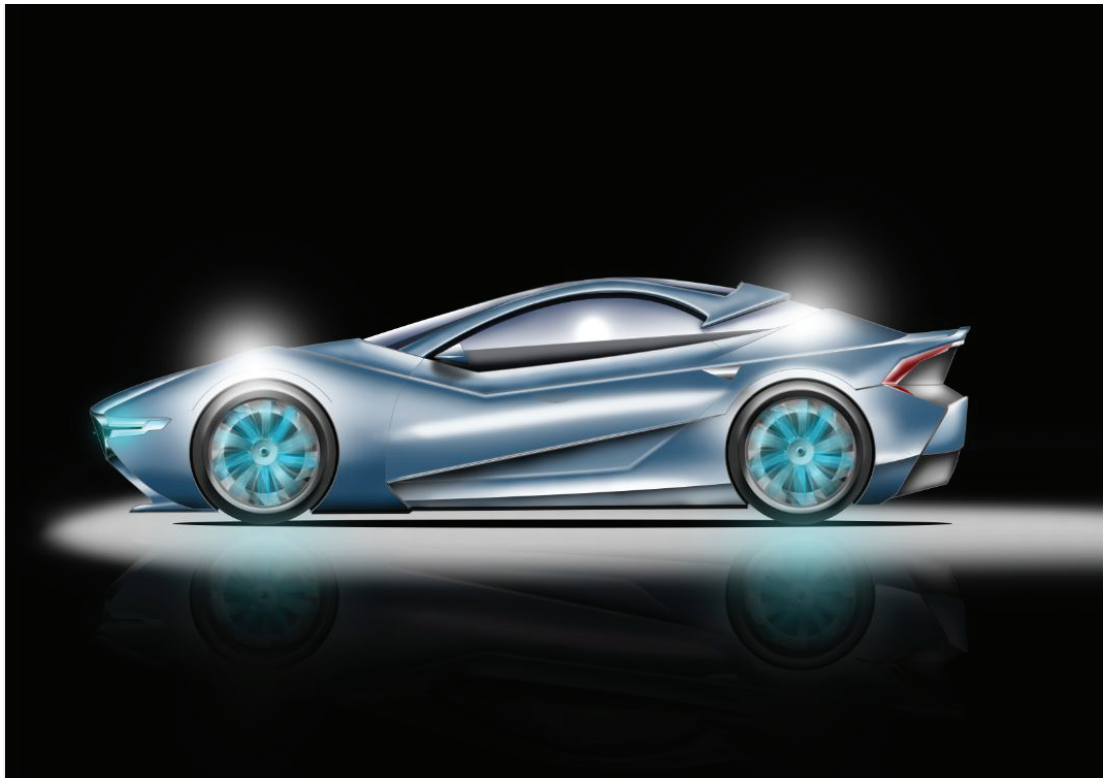


Figure076
"Concept Sketches"

SKETCHING
DEVELOPMENT SKETCHES

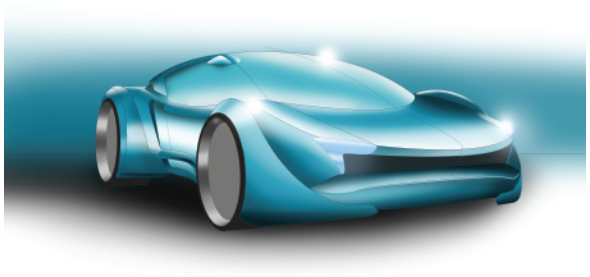
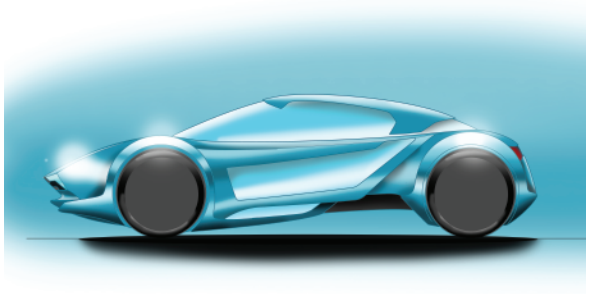
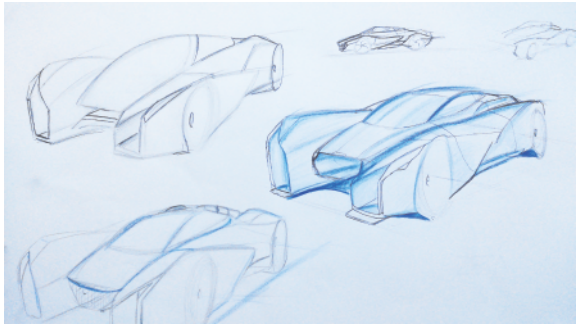
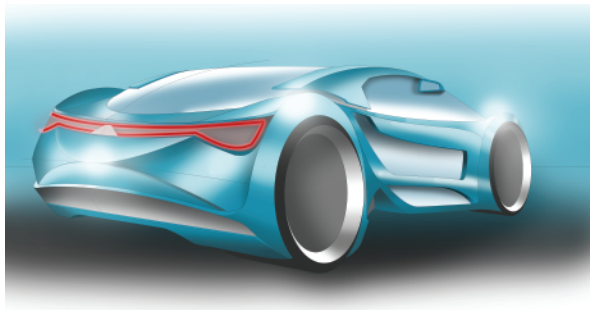
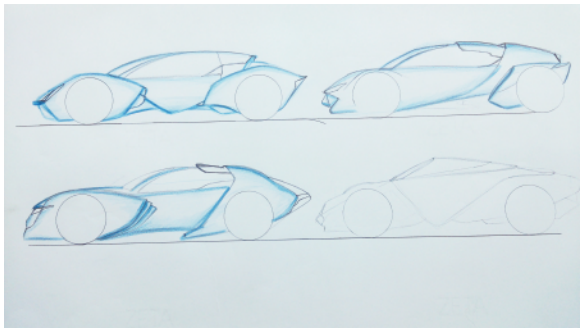
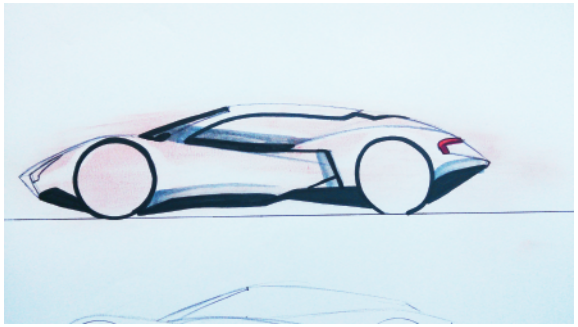
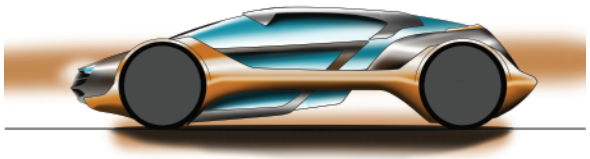
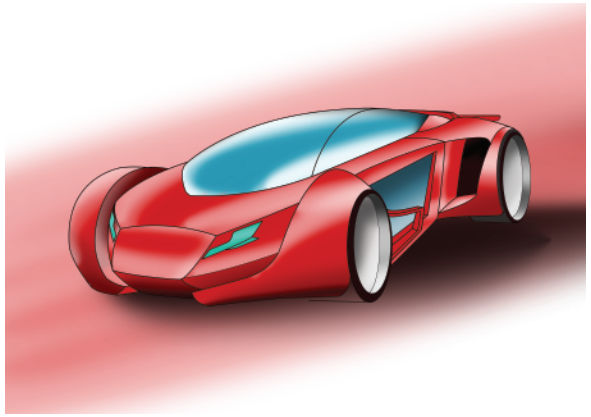
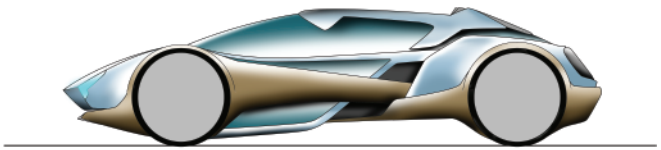
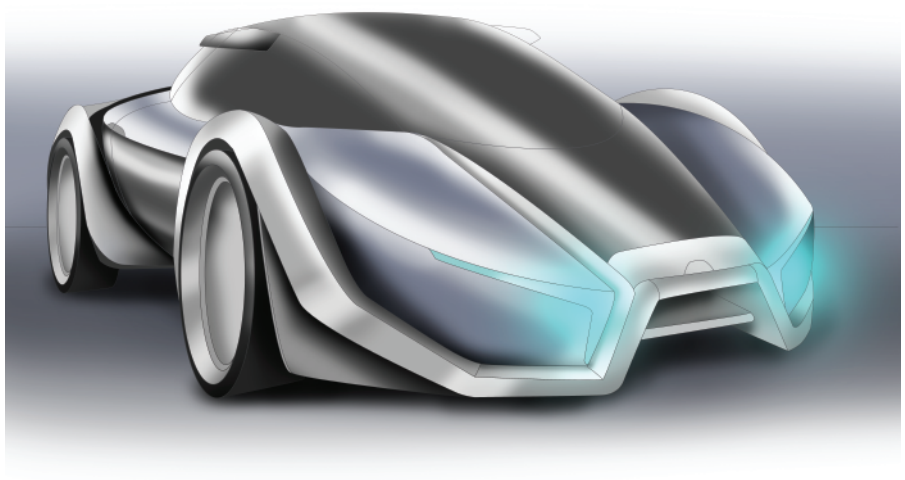
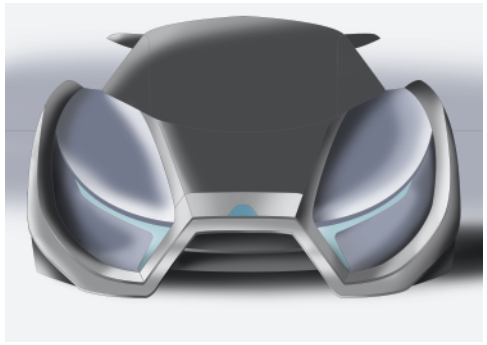










Figure077
“Development Sketches”

SKETCHING
DEVELOPMENT SKETCHES





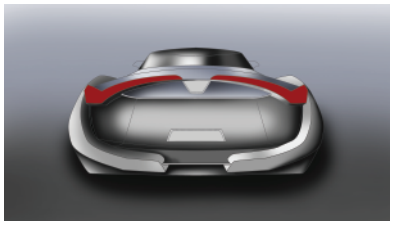
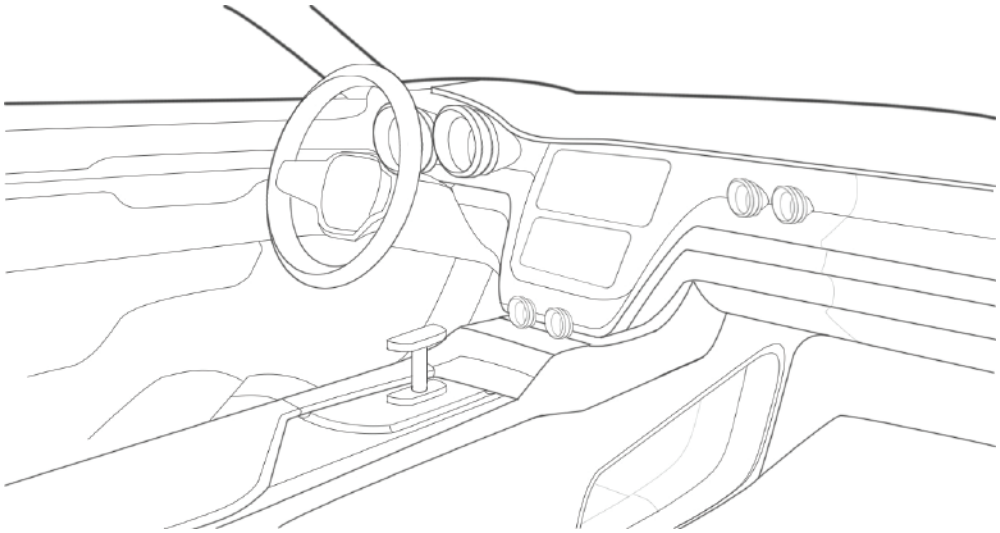
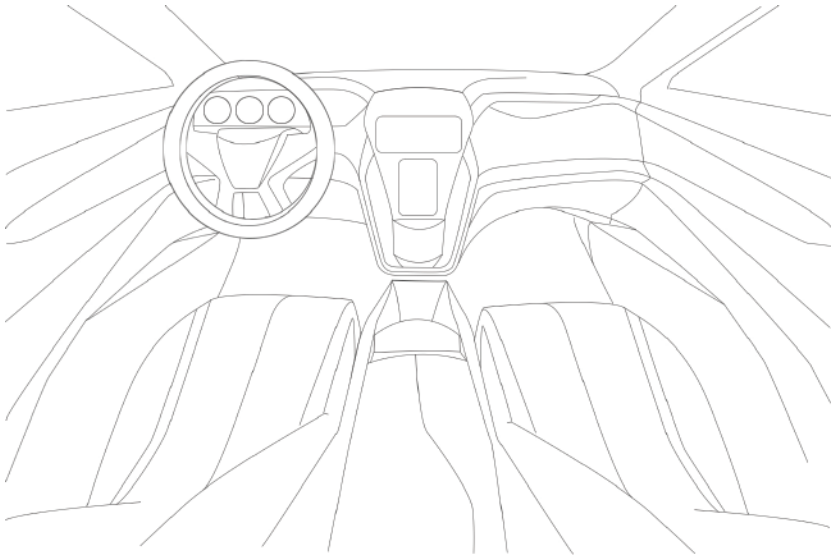
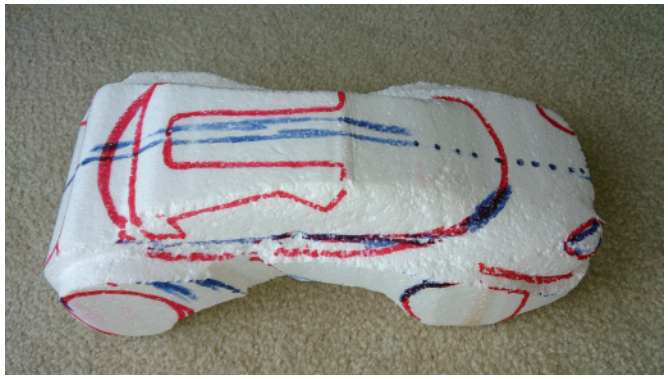


Figure078
“Development Sketches”





Mock Up Models



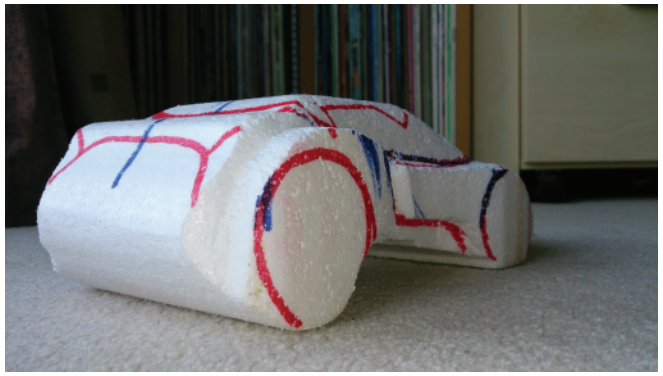
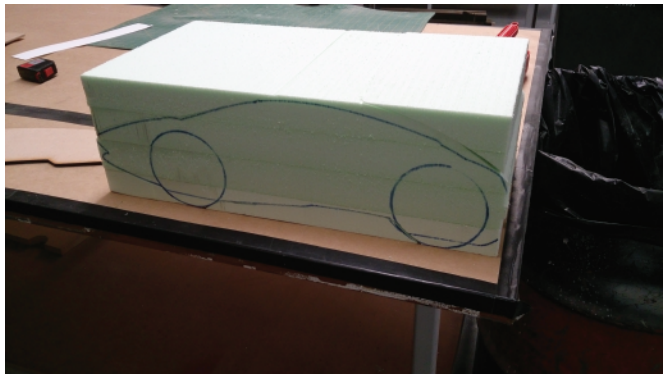


Figure079
"Mock Up Models Images"

11.2 Mock Up Models

To compliment ideation sketching, rough and simple mock up models were made to establish proportions, shapes and lines.

With these early foam mock ups it was easier to understand the proportions and overall dimensions of the car in a three dimensional way. It also helped in understanding the overall idea of the car and its look.



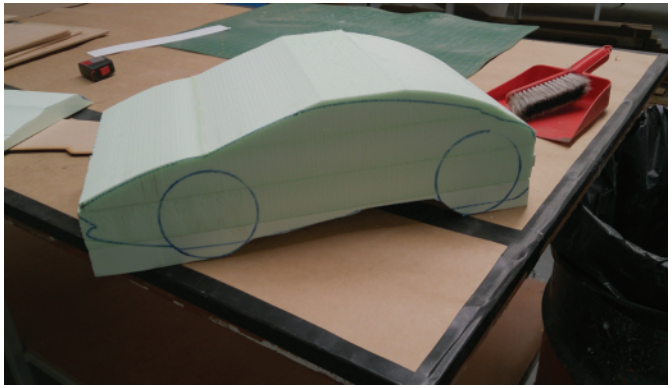


Figure080
"Clay Model Process Images"

11.3 Clay Models

Having finished the mock up process, the focus shifted to creating a 1:5 scale clay model, which was based on the previously established packaging dimensions. It was most efficient to halve the clay model in order to develop a different design on each side of the car.

With the help of the clay it was possible to work out lines, body panelling and surfaces in detail. In turn it created a more accurate representation of how it would look in real life, as opposed to on paper.

This method is still being used as one of the main methods in car design to establish and finalise designs and resolve them for the final product.

Clay Model 1

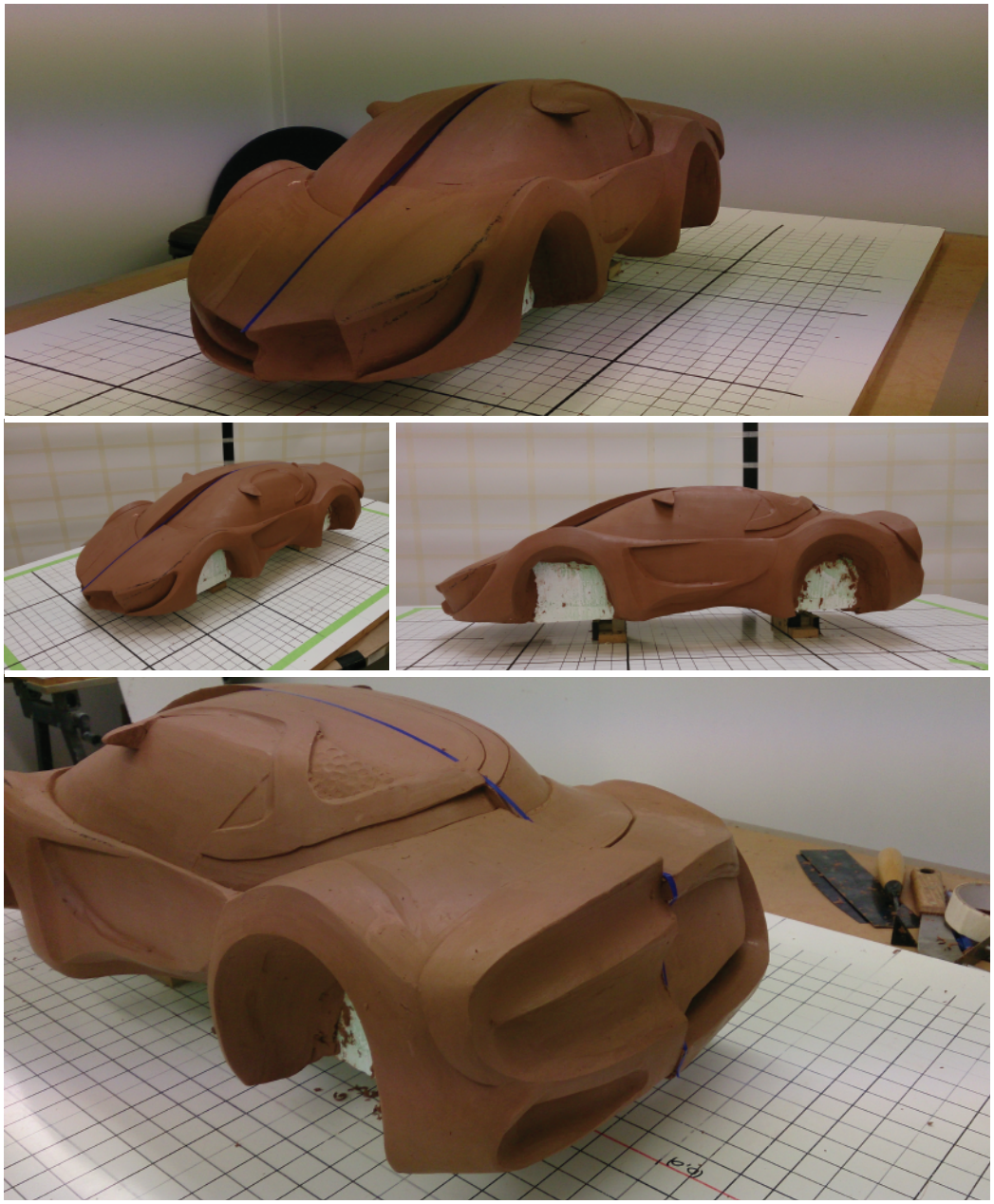


Figure081
"Clay Model Stage 1"

The first half of the clay model was produced and evaluated in terms of overall flow of design, proportions and design language, as well as overall feasibility of design.
The result of the evaluation was:

The overall design did not communicate the key design values well enough.

The design features did not work together well.

The design was too complicated, resulting in the observer not understanding the concept of the car.

The design needed to communicate the previously established key values more.

Front and Rear Lights needed to be refined and placed in the right place in order to work within regulations.

The body of the car needed more tension and the lines needed to be resolved in the overall design.

After the evaluation of the model, it was concluded to model an alternative side in order to compare, refine and monitor the design progress.

Clay Model 2

Figure082
"Clay Model Stage 2"

The second half of the model was produced under the previously evaluated aspects of the first half model.
The second half was then observed and evaluated.

This model focussed more on an overall design language, as well as incorporating more design themes from the design inspirations and experiments.

The result of the evaluation was:

The design language was more successful, and the overall flow of design was more visible.

The inspiration of flower petals was more visible.

The aspect of modern regulations was better resolved in the second model.

The design was still too complex and "busy" and needed to be toned down, in order to accomplish a resolved design.

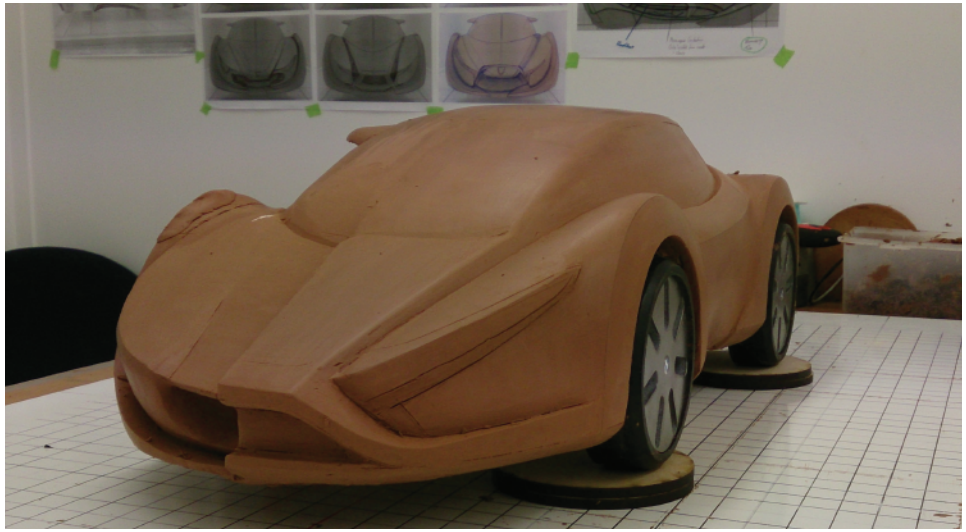
Some of the design features (air intakes, out lets) were too extreme for the overall idea of the project.

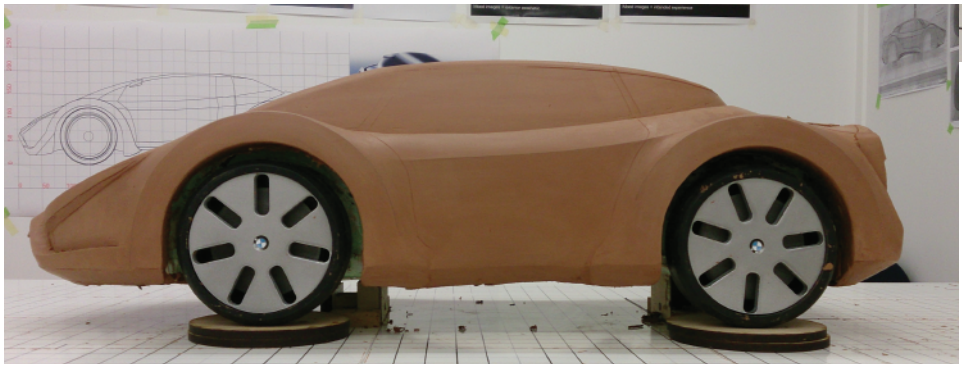
The idea of lightweight and key values was not communicated well enough.

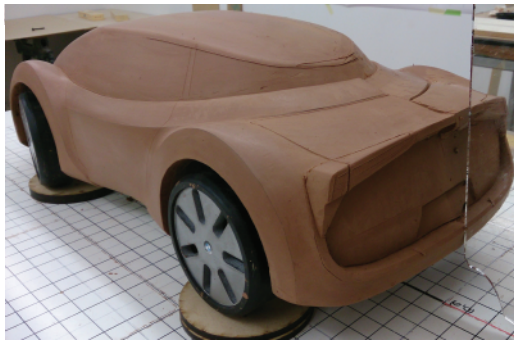
Still more flow and tension needed to be applied to the design.

It was concluded necessary to model a third alternative side in order to further refine and resolve the design of the project.

Clay Model 3







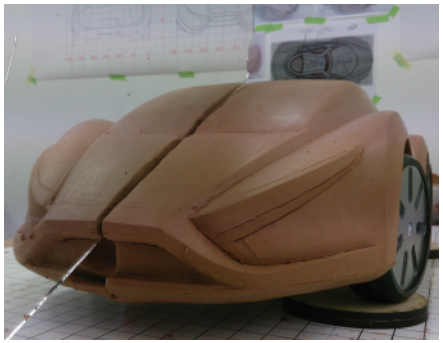


Figure083
"Clay Model Stage 3"

The third clay model was produced taking into consider the previously gained knowledge from the first two clay models.

Neil Stanely assisted with his expert knowledge in this stage of modelling. He is a professional clay modeler from the Automotive Industry (Porsche, Opel, Mercedes Benz, Nissan).

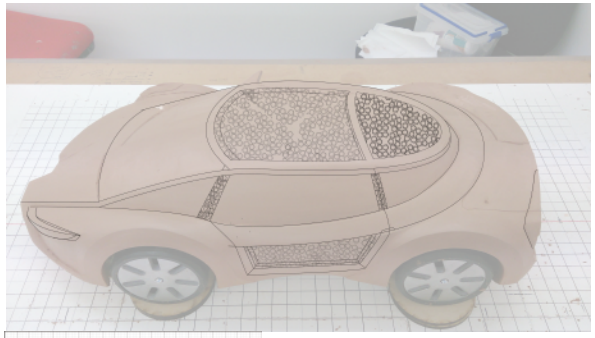
He helped to take into consideration important guidelines and rules from the industry in order to ensure the car complied with the legal requirements of the EU and US market.
(e.g. Bonnet height, pedestrian impact areas, head/taillight regulations, front/rear bumper height, folds and production part lines.)

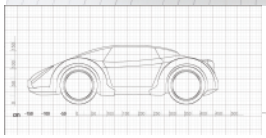
With this knowledge it was possible to better resolve the design, and focus on an overall better flowing design of the vehicle.

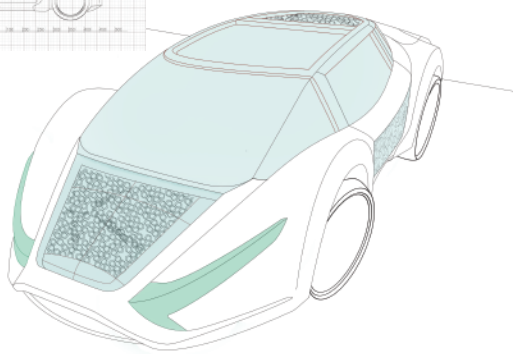
It was also possible to resolve the user interaction with the vehicle, in order to make the car function better during everyday use.

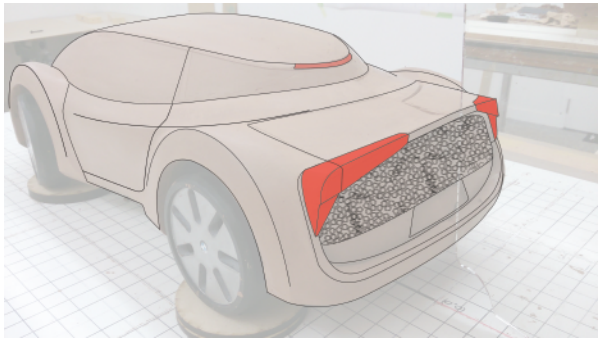
After this clay model was finished , the model was digitally scanned to refine the concept further in CAD programmes.

Final Development Ideas/Sketches









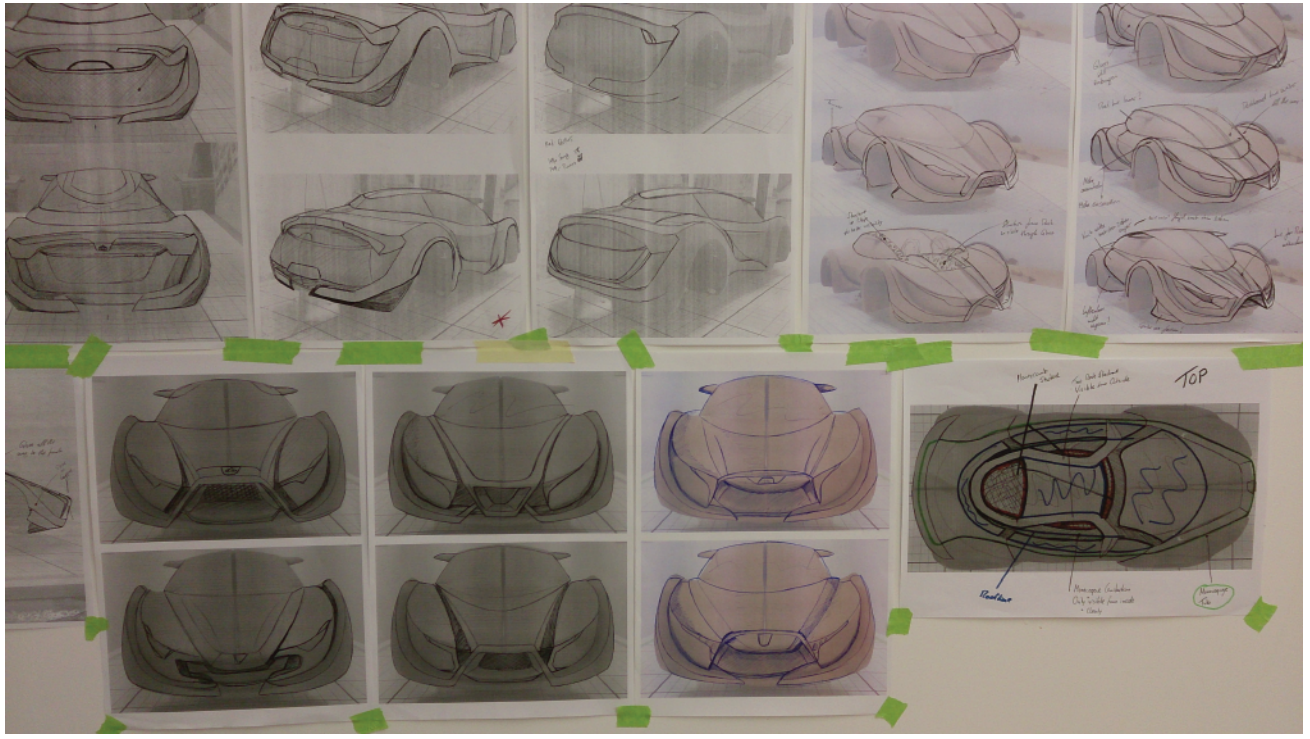


Figure084
"Final Development Ideas"

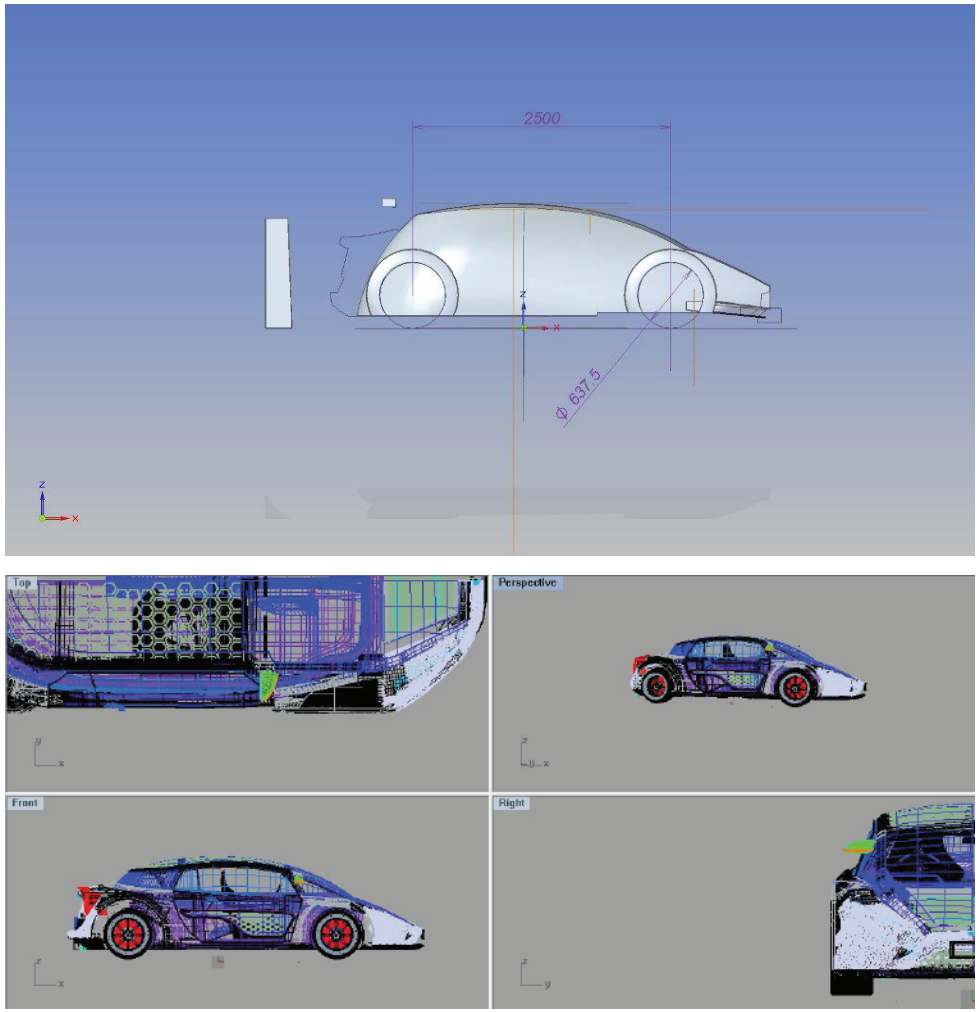


Figure085
"CAD Model Images"

11.4 The CAD Model

After the scan in of the clay model done by Form Scan New Zealand the scan file was remodelled and altered in order to make the overall car design more successful.

Some of the proportions were altered digitally, such as:

- The wheel base by 300mm to make the side profile more agile and dynamic. (New Wheel Base – 2500mm) This was done by moving the wheel arches in front forward by 300mm which increased the wheel base.

- Front and back wheel arches have been decreased in size (Now 130mm Volume) to make them less prominent in the overall design

- The wheel size was decreased to 20inch wheels (215/30/R20 = Diameter of 637mm)

- The lower door panel was adjusted to make the side door glass cut out more prominent and the inside look into the construction of the car more interesting.

- The front nose and overhang in the front had to be decreased in size to reduce the visual and actual weight in the front.

- The Roof line was lifted by 70mm in order to increase Head Room

- The Headlights were designed smaller to fit better into the design

- The rear bumper was lifted up in regards to overall proportions

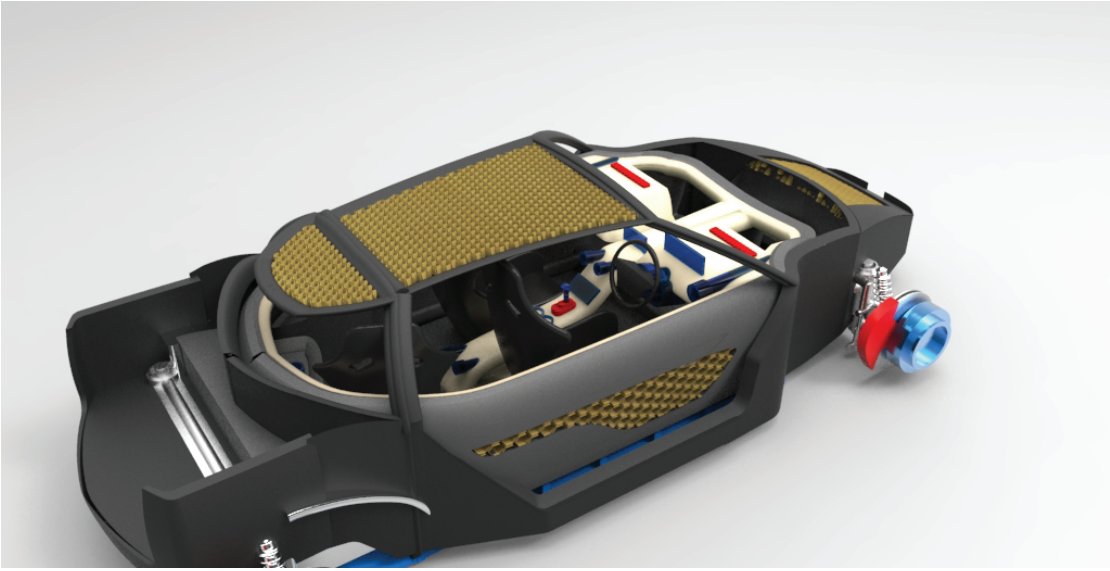
12.0 FINAL DESIGN

Figure086
"Final Design Images"

DESIGN FEATURES

INTERIOR DESIGN FEATURES

DASHBOARD DESIGN

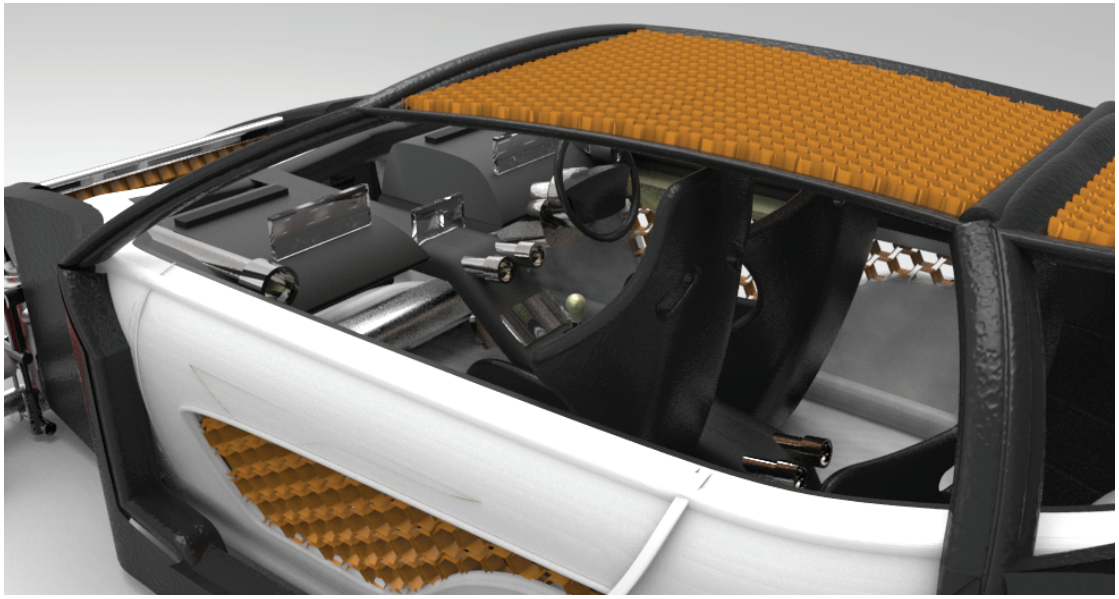


ROOF STRUCTURE

Figure087
"Interior Design Features 1"

DESIGN FEATURES

INTERIOR DESIGN FEATURES



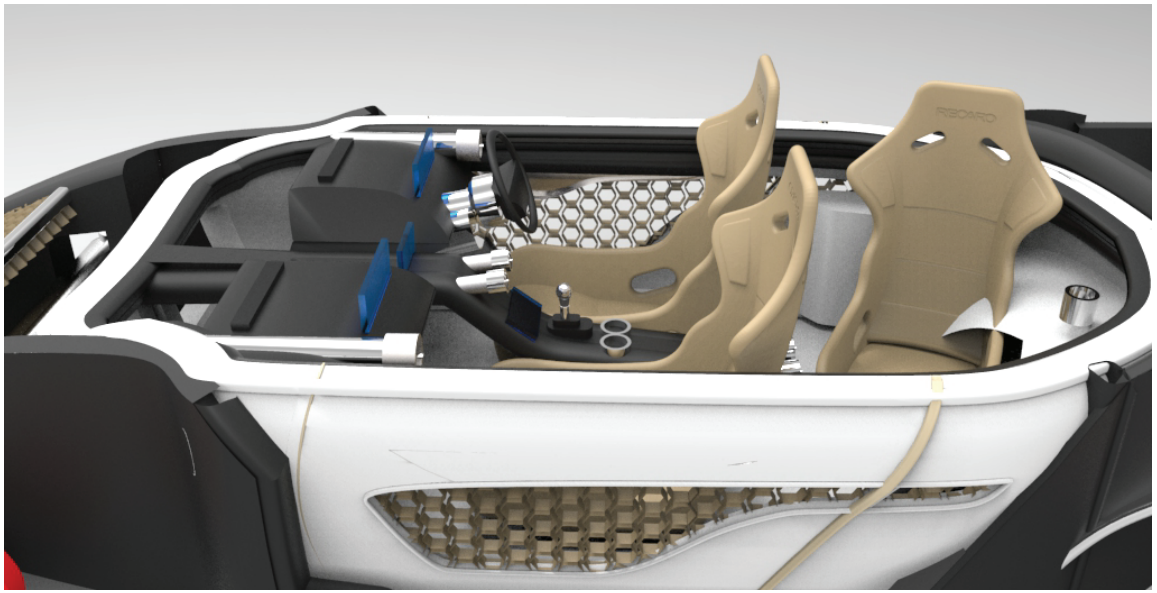
HONEY COMB STRUCTURE

MONOCOQOUE DESIGN

Figure088
"Interior Design Features 2"

DESIGN FEATURES

INTERIOR & EXTERIOR DESIGN FEATURES



SEATING POSITION

VISIBLE CONSTRUCTION

Figure089
"Interior Design Features 3"

DESIGN FEATURES

EXTERIOR DESIGN IMPRESSIONS

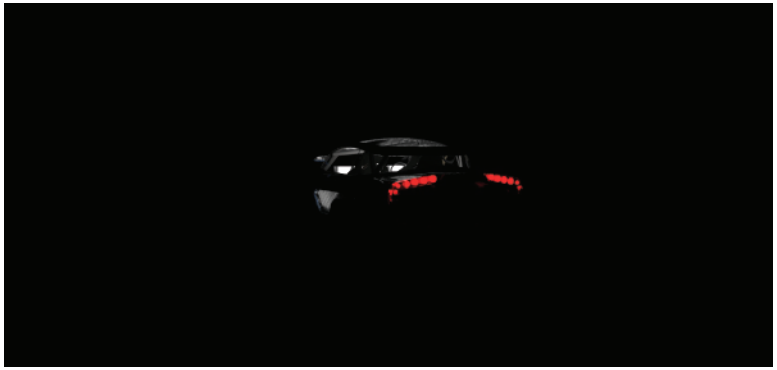


Figure090
"Exterior Design Features"

12.1 The Scale Model

The final scale model was made using the CAD files and CNC machining (Creative CAM, East Tamaaki, Auckland) to shape the main body of the car out of MDF wood.

Detailed parts such as the wheels were made, using 3D printing from files created in Rhinceros3D.

After the main body was machined out, it was then sanded by hand to smooth the surfaces, so that it would be ready for painting.

12.2 Power Concept

In order to save resources and especially fuel, the car uses a smart Hybrid Drive system that also gives the maximum driving experience. One of the main philosophies of this car was to create a high level of fun in driving, to use less power and therefore less fuel. One approach to solve this problem was to save weight via an overall lightweight design and construction; the other is to use a smart and powerful power concept.

The car uses a Hybrid system consisting of a high revving 1.6litre inline four cylinder engine. The combustion engine is also twin turbo charged to get the maximum power and torque from the combustion engine.

The other part of the power system is four in-wheel Hub Motors that are powered by lithium ion batteries stored in the bottom tray of the vehicle. The batteries supply the Hub motors with energy and can be recharged via plug-in system in every common Household with the right adapter.

But in order to make this car lighter, which is essential for this concept, it is important to use the minimum amount of batteries in the car, due to the heaviness of the batteries. If the car were purely electric this would decrease the range of the vehicle dramatically, but by using a hybrid system the supply for energy can come from different sources.

In this case the combustion engine has different tasks, depending on the mode and type of driving selected. It can be used as the main traditional power source, it can work together with the electric hub motors, or it can serve as a generator to recharge the batteries and increase the range of the car.

Sport Mode: A Combination of the Hub motors with the Combustion engine for maximum torque & performance

Eco Mode: The Hub motors work primarily, and the Combustion engine works mainly as the generator to support and extend the cars range

Traditional Mode: Only the Combustion Engine works

City Mode: Only the electric Hub motors work, but Combustion engine can be used as well to extend range

Due to the intelligent type of Hybrid system the car can go back to the rich in torque electric hub motors, which make the car both efficient and very fast.

The high revving four cylinder combustion engine delivers a great experience due to the classic attributes of sound and vibration known to sports cars. This set up of the best from both worlds offers a great driving experience, when driving fast on the track or efficiently in the city daily.

Power/ Performance

PERFORMANCE FACTS & SPECS

Top Speed

0-100km/h (0-60mp/h):	3.6sec.
80 - 150 km/h (50-92mp/h):	2.4sec.

Braking

100 – 0 km/h (warm):	30m
(cold) :	31m

Max Output

Hub Motors:	280HP
1.6l. Twin Turbo 4cyl. :	(10800 rpm) / 100HP
Combined:	380HP

L/km

(Generator Mode) :	1.8 L.
(Combustion Only) :	3.5 L. - 7.8 L.
(Sports Mode, Combined) :	3.1 L.

Range

(Generator Mode) :	750km
(Combustion Only) :	480km
(Sports Mode, Combined) :	90km

Emission Levels

(Generator Mode) :	50g/km
(Combustion Only) :	102g/km
(Sports Mode, Combined) :	139g/km

Weight

Total:	995kg.

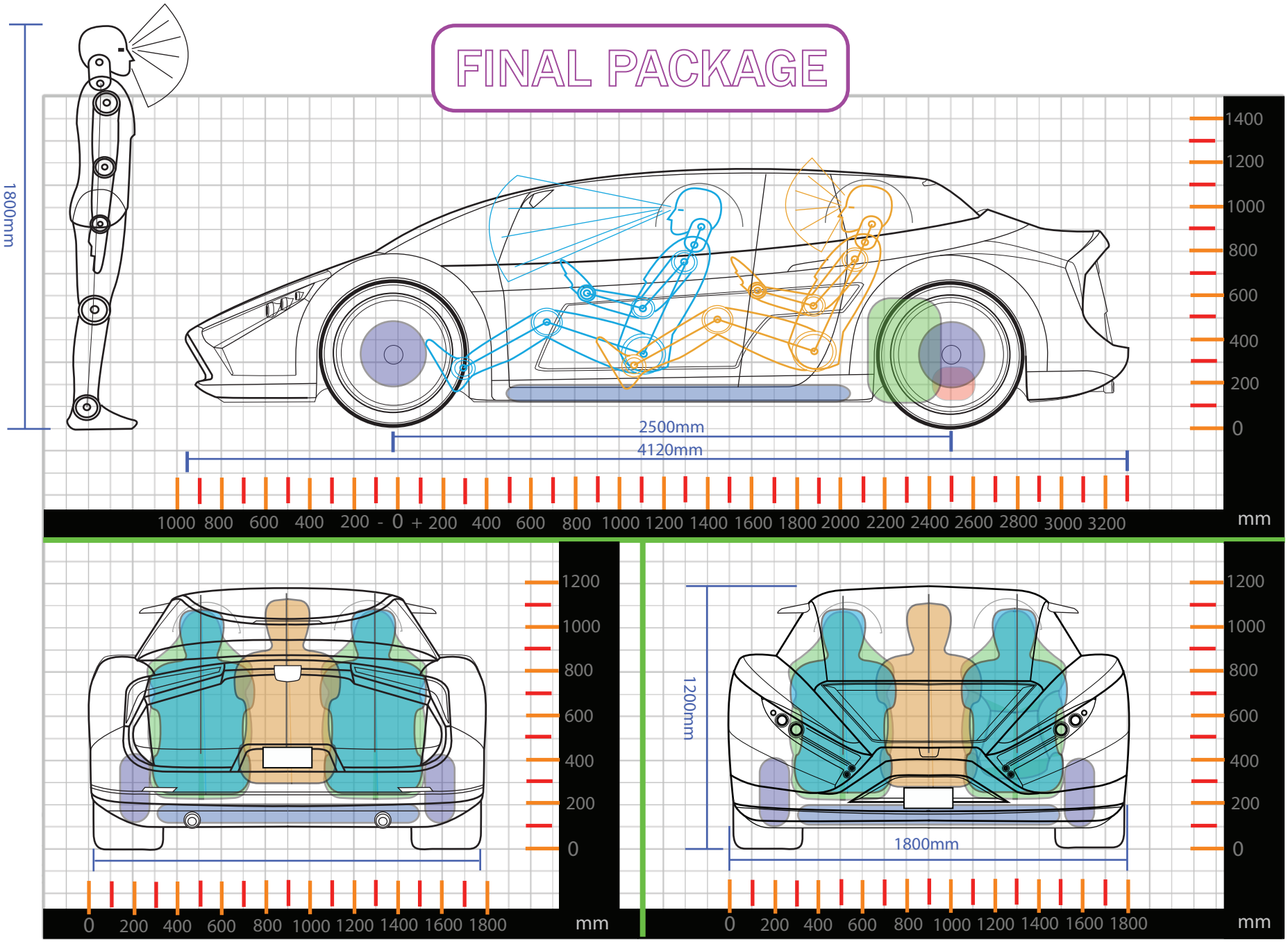
Luggage Space

Front:	80l.
Rear:	275l.
Combined:	355l.

Price

Estimated Price New (Gst incl.) :	$NZ: 245.000

FINAL PACKAGE



Hub Motors Combustion Engine Batteries Differential + Gearbox

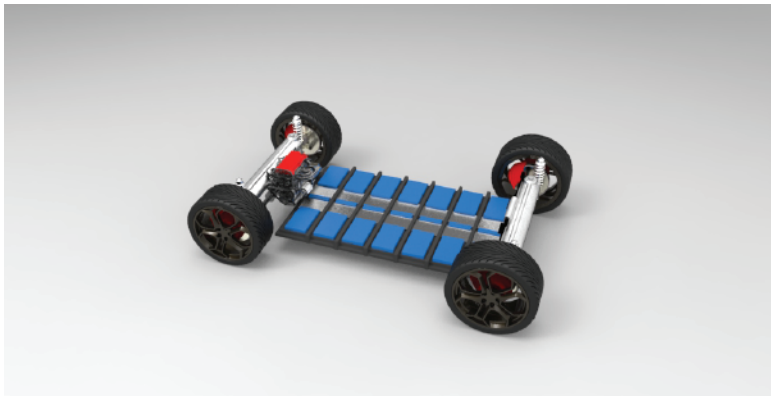


Figure091
"Monocoqoue/Chassis Renderings"

12.3 Production

The car itself would be constructed in a modern way, using natural composite fibres, in conjunction with:

Hand-layup Construction

Resin Transfer Molding (RTM)

Conventional Sheet Molding Compound (SMC)

These composite construction techniques have lightweight and safety as their main target. The inner main component would be the Monocoque passenger area, constructed out of natural flax fibres combined with a bio-resin. This Monocoqoue section would be visible in the outer and inner design of the car. It offers great safety characteristics by saving weight.

The outer body panels would be constructed in a similar way to modern carbon fibre panels but in this case would consist of natural fibre sheets (Corn Fibres) and a bio based thermo resin.

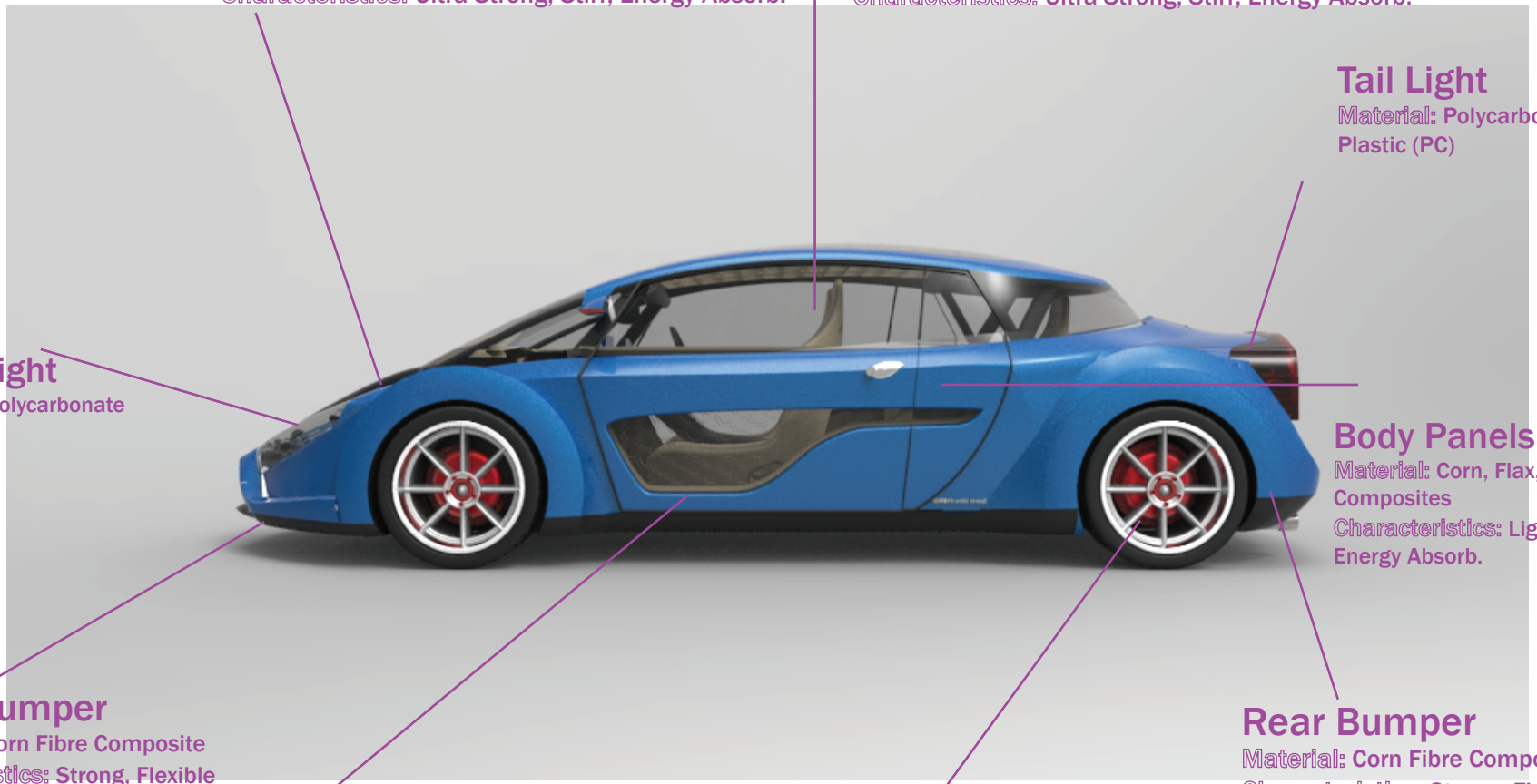
The sourcing from the composite components (mainly fibres) would have a sustainable background. This means, for example the main fibres from corn would come from the waste of the usual corn field production. This would prevent the need to create additional corn fields that would take up space and other important resources. This is also applicable to the use of other fibres, like coconut or rice.

Production/Construction

Construction-Component Layout

Monocoqoue
Material: Flax Fibre Composite, CRFP Reinforced
Characteristics: Ultra Strong, Stiff, Energy Absorb.

Dome Structure
Material: Flax Fibre Composite, CRFP Reinforced
Characteristics: Ultra Strong, Stiff, Energy Absorb.



Tail Light
Material: Polycarbonate Plastic (PC)

Head Light
Material: Polycarbonate Plastic (PC)

Body Panels
Material: Corn, Flax, Hemp Fibre Composites
Characteristics: Light, Flexible, Energy Absorb.

Front Bumper
Material: Corn Fibre Composite
Characteristics: Strong, Flexible

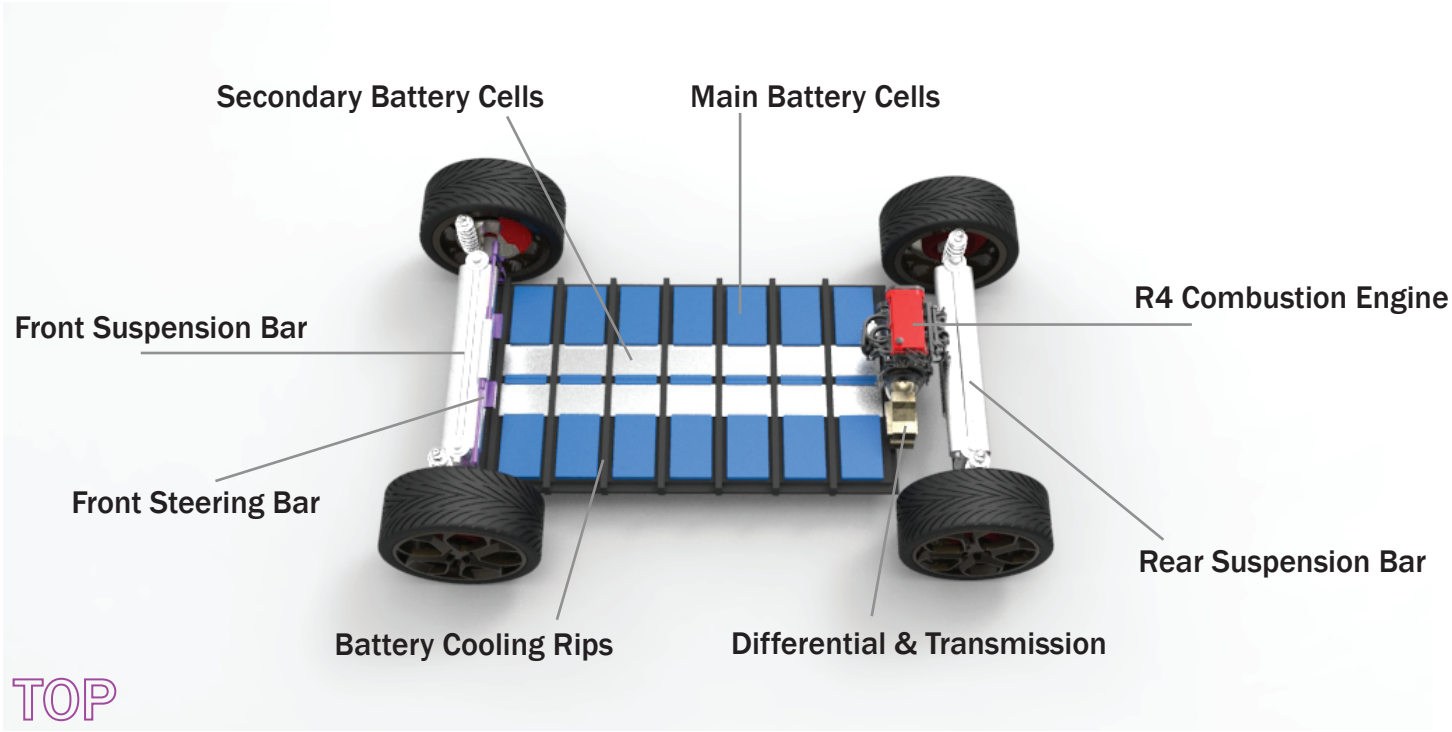
Door
Material: Corn Fibre Outer, Cocos Fibres Inner
Characteristics: Strong, Very Light, Noise Cancelling

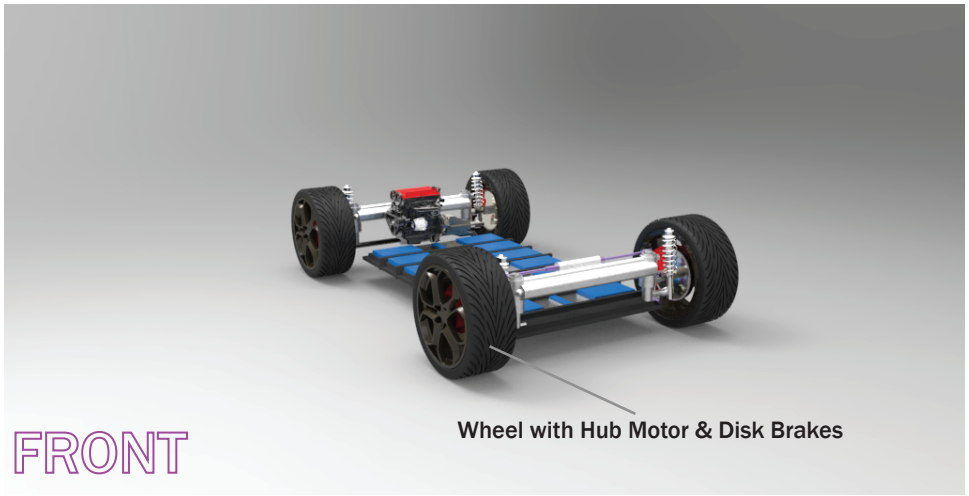
Wheels
Material: Aluminium
Characteristics: Light

Rear Bumper
Material: Corn Fibre Composite
Characteristics: Strong, Flexible

CONSTRUCTION

FLOOR DESIGN DIAGRAM





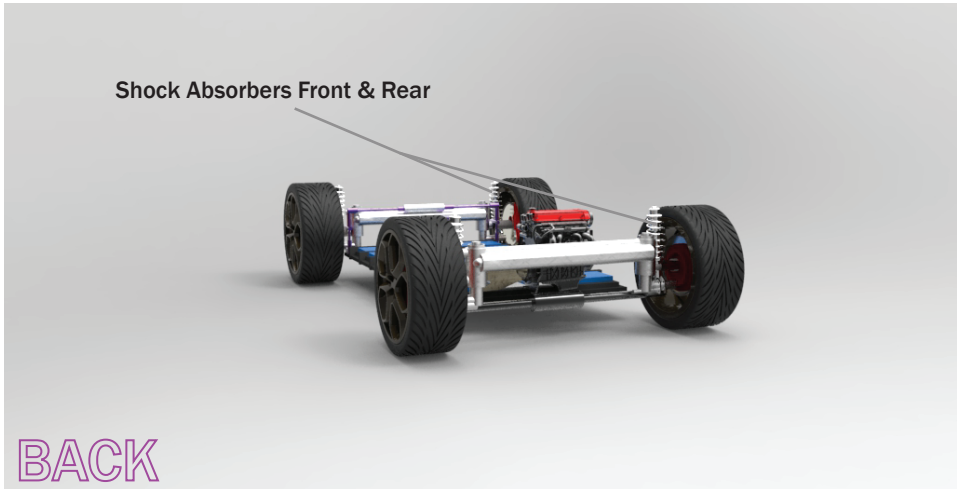
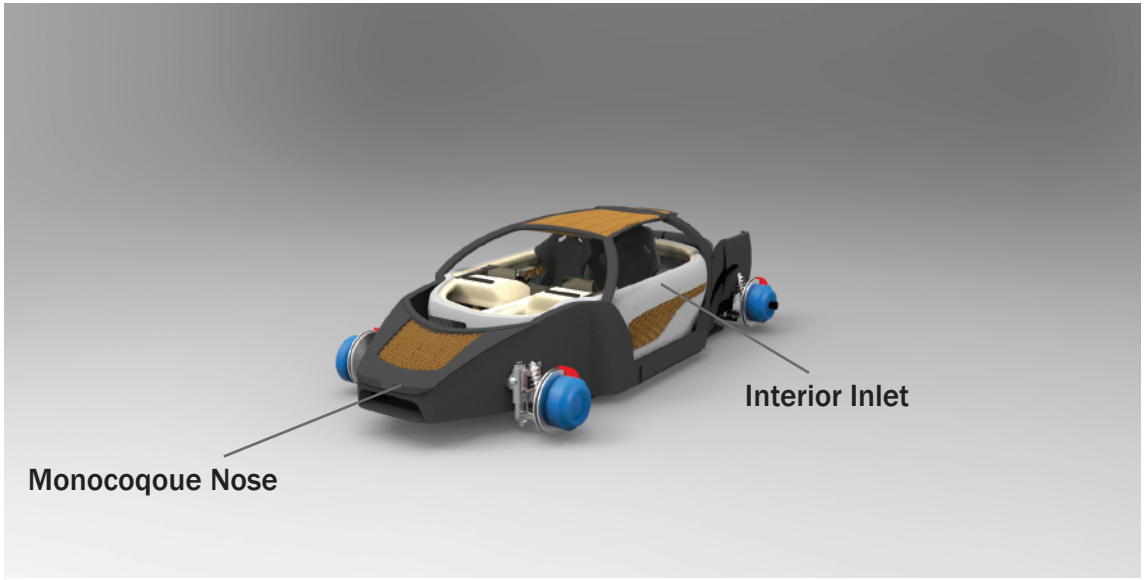
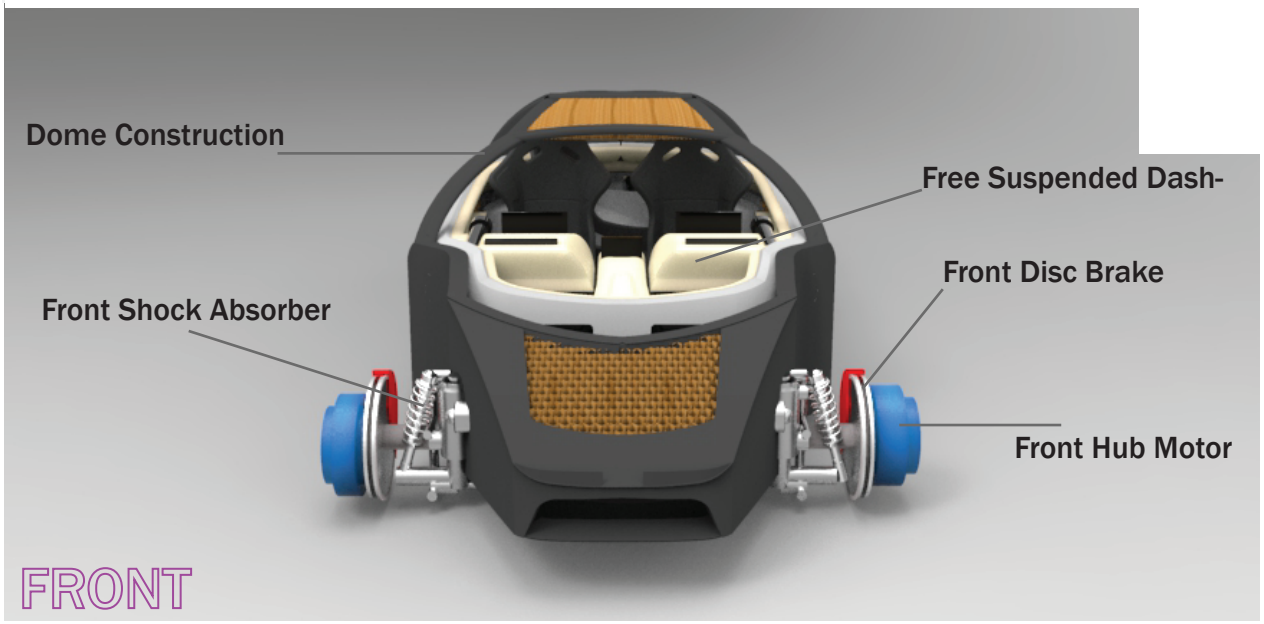


Figure092
"Chassis Renderings"

CONSTRUCTION

MONOCOQUE DESIGN DIAGRAM





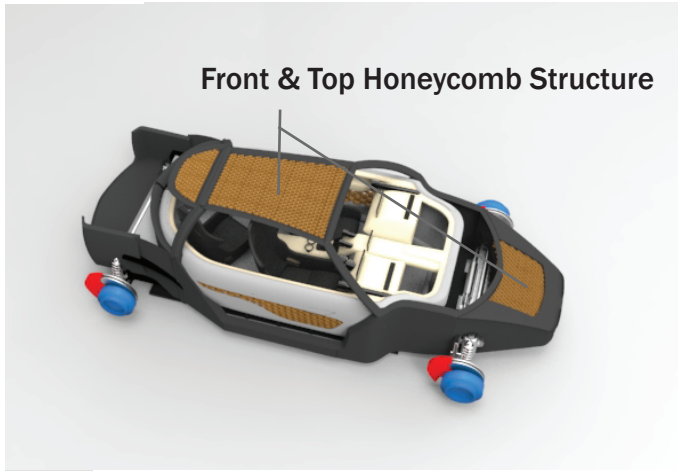


Figure093
"Monocoqoue Renderings"

12.4 Interior

The interior of the sports car is a reflection of the construction design of the car and the new power concept layout of the car. This enables the interior concept to be more open and unconventional than present designs.

The interior hosts seats for three adults, with two in the front and one in the back, where the rear passenger has the option to move the rear seat on a slight angle towards the driver's side. This decision goes back to my ergonomic research where I found that people who sit in sports cars or coupes in the rear often sit on a slight angle to use the maximum of the tight space offered. All three seats are Recaro seats to offer the ultimate sportive experience, with a high interest in support and safety while driving.

The rear area also offers space for shopping bags or other daily luggage usage, which is important for the everyday usability factor. The car uses free flowing components such as the middle console and the two dashboard parts in the front. Each part of the dashboard is seemingly floating, only being suspended from the side connection, to offer a simple and light design, and great visibility for a good driving experience.

The dashboard and middle console submit their necessary information (steering, gear change, etc.) through electronic signals, which enables the free floating design for these components. Overall the hybrid power train concept offers new interior layout opportunities, which create more space for the passengers.

It enables the front part of the vehicle to be transparent, open and relatively small. This space in the car is usually reserved for a large combustion engine and is therefore very large and prominent in the design.

As an additional support system to reduce weight and increase strength to the body of the car; a honeycomb structure is placed where it is most important to reduce the weight. This structure would be 3D printed out of plastic, which would make it easy to recycle. It would also absorb the energy during a crash from the side or front.

In this case it is relatively open and small, which should communicate the philosophy of the vehicle. This was an aim of the design concept, to find new ways of utilizing the new layout of the car.

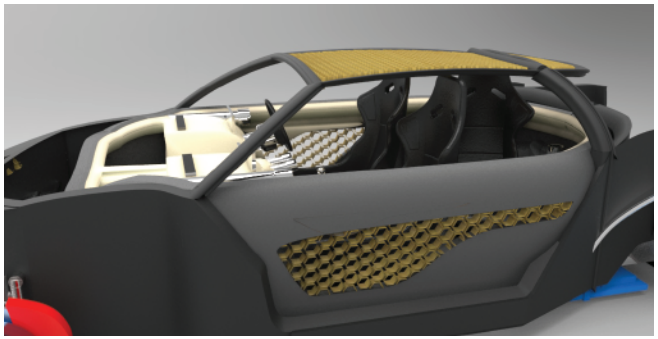
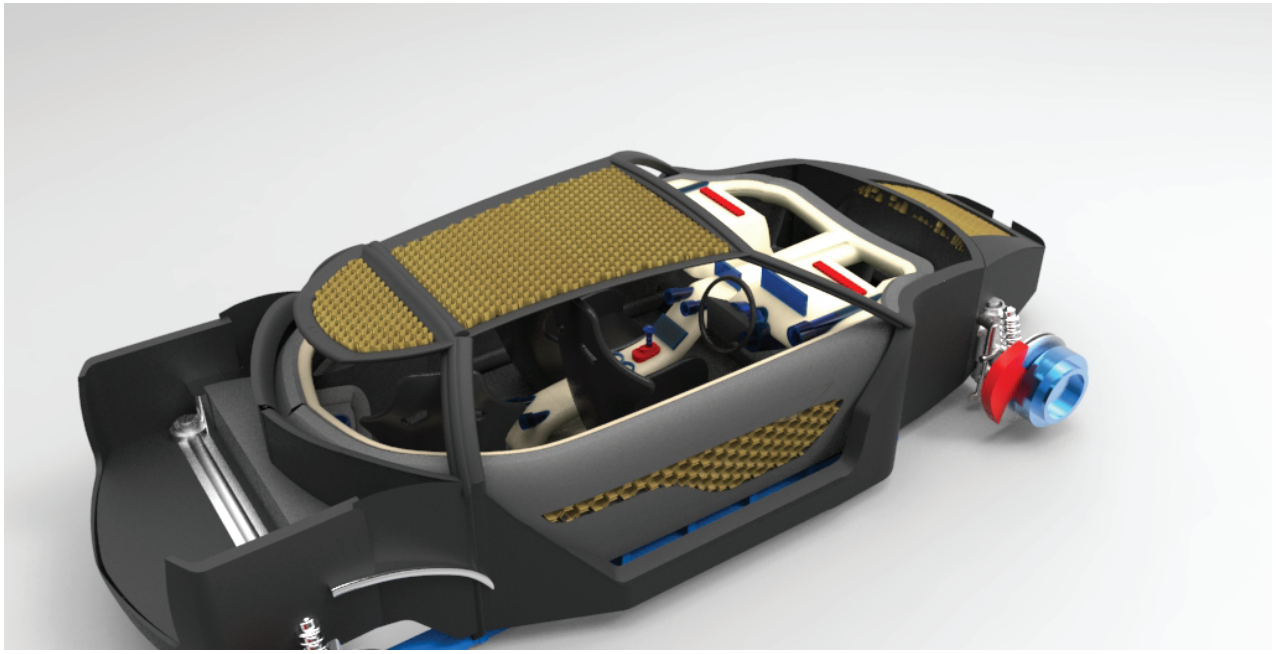
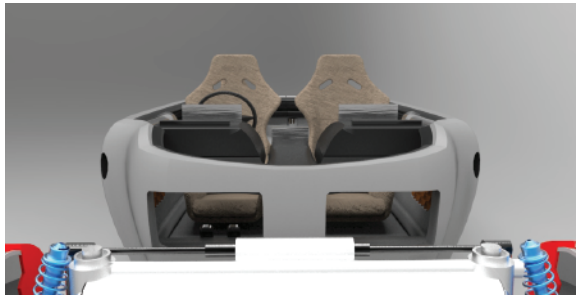


Figure094
“Monocoqoue Renderings”





13.0 CONCLUSION

This project focussed on the development of a modern sports car. In a time where there is a change to be seen in people's behaviour towards nature, and the well known fact that we are contributing to changes in our climate; a car development focuses on different tasks than it did 20 years. For this project I tried to incorporate the idea of being sustainable into something that usually is not very sustainable - the sports car.

When people think of sustainability or environmental awareness, the idea of fun or thrill does not generally come to mind. With this project I was trying to prove that it is possible to connect two usually total different philosophies into one, in order to offer a sports car concept that caters for the next generation of motorists. It was also important for me to prove that being efficient and sustainable can also be fun and exciting.

Early in the research project it became apparent that in order to design a sports car for the near future, it would be necessary to look at ways to save energy and resources, as the interest lay in the juxtaposition between the authentic sports car and sustainable practises. I did not set out to design just another sports car as already exists in the market.

These new philosophies on how to save resources and energy bring some of the most interesting ideas and designs forward, because the form often follows a real function, and therefore has a meaning to it.

With this project the core was the idea of saving energy by being light. This philosophy of being light made sense to me, as it is appropriate for sports cars and also efficiency.

During the research project I tried to understand the development of a car as a whole with all its components. It was important for me to understand different methods and current guidelines in car developments, in order to understand the car itself.

During this project I re-discovered the car again for myself, because I am now more able to comprehend certain decisions and the ways in which they are designed. The literature research and field studies really made me think differently about how cars are being made and how I look at them now, in terms of how details are being resolved.

In this project, case studies and design experiments really helped to identify design features in modern car designs. This being an integral part of the project, it was important for me to identify the idea of lightweight visually. I tried to solve this matter, by showing the construction of the vehicle, where it is usually hidden. This form of design communication helped me to visualize the lightweight philosophy of the vehicle.

Through showing the components and construction of the car I also tried to deliver an honest vehicle, that is clearly showing what it is. This idea of being transparent is also important when it comes to sustainability. Having all the ingredients shown to the public, it created a good and honest product communication to the customer. Additionally it was important to me to integrate new high tech materials, like bio-composite materials, which work well in regards to being efficient, sustainable and safe.

With the help of professionals like Tony Parker (Hulme), Oliver Neuland (BMW) and Neil Stanley (OPEL) I have gained a deeper insight into the industry of car design. During the ideation phase and development phase, it was of great benefit to gain this knowledge.

Particularly during the clay modelling phase, where I had some issues in finding the right form of the vehicle, it was extremely useful to talk to these professionals. With their feedback and comments, I found that there was more to car design than I originally thought there was.

Overall I think that this sports car project offers an alternative for the next generation of sports car drivers, who will have to think about more than just the pure performance figures, than previous generations

Figure095
"VENTUS CutOut Image"

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FIGURE0100: **N.Blum (2013)** *H - Point Ergonomic Dimension Charts* **Retrieved from: Macey,S & Wardle, G. (2008). H-Point: The Fundamentals of Car Design & Packaging. Pasadena/California, U.S.A.: Art College of Design: & Culver City/California, U.S.A.: Design Studio Press.**

17.0 APPENDIX

17.1 Low Risk Form

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA

30 April 2013

Nils Blum
853A Old North Road
RD2 Waimauku
Auckland 0882

Dear Nils

Re: Intelligent Sports Car

Thank you for your Low Risk Notification which was received on 26 April 2013.

Your project has been recorded on the Low Risk Database which is reported in the Annual Report of the Massey University Human Ethics Committees.

The low risk notification for this project is valid for a maximum of three years.

Please notify me if situations subsequently occur which cause you to reconsider your initial ethical analysis that it is safe to proceed without approval by one of the University's Human Ethics Committees.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

> *"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.*
>
> *If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor John O'Neill, Director (Research Ethics), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".*

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to provide a full application to one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

J. O'Neill

John G O'Neill (Professor)
Chair, Human Ethics Chairs' Committee and
Director (Research Ethics)

cc Oliver Neuland
School of Design
Albany

Prof Tony Parker
College of Creative Arts
Wellington

A/Prof Claire Robinson, Pro-Vice Chancellor
College of Creative Arts
Wellington

Massey University Human Ethics Committee
Accredited by the Health Research Council

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E humanethics@massey.ac.nz animalethics@massey.ac.nz gtc@massey.ac.nz **www.massey.ac.nz**

17.2 Questionnaire Sheet 1

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA

Everyday Lightweight Sports Car Project

Questionnaire

Name (Optional):

Age:

Gender:

Occupation:

Do you own a car?

How many kilometres do you travel per week? (circa)

Do you enjoy driving?

Do you enjoy driving **your car**, and if yes or no what is the reason for it? (Are there any specific attributes to your car?)

What would you prefer in a sports car? Comfort, Agility or Power?

What would be important for you in a sports car?

What do you associate with sports cars? Do you have an opinion about them?

Would you use your sports car as a: Everyday drive, Sunday drive or Weekend Race track adventure?

Do you prefer a high-tech and controlled driving experience or a pure and unfiltered driving experience?

What aspect of (sportive) driving is most important for you?

Would you include the factor of comfort in your sports car?

Would you transport luggage in your sports car? If yes how much?

How many seats would you prefer in your sports car?

Would you prefer a closed or open roof vehicle as your sports car?

Are you interested in green / sustainable technologies?

Would you want to integrate the green sustainable aspect of saving recourses and fuel into your sports car?

What is your image or opinion about electric or hybrid cars?

Do you have any problems with electric or hybrid cars?

Would you be interested in driving/owning/buying an electric or hybrid sports car?

17.3 Questionnaire Sheet 2

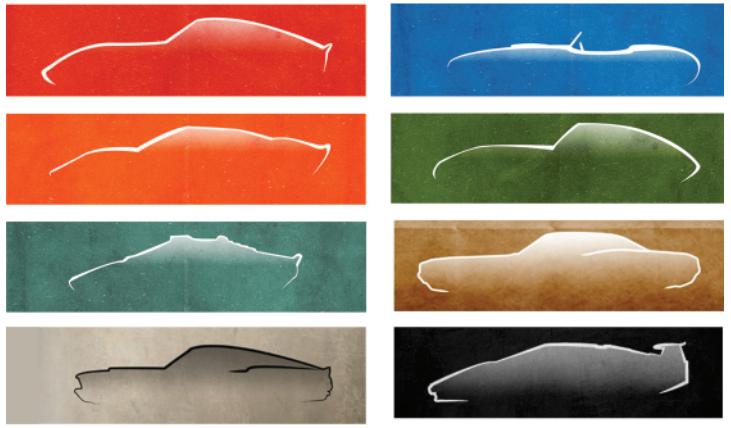
Group 1 *"Iconic Looks"*

Which of the following shapes has the most appeal to you? &Why?

Which of the following shapes has the least appeal to you? &Why?

Do any of these shapes have an association with something for you that you would connect to a certain lifestyle or character? (bullet points)

Sheet 1



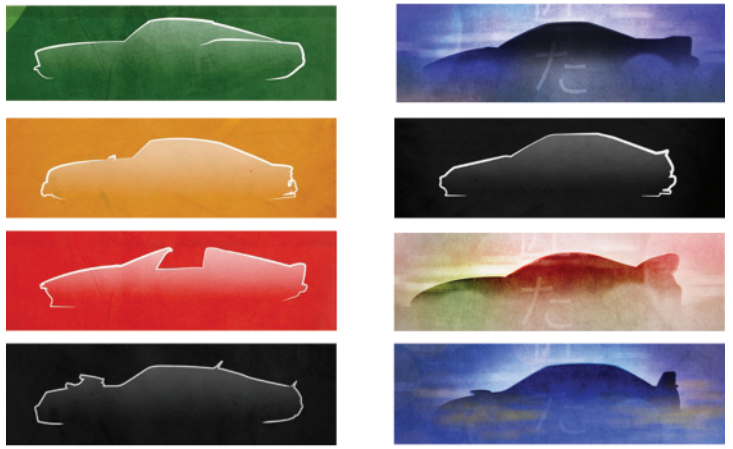
Group 3 *"Car Scenes"*

What Group of cars would you prefer to drive? (left or right)

Do any of the shapes stand for something for you?

Do any of those have an association with something for you? (positively or negatively)

Sheet 2



This questionnaire was created at an very early stage of the project, in order to gain very general information about the topic of sports cars. There were no structured user groups used for this questionnaire.

17.4 Material Case Study

To get an understanding of the natural composite materials that I would use for my car,
I looked into companies that already tried to use this type of material for a new types of applications, in this case high performance bycycles.

Figure096
"Museeuw Bikes"

Johan Museeuw, Fangio Reybrouck and Joris Van Raemdonck founded Museeuw Bikes in 2007.

The goal was to produce a complete line of race bikes. While other manufacturers have been working with carbon composites for many years, Museeuw Bikes chose to use a new innovative composite blend: a mixture of chemical fibre (carbon) and a natural fibre: flax.

From the beginning they believed that this new Flax-Carbon composite had special characteristics that were suitable for use in the production of bicycle frames and components.

The initial conception stage, laboratory research, and the ultimate production of this highly specialized material was performed by IPA-Advanced Composites of Belgium, a company owned by Joris Van Raemdonck.

Source: http:/www.museeuwbikes.com

Figure097
"Density comparison of bike frame materials"

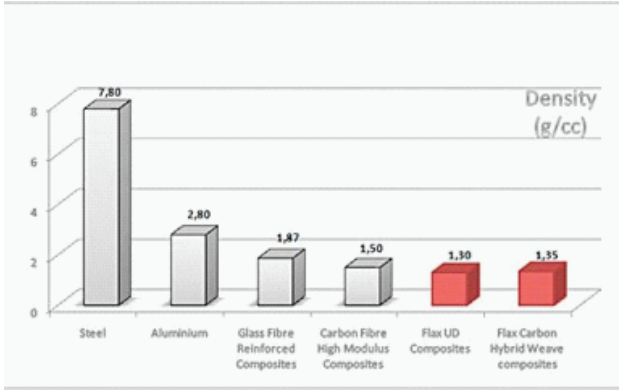
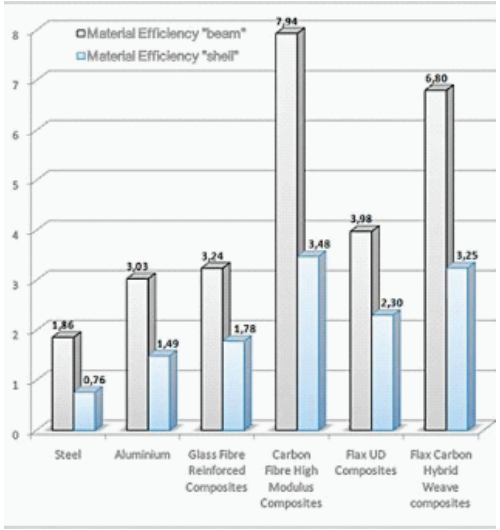


Figure098
"Material efficency comparison of bike frame materials"



In order to understand the idea of new composite materials more, I did some simple experiments with natural fibres and a resin, to see if those materials would have suitable characteristics.

Cocos Fibre Sheets + Resin

Flax Fibre Sheets + Resin

Cocos Fibre Sheets

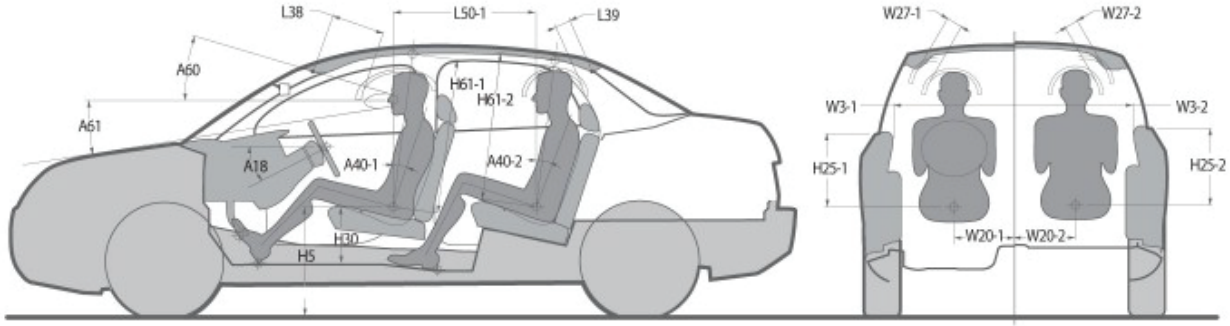
Hemp Fibre Sheets

Figure099
"Material Experiments"

17.5 Ergonomic Dimension Explanation

OCCUPANT ENVIRONMENT DIMENSIONS

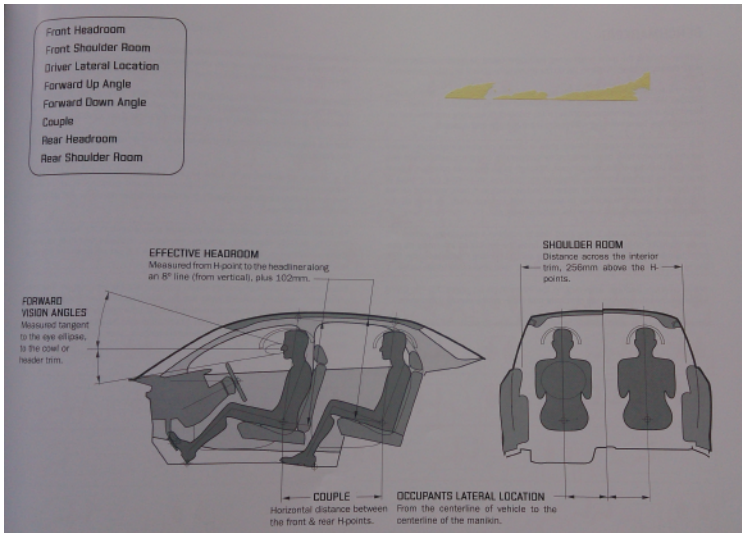
Below is an illustration of the major dimensions that set up the interior environment around the occupant package. These are part of the SAE J1100 measurement index. Using the same measurement system for every project ensures that there is no confusion and the package database remains consistent.

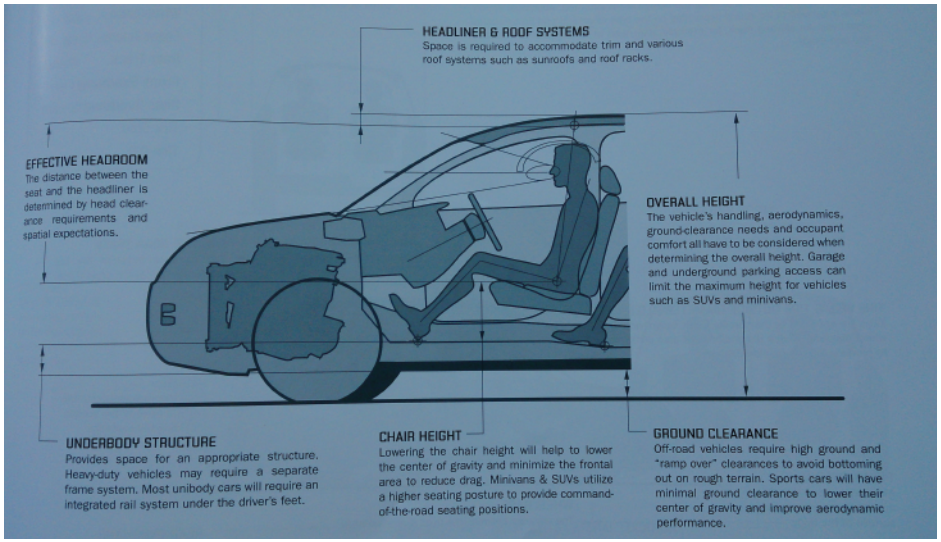


Some of the SAE J1100 (Interior) Dimensions

With the help of this ergonomic data charts was the gathering of ergonomic data concluded. These charts are taken from the lecture "H-Point, the fundamentals of car design"

Figure100
"H - Point Ergonomic Dimension Charts"





VENTUS

An Everyday Lightweight Sports Car For The Next Generation

2013/14 Nils Blum