



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Vehicle Tech 2

Vehicle Structure and Aero

Emily Sharwood-Smith (1700057)

Question 1 Part A.

Bonded Aluminium chassis tub with a fibre glass body (Lotus Elise)

There are a variety of pros and cons to using bonded aluminium and a fibre glass in the way that Lotus have decided to in the Elise. Cost, crash resistance, aesthetics and performance are all affected by the use of these materials.

Lotus was late to the game when they decided to use aluminium for the Elise (see the photo to the left). The first sports car featuring an aluminium body premiered at the Berlin International Motorshow (Metal Supermarkets, 2015), however in 1994 they noticed the benefits the material would have on their vehicles and released their first aluminium chassis tub in 1996. The use of a tub would result in a lighter and stiffer chassis, improving handling accuracy, enabling higher performance and resulting in superior ride quality to be achieved (Sands, 2018). As well as this,



Figure 1 - Lotus Elise (Anon, 2019)

the light weight structure, weighing in at just 65kg for the bare structure, was excellent for fuel economy as well. These are features of Lotus's that are very important to the company, and they were used to maintain their competitiveness.

One issue that Lotus had to address when the decision to use an aluminium tub was made, was the issue of cost. The cost of raw material for aluminium is significantly higher than steel. None the less Lotus managed to keep the car to a cost that was competitive with its steel predecessor. The use of aluminium also had the added benefit of increasing the life expectancy of the car, since aluminium does not corrode and rust in the way that steel does. Furthermore, the simple and cheap process of anodizing meant that leaving sections of the chassis exposed, would not require expensive processes to make them attractive for passengers.

Another added advantage of Aluminium is its excellent thermal conductivity. This means that it will be useful in scenarios that require rapid transmission and exit of heat such as in the engine of a vehicle and on fins (Quora, 2015). Additionally, in a world where recycling is becoming increasingly important due to the dangers that waste can impacts on the environment, producing a vehicle that is environmentally aware has become increasing important. Aluminium can easily be recycled without compromising its purity or quality (Quora, 2015).

An alternative to the aluminium or steel chassis might have been a carbon fibre chassis, such as the ones used by Ferrari and Porsche. This however would have resulted in a far more expensive car. Using aluminium allowed them to produce a car that was only one tenth of the cost of their competitors (Grabianowski, 2019).

As with all products there are some negative aspects that can reduce a product warranty or increase the price of a product, this is the case with aluminium. Aluminium can be difficult to repair making the vehicle difficult to restore should anything go wrong. Additionally, aluminium has a poor strength unless it is alloyed (Ten Tenths, 2008).

Fibreglass is a reinforced plastic material made of glass fibres embedded in a resin matrix. The Lotus Elise is an example of a vehicle that uses a fibre glass body. Using a Fibre glass body means that the vehicle will not degrade overtime as Fibre glass does not corrode. Fibre glass is also lightweight. This will aid in keeping the weight of the vehicle to a minimum thus improving handing and fuel economy. Fibre glass also has an excellent strength to weight ratio this means that it can make the vehicle stiffer without adding to the weight of the vehicle (Alpen Clear Performance, 2018)

A disadvantage of using Fibre glass is that it can be subject to UV degradation. This means that if it is left out in the sun for a prolonged period of time the resins in the Fibre glass will become brittle and start to degrade. The colour in the top surface may also disappear as the sunlight bleaches it. Adding to this fibreglass can also deform with heat causing the body work to lose its shape (Mechanics Stack Exchange, 2019)

To conclude this section of the report there are many different advantages and disadvantages to using both an aluminium chassis and a fibre glass body. The most important of these include an improved performance to the overall vehicles through a lightweight and stiffer chassis which intern aids in improved handling and fuel economy this could be one of the many reasons why the Lotus Elise is described as a 'revolutionary' sports car by Autocar.

Question 1 Part B,

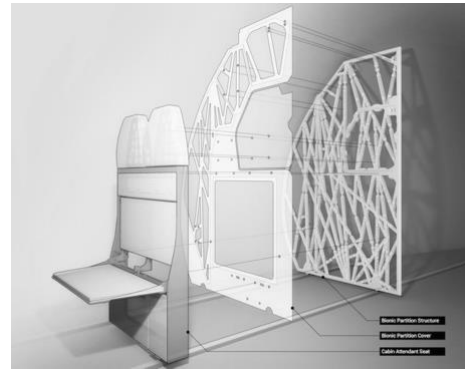
Generative design (A potential new approach to chassis design and manufacture)

In line with bonded aluminium and Fibre glass there are many different advantages and disadvantages to using generative design to aid in the design process of a vehicle chassis and in manufacturing techniques. Some ideas that I wish to cover include how generative design is being used, how it will affect human intervention and how it might have a positive effect on the environment in our environmentally conscience age.

Generative design is a design process that mimics nature's evolutionary approach to design. It can be used by both designers and engineers. The process works by inputting design goals into generative design software, along with parameters such as materials, manufacturing methods, and cost constraints. The generative design software can then explore all the possible arrangements of a solution, quickly generating alternative design solutions. It tests and learns from each iteration what works and what doesn't (Autodesk, 2019).

Generative design can aid in reducing the overall mass of material used in a product, such was the case with the interior of the Airbus A320 plane, seen in the photo to the right on the next page. Generative design enabled engineers to take 45 percent of the weight of the interior partitions. Leading to a huge reduction in the overall weight of the aircraft this intern lead to a reduction in the use of fuel per flight (Manufacturing Lounge, 2019).

The reduction of weight is particularly useful in the aerospace and automotive industries. An example of this can be seen in General Motors, where engineers used generative design software to produce a new seat bracket. The part combined eight components in one which resulted in a 40 percent weight reduction and a 20 percent strength increase when compared to the original design (Manufacturing Lounge, 2019).



An advantage of Generative design is that it helps in increasing customer satisfaction. This is due to the fact that designs are generated faster additionally multiple designs can be achieved at once. Additionally, as more designs can be created within a shorter time frame, the optimal design solution can also be found quickly. This enables products to be rolled out to clients and customers sooner thus increasing satisfaction. Designs are also produced to a higher quality and meet all the customer's requirements. This makes generative design a great way to increase customer loyalty and build up a good reputation (Manufacturing Lounge, 2019).

A new way of thinking can be achieved with generative design. Designers no longer have to spend hours thinking up designs thanks to powerful artificial intelligence software. This can be achieved by the designer inputting desired parameters such as the weight, material, and volume and the software which internally will deliver all possible designs that meet the chosen criteria. This internally will increase productivity due to a number of designs being available. The extra time now available to designers can be used towards other projects (Manufacturing Lounge, 2019).

Generative design will decrease the need for human intervention. For many businesses, employee wages account for a large portion of working expenses. Multiple designers working in groups are used in projects to come up with innovative ways to solve design problems. These costs can now be reduced with the help of generative software this reduces the amount of money a company will need to spend (Manufacturing Lounge, 2019).

The current global environmental situation called for manufactures to design products that produce little waste, can be recycled or reused thus reducing the global dangers that waste can impact on the environment. Generative design consolidates multiple parts of a product thereby reducing the amount of material used in each product (Manufacturing Lounge, 2019).

As with all process there are some disadvantages that should be covered. Generative design is still in its early days and can currently only be used to produce simple components (Fryer, 2017).

The decrease of human intervention brought about by generative design could have a negative effect on many jobs. Traditionally designers and engineers worked in teams to come up with multiple design or solutions for a product, however if generative design software can now be used to do this less people will be needed in each team. This will reduce jobs and leave people redundant.

To conclude this section of the report there are many advantages of incorporating generative design into daily manufacturing situations. The most prevalent of these include the reduction of time, increase customer satisfaction, reduced wastage of materials. However, generative design still has a long way to come in addition to tackling a few issues along the way such as the potential impact of job redundancy.

Question 2

An understanding of aerodynamics as it relates to automobiles is considered to be important in order to improve which major areas of performance and explain the criteria that effects drag/ Wind resistance of the vehicle?

Aerodynamics is the study of how air flows around and inside objects. Aerodynamic drag is a force which oncoming air applies on a moving body. when a car moves it displaces the air around it. This displacement of air affects the car's speed and performance (Car Bike Tech, 2019). Most people don't think of air as solid. This is because at low speeds or when stationary, most people don't notice the way that air and wind interact with the vehicle. At higher speeds, air resistance becomes much greater. The air around a vehicle can have a massive effect on the way that it accelerates and handles (Clark, 2016).

Major areas of performance effected by aerodynamics

One of the most important factors for vehicle manufacturers is to keep the Aerodynamic Drag to the minimum possible. A vehicle's performance and efficiency will be negatively affected by aerodynamic drag. The shape of some vehicles gives a drag coefficient of 1.30 while a raindrop design has the least amount of drag. To reduce the drag coefficient of a vehicle, manufacturers design cars to be more streamlined. Nowadays, the cars have an average drag coefficient of 0.40 and some car have as low as 0.26 (Car Bike Tech, 2019).

Designers and engineers have to design cars with aerodynamics in mind, every panel of a vehicle is designed to make it easier for the vehicle to cut through the air around it, thus reducing drag (Clark, 2016). An example of this can be seen in the photo to the right, the air flows around the car reducing the drag on the vehicle. A reduction in drag can help to decrease the wind or air resistance of a vehicle. This intern will aid to increase a vehicles



Figure 3 - (Kiser, 2016)

fuel economy to some extent. It also improves other performance characteristics such as handling and acceleration (Car Bike Tech, 2019). When a vehicle is designed to the key elements of airflow they accelerate faster and more easily and are more stable at speed. These vehicles also achieve better fuel economy as the engine doesn't have to work so hard to push the car through the surrounding air (Clark, 2016).

The two main areas that have the most impact on a vehicle's overall drag effect are the vehicle's frontal area and the drag coefficient (Car Bike Tech, 2019). Reducing the frontal area of a vehicle will make it easier for the vehicle to 'cut' through the air. Less resistance will mean that less energy will be needed to overcome the drag. The leftover energy can be used to power the vehicle. As a result, aerodynamic shaping affects the top speed of your car (Pandit, 2018). The faster a vehicle travels the more power that is needed above 60 km/h, a lot of power is needed to push the car to overcome the aerodynamic drag (Car Bike Tech, 2019).

What effects drag/ wind resistance of a vehicle



Figure 4 - (Autovlan.be, 2019)

Reduction of aerodynamic drag is achieved in the first stages of designing by putting in place character lines along the sides of vehicles. These lines aid in channelling airflow and allowing it to pass smoothly over the body of the vehicle which will help in reducing the air resistance (Car Bike Tech, 2019). The Mercedes-Benz CLA 200, seen in the photo on the left, is an example of a vehicle with character lines to reduce the aerodynamic drag.

The drag coefficient of the vehicle can be reduced by streamlining the exterior body. This is done by engineers who use precise calculations of the surrounding airspeeds. Rear spoilers on the back of vehicles can be used on high-speed cars to reduce the drag by a greater extent. (Car Bike Tech, 2019)

To lessen aerodynamic drag components such as roof racks, mud flaps, rear spoilers, side mirrors, Radio antennas and windscreen wipers, these must be aerodynamically designed (Car Bike Tech, 2019).

Sports cars often have modified features to aid with the aerodynamics these include modified front bumpers, redesigned wheel covers, fender skirts, splitters, spoilers, diffusers and wings. These added features are designed to direct the airflow around the vehicle therefore improving their performance at high speeds. The aerodynamics of a supercar or racing car are designed to keep high pressure air on top of the car. Downforce is created by the high pressure pushes down on the body of the car, this prevents a car from becoming unstable at speed, maximising traction which improves acceleration and aids in better cornering (Clark, 2016). Spoilers can help in achieving maximum downforce. Formula One cars can generate as much as 3.5Gs in the corners, this is because the power of its aerodynamics is so great (Clark, 2016).

To conclude the final section of this report there are many ways in which aerodynamics can affect the performance of a vehicle. The most common of these include a vehicle handling, speed, acceleration and fuel economy. Designers and engineers are having to think outside of the box and work hand in hand with physics in order to produce vehicles that meet public's demand for fast, reliable and high-performance vehicles.

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