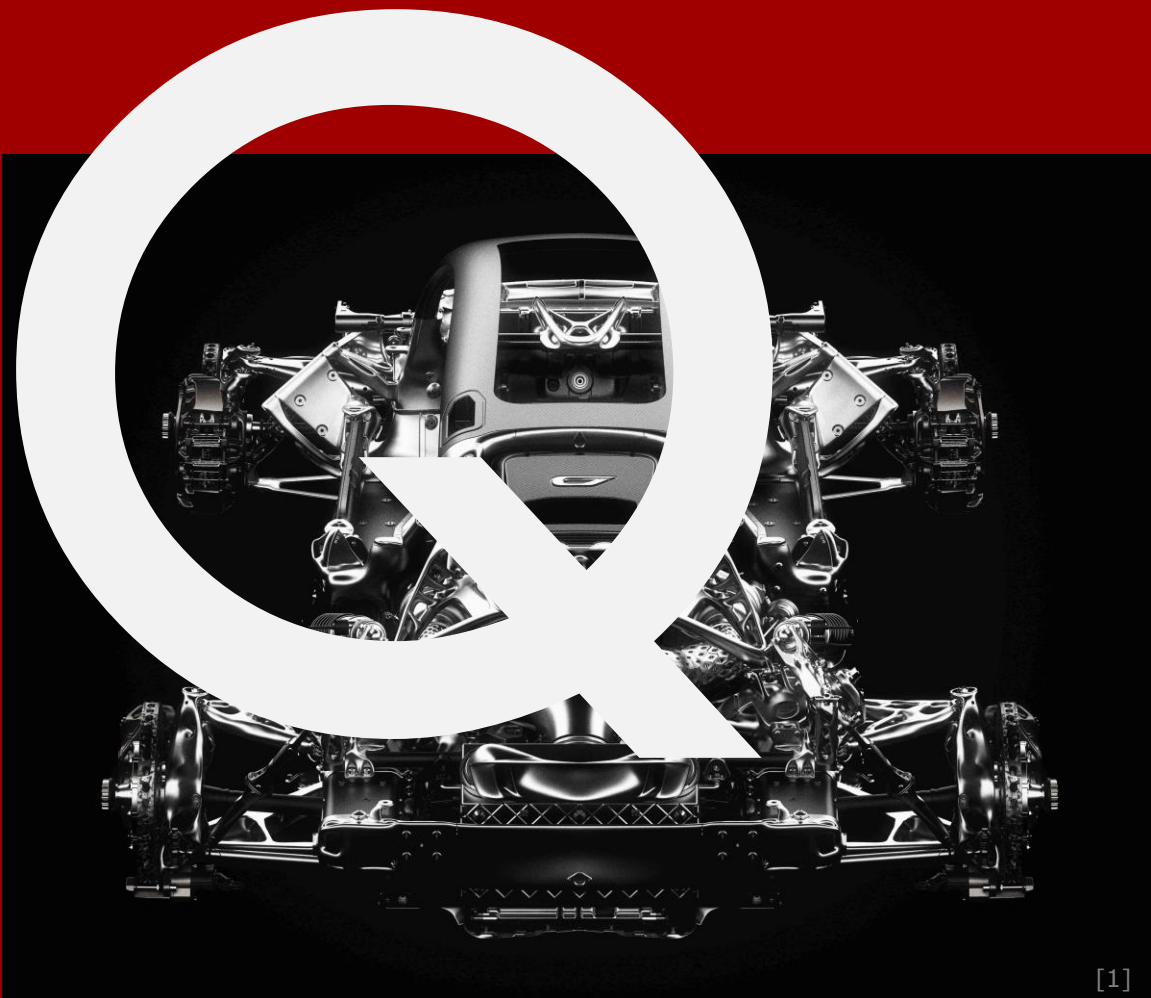




VEHICLE STRUCTURE and AERO

ACHA4004 VEHICLE TECH - 2

OLIVER RYE



[1]



BONDED ALUMINIUM CHASSIS TUB WITH FIBRE GLASS BODY

Bonded Aluminium chassis use aluminium plates and extrusions fixed with special industry adhesive. The positives to this are Low weight and rigidity, especially when compared to a more commonly used material such as steel. In a car such as a Lotus these qualities are key. Aluminium is a well established lightweight material. Being applied in producing cans, power lines, aircraft components and car components. Companies such as Lotus are famous for utilising aluminium in their cars such as the Elise [2]. However, Polestar have made moves in the application of aluminium in recent times.

The EV market is currently expanding faster than any other. This is due to many factors, one of the largest being recent laws forcing automotive manufacturers to go electric. Polestar is one of the few fully electric automotive manufacturers today. Aluminium, to Polestar, is a no brainer.

Batteries are heavy, very heavy. So modern manufactures look for anywhere they can save weight, without compromising a cars strength or durability. Having a lighter, more rigid platform is the perfect direction. The best option would be carbon fibre. However carbon fibre is expensive, very expensive. For a mass produced car to the average consumer, carbon is not an option. Aluminium it is then. Cheaper than carbon but lighter than steel.

The consequences of a lighter chassis boost other characteristics of the car. In the case of Evs, it can increase the range of the car. Literally due the fact that the car doesn't have to use its energy to lug its excessive weight around. However, I want to go faster as well. Weight is very important when looking for speed. So carbon again. Although carbon is still expensive, even for people looking for a fast car.

Introducing Fibre Glass. The cheaper carbon fibre. The now discontinued Lotus Elise combined a bonded aluminium chassis tub with a fibreglass body on top. This meant the Elise could be lightweight and rigid to improve performance and handling, without the dramatic price tag of a full carbon construct. Fibreglass is not without its flaws however. As a material it cracks and breaks on impact. This is in juxtaposition with metal, which crumples and can be forced back into shape. On a race car this is not such a problem and as this disadvantage is outweighed by the lightweight benefit. For a road going mass produced car however, this could be seen as too much of a disadvantage. Needing to replace entire panels becomes expensive. A fibreglass panel may have a higher inability to deform, however, when it breaks, its breaks.

When it comes to a sports car, the combination of a bonded aluminium chassis and fibreglass bodywork, create some very important characteristics. Lightweight, for increased speed, fuel efficiency and handling. Rigid, for sharper handling and lower deformation rates. Corrosion Reduction, fibreglass outer panels being harder to corrode than metal. Cheaper than carbon, the combination of the two are essentially the one below full carbon in performance constructs.

GENERATIVE DESIGN

Generative design is when 3D models are created and optimised by computer software. This means a user can apply requirements such as weight limits and materials, then the software provides options for the user to pick. An immediate advantage or disadvantage is apparent. If the user applies inaccurate parameters, then the software will produce designs that are incompatible with what is actually required. In addition if the user is spot on with the parameters, then the software will be almost guaranteed to produce spot on designs. These parameters also allow users to simulate circumstances. For example they might first say the product will be 3D printed. Then after they have received a design, they may change the circumstance to a milling process. The user can then compare how much the processes change the design.

Czinger is an excellent example of a company using generative design. The Czinger 21C [3] is 1,250 kg, 1,250 hp, hybrid hypercar. It was designed in collaboration with "Artificial Intelligence" and 3D printing [4]. It's 1:1 power to weight ratio acts as a tell tell sign of software influence. Czinger will have made the decision to utilise the golden performance ratio and provided software with said parameter. This also allows Czinger to create a highly competitive performance vehicle (HCPV). One of the largest priorities with any HCPV is precision. Precision in every component and factor. Through generative design the 21C is provided with AI precision in every component. All this precision does have one downside. Sort of. AI designed performance components tend to have very organic or alien-like forms. Changing this consequence would decrease to precision and performance of said components. That being said, AI designed is the selling point of the Czinger. If a consumer is purchasing one, then they are fully aware of its characteristics, which are likely the reason for purchase.

Generative design can side in reduction of many things as a consequence. For example cost of material and weight. With the use of software a component can be designed to do a purpose as efficiently as possible. This is how the organic, alien forms appear. There is not excess material. A downside to this is the complexity of some shapes. There are few simple squares or triangles. This may result in compromises. A component may be restricted in space available. This can be taken into account, but may result in a less efficient component compared to one with no limit on space.

There is also one downside to generative design, separate to the components it produces. Using software to design components reduces the need to employ humans. The designs and engineering is performed by a computer. The designs are then sent to another computer. That computer then tells robots how to assemble the components. Its a process with little human error or interaction. That may be a selling point to some. However, some may not appreciate such a vehicle. Perhaps it should be generative design in moderation.

AN UNDERSTANDING OF AERODYNAMICS AS IT RELATES TO AUTOMOBILES IS CONSIDERED TO BE IMPORTANT IN ORDER TO IMPROVE WHICH MAJOR AREAS OF PERFORMANCE? ALSO EXPLAIN THE CRITERIA THAT EFFECTS DRAG OR WIND RESISTANCE OF A VEHICLE?

Aerodynamics are a major part of vehicle design. If the aerodynamics of a vehicle are correct enough, the vehicle can see an increase in efficiency, speed and handling.

In on-highway applications, aerodynamics contributes 50% to overall fuel economy. So it is critical that a vehicle is designed and spec'd to minimise aerodynamic drag. One of the basic principles of aerodynamics is to keep airflow "attached" to the vehicle. This attachment results in smooth airflow around the vehicle instead of allowing the air to become detached, creating highly turbulent airflow. These turbulent areas cause the air to behave as if the vehicle were larger than it really is, resulting in increased drag and decreased fuel economy. [International, no date]

International is an American lorry designer and manufacturer. Due to the sheer size of their products, aerodynamics is of up most importance. Small vehicles tend to gain aerodynamic points from size, so when designing a lorry, International employs aerodynamic design features. Smooth radius edges are a signature tool utilised and designed in conjunction with wind tunnels. Wind tunnels provide users with a simulated atmosphere in which to investigate how airflow is effected by certain forms. It makes clear that smooth transitions do not interrupt airflow like flat and unaligned transitions. It is simple to see that if a form is acting as a barrier to air, then more energy will be consumed to force that form through air. Due to lorry trailers being an optimised rectangle shape for transporting goods, companies such as International, utilise the lorry cab to guide airflow around the trailer. Smaller components are then optimised to create as minimal effect on the larger airflow as possible. Details like the mirrors and sunshade are designed with this in mind.

The fuel efficiency of a lorry is always important. Ensuring heavy goods vehicles (HGVs) consume as little fuel as possible while going for as long as possible, ensures less emissions and less money spent in transportation. From the perspective of transporting companies, it means larger profit margins and less environmental impact. Two very important positives.

One great way to understand the importance of aerodynamics is by simply holding your hand out of the window while driving. Aerodynamics will change in proportion to airspeed squared, so an increase in speed is an increase in force. Air will flow around the entirety of the car, so it greatly affects performance. This is from the windscreen to bumper. With that, everything plays a role in the aerodynamic performance of the car. [Zero2Turbo, 2019]

Similarly to International, when thinking about aerodynamics and speed, design features are a key tool. Induced drag occurs when lift or downforce occurs. These are common effects on race cars. Aerodynamic features such as front splitters and rear spoilers are utilised to control lift and downforce. Increased downforce can make a car go faster, so aerodynamic design features direct airflow in certain directions to push the car towards the ground. This is called controlled drag.

Race cars have the benefit of being able to be designed with aerodynamics as a priority over something like practicality of a road car. F1 cars [3] are an extreme example of this. Spoilers, splitters and venturi tunnels are all implemented to simultaneously push the car down as it slips through the air, collecting air for cooling and holding air for stability.

The aerodynamic lateral force and yaw moment under the action of crosswind have a great influence on the handling stability of the car. When the driver encounters strong crosswind during driving, the car will leave the track if operation is improper, and the stability of the car will be seriously affected. After completing the modification of aerodynamic force [5]. The results show that the critical cornering speed of the FSAE car [5] is improved after the aerodynamic force adjustment. After completing the aerodynamic torque modification, the ultimate cornering speed is increased slightly under the condition of the same dynamics parameters of the car, the steering-wheel angle of the snaking test is reduced and handling performance of the car is improved. [Zhang et al, 2022, pp. 27-28]

This study was conducted into the capabilities of an Formula SAE (Society of Automotive Engineers) car. It highlights how aerodynamics can drastically affect the stability and handling of a car. The aerodynamics affect the balance of the car. As the car goes gains speed the aerodynamic force affects its ability to take high speed corners. If a car has poor aerodynamics, it can increase the amount of counteraction the driver will have to partake in. This can increase fatigue and reduce the ability of the driver being able to correct mistakes. This results in danger to the driver and others. The more stable a car is, better it can perform in cornering and straight line speed. In racing, the ability to go round a corner faster can be what ensures a win or loss. Aerodynamic features such as fins are often applied to increase the stability of a car, most commonly seen on Le Man Prototype (LMP) cars [7].

When a vehicle is designed to have a low drag coefficient but also intelligently direct airflow, it has good aerodynamics. Race cars take aerodynamics to the extreme. However, aerodynamic are taken into account in all vehicle designs, from family SUVs, to sports cars, to lorries. Aerodynamics can influence how much power a vehicle can use and how effectively it uses that power. The further aerodynamics is taken, the more a vehicle can access performance that would otherwise be dangerous or simply unrealistic.



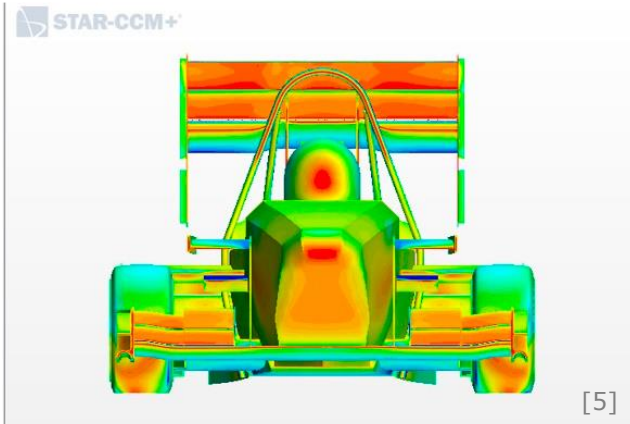
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