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Transport Design

Vehicle Technology

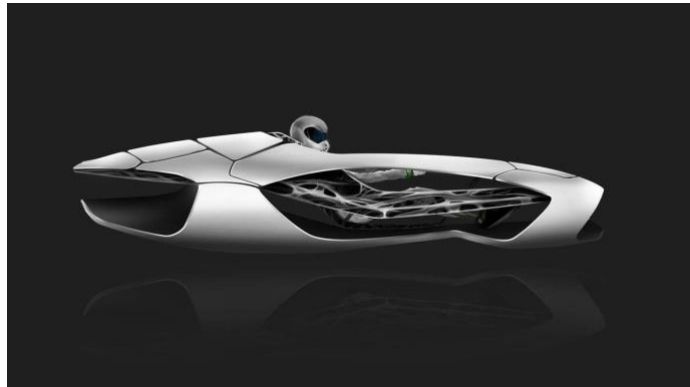
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Vehicle Structure & Aero

Q1

Generative Design

Many people ask the question of what is generative design? Reasoning behind this is due to new technology developing at a such a great speed it's difficult keeping up with what's next. Generative design is what's taking the engineering and design process to a whole new level allowing new ways of production to be carried out on future vehicles. It's



main fact of being as light as possible using the least amount of material as possible without losing performance and strength. In a nutshell, generative design is allowing engineers and designers input basic parameters such as height, weight, strength of what it can withhold and multiple material options by using new cutting edge AI computing systems allowing them to not only receive a handful of designs, but thousands of solutions allowing them to achieve the best possible form to suit their needs.

During the Ted conference in Portland 2016, futurist Maurice Conti discussed the uses of new upcoming technology and that we are at the dawn of a new age, an age he is calling the augmented age. Conti went on to say that "more will change in the next 20 years than has changed in the last 2000". He believes that new technology such as generative design is new revolutionary way of production with any form of product. This opening new doors to a whole new range of design and possibly the discovery of new materials working with these processes. This form of design has taken off with large companies using this technology in



new upcoming products such as Airbus. The large airplane manufacturer has begun using this technology in interior panelling such as cabin partitions ensuring the same strength capabilities as previous processes but saving half the weight allowing a more lightweight aircraft. This process will be used in their upcoming A320 aircrafts with other pieces shortly being developed with the same processes.

Some other companies have been using this technology to its full potential such as Hack rod. The generative design has been implemented with their team to use what's current and then re design its main components allowing a new design to be used in future vehicles. Their main backbone to this process is scanning current chassis frame designs and then using new AI computer technology including generative design software allowing them to explore the vast amount of alternative designs. Other systems such as Autodesk

dreamcatcher is allowing them to view growing iterations of structures to show the different ways of constructing to suit the needs of the criteria. This allowing them to achieve the maximum performance of the product with nothing to waste. Its technology is ground breaking to the entire design process and with this new process expect a vast change in object designs whether it's automotive frames or everyday products.



Steel Monocoque

In 2019, about 99% of cars on the road are using this kind of chassis design. This chassis design is seen in almost every mass-produced vehicle due to its low production cost and its suitability for automated production. This chassis is a one-piece structure defining the overall shape of the vehicle which is the main reason behind most cars on the road these days looking fairly similar.



Everything such as stress members is incorporated in the chassis design meaning that there's less to worry about during the manufacturing process meaning a simpler and more refined kind of production. Unlike any other chassis the whole structure is an outer shell allowing significant amount of space and with nothing like transmission tunnels, large roll over bars, high door sills etc, meaning it's use is significantly attracted to mass produced cars. Due to the simplicity of its design the entire manufacturing process takes only minutes and due to the shape and its material such as steel it has a large benefit crash protection.

On the downside of this it's very heavy meaning the car will weigh significantly more than other chassis designs. Due to the use of steel where most exotic car manufactures are using similar methods but with carbon fibre instead to reduce weight. Benefiting over the carbon fibre is the fact that steel is much cheaper to manufacturer and much easier to repair. Although in most cases space benefit is hard to overrule if the option is there for more room but as this was such a high priority its slight weakness of strength is down to the fact, they used pressed sheet metal rather than metal tubes or extruded metal. The rigidity to weight ratio is also the lowest among all kinds of chassis except the ladder chassis. Its weight is



down to the fact of the whole monocoque is built completely of steel where some manufacturers are using part aluminium or carbon fibre material to reduce its weight. Monocoque chassis are heavier than other chassis designs. It's significantly benefited in the production of mass-produced vehicles which are manufactured by robotics but

is nearly impossible for small scale production as the setup costs for tooling etc are too expensive in comparison to their benefits. Porsche is one of the most common and possibly one of the only sports car specialists to be using monocoque due to their production volume.

Q2

Aerodynamics

In a nutshell the more aerodynamic a car is the better it performs. The more you resist motion, the more energy you will need to overcome the resistance and move forward. When a car moves through the air, it tries to move divert the air around the vehicle creating a pathway for the object to travel. Resistance to a vehicle is defined on what the vehicle looks like and its design. For example, a motorbike would be far



more aerodynamic than a 20-tonne truck and due to the weight difference and its more aerodynamic weight the bike will be far quicker and more aerodynamic. The more area the air has to travel around the less aerodynamic the vehicle is. Most aerodynamic shapes try to reduce the amount of surface area especially at the front of the vehicle where this is where the air will begin to divert around the vehicle. The narrower and more aerodynamic the front of the vehicle is the easier it will cut through the oncoming air.

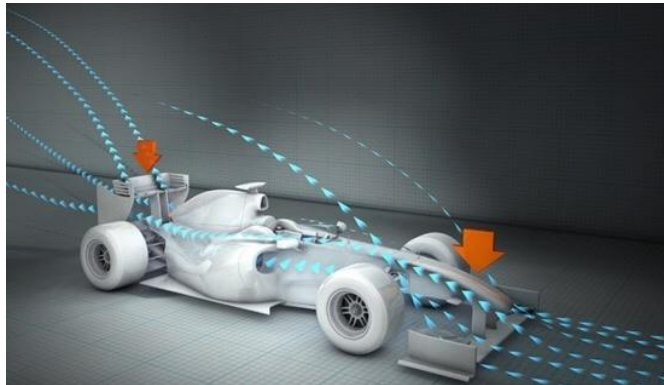
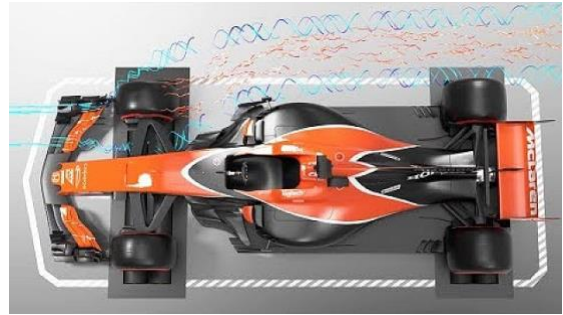


Aerodynamics has a negligible effect for cars having top speeds below 100mph, in other words most day to day cars will not be as aerodynamic as possible as the drag is irrelevant to these vehicles at lower speeds but for faster sports cars the design is a valuable impact on its performance. Normally with the front much lower than the rear creating a more aerodynamic shape minimizing the drag pressure on the car. Drag also increases the

square of airspeed, so to go twice as fast you need four times as much power of fuel. A great example to this is the Bugatti Veyron with its intention to be one thing only, the fastest production car ever. The Veyron needs 1,200HP to go to 254mph but as many cars can reach 200mph with less than half the power. It needs the last 600HP to go 54mph faster. Aerodynamics allow the vehicle to cut through the air to achieve higher speeds but not only does it have this effect but careful designing will allow the vehicle to remain stable at these high speeds using drag pressure in smart areas to keep downforce on the rear end of the vehicle allowing it to keep its power down while staying stable throughout the entire process.

Formula 1 sports is possibly one of the greatest effects of aerodynamics and drag pressures.

Airflow is the main feature when designing these vehicles. Although these vehicles aren't very practical, they are great when performing on the race track due to the complexity of the aerodynamics of the vehicle. Using large amounts of the airflow in certain areas helps force the car to the ground keeping it stable throughout the racetrack meaning it's performance is superb allowing it to reach high speeds on straight areas and maintaining those speeds through the corners increasing the amount of tyre vertical load meaning it can go faster than a normal car. Today's formula one cars manage the airflow not only above the body but below to maximise the capabilities of the car and downforce with the front and rear wings used to properly balance the aerodynamic downforce of the front and rear. The mostly flat bottom of the car controls the airflow under the car, which uses a rear diffuser to suck that air from beneath the car, thus generating more than 50% of the total downforce.



The photo to the Left: shows how the air is affected by this design of vehicle passing through the air on a racetrack at speed. Even the airflow around the body of the car is not affected directly from the front and rear wings which is important to control. Formula one cars have been using a new technology in the recent years called DRS (Drag reduction system) this meaning that at

certain areas of the race track drivers can activate this system which drops part of the rear wing making the car more aerodynamic reducing the amount of drag allowing them to reach an extra 5-15mph on their top speed. Just like winglets on airplane, wing end plates on F1 cars effect the size of the vortices generated by the front and rear wings. On the front wings, they are designed in a way to force the airflow over different parts of the car rather than just to the side.

Active aero is a new thing that appears in almost all high-tech exotic cars not only to improve performance but to improve aesthetic as well. Most high-performance supercars are very rarely driven at high speeds using their performance to the full potential. For example, Bugatti's new Chiron is hardly ever seen hammering around a racetrack, instead they are seen cruising around places such as Monaco showing off.

Most exotic cars with this new technology aren't being used to their full potential but manufacturers are now pushing for these vehicles to be used for what they were designed for, for example McLaren with their new Senna was a vehicle designed only to be used on a race track to enjoy the thrill of the vehicle. Using less comfortable features just what's relevant. The McLaren Senna is a



vehicle which is pushing the boundaries with new technology and aerodynamics to create a car that can sit comfortably around a race track with one thing in mind, to break lap records. A similar vehicle is the Zenvo TSR-S where it has a rear wing which not only moves up and down but side to side to use the drag to create downforce on the rear end of the vehicle giving it grip to the rear tires allowing the car to keep its speed through the corners.

To add it all up, the larger the vehicle the more air it will need to cut through causing it to be slower and less likely to be used as a performance vehicle. Formula one is leading the direction as to how manufactures should be using aerodynamics. Using it to the benefit of the vehicle allowing cars to become faster and hopefully one day break the 300mph mark.

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