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PROGRAMME: Automotive Design

MODULE: Vehicle Technology (M5X01364)

STUDENT P NUMBER: P150218

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29/4/2018

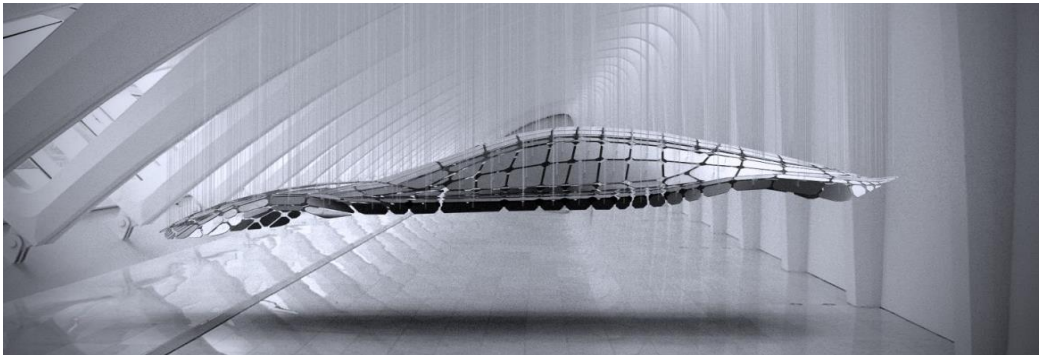
Factors that influence our current automotive design

This report is focused in to discuss the various production methods needed to create a vehicle looking for the best performances and reliability regarding the automotive industry, such as:

The various methods of joining the parts for the car frames, the use of glass fibre in the car body panels, as well as the processes of optimization such as generative design.

Another topic will be aerodynamics in relation to cars

where the criteria that effects drag, or wind resistance of a vehicle will be explained.



Ergonomics and efficiency is a must in the automotive industry, many aspects are influencing this characteristic, however they are the result of a deep understanding about the function that the subject have to fulfil. Other important factors to consider are safety, manufacturing cost and environmental concern.

As times change, technology is advancing therefore structural assemblages become more sophisticated and efficient, manufacturing techniques must be refined to accommodate new needs in structural applications.

As far as the car industry is concerned the use of these new technologies is very important, which allows us to create a highly sophisticated product that satisfies the regulations and the customer.

An example is the construction of frames in which are used junction methods such Mechanical fasteners and welding, nevertheless structural adhesives are a great alternative to traditional joining technologies.

Automotive manufacturers now mostly emphasising on creating a high strength chassis and bolting light weight body panel components and this is our case.



Bonded aluminium chassis tub with fibre glass body (lotus Elise)

The best joining method for aluminium chassis

Traditional joining methods

Mechanical fasteners and welding are traditional joining methods that many manufacturers are comfortable with; however, these methods are not always the most practical solution for modern assembly. Mechanical fasteners can drive up costs, limit options for materials, and cause fatigue, metal distortion or tearing. (Fsmdirect, n.d.)

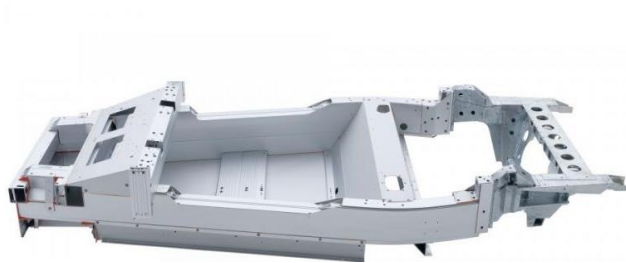
Alternative joining solution method

Epoxy structural adhesives are steadily gaining acceptance with designers and engineers in many industries. car manufacturers such as Lotus are adopting this method to bound the parts together this method provides extreme strength and rigidity – allowing new designs that further reduce weight, costs, and labour. (Fsmdirect, n.d.)

Main positive aspects in the use of structural adhesive

Epoxy adhesives effective alternative to Mechanical fasteners and welding. Adhesives offer additional benefits over traditional methods such as:

- simplifying surface prep by eliminating the need to abrade or clean the surface with solvents.
- Provide a smooth, aesthetically pleasing appearance since they don't distort or chance surface appearance.
- Post welding abrasion is eliminated.
- You can bond and seal in 1 step!
- It offers excellent corrosion resistance



Strong because

Stress and fatigue are reduced since the applied load is distributed evenly along across the bonded area not just around concentrated stress point, resisting to an applied force of 4000 pounds. (adhesives, n.d.)

Disadvantages in the use of structural adhesives

There is one potential negative side effect of adhesive use -- more expensive repairs. If an adhesive-bonded structural part breaks, most repair shops will not have the facilities necessary to rebound the adhesive. Instead, they would have to use a pre-**bonded** component sent by the manufacturer.

Body panels

Car body panels could be made of steel, aluminium, polymers, composites a much more depending on what characteristics our product must satisfy.
The material chosen in this research is glass fibre reinforced composite.

Body panel Material

since the vehicle must be light for high performances but at the same time the production costs in the average, the material chosen is fiberglass.

Characteristics of fibreglass

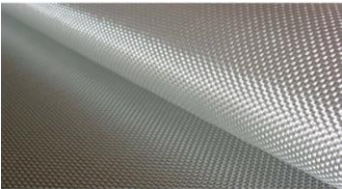
- No conductive
- Cost effective
- Hight strength
- light weight



Commented [Maximilia1]:

Material properties

Percentage of Glass Filling	20 % by volume
Tensile Modulus	5910 MPa
Tensile strength	38.1 MPa
Flexural modulus	3300 MPA
Density	840 kg/m3
Moisture Absorption	0.30%
Creep resistance	Good
Corrosion resistance	Good
Chemical Resistance	Alkalis, Hydrocarbons, Fuels and Solvents



(performancecomposites, n.d.)

Disadvantages in the use of fiberglass

Stiffness

Regarding the stiffness fibre glass is not reliable in fact cracks and breaks in an impact, rather than deforming and absorbing energy, other composites react in a much better way as we can see in the carbon fibre front nose used in F1

Lightness

the material is not as light as others available today.

Health

Fiberglass is plastic wrapped in glass composed of plastic, in the case the composite cracks for wearing or other reasons small particles will spread, the result to Inhaling this fiberglass particles can cause irritation or potential life-threatening conditions.

Conclusion

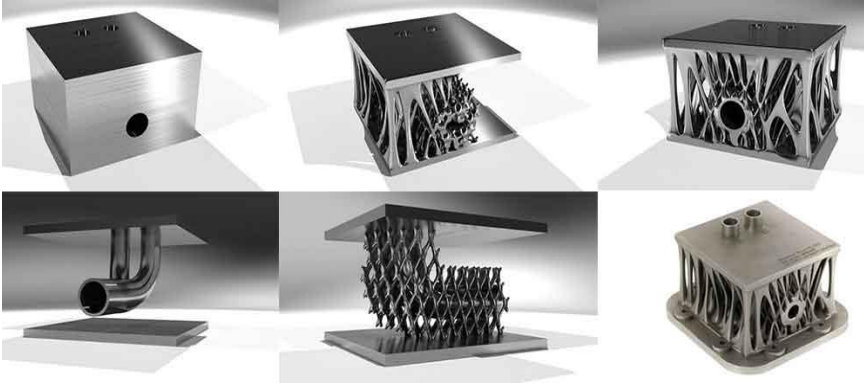
Analysing the various element, we have understood that applying the correct method is possible to get the best product saving money in material a production cost, however is important to understand that the main goal is to maintain high standard production.

Other sources

(lotustalk, n.d.),(adhesives, n.d.)

What means generative design or topology optimisation (TO)

generative Design or 'TO' Is a mathematical method that optimizes material layout within a given design space, for a given set of loads.



In the new method, instead of a designer having fully formed an idea of the design that they have in mind, what the designer does is to specify its goal, then the generative design synthesized multiple solution of geometries given some info like load gravity and lift etc

Process

what the system does initially, is to create a volume of material that then is removed in the first interaction, the process is like a material erosion.
in any subsequent interaction with the program does an analysis of the strength to determine how much material can be removed or not.

The algorithm that helps the design and ergonomics

as an example, I will take a chassis, a mechanical element of a vehicle that must maintain his strength for safety reasons. In the case of a chassis, we need the data about the forces which the structure will be subjected nevertheless also the physical and mechanical properties of the material selected for production.

A way to acquire this information is with a rapid prototype analysed in the program or using an existing chassis.

In the second case, the sensors are grafted into the chassis that reacting to forces send information that are transferred to the database, this information assimilated is then transferred in the algorithm of the Generative design, in this way the program creates another prototype of Chassis based on the information acquired.

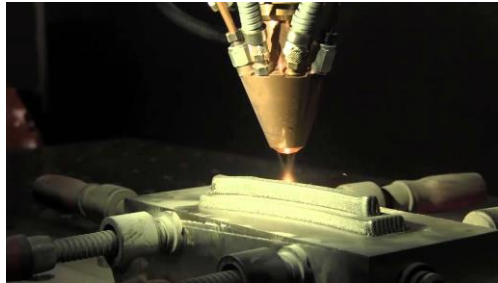
As a result, a possible synthesized design for a new chassis could be produced.



Production process

Now is time to choose the production process that will be the one that will determine our final product characteristics, some of the possible solution for production process are metal 3d printing or casting, another simpler possible solution is to utilize chromium-molybdenum tubes welded together to form a structure.

In the first case the **3d printing** will allow us to produce complex shapes and reduce the amount of material use for production this means an important cost reduction 3d printing is the future of manufacturing and is currently developing itself one obstacle are the dimensions of the objects that could be created. (APworks, n.d.), (Arconic, n.d.)



The second case **sand casting** allow to build complex figure however surfaces could deform and sizes this means a not enough advanced method to be able to build that complex shapes created by the generative design. (Reliance-Foundry, n.d.)

Prototype optimization

Returning to the Algorithm 'Generative Design' If we choose the **welding method** of production are given directions to create the structure with steel beams rather than a type of more organic optimization

In this way the design changes but the performances are the same overall reduction of the weight of the Chassis a shortcut using the information of the sensors to produce a new design. (education, n.d.)

Algorithm inspiration

Another Example of this algorithm could be taken by nature as the bones only where we need the bones are stronger than their structure and quarry but at the extremities where the weights are loaded more the bone structure thickens becoming more resistant. (education, n.d.)



In Generative Design the same things is happening where a similar algorithm is applied like in the trabecular structures.

Futuristic Structures

Another positive aspect of the generative design is that Enables to create a custom material through 3d printing



Density is changing in base were the forces are loaded

Cons of Generative Design

- It lacks a clear theoretical framework in generative design.
- If manual changes are made to the generated model, these changes will be lost when the program is re executed and the model regenerated.
- It requires an obvious initial investment.

Conclusion

Generative design is a valid option for the future of design is a way develop our ides in a more technical way, it allows us to space our creativity meeting the limits that design could be, nevertheless it requires an important initial investment. hence, is important to value the benefits that we will acquire from this optimization.

Other sources

(Koenigsegg, n.d.), (3D, n.d.), (Slideshare, n.d.)

The crucial elements of aerodynamics

Controlling the drag and downforce of the car is a highly technical and painfully complex challenge.

These two elements are an important part of the car that determines many aspects in the performance of the vehicle.

Downforce

The downforce is a very important factor in automotive aerodynamics, where the profiles must work in the opposite way to that of an airplane, it means that the forces must act from top to bottom.

In the case of F1 the wing fins of the ailerons are facing downwards, this generates a deporting force that precisely acts from the top to the bottom creating an aerodynamic efficiency useful to keep the car stuck to the ground, a force that can allow the car more stability as speed increases.

Aerodynamics

The definition of aerodynamics itself concerns the flow of the area that interacts with a changing body

Some of the first most aerodynamic designs are the German ones with the famous Auto Union designed by Max Wagner and then the brilliant Colin Chapman with Lotus.



1939 Audi Auto Union Type D



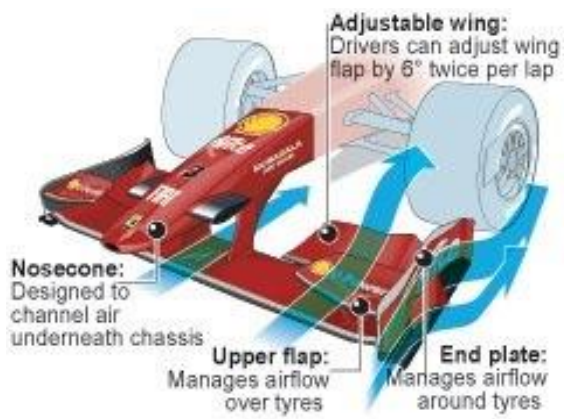
1964 Lotus F1 25 33

"Adding power makes you faster on the straights. Subtracting weight makes you faster everywhere".

Colin Chapman 'Lotus founder'

Elements that influence aerodynamics in a car

Air is an important factor and also an element to understand the air flow around the car. To demonstrate how the air flows around and over the bodywork wind tunnels are used.

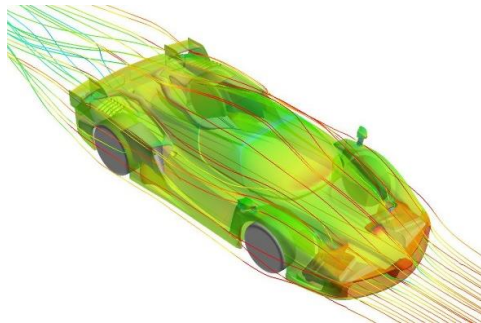


Front F1

The first factor that influence the aerodynamics is the front. Depending on its design it will direct the air flow in different ways, in the case of the F1 is the front wing that determine the levels of downforce this element is adjustable during the Grand Prix,

which creates a downward force referred to as a negative lift in order to push the front tires much harder into the race track, than simply the weight of the car alone.

Even a small adjustment up or down makes a big difference to the level of downforce.



Body shape

The body work of a car is also an element that influence Drag depending on his shape it could direct the air flow in different places. One of the major interests is to build the car as more aerodynamic as possible giving a shape that reduce to a minimum the resistance to the advancement (*Drag*) and therefore, that it opposes a lower resistance with respect to the motion of the vehicle

Rear wing

The air flow that is coming from the side and top of the car is directed to the back, were if the car is equipped with a rear wing this will allows us to increase downforce.



Diffuser

What the diffuser does is to reduce drag increasing downforce reducing turbulences on the back of the car this because low pressure flowing underneath the car at high speed that is directed to the diffuser where the air expands this creates a vacuum that pulls the vehicle to the ground.

This effect streamlines the airflow giving a smoother return to the atmosphere.



Conclusion

Optimization of the aerodynamics in a vehicle body results in:

Reduction of resistance to advancement that leads to a significant reduction of fuel consumption as well as increased downforce for a more comfortable driving experience.

Other references

Aerodynamics

https://www.youtube.com/watch?v=jYalXWNOa_A

Aerodinamica

] https://www.youtube.com/watch?v=jYalXWNOa_A

Type of forces to which the vehicle is subject

<https://www.youtube.com/watch?v=S-xxVF6VpdY>