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1 Introduction

The purpose of this report is to analyse the development of aerodynamics in Formula One through the years. The intent of this report is to look at the first ever aerodynamic features on a Formula One car, such as the Lotus 49B. The current aerodynamic features on Formula One cars and how the aerodynamic features could look like in the future. The introduction of aerodynamics to Formula One has drastically changed the looks and the performance of the cars. The principle of aerodynamics is to create downforce to aid in cornering in order to have more traction and helps tyre wear throughout a race, however by doing so it creates more drag which influences the top speed. The presence of aerodynamic features on a Formula One car has significantly increased throughout 60 years of the sport. (Ayushman, 2020)

1.1 Aims and Objectives

The aim of this report is to see how aerodynamics in Formula One has developed throughout the years by looking at different Formula One cars, development of different aerodynamic features and the new 2022 regulations. This will show how Formula One Cars have created more downforce throughout the future.

2 The Origins of Aerodynamics

2.1 Bernoulli's Principle

Daniel Bernoulli saw a relation between airspeed and pressure. Bernoulli saw that if air flows quicker around the vehicle, the pressure will be lower, the body shape of the car influences the speed of the air flow around it. This is seen on current Formula One car as their shape resembles a teardrop. Bernoulli states that in order to create high levels of downforce there must be a faster flow of air on the lower surface than on the highest surface, this will create low pressure on the lower surface of the car. (Katz, 2006). This creates a negative lift which results in higher top speed throughout corners.

2.2 Venturi Effect

The venturi tube shape can be seen on the current Formula One cars as new regulations allow Formula One cars to use the venturi tube shape, rather than using a flat floor on the underbody of the car. A venturi can be described as a tube that has a narrow section at the centre. This allows for air to move much faster through the narrowest section of the tube. (Katz, 2006). This will result in lower pressure towards the centre of the car.

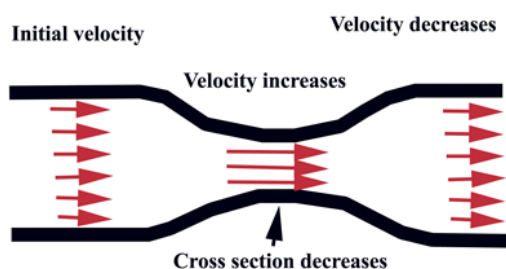


Figure 1- The Venturi Effect (Roberts, 2014)

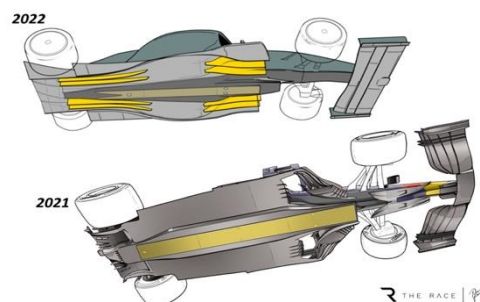


Figure 2- Venturi Effect on Formula One Cars (Giuliana, 2022)

3 Evolution of Aerodynamics in Formula One

3.1 The Ground Effect on the Lotus 79

The Lotus 79 is said to be the first Formula One car that has qualities of ground effect technology. Engineers Peter Wright, Colin Chapman, and Tony Rudd decided to use Bernoulli's principle to extract more downforce. To achieve this, they decided to create the sidepods in the shape of air foils. Alongside the new sidepod design Lotus also added side skirts to the car which would further avoid the low air pressure from escaping the underbody of the car. These upgrades would lead the car having a 15% downforce advantage compared to the other cars. (Hughes, 2018)

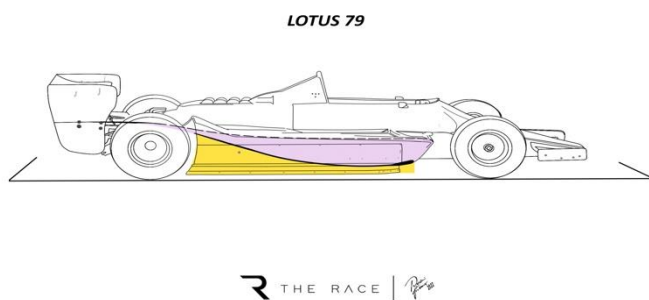


Figure 3- Ground Effect on the Lotus 79 (Giuliana, 2022)

The ground effect features on the Lotus 79 did help Lotus win many races and a championship by a big margin, however the 'Ground-Effect' was banned in 1982 due to the downforce being extremely powerful which brought a greater risk of life to the drivers if the side skirts are broken or if a driver hit another car it would cause the flow of air under the car to be broken, which eventually will cause the car to crash off the track. (Chachra, 2020)

3.2 2022 Formula One Regulations

The new 2022 regulations have seen a number of new changes, one of which is the use of aerodynamics. Due to changes made to the front and rear wing and wheel winglets, as well as the floor on Formula One cars, this will possibly result in better racing on track.

3.2.1 Front Wing

The front wing on the new generation cars have been completely redesigned for 2022. The redesign of the shape of the front wing will be able to influence the energy of the airstream, concentrating it towards the floor which will result in getting the maximum energy air to the front of the tunnels. The wing will also be designed to be swept back from the nose of the car; this will result in faster cars. The endplates on the front wing have also been designed to create a curved profile which blends into the wing, this will be more efficient in creating less wingtip vortices, which will create more 'clean air'. (Masdea, 2022)



Figure 4- Difference Between the 2021 and 2022 Front Wing (Reynolds, 2021)

3.2.2 Rear Wing

The rear wing on formula one cars has also been reshaped to look curvier and smoother compared to the rear wing on the 2021 Formula One cars, this can be seen on fig. 4. The main objective of the new rear wing shape is to create cleaner air which allows cars behind to follow more closely to the car in front. The rear wing features rolled tips instead of straight endplates like the 2021 car. The rolled tips produce a rotational airflow that gathers the rear wheel wake and rolls it into the flow leaving the diffuser. (Stuart, 2021). This allows for less 'dirty air' as the vortex's produced are less heavy.

3.2.3 Floor

The new 2022 regulations have allowed teams to use underfloor tunnels. This was first seen on the Lotus 79 using full use of ground effect and Bernoulli's airfoil making use of a steep floor towards the rear of the car, this can be seen in fig.3. The new 2022 floor has made use of Venturi's effect which can be seen in fig.2. The underfloor tunnels will allow cars to have more downforce through ground effect, this will then allow for less disruptive airflow for the car following closely behind. (Stuart, 2021)

3.2.4 Wheel Covers and Winglets

The wheel covers have been introduced to decrease the amount of 'dirty air' caused by the front wing, by doing this it will create clean air flow for the car behind. (Reynolds, 2021). The over-wheel winglets have also been introduced to create clean air by controlling the wake and vortex coming off the front tyres and targeting it away from the rear wing of the car. (Stuart, 2021). These features can be seen in fig.5 below.

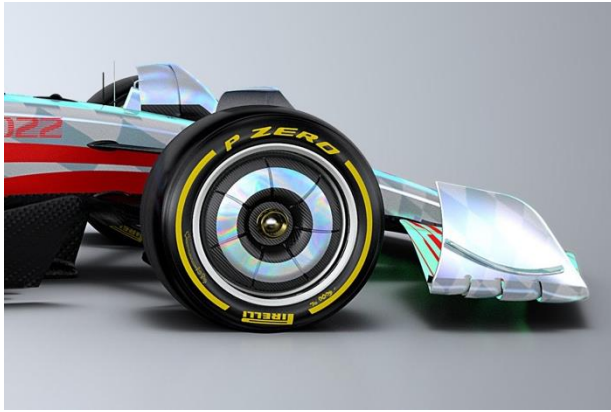


Figure 5- Wheel Caps and Over-Wheel Winglets (Somerfiels, 2021)

4 Conclusion

Aerodynamics has developed drastically throughout years and viewers have possibly seen better racing due to this development. Aerodynamic features on Formula One cars have significantly changed the way the cars look and feel when driving. Due to the growth of aerodynamic features teams are able to fully exploit the amount of downforce each car has; this can be seen in fig.6 as it shows how aerodynamic features has increased the amount of downforce a car has. The ground effect structures on the Lotus 79 brought a new era to Formula One, that had a big influence on the sport as it is still used today. The new 2022 has brought better racing as Pirelli have announced a 30% increase in overtakes, which is 785 overtakes in 2022 compared to 599 overtakes in 2021 (Smith, 2022). Overall, the aerodynamics in Formula One will keep on developing and teams will find more effective way to help get downforce on the cars in the future.



Figure 6- The Increase of Downforce on Formula One Cars Throughout 50 Years (Beves, 2018)

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