

Technical Report

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Assignment: Exploring the Evolution of
Aerodynamics in Motorsport

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Introduction

For my technical Report I will be analysing and investigating into the evolution of aerodynamics in motorsport over the years compared until the current age, and my objective will be to go into depth explaining how the simple movement of wanting to create more streamlined cars and simply go faster in the middle of the 20th century, ultimately became so impactful into today where the top teams & race cars are influenced by how well they react to drag, fuel economy, top speed, cornering speed and downforce.

My main aim within the technical report is to show on how it all began, and how it taken off, with 100's of different attempts by designers over the course of the last century, some proving to be worth their weight in gold with the success that followed their innovative designs, and others not so much. and how up until the current era it still plays a huge role developing and beating the regulations to produce a car that no rival can match.

As a general statement, Formula one, which is the pinnacle of motorsport racing in terms of racing, and talent. Also has lower feeder categories, now currently known as F2, F3, F4, Etc. with lower displacement engines, smaller vehicles, and smaller budgets, with less experienced racers, and a way for people to begin their career with racing in hopes of one day achieving F1. This method of working your way up the ranks over the years has produced the greatest drivers of all time, being Ayrton Senna, Sir Lewis Hamilton, Michael Schumacher, and many more. However, my task is to explore the past of aerodynamics where it all started compared to modern years and show my findings.

Literature Review & Main Body

Going back to where the evolution of aerodynamics in motorsports started, it all began with the first Purposely built Race cars all starting to adapt a more streamlined cigar tubed shape bodywork to help with reducing drag effects and increasing top speed, back then there was nowhere near the research information and infrastructure there is today in the cutaway image below you can see the design of the lotus 49B which was used from 1967-1970 with various versions and aerodynamic changes on the same chassis.

See figure 1.1 for Cutaway and specifications of 1968 Lotus 49B

(Fig 1.1)

Engine: 3.0 L V8 Ford Cosworth DFV

Top speed: 180 MPH

capable of 430bhp @ 10,000 RPM

Bore x Stroke: 85.7 x 64.8mm

Dry Weight: 530kg

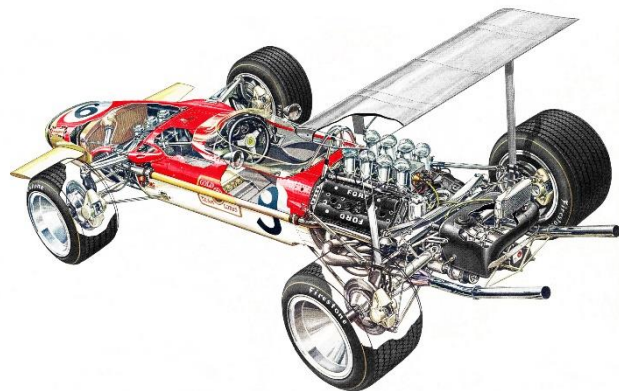
P/W ratio: 0.81kg/BHP

Key Designers: Colin Chapman & Maurice Phillippe

Drivers: Jim Clark, Jackie Oliver & Graham Hill

WDC: Graham Hill with 3 victories

WCC: Lotus Ford



As seen above, development of the rear wing developed over the season Going through the 1968 season and into the next year later In 1969 the Designers were finding ways to develop the aerodynamics which came out in ways which were quickly banned by the governing body due to the danger to overhanging buildings, the crowds, and the overall concern of the safety the high rear wings had which only lasted the Spanish, south African, and Monaco grand prix into the 1969 season before the regulations were changed and they had to be banned and redesigned completely.

Within the principles of aerodynamics, there were 2 simple goals within the research which needed to be achieved to be the most desirable of the cars, to simply reduce drag and downforce as much as possible while still having good stability, In simple terms Drag is the air resistance and resultant force that is opposing the forward motion of an object, the more that the Drag of the cars were reduced, the bigger the benefit is as it allows for increased speed, reduced fuel usage and helped the design of cars a lot.

Advancing through the seventies

Once Teams decided to leave behind the shape of the cigar tube in favour for wedge shaped bodywork which was developed Starting in 1970, the first formula one car developed with side mounted radiators was the Lotus 72 which was also the successor to the Lotus 49B Mentioned earlier which it ran its chassis from the second race of the 1970 season until the end of 1975, which is shown below, Being developed by the some of the greatest and innovative design engineers of all time, colin chapman, Maurice Phillipe, and Tony Rudd. It was considered by many to be the most successful grand prix racing car of all time, as through the 7 seasons it ran, it racked up 20 victories, along with 3 constructors titles and 2 drivers titles. Its specifications were very similar its predecessor being the lotus 49B except the newly designed chassis and bodywork greatly improved the aerodynamics with the more defined front nose wing compared to the older intakes.

(Fig 1.2) Lotus 72



The main advantages of the sidepod mounted radiators was that it had far better weight distribution along with the improved aerodynamics as well, although the new design didn't have as much

momentum in being a race winner then the 49B, it was revised with less unsprung weight within the brake ducts, and then also revised suspension, Then rolled the true success of the lotus 72 as it won 4 GP's in a row, Fatally one of the drivers of the lotus 72, Jochen rindt died at the Monza circuit in 1970 while still claiming the championship that year. In the following year the car didn't hit the ground running as it suffered due to other teams like McLaren now on the rise and claiming their first title in the late 70's, and with Ferrari also coming back stronger, lotus had competition and didn't get as competitive again until they further developed the lotus 72 and came back in 1972 with a new engine mounted airbox to aid with cooling the engine. Later, with the design, Emerson Fittipaldi taken lotus to many victories and titles up until 1975, however lotus repeated the winning streak past this and up into the ground effect era which started in 1977.

Fast Forward to Modern Era

the current regulations and FIA now have made the rules very strict which doesn't allow for experimentation like there used to be and cars like the Lotus 72, due to many factors like the newly enforced budget cap of 2021 which keeps teams on a level development scale between them with their facilities.

In the modern era there was a huge regulation change going into 2014 with many seeing Lewis Hamilton's 2013 move from McLaren to Mercedes due to Michael Schumacher's retirement from the sport, many branded Hamilton's move as a "career destroying move" and how it would fail, but soon came 2014 regulations with the change from the 2.4L V8 engines to 1.6L V6 hybrid engines which are still used today except with more power and slight modifications every season.

What is considered as the most successful run in F1 history. Mercedes only got stronger winning 8 back-to-back constructor titles and producing the fastest and some of the most dominant cars in history, with the statistical best F1 driver in history, they also won 9 driver titles, becoming nearly as successful as teams who have been in the sport for 70 years, only doing it within 14 seasons.

Conclusion & discussion

My results have concluded that over the past 50 years, many cars have been a huge success with Ferrari, red bull, Mercedes, McLaren, Williams, being the key names of the champions in terms of the evolution of the cars and thanks to advancements in aerodynamics, and seeing how airflow affects their car, I have found some CFD images and have compared them with one being the lotus 72, compared to a 2019 formula one car, As you can see from below images, the designs have changed hugely, every aspect of the car has advanced and is way more aerodynamically efficient then before due to the amount of testing, evolution, and resources available, they can go a lot faster, take corners way quicker, produce a lot less drag, way more reliable, and the engines use less fuel loads and the downforce is a lot more effective in cooling the car, to add to this with weight distribution is almost perfect for balancing the vehicle, shown below concludes how drag effects take place.

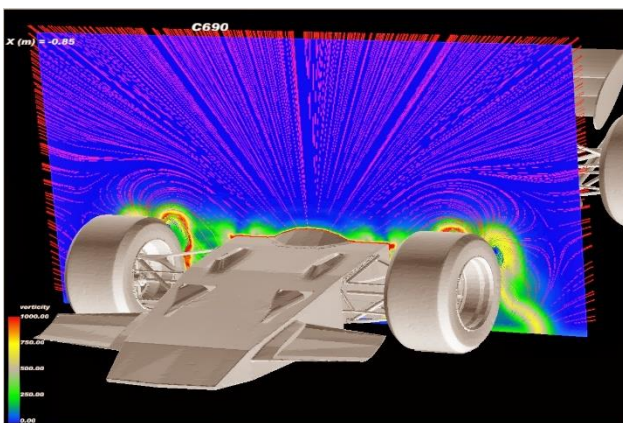


Fig 1.4 Lotus 72

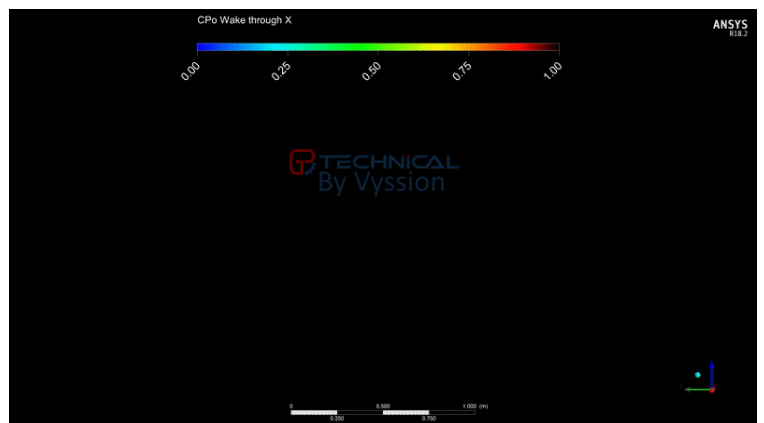
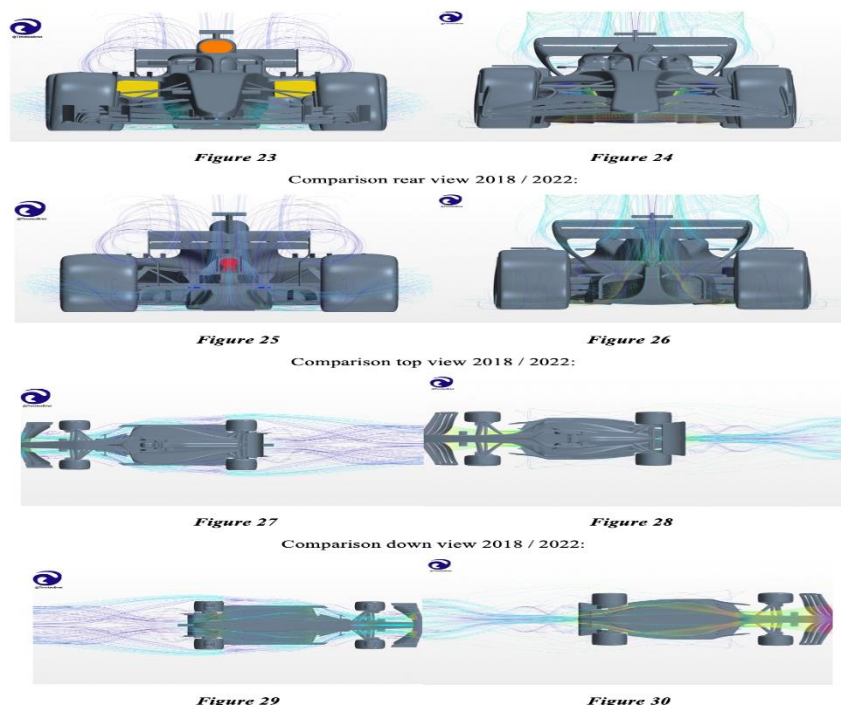


Fig 1.5 Animated GIF of total pressure for 2019 F1 car

Also adding into my conclusion, here shows the comparison between 2018 and 2022 F1 cars and how the aerodynamics changed shape and how the Wake / airflow has changed which was an effort to make overtaking harder for cars this season.

Fig 1.6 2018 vs 2022



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