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# **The Evolution of Front Wings in Formula One**

ACHA4005 Academic Skills

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## 1. Introduction

This report will look at how formula one front wings have evolved since their introduction and what has influenced the changes. It will also discuss how they are likely to change in the future.

## 2. Research/Background

The front wing is arguably the most important aerodynamic part of an F1 car as it is the first point of the car the air comes in contact with and it can condition the airflow to better work with every aerodynamic part downstream. The front wing is used primarily to generate downforce over the front axle, aiding traction and allowing faster cornering. It is also used to help balance the car between the front and rear.

The first F1 front wing was seen on the 1968 Lotus shown in figure 1. This was a simple design with a single element on either side of the nose cone.



*Figure 1 - 1968 Lotus 49 driven by Graham Hill, Paawy (2017)*

Many different designs were tried over the years, as teams learned more about aerodynamics and tested their ideas, resulting in some unusual looking cars, as can be seen in figure 2. In later years, front wings would develop into multi-element structures where they would have 2 planes which allowed for adjustments to be made quickly and easily, even during a pitstop by adjusting the flap. The flap is the rear most element on the front wing. Figure 3 shows the 1988 McLaren MP4/4 which has a simple 2 element wing.



Figure 2 - 1969 McLaren M7C-1, McLaren (2014)

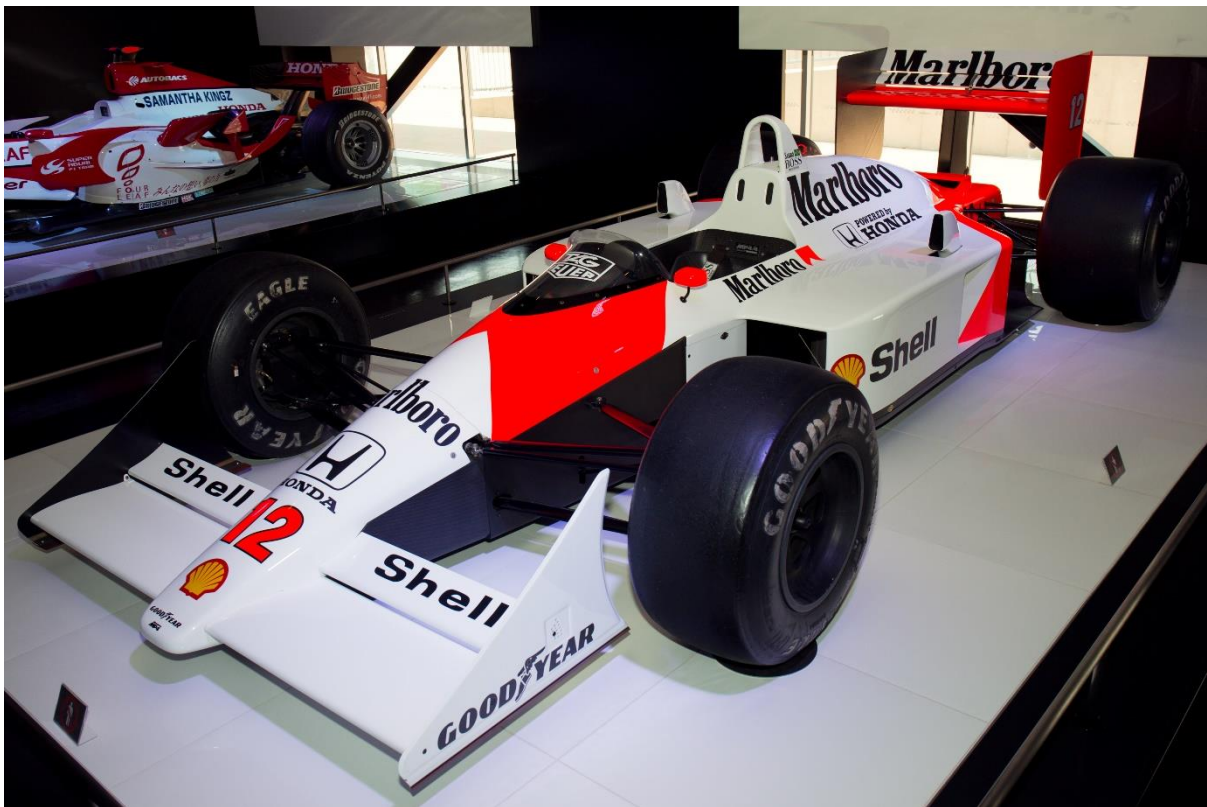


Figure 3 - 1988 McLaren MP4/4, Morio (2020)

Front wings remained relatively simple in design until around 2005 where the increased use of CAD and CFD programmes made it possible to create much more intricate and complex designs. The use of carbon fibre also helped as it made it easier to create lightweight and very complicated designs. Initially, front wings remained relatively simple, for the most part using 2 to 3 planes but around 2005 the shape of them started to become much more curved, dipping down around the nose cone of the car, which can be seen in figure 4 with the 2005 McLaren. This would have been very hard and time consuming to make using metal and would have likely weighed considerably more.



*Figure 4 - 2005 McLaren MP4-20 with curved front wing, Ostler, S. (2024)*

By the time the 2022 rule changes came into effect, the wings had become extremely complex, with many having 100+ parts making up the overall structure. Figure 5 shows just how complex front wings had become. Cascade wings were one of those smaller parts, it was a wing-like structure which was located above the wing's main plane at either side, connected to the wing's end plates. The cascade wings were used to work the airflow harder and increase the downforce generated by the wing whilst still complying with the sports regulations. All the parts that made up these front wings can be seen in figure 6. The design of the main wing and the cascade wing, also aided in pushing over and around the upper part of the front wheels as is shown in figure 7.



Figure 5 - 2018 Renault RS18 front wing, Madanvivek (2018)

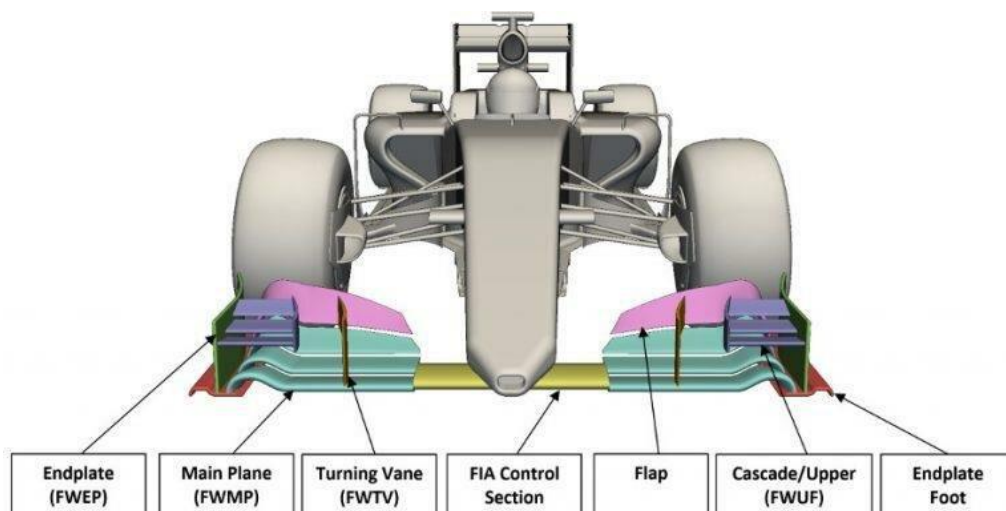


Figure 6 - Parts of a pre-2022 front wing, Hamza, S.M. (2023)

The end plates were also partly used to manipulate the airflow, but not to generate downforce. It was used to push some of the airflow out past the outer edge of the front wheels. The outwash airflow helped reduce drag around the front wheels. This drag on open wheel race cars occurs as the top of the wheel rotates in the opposite direction to the air flowing over it. Figure 7 demonstrates this showing the vortices generated by the front wing. Turning vanes are found on either side of the wing, closer to the nose cone but still outside the FIA control section, where no aero devices are

allowed. The turning vanes are used to control airflow on the inside of the wheels. Ducting it into areas such as the brake cooling ducts, the radiator cooling openings in the sidepods and towards the coke bottle area where the airflow passes around and under the sidepods of the car.

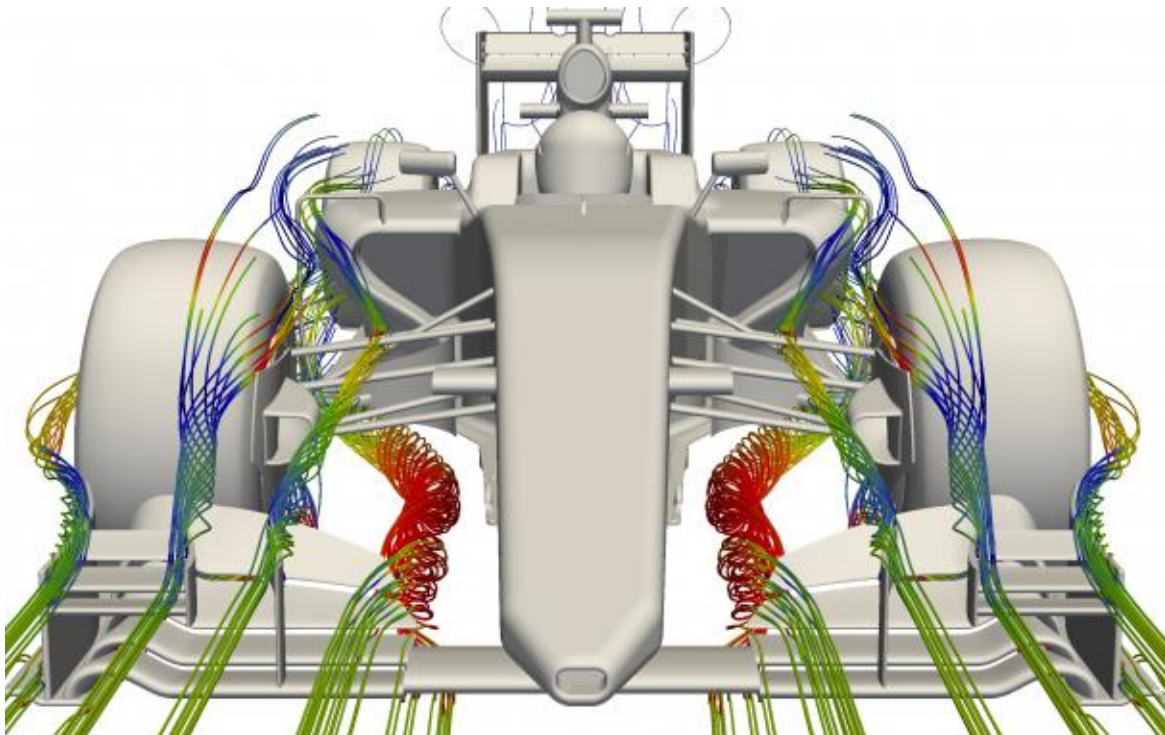


*Figure 7 - Vortices generated by a front wing, Total Sim (2012)*

The percentage of downforce produced by the front wing has reduced over recent years as car aerodynamics have become better understood and exploited by the teams. In the 90s, the front wing was responsible for between 40 and 50% of the car's overall downforce (Neural Concept, 2023). Recently, that number fell to around 30% or less in some cases, table 1 shows the breakdown between front and rear. The source, Neural Concept, only states "recently" and gives no suggestion as to when they are referring to, the author has assumed this was around 2022. This is likely due to modern front wings being well designed to condition and direct the airflow to optimize the amount of downforce produced by other parts of the car, making them much more powerful. Thus, the front wings real power, nowadays, comes from its ability to direct the airflow and effectively amplify the downforce created by the aero parts downstream, such as the ground-effect floors and the rear diffuser.

*Table 1 - Overall downforce percentage split between front and rear, Neural Concept (2023)*

|       | 90s      | Recently    |
|-------|----------|-------------|
| Front | 40 - 50% | 30% or less |
| Rear  | 50 - 60% | 70% or more |

The front wing's design was not just influenced by performance but also by the sports regulations. Formula 1's governing body, the FIA, updates the regulations on a regular basis and makes larger rule changes every 5 to 6 years. Since the 90s, many of the rule changes have been, at least in part, aimed at reducing the speed of the cars and reducing the downforce of them is a good way to do so.

In 2022, the FIA brought in a new set of rules which was considered to be “one of the largest rule changes in history”, according to (Sky Sports F1, 2022). Again, the aim was to reduce the overall downforce of the cars, but to also reduce the amount of turbulence left in the wake of the cars, making it easier for cars to follow each other closely and increase the chances of cars overtaking each other. This was in response to overtaking having become very difficult as when a car got too close to the car in front, the turbulence the leading car created caused the following car's aero package to stall. As a result, this reduced its downforce and made it harder to control under braking and cornering. This often led to cars following but not being able to pass. The FIA reduced the turbulence by making the aero packages neater by not allowing extra parts on the front wing (cascade wings, turning vanes, etc.) and by limiting the number of elements the wing could have. Figure 8 shows McLaren's 2022 Car with the new wing design. There were changes all over the car, but this will not be discussed here.



Figure 8 - 2022 McLaren MCL36, Kalinauckas, A. (2022)

### 3. Discussion

The FIA are currently working on a new set of regulations due to come into effect at the start of the 2026 F1 season. These regulations are meant to continue along the same path as the 2022 rules. They are aiming to reduce the cars downforce by an expected 30% overall, as well as a 55% reduction of drag (Williams Racing, 2024). As a result, it should make it easier still for cars to follow each other. This is due to the 2022 rules working but not quite as well as hoped and to offset the work of the teams in regaining the downforce they lost when the rules initially changed.

The 2026 regulations will also see the introduction of active aero on the cars which is aimed at keeping cornering speeds high but reducing drag down straights. This should also aid overtaking. The cars will also be 200mm shorter, 100mm narrower and 30kg lighter than the 2022 cars (Williams Racing, 2024). This is being changed to aid the handling and efficiency of the cars. Figure 9 shows a concept design of what the 2026 McLaren may look like.



Figure 9 - 2026 McLaren concept, Optical Dreamsoft (no date given)

## 4. Conclusions

The future of the front wing will, as it always has, depend on the regulations of the sport and the engineer's interpretation of them and their ability to exploit any loopholes that they find. The FIA are likely to continue to try make it easier for cars to follow each other, allowing for closer racing and more overtaking, whilst trying to keep the cars at a fast but safe speed. As the teams find more clever ways of making the cars quicker the FIA will continue to alter the rules to slow them down again. However, it is likely that the front wing's individual role on the car will remain to be, guiding the airflow into areas of the car that will benefit the other aero parts.

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