A Project Report on

"A Comparative Study of Constructors in Formula 1 with Special Reference to Mercedes AMG"

By
Shlok Shah

SUBMITTED TO

Department of Sports Management

NAGINDAS KHANDWALA
COLLEGE OF COMMERCE,
ARTS AND MANAGEMENT
STUDIES

MUMBAI - 400064

In partial fulfilment of the requirements for the degree of
Bachelor of Management Studies - Sports Management - Sem VI

Academic Year 2022 - 2023

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Department of Sports Management

CERTIFICATE

This is to certify that Mr. Shlok Shah - has successfully completed the Dissertation as a part of the semester VI syllabus titles **A Comparative Study of Constructors in Formula 1 with Special Reference to Mercedes AMG** under the guidance of Dr. Deepak Gupta during the Academic Year 2022- 2023

Prof. Dr. Deepak Gupta

Principal

Co-Ordinator

Date: 4 March 2023

College Seal

DECLARATION

I wish to state that the work embodied in this dissertation titled A study on the Comparative Study of Constructors in Formula 1 with Special Reference to Mercedes AMG. The Dissertation is carried out under the guidance of Dr. Deepak Gupta in this academic year 2021 – 2022.

Shlok Shah .

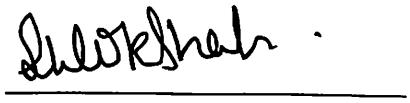
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SHLOK SHAH

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Chapter 1: Introduction

1. Introduction to Formula 1

Formula 1 is the highest class of international racing for open wheel single seater formula racing cars sanctioned by the Federation Internationale de L'Automobile. The World Drivers' Championship, which became the FIA Formula 1 World Championship in 1981, has been one of the premier forms of racing around the world since its inaugural season in 1950. A Formula 1 season consists of a series of races, known as Grand Prix, which take place worldwide on both purpose-built circuits and closed public roads. Formula 1 cars are the fastest regulated road-course racing cars in the world, owing to very high cornering speeds achieved through the generation of large amounts of aerodynamic downforce. The cars underwent major changes in 2017, allowing wider front and rear wings, and wider tyres, resulting in peak cornering forces near 6.5 lateral G and top speeds of around 350 km (about 217.48 mi)/h (215 mph). The cars are dependent on electronics and aerodynamics, suspension and tyres. Traction Control, launch control, and automatic shifting, plus other electronic driving aids, were first banned in 1994. They were briefly reintroduced in 2001 and have more recently been banned since 2004 and 2008, respectively.

Constructors Competing in Formula 1:

i. Mercedes AMG F1
ii. Red Bull Racing
iii. Scuderia Ferrari
iv. McLaren Racing
v. Alpine
vi. Aston Martin Racing
vii. Alfa Romeo
viii. Alpha Tauri
ix. Williams
x. Haas F1 Team

2. History of Formula 1

The modern era of Formula One began in 1950, but the roots of Grand Prix racing are far earlier, tracing to the pioneering road races in France in the 1890s, through the Edwardian years, the bleak twenties, the German domination of the 1930s and the early post-war years of Italian supremacy. At the birth of motor racing, cars were upright and heavy, roads were tarred sand or wood, reliability was problematic, drivers were accompanied by mechanics, and races — usually on public roads from town to town — were impossibly long by modern standards. Regarded as the first motor race proper was a 1,200 km (about 745.65 mi) road race from Paris to Bordeaux and back in1895, won by Émile Levassor with his Panhard et Levassor in 48 hours (about 2 days). One of the mostsuccessful drivers of the early year was Fernand Charron, who won the Paris-Bordeaux race in 1899, also in a Panhard, at the blazing average speed of 29.9 mph.

The first race using the appellation "Grand Prix" was 1901's French Grand Prix at Le Mans, won by Ferencz Szisz with a Renault, who covered the 700 miles at 63.0 mph. The 1906 Grand Prix de L'Automobile Club de France, commonly known as the 1906 French Grand Prix, was organized at the prompting of the French automobile industry as an alternative to the Gordon Bennett races, which limited each competing country's number of entries regardless of the size of its industry. In 1908 the Targa Florio in Sicily saw the appearance of "pits," shallow emplacements dug by the side of the track where mechanics could labor with the detachable rims on early GP car tires — themselves a major technical improvement over the earlier technique of permanently attached wheels and spokes. But even so, racing cars of the early years were too heavy and fast for their tires; Christian Lautenschlager's winning Mercedes shredded 10 tires in the 1908 French Grand Prix at Dieppe.

3. Initial Years in Formula 1

Motor racing after World War II initiated a new formula — originally called Formula A but soon to be known as Formula 1 — for cars of 1,500 cc supercharged and 4,500 cc Un supercharged. The minimum race distance was reduced from 500 km (311 miles) to 300 km (186 miles), allowing the Monaco Grand Prix to be re-introduced after a two-year interval in 1950. The FIA (Federation Internationale de L'Automobile) announced plans for a World Championship at a meeting held that year. On 10 April 1950, Juan Manuel Fangio, in a Maserati, won the Pau Grand Prix, the first contest to be labelled an "International Formula One" race. A month later Silverstone hosted the British Grand Prix, the first sanctioned championship race for Formula One Grand Prix cars, and the F1 World Championship was born. Only seven of the 20 or so Formula One races that season counted towards the drivers' title, but the championship was up and running. Even as more races were included in the World Championship, there were plenty of non-championship Formula One races as well — like Britain's International Trophy race. (Non-championship GP races continued until 1983 when rising costs ruled them unprofitable.)

Winner at Silverstone in 1950 — adding pole position and fast lap in the process — and the first F1 champion, Giuseppe ("Nino") Farina drove an Alfa Roméo 158, capturing the Belgium, Swiss and Italian races as well, along with non-championship wins at Bari and Donnington Park. The season continued this way with the Alfas dominating by winning all pole positions and all races. Farina was able to capture the World Championship by a slim three points because in addition to his three wins he had a 4th place finish, as opposed to Juan Manuel Fangio's three wins and no other points-paying positions. Farina is best remembered for his style of driving; the relaxed, inclined position and outstretched arms that was to influence a whole generation of F1 pilots.

In the '50s, at the start of modern Formula One, the cars were front-engine beasts with large-displacement motors and minimal testing and design improvement. Thus, even in post-war days, many of Farina's contemporaries still sat crouched, fighting with the wheel. Leaving for Ferrari in 1951 — the first World Championship for Juan Manuel Fangio, driving an Alfa, and the year of Scuderia Ferrari's first official F1 win, at Silverstone, "The Pampas Bull" José Froilán González driving — for the next two seasons Farina fought a personal battle with Alberto Ascari, a battle he was bound to lose. Ascari was by far the better driver; more controlled, faster and more precise. Ascari won the F1 World Championship in 1952 and 1953 in the iconic Ferrari 500.

It was not an easy beginning. In those twin early years of '52-'53, the lack of entrants meant the authorities were forced to conduct most races to Formula Two regulations. Of the 20 marques that competed in 1950, a large number were soon forced out by cost. Nonetheless, Ascari claimed the distinction of being the first repeat World Champion at the end of the 1953 Grand Prix season. Development of the cars was slow, because the engine formulas would be changing again for the next year. This meant that F1 cars were basically the same with only slight modifications as time allowed. Fangio was able to pull Maserati back up into the winner's circle by year's end, thus preventing Ferrari from having two perfect seasons in a row. Indeed, it is Juan Manuel Fangio, from Argentina, who epitomizes the first decade of Formula One, winning five World Championships for five different constructors and four consecutively from 1954-
57. Mercedes and Lancia would debut their cars mid-season 1954, releasing their drivers to run other teams' cars early on. It was this strange practice that allowed Fangio to become World Champion while winning for both Maserati and Mercedes in the same season.

In 1955 the only race Fangio did not win was the British Grand Prix, which was taken by the man who was to give him an iconic challenge in future years, Stirling Moss. This was the first time an Englishman had won his home GP, albeit for a German team. However, Fangio won the drivers' championship from Moss, Castellotti and Farina. The 1955 season was also the Formula One year that will go down in infamy in motor racing. In a single season the lives of Alberto Ascari and Bill Vukovich, two-time winner of the Indianapolis 500, were lost and the terrible Le Mans disaster occurred. Automobile racing came to a virtual standstill and much of the F1 season was cancelled. When Mercedes withdrew from racing after that horrific, multi-car accident (which Fangio barely escaped) at the '55 Le Mans 24 Hours which left 85 people dead, Fangio moved on to Ferrari — racing Lancias for a year — winning in 1956 with five poles, three wins and one 2nd out of seven World Championship races.

In the 1957 season, Fangio recorded his 4th consecutive drivers' title. Perhaps Fangio's greatest race was the 1957 German GP at the Nürburgring. Driving a Maserati 250F, he lost 56 seconds and the lead in a pit stop but returned to win by letting loose the most spectacular pursuit of his life, bettering the track record for the 14.2 mile by an amazing 12 seconds on three consecutive laps. He broke and re-broke the Ring lap record and when the Ferraris realized the danger, he was already in their mirrors. As the cars thundered past the South Curve, Fangio closed right up to Peter Collins' gearbox and swept by with one wheel on the grass, peppering the Englishman with stones. It was the Argentine's 24th and final Grand Prix victory, and his most impressive.

Fangio's rival, erstwhile teammate and admirer was Stirling Moss — the greatest F1 driver never to win a championship — who finished second to Fangio at Mercedes in 1955 in the famous covered-wheel "Silver Arrows," with Maserati in '56 and then again with Vanwall in '57. Moss became the first Briton to win the British Grand Prix, at Aintree in 1955, and the first to do so in a British car, the 1957 Vanwall VW5. After learning his craft in Fangio's slipstream, Moss increasingly became the great Argentinian's main rival. After Fangio retired, Moss took over the mantle of the best driver in the world, but his career declined, leading to retirement, following accidents during the 1960 Belgium Grand Prix at Spa-Francorchamps — where Moss was thrown from the car while navigating the intimidating "Masta Kink," breaking both legs, after a rear axle broke at over 130 mph — and an even worse shunt at Goodwood in 1962.

4. Objectives of the study

- ***To see where Formula 1 Constructors stand in terms of their performance.***
  Determining the current on-track form of all the Constructors/Teams as a base to find out who is more successful now.

- ***To compare each Constructor/Team in Formula 1 with their competitors based on performance.***
  Compare each Constructor with their close competitor and find out how they fare against each other and how they develop and build on their performance.

- ***To analyze all the Constructors/Teams' cars from a technical standpoint.***
  Formula 1 is a very technically oriented sport. Formula 1 cars are the epitome of automotive engineering and aerodynamics plays a major role in the sport. Analyzing how the Constructors showcase their dynamics and engineering brilliance on their Formula 1 car and making it a tough competitor in the circuit.

- ***To determine and forecast their future performance in Formula 1.***
  Based on their current statistics and performance, forecasting their future performance in the sport.

5. Limitations of the study

- Scarcity of on-track data.
- Unavailability of potential future data resources depicting performance in future.
- Unavailability of data for direct comparison between the Constructors.
- Limited data on certain Constructors and no data on other Constructors.
- Very few research papers on the topic.
- Specific information on certain Constructors unavailable.

Chapter 2: Literature Review

The Most Successful F1 Teams

By: Joe Holding, April 22, 2022 (Autosport)

The first Formula 1 world championship took place in 1950, but it wasn't until 1958 that a constructors' title was contested.

Back then, the constructors' championship was known as the International Cup for F1 Manufacturers, and it's adopted a number of names in the years since.

The rules have evolved a great deal too: until 1980 only the best-placed car would contribute points to the constructors' standings, with various rules about counting a team's best results over the course of a season.

1. Ferrari - 16 Constructors' titles, 15 Driver titles

Ferrari is by far the most successful F1 team in history, becoming the first to celebrate its 1,000th race at the Tuscan Grand Prix in 2020. It won its first constructors' title in 1961 with Phil Hill, Richie Ginther and Wolfgang von Trips leading its line-up, although the German driver was killed at the penultimate race having led the drivers' standings going into the Italian Grand Prix at Monza. Controversially the race wasn't stopped after the accident, allowing Hill to take the chequered flag and the title by a single point.

2. Williams - 9 Constructors' titles, 7 Driver titles

Williams only entered F1 as a fully-fledged constructor for the first time in 1978, but with owner Frank Williams at the helm and designer Patrick Head developing the car, the team claimed its first constructors' and drivers' titles in only its third full season. Alan Jones and Carlos Reutemann formed the driver line-up that year, with a second title following in 1981. Ford powered Keke Rosberg to a drivers' title with the team in 1982, but it wouldn't win the constructors' championship again until its 1986 and 1987 double with a Honda engine.

3. McLaren - 8 Constructors' titles, 12 Driver titles

McLaren was founded by New Zealander Bruce McLaren in 1963, with the team making its first F1 appearance at the Monaco Grand Prix in 1966. The team's founding driver secured its first championship victory at the Belgian Grand Prix two years later, although its first titles didn't arrive until 1974. McLaren fielded three cars that year, although it was eventual world champion Emerson Fittipaldi who proved to be the most consistent behind the wheel of the team's M23 chassis.

4. Mercedes - 8 Constructors' titles, 9 Driver titles

Mercedes returned to grand prix racing in 2010 having agreed to buy the Brawn outfit that sensationally won both F1 world titles in the previous season. It tempted Michael Schumacher out of his four-year retirement, fielding an all-German driver line-up with Nico Rosberg signed from Williams. Schumacher was replaced by Lewis Hamilton in 2013, and the team's unprecedented run began a year later as new rules ushered in the V6 turbo hybrid era.

As of the start of 2021, Mercedes' seven consecutive constructors' and drivers' titles was a record, surpassing the six constructors' and five drivers' crowns that Ferrari won uninterrupted between 1999 and 2004. In that time Hamilton became world champion six times, losing out only once to team-mate Rosberg. The German driver dramatically quit F1 just days after winning the title: he was replaced by Valtteri Bottas, who has contributed to Mercedes' four constructors' victories since. They went on to take the 2021 constructors' title, but famously lost out on the driver title on the last lap of the 2021 season.

5. Lotus - 7 Constructors' titles, 6 Driver titles

Lotus is a name synonymous with F1, as it is the innovative engineering of founder Colin Chapman. Lotus's first entry came at the Monaco Grand Prix in 1958, and its first constructors' title came along five years later. That year it won all but three of the 10 championship races with Jim Clark, propelling the Scot to the first of his two drivers' crowns with the outfit.

6. Red Bull - 4 Constructors' titles, 5 Driver titles

Red Bull entered F1 for the first time in 2005, having taken over the Milton Keynes operation left behind by Jaguar. Crucially it secured the services of star designer Adrian Newey - who'd played a key role in Williams' success in the 1990s and that of McLaren in 1998 - in 2006, and the team hasn't looked back since.

Most successful team by championships

Position	Team	Constructors' Championships	Driver Championships
1	Ferrari	16	15
2	Williams	9	7
3	McLaren	8	12
4	Mercedes	7	9
5	Lotus	7	6
6	Red Bull	4	4
7	Cooper	2	2
8	Brabham	2	4
9	Renault	2	2
10	Vanwall, BRM, Matra, Tyrrell, Benetton, Brawn	1	2 (Tyrrell, Benetton), 1 (BRM, Matra, Brawn)

Most successful team by total race wins

Position	Team	Total Race Wins
1	Ferrari	238
2	McLaren	183
3	Mercedes	121
4	Williams	114
5	Team Lotus	79
6	Red Bull	74
7	Brabham, Renault	35
9	Benetton	27
10	Tyrrell	23

This article very clearly explains the level of success each Constructor in Formula 1 has had over the years and which Constructor is the most successful. Ferrari are undoubtedly the most successful Constructor in Formula 1. They are one of the very few constructors who have been the from the start of Formula 1, that is, from 1950 and are currently part of the grid. They are a very historic team and their emergence in Formula 1 is nothing short of brilliance. They are well ahead of any other Constructor in terms of the number of Constructors and Drivers Championships won.

Williams is another very legendary team to compete in Formula 1 in the initial years and even currently. Williams may not be as successful as they were in the past, but their rich history and success shows their capability to bounce back. They have won 9 Constructors' championships,which is the 2nd most by any team in Formula 1 history.

McLaren and Mercedes are the other two most successful Constructors in Formula 1 with the latter winning 8 Constructors Championships in a row in the current generation of Formula 1.

Chapter 3: Comparison of the Teams' Performance Over the Years

1. Red Bull Racing

Drivers: Max Verstappen and Alex Albon (As data is from 2020 and before)

Red Bull Racing came into existence late in 2004 with ambitions to challenge for race victories and world championship titles. Christian Horner was appointed team principal soon after and has guided the development of the team ever since.

This was not the work of a moment. Over the next four seasons, solid foundations were laid. The team recruited in both quantity and quality, steadily expanding until it could gotoe-to-toe with the most illustrious names in racing.

As you can see from the graph below, which charts Mercedes and Red Bull's 2019 and 2020 qualifying times, Red Bull's performance was significantly worse in 2020 than last year, with the majority of time appearing to be lost on the run out of Turn 1, where the handlingimbalance in the RB16 prevented Verstappen from getting on the power.

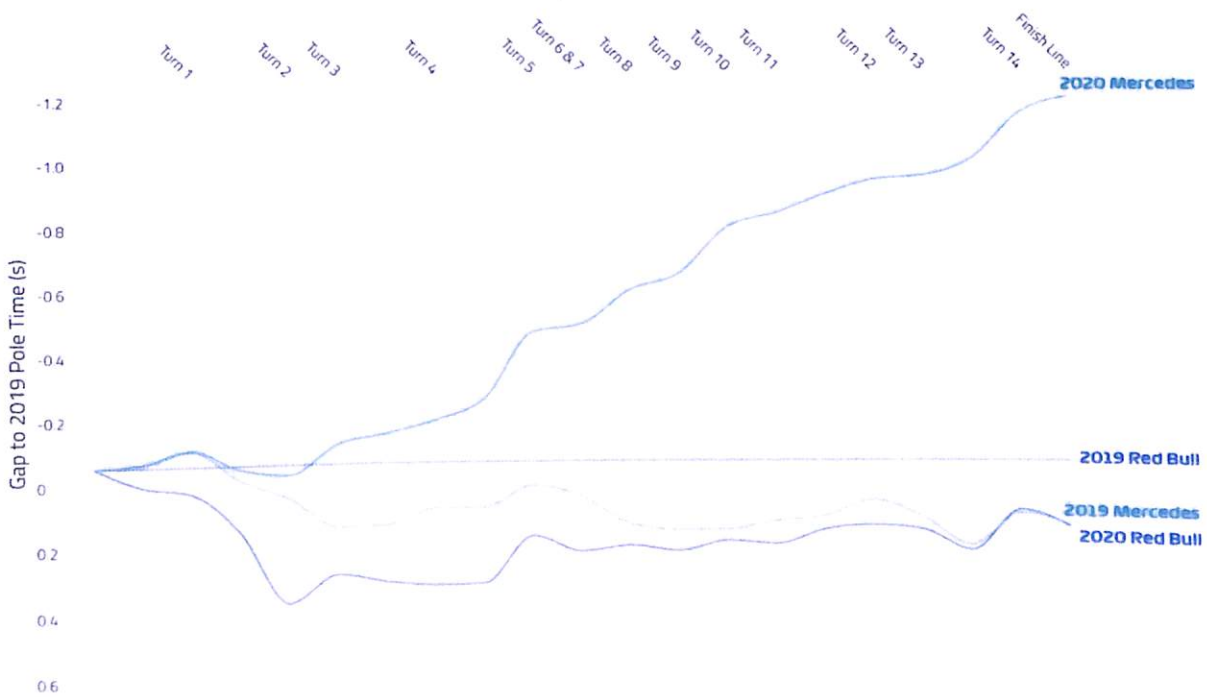


Figure 1 Comparison of Red Bull's lap times in the Formula 1 Qualifying Session

The problem is then compounded when you look at how Mercedes have made gains from last year, with the W11 finding 1.3s from 2019. Gains have been found mainly in the high-speed Turn 4 and the medium-speed middle sector of the circuit between Turn 8 and Turn 11. Ironically, Hamilton's 2019 third place in qualifying was 0.1s faster than Verstappen's 2020 effort.

Both Verstappen and Albon spoke of the car having a poor balance, with the Dutchman suggesting it was also unpredictable. "You push it [the car] to the limit but when you get to that limit it becomes a bit tricky and easy to lose the rear or you understeer wide," he explained.

Ahead of the first race in Austria, Red Bull added a lot of upgrades to their RB16, with Christian Horner explaining that "all the updates that were in the pipeline prior to the shutdown, plus whatever we have learned after the shutdown, have been implemented to the car so there are subtle revisions all over the car.

It is not clear if adding so many at once has complicated the team's aero understanding, but in a normal season, Red Bull would likely have drip-fed these upgrades onto the car over a longer period.

What is certainly clear from the data is that Verstappen is having to make more steering inputs than he did last year to deal with the car's less stable platform.

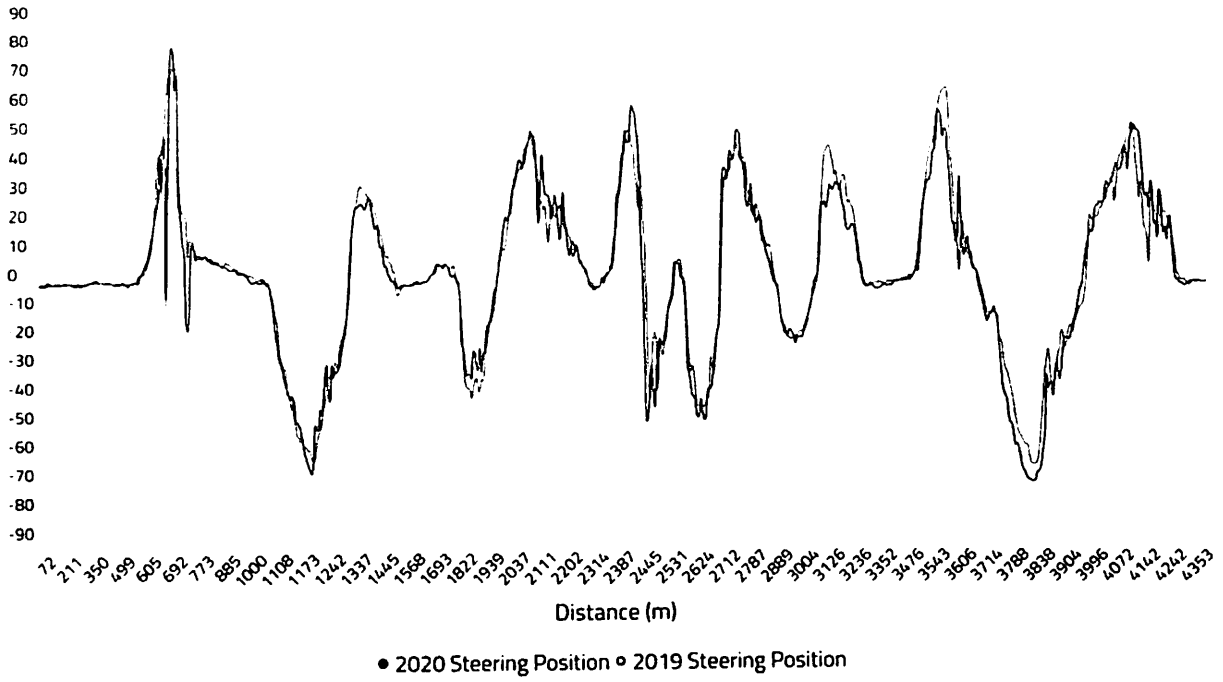


Figure 2 Max Verstappen's Steering Inputs Compared between 2019 and 2020

The graph above shows Max's steering inputs across the same laps of the Hungarian featured in the lap time graph. The red line represents his 2019 inputs, the black ones his 2020 ones.

As you can see, in 2019 there is one definitive input into Turn 1. In contrast, the 2020 trace has a lot more variation as Verstappen struggles to find grip from his front Tires. The peak steering angle in 2020 is also greater than in 2019. The rest of the lap shows signs of this trait,in the medium-speed Turn 2 and low-speed Turn 12.

RB 18, 2022 Car:

High nose:

In a crop of cars which display a big range of philosophies on nose and front wing height, Red Bull have opted for a high nose with a big clearance under the center section of the wing to maximize the volume of airflow to the underfloor.

The underside of the nose tip can be between 125mm (about 4.92 in) and 250mm (about 9.84 in) above the ground, and we have seen both high and low. The low nose and the wing elements attached to it will tend to generate greater direct downforce from the wing itself. Operating closer to the ground, there should be a bigger difference in air pressure between the underside and upper surface of the wing.

But the lower wing also forms a blockage to the flow being fed to the floor and the inlets for the crucial venturi tunnels which create the car's underbody downforce. Because there are dimensional allowances for where the front axle is in relation to the nose tip, there are significant variations between cars in the distance between the axle and the sidepods which contain those inlets.



Figure 3 RB 18 depiction of high nose

As such, the optimum nose/front wing height needs to be considered as a three-dimensional challenge. Part of that includes how the front suspension is packaged – and Red Bull have joined the McLaren club in switching to a pull-rod front, with the inboard rockers down low.

At the rear, Red Bull – like McLaren and Alfa Romeo – have switched to a push-rod layout. Given that AlphaTauri are taking the full Red Bull rear end, it means that the AT03 is also push-rod at the rear (even though the launch renders suggested pull-rod).

Unique Radiator Inlet:

Although the rectangular radiator inlets themselves are like those seen on the Mercedes and Aston Martin, the bodywork around them is quite different, with a long 'tray' extension separating the air heading for the inlet for cooling purposes from that feeding around the sidepod undercut underneath, which has important aerodynamic work to do.

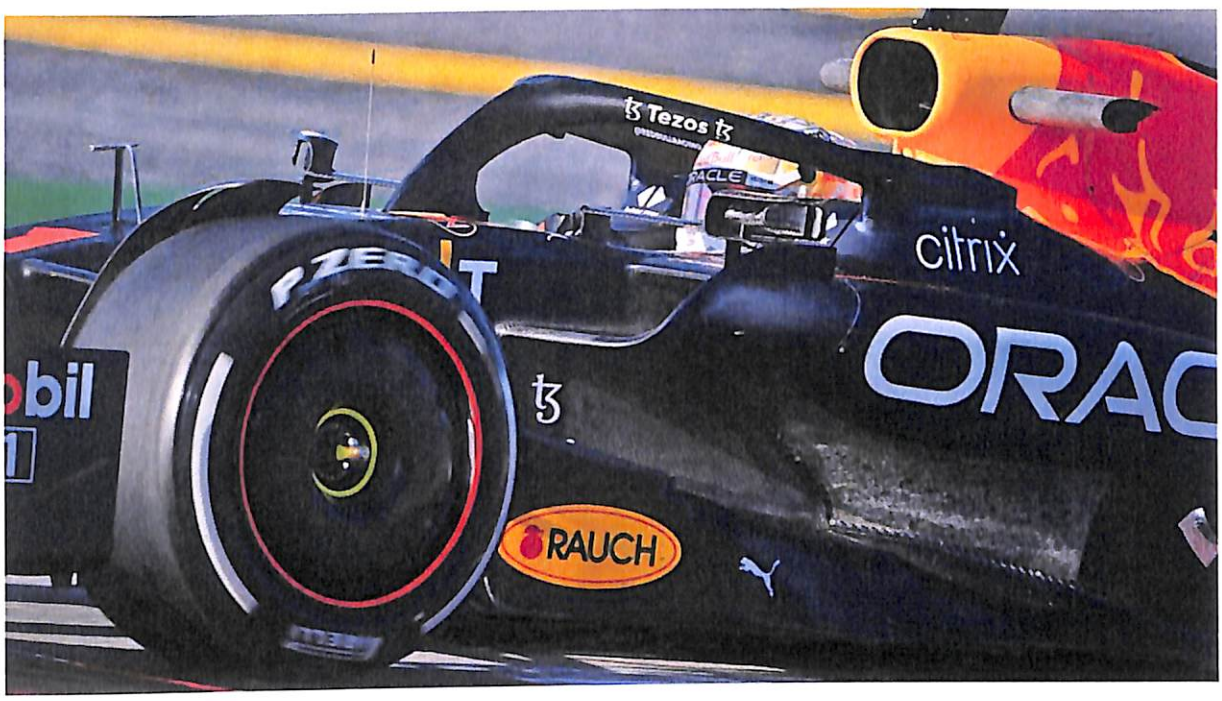


Figure 4 Radiator Inlet

Above that undercut is a relatively flat-topped sidepod which then ramps down at the rear to accelerate the airflow between the rear tires. There is a similarity with how the AlphaTauri's sidepods are shaped in profile and with how the cooling channels must break away internally from the external shaping to exit around the exhaust outlet at the back.

Just behind that outlet is a very interesting take on the beam wing, which is much more aggressively shaped than on other cars in how it effectively extends the diffuser. The aerofoil profile of that wing – and therefore the strength with which it will pull on the diffuser – is limited by the two-element stipulation.

But Red Bull has arranged the elements in such a way that the lower one is shaped almost as a single, aggressively shaped aerofoil.

Change in sidepod design:

The most visually obvious change is a significantly reshaped sidepod. The contouring around the radiator inlet is tighter, to give a bigger undercut there (as can be seen from how the 'E' of Oracle on the right-hand side now sweeps partly beneath the lateral plane).



Figure 5 Sidepod design

This will further enhance how hard the air is being accelerated along the body sides, and thereby the energy that flow will retain as it exists at the rear between the rear wheel and over the venturi tunnel exit. This draws the underfloor air through those venturis yet harder.

Although we have not yet seen the detail at the leading edge of the floor of the updated car,we can assume that the treatment of the vanes will be slightly different to better meet the new contouring behind.

Helping further energies flow through the venturis is a new outer floor, with a very distinctive and accentuated vortex generator.

This will trip the air making its way along the upper floor into a vortex of spinning air, which will curl its way into the underfloor and speed up the flow there, by pulling the air ahead of it through faster. The faster the air flows through those tunnels, the more downforce is created.

2. Scuderia Ferrari

Drivers: Charles Leclerc and Carlos Sainz

Ferrari's best-of-the-rest performance in the Spanish Grand Prix marked the first time in the 2021 Formula 1 season it converted its midfield-leading pace into the same result on race day.

Fourth place for Charles Leclerc and seventh for Carlos Sainz Jr also meant Ferrari finally outscored McLaren in 2021 and trimmed the gap to third place in the constructors' championship to just five points.

McLaren finished third behind Mercedes and Red Bull last year, and it has occupied the same position in the standings since the first race in 2021, scored a podium in the second round at Imola, and been widely praised for how its season has started.

But McLaren has been slower than Ferrari in every qualifying session so far and finally succumbed to the Maranello team in a race at Barcelona. However, the early trend suggests that it's Ferrari that has F1's third-fastest car, and on the evidence of Spain there is reason to believe it can avoid last year's pattern of a Leclerc qualifying special giving way to a slump in the race as an out-of-position Ferrari slips back to where it should be.

A core component of Ferrari's race performance in Spain, where Leclerc even ran ahead of Valtteri Bottas's Mercedes in the opening stint, was strong tire management.

That was an area that had compromised both drivers in the season opener in Bahrain and where Sainz suffered badly in Portugal.

"Bahrain was very specific because of the overheating of the rears," said team boss Mattia Binotto after the race at Barcelona.

"And at Portimão Ferrari made some mistakes with tire management. But [in Spain] Ferrari were focused on that aspect and managed it well.

"It's good to see that in the race, Ferrari had the pace they may have in qualifying.

"Obviously when you are struggling such as in Portimão there is always a lesson learned, it can be car set-up, car balance, the way you manage the tires on track.

"So, Ferrari made the analysis of all the data they had, discussed it then with the drivers, sharing with them the solution or what may be the actions.

Binotto felt it's not the first time Ferrari's had strong race pace, believing it was also the case at Imola – where Leclerc also felt the team was "very strong" as he finished fourth.

He felt that he had not done a good enough job himself managing the tires in Bahrain and says the car is stronger on one-lap pace and race pace then in 2020.

"I don't think there's a big weakness like there was maybe a bit more last year on the race pace," said Leclerc.

Ferrari qualified ahead of both McLarens in Spain, but Sainz lost out to Daniel Ricciardo on the opening lap and spent the final part of the grand prix hounding his replacement at the team.

But he felt there was a clear improvement in Tire management after his unhappy stint on mediums in Portugal, believing that Ferrari was able to maintain a "step better" pace than its midfield rivals in Spain.

"Obviously Ferrari want to understand exactly why, and they will analyze this week to see why today the car was so strong," said Sainz at the end of the race.

McLaren's Lando Norris reckoned the pace advantage Ferrari had in Spain played a part in its improved tire management, too.

"They were just that much quicker in the race that they could look after the tires more than usual," said Norris.

"I think at tracks where they are a bit slower, they must push more, they use the tiresmore and so on.

"It was not a surprise. They are not always terrible in the races. Sometimes they can be very competitive throughout the whole race.

"They're not always dropping off our tail, they've been quick all season, and they put it together and did a good job."

While Ferrari also felt Barcelona was not the first time it showed strong race pace, the key difference was it was enough to trump McLaren – which was quicker in the dry at Imola, where it benefited from the red flag period that had cancelled out the gap Leclerc built up in the first half of the race.

Spain was made slightly more difficult in judging the respective performance of the two teams given McLaren's form driver, Norris, started behind Ricciardo after a compromised qualifying.

Though Ricciardo put in his best performance of the season, he is still getting used to his new surroundings and admits he is not producing the cleanest races.

Sainz had to pass Norris on track but was aided by fresher tires on a different strategy.

But he felt Ferrari had a fundamental advantage over McLaren in Spain even though he could not utilize it when he came across Ricciardo.

Sainz had a 15-20 lap tire delta to Norris which made the overtaking a lot easier than what it was to Ricciardo because we had the same tires, same age of tire.

"Compared to the McLaren, Ferrari were at least two or three tenths faster per lap. But with the dirty air of these cars, you need to be more than a second [faster] than the car in front to be even able to do a move on someone.

So those three or four tenths advantage that Sainz had on pace to Ricciardo was not enough to go side by side with him into Turn 1.

"It is something Ferrari are trying to also improve, the top speed, and hopefully we can be better at it later in the year."

McLaren conceded after the race that it was simply not at Ferrari's level at Barcelona.

"It wasn't a surprise, they've had a good car all year and we knew about their strength on a track like this with this layout," admitted McLaren team principal Andreas Seidl.

Binotto believes Ferrari has a performance edge in slow-speed corners, even if it is not a significant advantage, and that was shown by the two teams' pace in the final sector at Barcelona.

Norris and Ricciardo have both reported the McLaren is slightly nervous at the rear, which Norris said is exaggerated at certain tracks and conditions.

"The times we've suffered more with the rear end of the car, like Portugal and Spain, it's when Ferrari are a lot more competitive and we are not as competitive," Norris said.

"But when the car is not struggling with the rear then we are much stronger. Places like Imola for example.

F1 75 – 2022 Car:

The Ferrari designers have opted for a sidepod arrangement which ramps gently down in its lower regions, but which has an upward ramp where the sidepods merge into the engine cover and with a scalloped-out section in that transition. Like the Aston Martin, it has cooling slats on the sidepod top surface.

The upward profile of the upper bodywork above the sidepod strongly suggests that the radiators have been laid out almost horizontally, with the cooling tunnels sweeping upwards past the engine cam covers rather in the way of last year's Williams.

This has given a sidepod shape which is heavily undercut at the very front beneath the small slat-like radiator inlet, but which quickly merges with a flat, slab side before then heavily undercutting once more as it merges into the coke bottle section at the rear.

Because the new regulations have taken a lot of forward sidepod area up with the floor venturi tunnels and the wheelbases have been shortened to a maximum of 3600mm (shorter than last year's shortest car), it has led to a re-assessment of what the optimum aerodynamic solution is for the cooling architecture and therefore the sidepod and engine cover shapes. Hence the great variation between teams.

Aero challenges:

The big aerodynamic challenge in this area of the car remains how to maximize the speed of the airflow into the floor (now via the tunnel inlets) and down the sides and what the most efficient trade-off is between those separate flows.

The effectiveness of the venturi tunnel shape in lowering the air pressure of the underside (and therefore increasing the downforce) will determine how strongly the airflow is pulled into those venturi inlets. The sizing and shape of those inlets is therefore crucial. The cooling arrangement must be configured around that aerodynamic requirement.

Whereas McLaren have opted for a very bluff sidepod shape when viewed from head-on, creating a high-pressure area there which will help give a more powerful outwash away from the floor, Ferrari have used only the top leading edge to do that and instead hollowed out a big undercut area beneath. These are just different ways of making that trade-off.

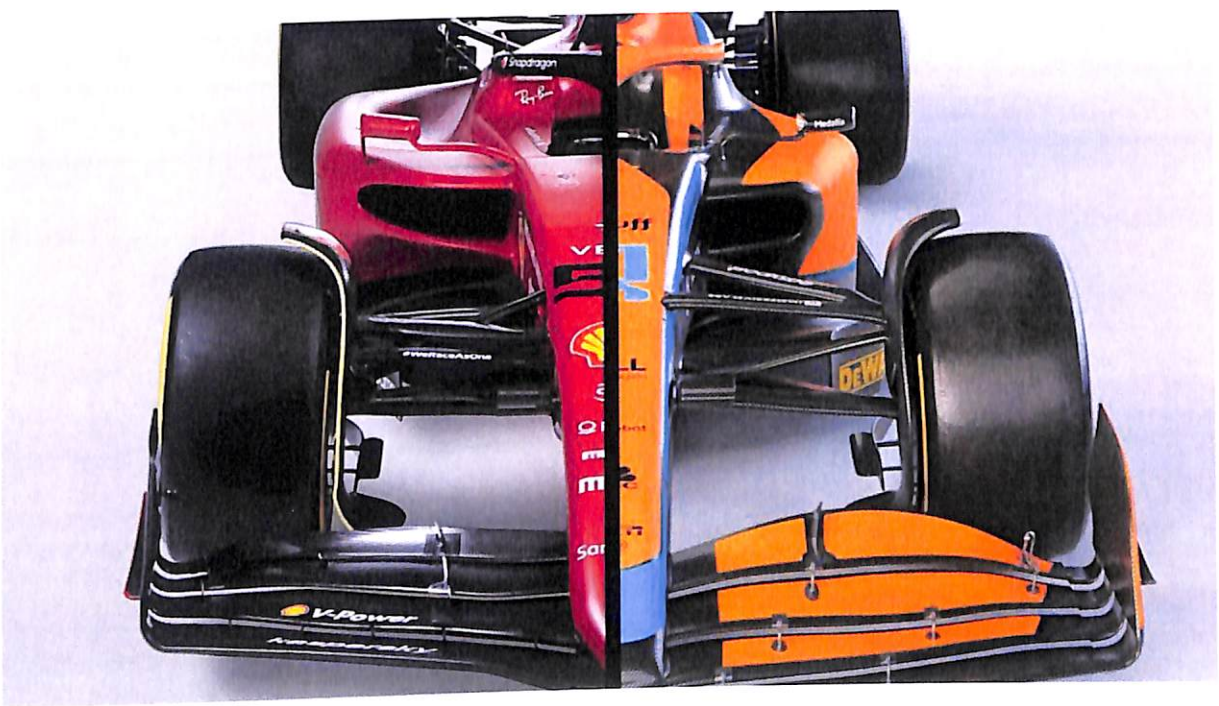


Figure 6 A front-on comparison of the 2022 Ferrari (L) and 2022 McLaren (R)

Just ahead of those undercuts, Ferrari appear to have made the same 'double tea tray' ruse as Aston Martin, initiating the airflow into splitting into separate flows with one feeding to the venturi inlets, the other around the bodywork sides. Underneath that distinctive engine cover is an all-new power unit on which much of Ferrari's hopes rest.

Team boss Mattia Binotto confirmed this has given a useful performance boost over the previous unit and is combined with the new energy recovery system that was introduced in the latter part of last season.

The architecture of the engine is quite different, though it is believed to retain the combined turbine/compressor turbo which, now that Alpine have switched to the split layout, makes the Ferrari unique in that respect.

Up front, the wing elements are clearly not the real ones as they have no aerofoil profile, but the nose shape can be seen to have a pronounced hollowed out section beneath which will reduce the air pressure and thereby enhance downforce. The front suspension remains pushrod and the rear pull rod.

3. McLaren Racing
Drivers: Lando Norris and Daniel Ricciardo

McLaren's "painful and disappointing" form in the Bahrain Grand Prix is expected to continue as the team confronts the reality it is "a long way off" at the start of the 2022 Formula 1 season.

After topping the first day of testing at Barcelona, where it had an encouraging start to pre-season, McLaren's new car has proven to be more troublesome than expected.

It suffered front brake cooling problems that badly limited its mileage in the second test in Bahrain and, at the same track last weekend, the team had a clear lack of performance in the season opener.

Daniel Ricciardo and Lando Norris each ran in last place during the race and eventually finished 14th and 15th, giving McLaren a point-less start.

Team boss Andreas Seidl said "we know we have an issue on the performance side, which is disappointing and painful" and Norris – who signed a new long-term deal with McLaren prior to the start of the season – said that will be the case in the short-term.

The MCL36 was said to be working as expected aerodynamically and mechanically in Bahrain but simply lacking grip.

Norris said the car is "a long way down on downforce" and that he expected McLaren's race "looked as bad as what it felt" inside the car.

It marks a major step back from where McLaren has been in the last couple of seasons, occasionally scoring podiums and re-establishing itself as the best team in F1's midfield.

Conventional Bodywork:

Unlike the Aston, the McLaren's sidepods have little apparent undercut but do taper in very extensively at the rear to give quite an extreme coke bottle section.

This creates a lot of volume for the airflow to expand into, accelerating the flow all the way down the sides, as it rushes to fill the low-pressure area created by the expanded space. The outer floor surfaces of the launch car were plainly not what will be raced, featuring none of the flicks and line changes which will be seen on the real ones, and which help accelerate the flow further.

There has been no Aston-like attempt at a double floor in this region, and hence no need to have inclined the radiators so horizontally – and this has allowed the sidepods their greater coke bottle section.

In plan view, the McLaren's teardrop-shape (fat at the front around the radiators, slimming down considerably at the rear) is much more Haas-like, but without quite the same width at the front and with a fatter section engine cover aft of the roll hoop running quite far back.

This suggests that some of the cooling channels have been moved into that area, which will have allowed the front of the sidepods to be not quite as wide as those of the Haas.

Suspension Rethink:

Where the McLaren is very different to either the Haas or Aston Martin is in its suspension layout – both front and rear.

In place of the conventional push-rod front/pull-rod rear is the opposite! McLaren have opted for a pull-rod front (last used at McLaren in 2013). This places the inboard rockers down low to give the aerodynamicists their preferred airflow route to the venturi tunnel inlets at the mouth of the sidepods. These venturi tunnels create as much as 50% of an F1

car's total downforce under the new regulations, a much greater proportion than the floor generated previously.

McLaren have shaped their front wing in sympathy with the suspension layout, and it is notable that the flap adjusters are a long way across the width of the wing. They will create vortices of air which will be directed in a way which enhances the flow of air from the wing to those venturi inlets, crucially important, especially with no barge boards there to help.

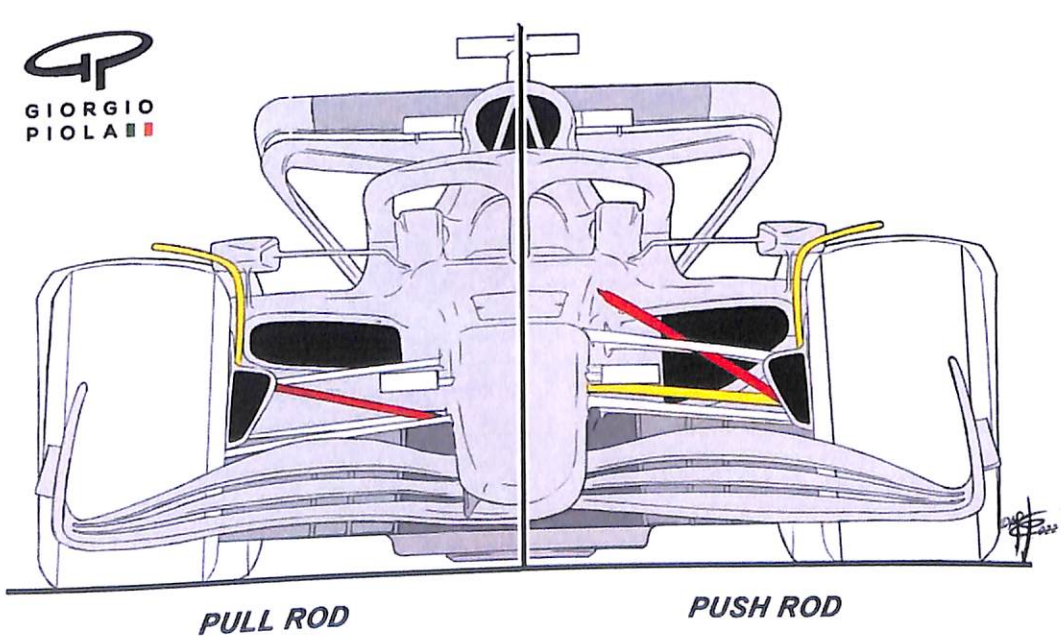


Figure 7 MCL 36's Pull rod vs Push rod suspension

At the rear, McLaren have dispensed with the conventional pull-rod arrangement for push-rod. Under the previous regulations, the placement of the diffuser made it advantageous to place the rockers down low to maximize the airflow through the floor.

But the placement of the new venturi exits is quite different and has triggered McLaren into a reassessment, with the rockers now moved up out of the way – for the exact same reason as they were lowered under the old regs!

4. Aston Martin Racing

Drivers: Sebastian Vettel and Lance Stroll

The AMR22's front wing has four elements, which is the maximum possible under the new regulations.

However, that's where the comparisons really end because the second element is much taller and almost artificially widens the nose tip where the two meet.

The uppermost flaps are a little squarer than the sinuous version that FOM's (Formula One Group) show car concept and Haas have presented. It appears both will be adjustable, with the adjuster mounted inboard, alongside the nose.

The nose itself is also much squarer than the rule makers envisaged. There is a defined surface on the bridge of the nose and its sides, rather than the domed shape we've become accustomed to from the FOM renders and show car.

Meanwhile, from the side view, you can see the effort that's been made to make the nose as slender as possible, as it gradually tapers to meet with the chassis.



Figure 8 Front nose of the AMR22 (Aston Martin Racing 22)

The most visually striking feature of the car is the sidepods, with a very small box-shaped inlet with bodywork that flares out to fill out some of the reference volume that is permissible in thisarea.

It means that the bodywork isn't as wide as we've seen in the Haas renders. But, unlike on the VF-22, the remainder of the bodywork remains high waisted to the rear of the car, rather than falling away abruptly as we have seen teams do over the past few seasons to follow the shape of the radiators and intercoolers within.

This is where the AMR22 holds some commonality with the FOM renders and show cars. But there is a much more aggressive approach, as the sheer size of the sidepod undercut shows.

On the top surface of the sidepod, we can also see that Aston Martin has taken the opportunity to run with cooling gills along the car's flank, which means that, at the rear of the car, the bodywork can taper into an extreme.



Figure 9 Sidepods

This not only results in an extremely narrow section in the coke bottle region, but it also means wehave the familiar engine cover bulges that were present on the car's predecessor, with the powerunit's inlet plenums shrink-wrapped to the max.

Aston Martin is also the first to show a version of the 2022 car with DRS (Drag Reduction System). Not only is the actuator on display, but also the shut lines and pivot points for the flap can be seen, which are inboard of the volute-shaped endplates.

The wing itself has some interesting geometrical design features too, whilst there also appears to be a slot in the rear quarter of the endplate, parallel with the taillights that must still be embedded in the trailing edge of the endplate.

The AMR22's rear wing also features a double element beam wing, rather than the single element we saw in the Haas renders.

The stark difference between the new Aston and the Haas (if we accept that the Haas images were formed from the real car) suggests that there is going to be a refreshing diversity of design in the field this year. This contrasts with what had been widely expected from regulationswhich are more prescriptive than before.

Wide top/narrow bottom:

There is clearly a divergence of thought in how best to optimize the regulations at this early stage of their implementation, particularly around sidepod length, and Aston have clearly favored a longer upper bodywork than the teardrop-shaped Haas.

Looked from above, the contrast between the two cars is especially stark, with the Aston's bodywork retaining its width all the way back. However, what this view does not show is just how extreme the undercut is in the Aston Martin's sidepod.

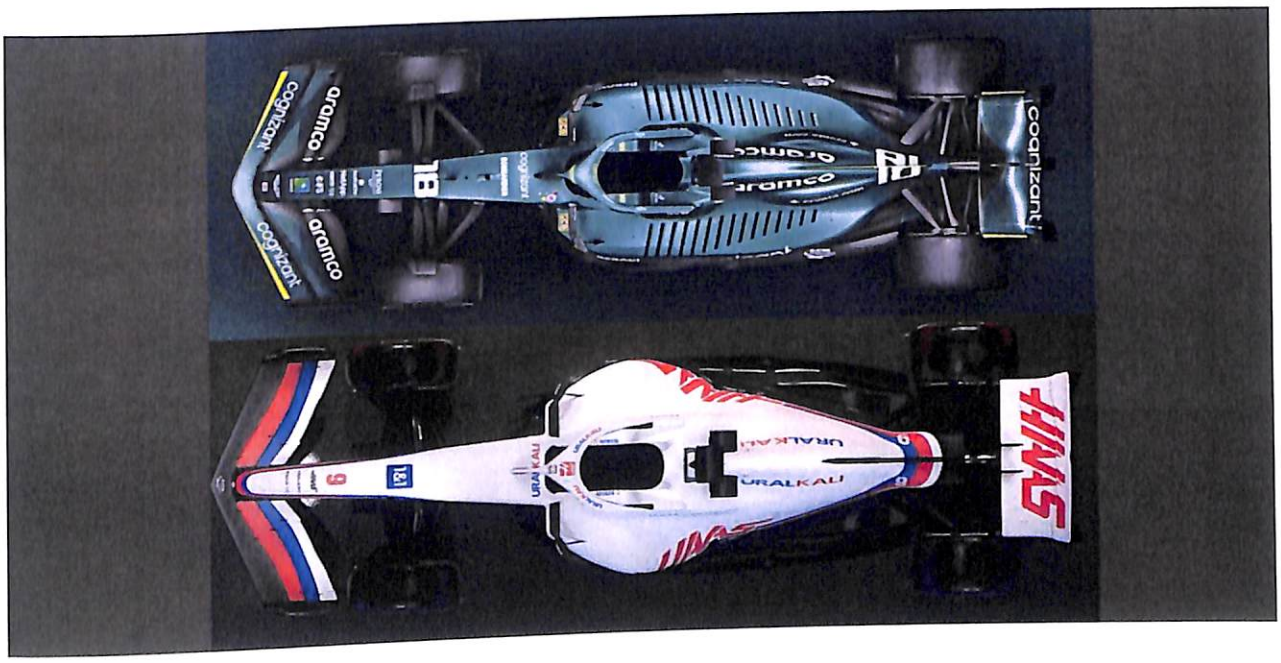


Figure 10 Comparing the Haas and Aston Martin car

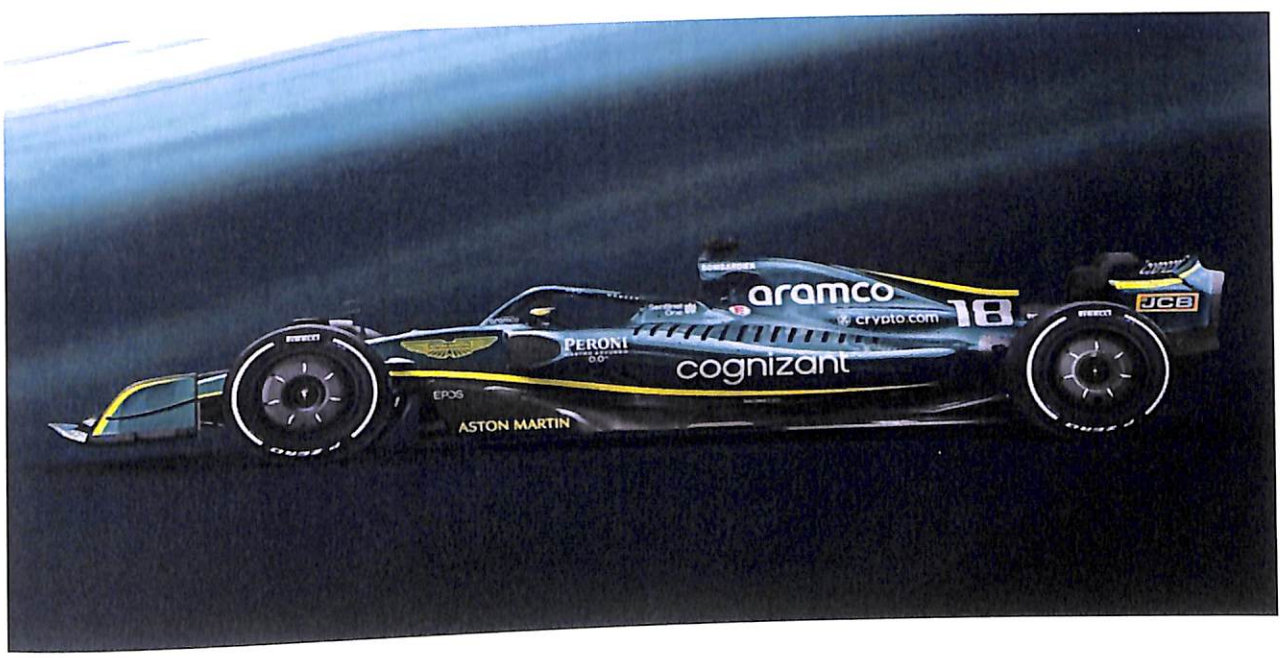
As can be seen from the profile perspective of the car, that scalloped-out section of the sidepods means that the lower bodywork is vastly slimmer than the upper.

The extensive louvres along the top of the Aston's bodywork also suggest that the radiators in each sidepod are laid out horizontally just below. Which suggests that the whole cooling system has been lifted higher than in the Haas to create the extreme undercut below.

Double Floor:

It effectively creates a 'double floor', such as was featured on the 2011 Toro Rosso and the 1992 Ferrari. So aside from the floor itself, there is a big, exposed channel of upper floor along the length of the sidepods to the back where it converges over the tunnel exits. The leading edge of the floor even has two stacked throats, the lower one directing the air to the venturi tunnel inlets and the upper one for the channel down the side.

Figure 11 Double Floor



The 'double floor' idea is about trying to optimize the relationship between the airflow which flows beneath the car and that which travels down the sides, two airflows which meet at the exits of the venturi channels which generate the car's ground effect downforce.

In the underbody, as the venturi tunnel ramps up at the rear, the expanding space creates a lower air pressure, which the air in the more constricted part of the tunnel further forward rushes to fill. The faster the airflow, the more downforce is created. The underbody ramp effectively increases the speed of the underfloor flow and therefore the downforce.

The air coming over the top of the tunnel's ramp – which has travelled in the channels down the side of the car formed by the undercut sidepods – meets with the air exiting from the underfloor and draws upon it. The faster that air can be induced to travel down the channels, the more it will draw on the exit ramp, thereby further increasing downforce. There's only so much airflow capacity to play with, so there is an optimum balance between how much goes to the underfloor and how much down the channels.

Typically, the double floor concept creates a lot of downforces at high speed but the optimum balance between the two key flows can be trickier to achieve at low speeds. It also brings

with it the penalty of an increase in the center of gravity height because of the lifting up of the cooling system to create the channels.

In contrast to the Haas, which appears to have most of its cooling apparatus squeezed into the front of the sidepods, the Aston's is spread long and horizontal. Hence the very long and wide upper bodywork. This has implications in how far forward the power unit is sited within the wheelbase.

The Haas layout would allow a more forward placement of the engine and the length of the venturi tunnels can then be maximized by a long gearbox casing. That of the Aston implies a more rearwards-placed engine – as also implied by how far back the plenum blister in the engine cover is – and a shorter gearbox.

In most other respects, the Aston is quite conventional, with a push-rod front/pull-rod rear suspension, just as all F1 cars of the last few years have featured. There is a four-element front wing with less extreme cambering than seen on the Haas (though both may well change by the time they appear in testing) and a double element beam wing rather than the single of the Haas.

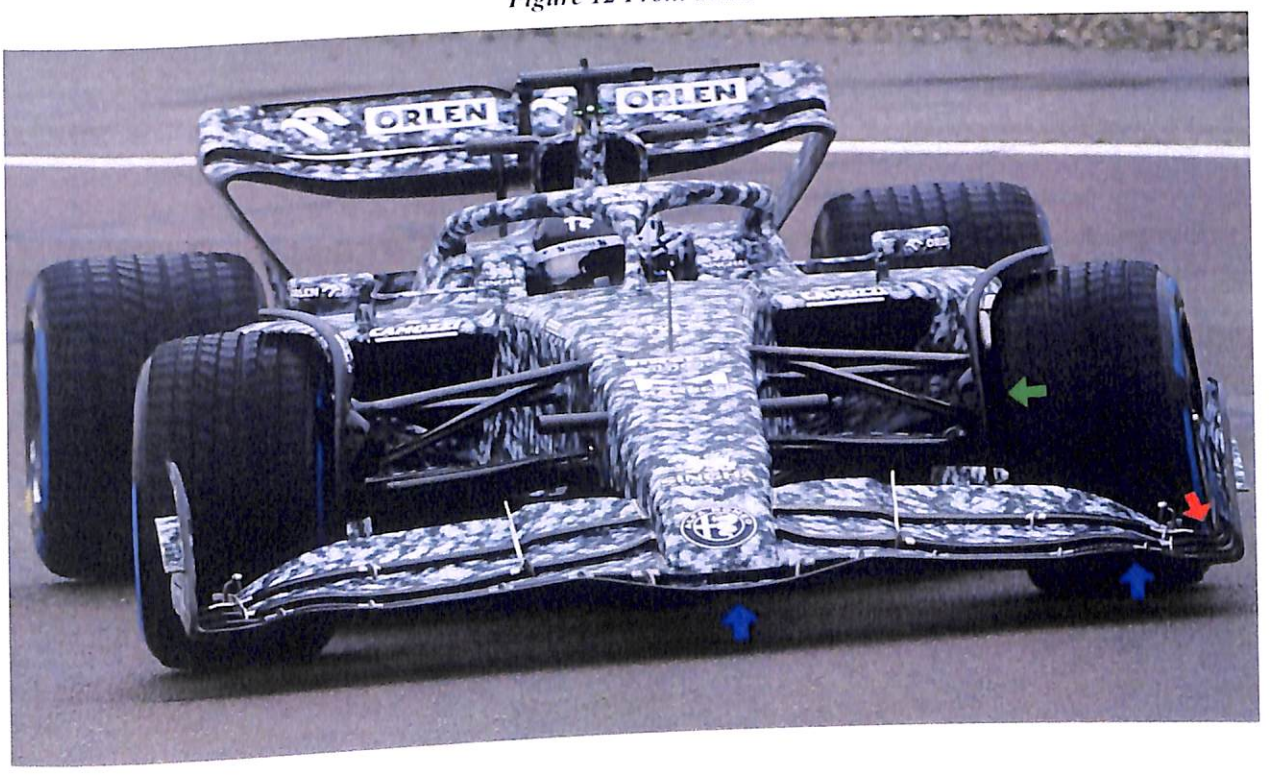
5. Alfa Romeo

Drivers: Valtteri Bottas and Guanyu Zhou

The front wing appears to be more like the final spec that you would expect to see in testing than what we have already seen from other teams.

Alfa has opted for a very unloaded outer section once again, having been the team that ran the most aggressive iteration when the regulations were changed in 2019.

Figure 12 Front detail



The elements have all been flattened out as much as possible in the outermost section (red arrow), with this being made more obvious by the lifted section just inboard of that (blue arrow).

Like the McLaren design, the central portion of the wing is also drooped in order to feed the underside of the wedged-shaped nose, which will in-turn feed the underfloor and sidepods.

The C42 has push-rod front suspension but the suspension layout is of interest with the forward arm of the upper wishbone placed very high up on the chassis. Also note how all of the suspension and steering arms are orientated downwards in an effort to guide the airflow into a desired location.

The front duct fence and wheel wake deflector (green arrow) has also been pushed away from the wheel assembly to help with cooling and better position the wake created for the aero surfaces downstream.

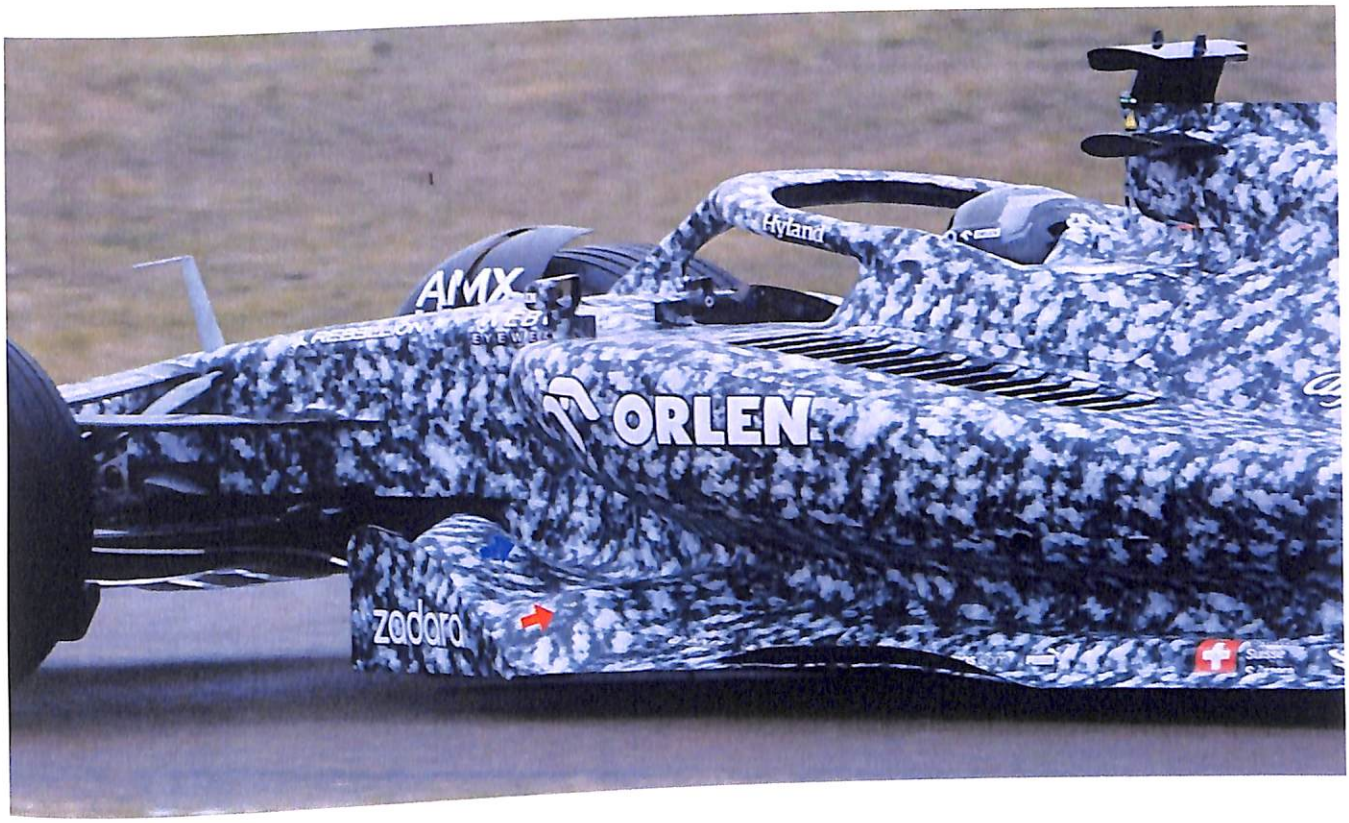


Figure 13 Sidepods and floor detail

The central portion of the car is a bit of an amalgamation of Aston Martin and McLaren, as it features a similar high-waisted sidepod with upper cooling gills and massive undercut like the AMR22 but shares a more intricate floor tunnel layout to the MCL36.

The tunnel has its own inner wall (blue arrow) and allows airflow captured on the car's center-line, beneath the chassis, a route onto the upper floor surface, which should better feed flow around the sidepod's undercut.

This does come with the compromise of not having the maximum height or width possible for the tunnel entrance but perhaps one outweighs the other, especially as two teams have now been seen with the feature.

The floor's surface sweeps back and upwards around what is likely to be the lower side impact support spar (red arrow), given the sidepod itself is raised so far off the floor.



Figure 14 Floor detail

Short wheelbase:

The 2022 regulations stipulate a wheelbase length of between 3460-3600mm. Everyone but Alfa is towards or at the upper end of this, as packaging of the power unit and their cooling systems is very demanding. But Alfa has managed to package everything into a wheelbase of just over 3500mm, making it easier to bring the car down to the regulation minimum weight.

Unusual front wing:

The front wing continues the team's tradition of the elements falling away heavily at the outboard ends to encourage outwash around the tire. It is unusual in how heavily the lower edge of the wing is contoured, making for quite a wavy line with the ground.

These curves reflect how the wing elements across the span of the wing are separated into three quite distinct sections:

1. Around the nose, where the elements are quite full and heavily cambered up to the flap adjusters. The nose and central section of the wing are positioned quite high – not as extreme as on the Aston Martin but higher than most. This is prioritizing airflow to the underfloor. The nose tip sits within a small drop-down extension of the lowest of the four elements, creating a slot there which will condition the airflow to the shaped underside of the nose, accelerating it towards the venturi tunnel inlets. There is a complex contouring of the four elements relative to each other in this inboard section as they manipulate the airflow between them, despite regulations which limit the overlap allowed between each element, and therefore their effectiveness.
2. The central section of the elements, from the flap adjusters to around level with the tire's inner face, are medium-cambered.
3. The outboard flaps which reduce dramatically in profile and are ramped steeply down, carrying very little camber.

A wing creates downforce by the pressure difference induced over its upper and lower surfaces. The aerofoil shape creates a low pressure beneath, which the air rushes to fill, and a high pressure on top. This pressure difference creates the downward force.

As the elements on the Alfa's wing become less aggressively shaped from inboard to outboard, so the downforce they create can be tuned with the shape of the lower edge relative to the ground.

The closer to the ground, the lower the air pressure on the wing's underside will be and the harder the elements will work. As the elements are reducing in how aggressive their upper contours are, so the bottom edge of the wing is closer to the ground, giving a compensating effect.

Extreme anti-dive suspension:

Although the C42's front suspension retains a conventional push-rod operation of the inboard rockers, the geometry is quite extreme. The top wishbone's front leg is mounted high, the rear leg much lower.

This will give a big resistance to dive when the car brakes, thereby keeping the aerodynamic platform of the car more stable. The venturi channels below the 2022 generation of cars dominate almost every aspect of car design, and keeping them fed with air throughout all the different states the car will see in roll, pitch and dive is crucial.

Alfa's Jan Moncheaux-led technical team has opted to prioritize keeping the car as level as possible under braking to retain as much of the ground effect induced by the tunnels as possible.

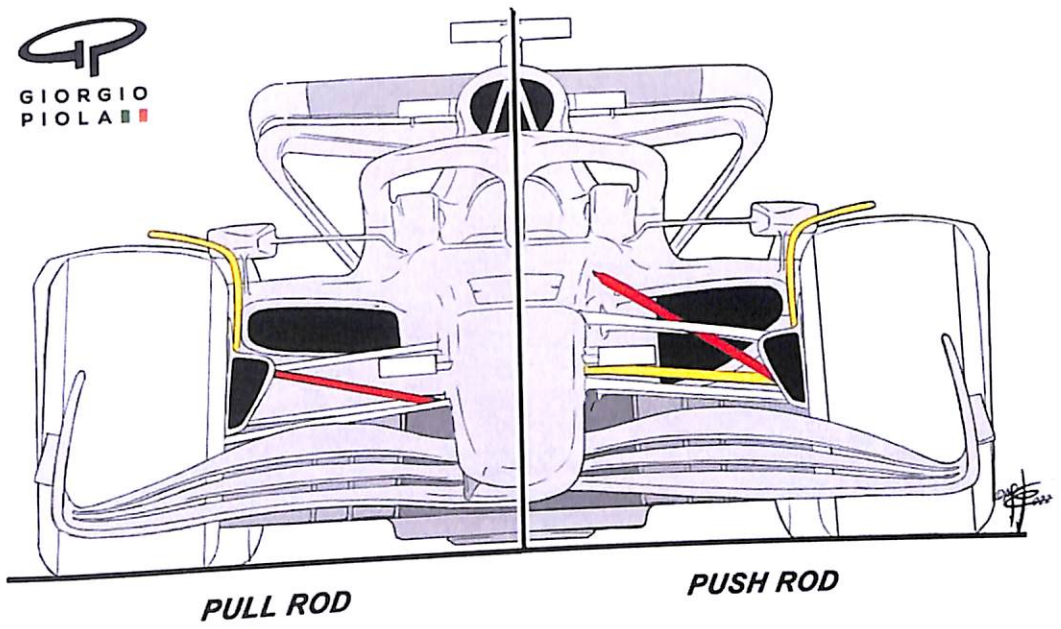


Figure 15 Front suspension

Sidepod:

The radiator arrangement for water, oil and intercooler on the new Ferrari power unit looks much the same as on the Ferrari and Haas, with a relatively small airbox inlet, a concentration of area into the front of the sidepod, giving a wide front but a teardrop shape in plan-view. Because of the shorter wheelbase, that teardrop stays fat at the front for longer.

While the teardrop shape helps accelerate the over body airflow as it travels to the back of the car, it reduces the space available for cooling exits. Hence the facility for a lot of louvred cooling on the upper face of the sidepods – and hence also the big radiator inlets at the front of the pods.

Significant Technical Changes for 2022:

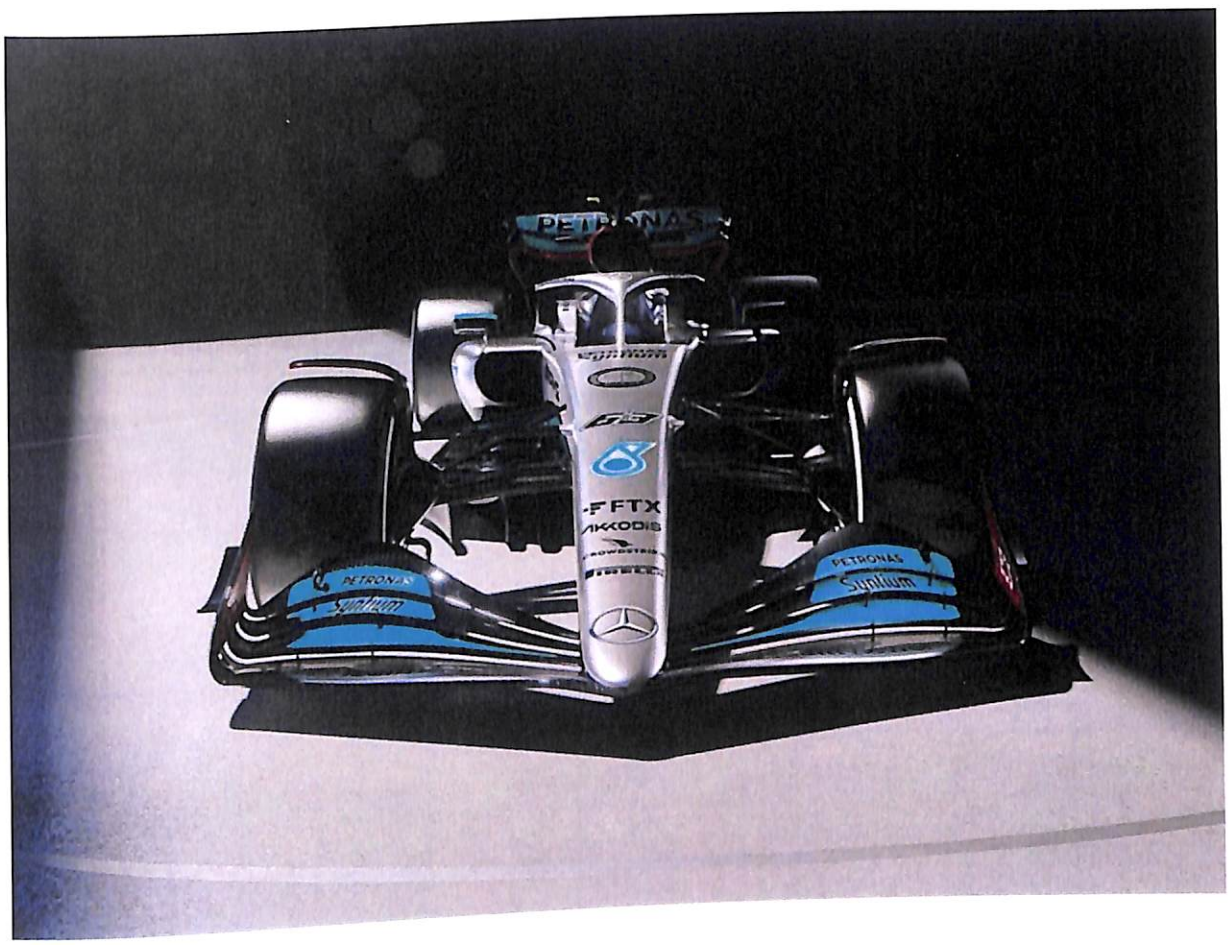


Figure 16 Mercedes W13

The technical regulation changes for 2022, whose introduction was delayed by a year as F1 negotiated the COVID-19 pandemic, represent a fundamental shift in design rules and one of the biggest regulatory changes the sport has ever seen.

"On the chassis side, the changes are huge," said Mike Elliott, the team's Technical Director. There are three aspects to this: first, the way the regulations are constructed is very different, particularly for aerodynamics, and that has a big impact. Second, what they are trying to achieve with the aerodynamics means the cars are fundamentally a different shape. Third, this is the first time we will have attempted such a big change under a cost cap."

The W13 is the product of a complete redesign from top to bottom, with the steering wheel the only carryover element from its predecessor. Operating with a blank slate and such a steep development curve has been a stimulating experience for the engineers at the team's Brackley base and something they have relished.

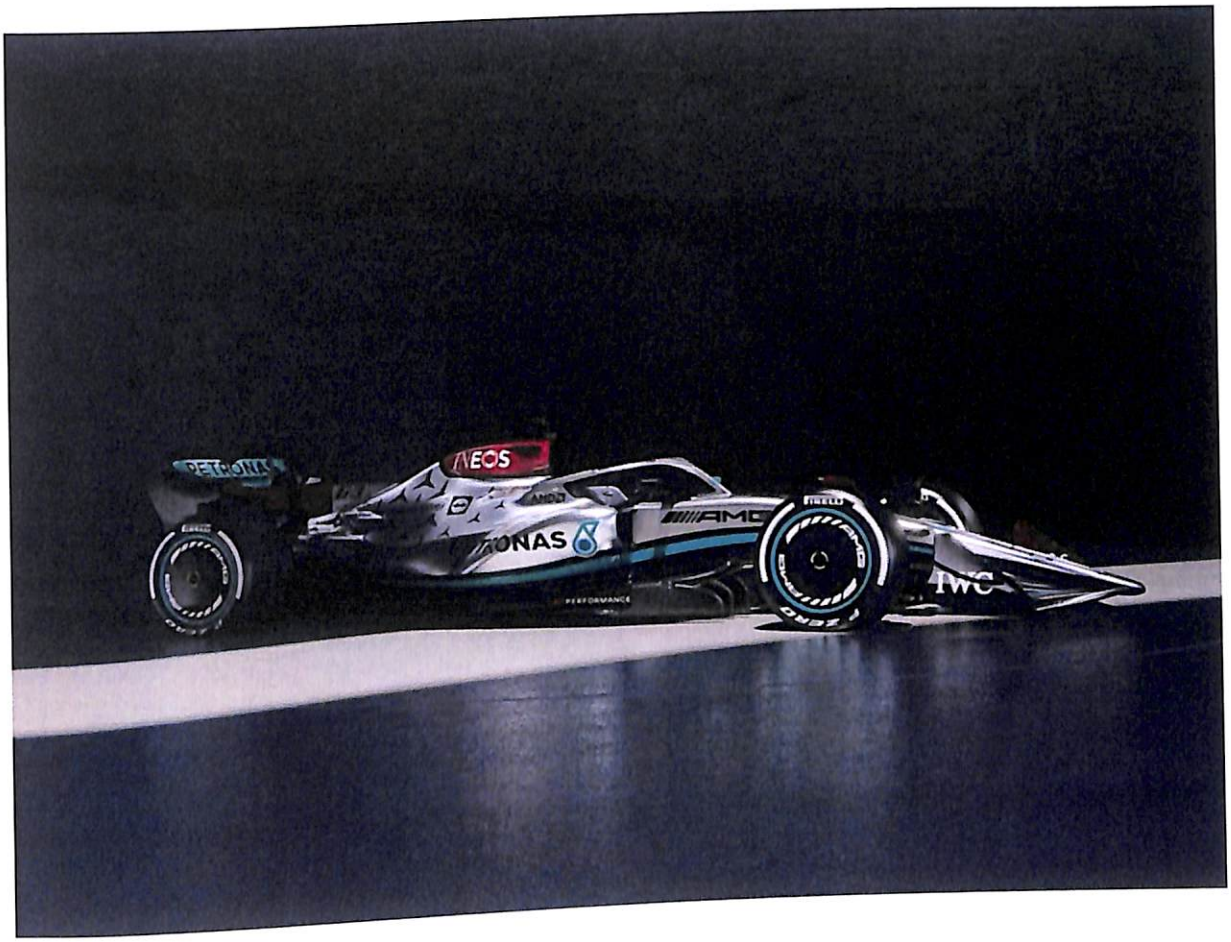
"Engineers love a challenge and therefore it is a fantastic opportunity to do something fresh. In the aerodynamic world, normally you are chasing after little bits and pieces, but with such big regulation changes, the gains have been coming in big chunks which is quite satisfying," Mike explained. "On the flipside, we have had a period of success, winning the last eight Constructors' titles and this is a reset. All the teams have started from scratch with the model provided by F1 and you do not get to carry over the benefits or fix the issues from last year's car, so everyone began this journey at the same level."

However, the Aerodynamic Testing Restrictions introduced in 2021 - aimed at levelling the playing field - mean teams have had varying amounts of development opportunity at their disposal, with aerodynamic testing allocated on a sliding scale based on a team's finishing position in the 2021 Constructors' Championship.

"The teams have started with different allocations of runs in the wind tunnel and hours of CFD (Computational Fluid Dynamics) so it has the potential to really mix up the order," Mike adds. "That's an exciting test as an engineer but there is obviously some risk in there too, in terms of our competitive position."

Under previous technical regulations, the component detail on the cars was far greater and small pieces of aero furniture, working in unison, contributed a large amount of aerodynamic performance. For 2022, teams will find performance gains in more fundamental shape changes and bigger components than in previous years.

"Getting to the desired aero shapes has meant a complete internal repackaging, right down to the electrical layout and where we fit things like the ECU. The suspension has been redesigned to account for the loss off hydraulics and remote springs, now banned in the new regulations.



One striking difference on the 2022 cars will be new 18-inch wheels, replacing the previous 13-inch rims. Their impact on racing remains to be seen but the early signs are positive.

"What we have seen in testing, particularly the Abu Dhabi test at the end of 2021, is that there are subtle differences. It is going to change what we want to do with set-up, but it is a step in the right direction as I think the tire will help improve the racing, won't overheat as much and will be easier to manage," noted Mike Elliott.

Another crucial element the engineers have had to contend with in the development of the 2022 car is the freezing of certain components which are now locked in for several years, including the gearbox and Power Unit. The stakes for getting both components as strong as can be, while maintaining reliability, have rarely been higher.

7. Alpine

Drivers: Fernando Alonso and Esteban Ocon

New PU

That engine cover shrouds Alpine's all-new power unit, which adopts a split turbo architecture, some eight years after Mercedes introduced the concept in the first year of the hybrid formula.

The ERS (Energy Recovery System) system is considerably lighter than before, and the cooling requirement of the whole package has been reduced significantly. This has made possible a cooling package which is 15% smaller than before, and the previous car's unsightly bulbous engine cover has gone.

Distinctive aerodynamics

Within the lower flanks of the engine cover, sitting inboard and above the sidepods, are a set of cooling louvres. Forward and outboard of those, on the upper surfaces of the sidepods, are further louvres before the pods ramp sharply downwards to accelerate the airflow between the rear wheels and diffuser outlets. This ramped section of the sidepod is free of louvres.

So far, the other '22 cars have had either a downward-ramped pod without louvres or a relatively flat sidepod top with louvres. The Alpine, in sharply separating out the engine cover area from the sidepods, has been able to incorporate both the downward ramp and the louvres.

Aerodynamically, it features a slim nose, with quite rounded sides which helps bring the airflow over the nose downwards more effectively than straight edges. There is a significant undercut beneath them to accelerate the airflow around the sides of the sidepods. The car

retains a conventional push-rod front/pull-rod rear suspension layout. The detailing around the floor edges is very bland, suggesting it is not representative of the real thing.

8. AlphaTauri

Drivers: Pierre Gasly and Yuki Tsunoda

Compact cooling

The AT03 features high-shouldered sidepods, which are both heavily ramped downwards and significantly undercut at the front, without having to raise the radiators up (as per Aston) or forgoing the undercut and using the engine cover bodywork to house much of the cooling channels (as per the McLaren).

That suggests the Honda-based power unit may need less cooling than the Mercedes.

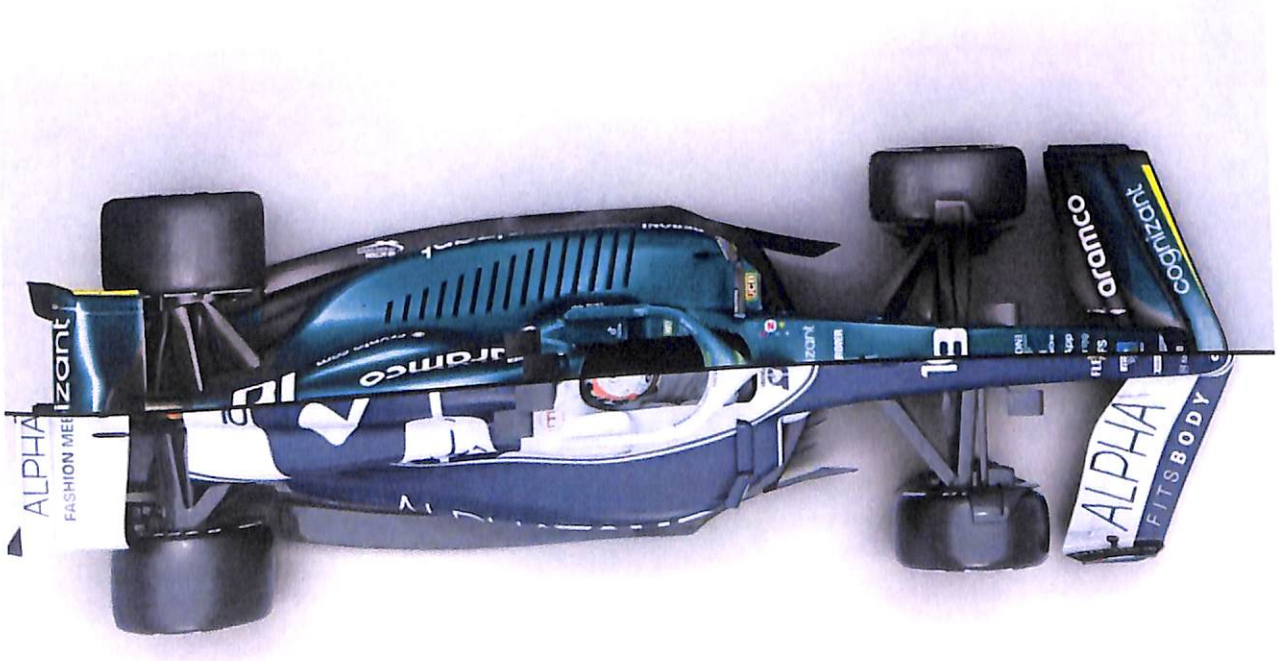


Figure 17 A comparison of the top views of the AlphaTauri AT03 (bottom) and Aston Martin AMR22 (top) illustrating different profiles surrounding the engine covers and front wings.

In terms of suspension, the car has retained the pushrod layout at the front and pull rod at the rear (unlike the McLaren, which has reversed that tradition).

The front wing profile shown (which may not be the one it appears with at Barcelona testing) is quite similar to that of the McLaren, with a heavily contoured middle section for each of the four elements, falling away sharply at the outboard ends, probably to aid easier outwash around the front wheel. However, unlike any of the other cars so far seen, the nose tip extends beyond the bottom element of the wing.

The rectangular radiator inlets at the front of the sidepods, and the sharp-angled bodywork linking them to the sides of the sidepods, is a very similar treatment to that seen on the Aston Martin.

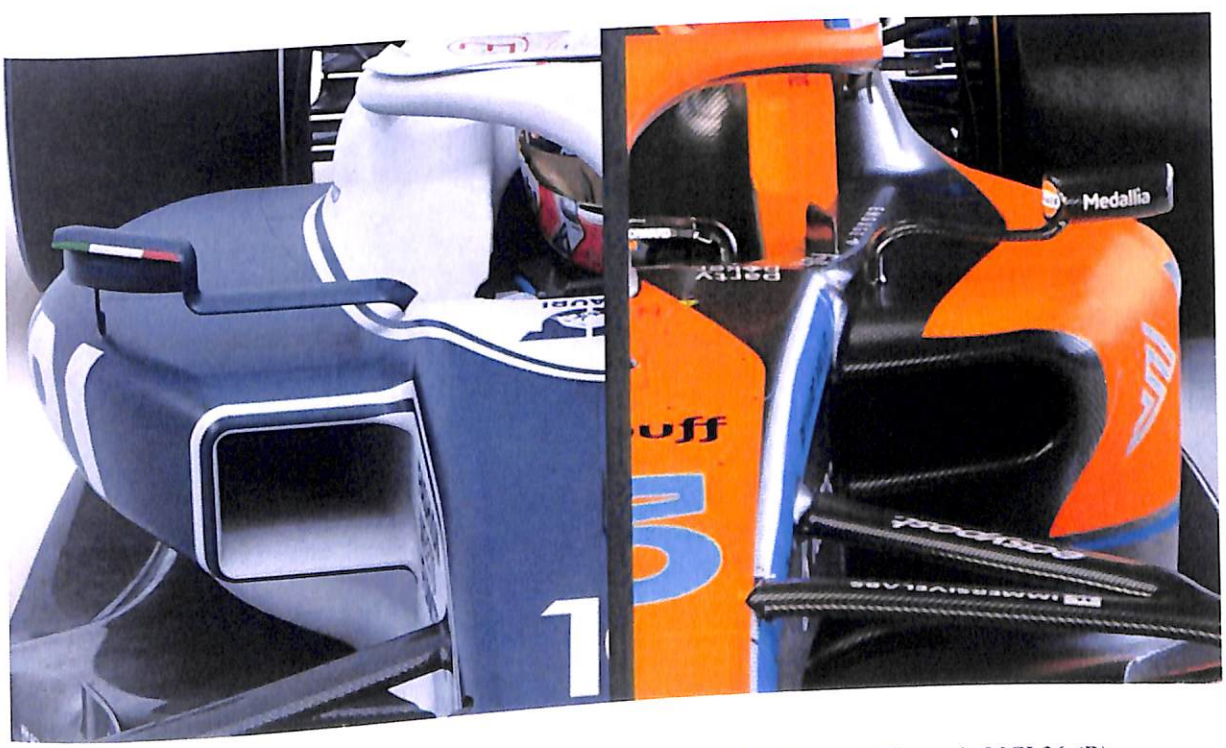


Figure 18 Sidepod comparison of the AlphaTauri AT03 (L) and McLaren's MCL36 (R)

Rear-end Red Bull Clues

Because AlphaTauri will this year be taking the full 2022 Red Bull mechanical rear end (gearbox, hydraulics, and suspension) we can see this is how the RB18 will be packaged, with pull rod activation of the suspension and a more Haas-like relationship between the front axle and sidepods, with the front axle appearing to be slightly further back than on the Aston and McLaren to maximize the length of the venturi tunnels in the floor while remaining within the maximum permitted wheelbase.

The implication from the bodywork shaping around the sidepods and engine cover is that, despite both power units sharing the split turbo architecture, with the compressor at the front, the power unit is further forward within the car than on the two Mercedes-powered cars so far revealed. The gearbox casing would therefore be longer.

The way that the sidepod downward ramp merges at the back with the upward ramp of the venturi tunnel is quite unusual. The hot air which has just cooled the radiator would not normally be fed into the diffuser area, so it may be possible that upward ramp is internally partitioned with an upper cooling exit and a lower venturi exit.

Chapter 4: Special emphasis on Mercedes' programs to develop the team

1. Corporate Social Responsibility (CSR)

Mercedes AMG F1's parent company Daimler AG defines Sustainability as creating lasting value for all stakeholder groups: for shareholders, customers, and employees as well as for business partners and society.

Mercedes AMG F1's Sustainability policy focuses on three key pillars:

- Countdown to Zero (Sustainability)
- Positive Footprint (Charity)
- Driving Change (Diversity)

Countdown to Zero (Sustainability)

What is the goal?

As a team, Mercedes-AMG Petronas aims to reduce our CO2 emissions by 50 percent by 2022, compared to the baseline set in 2018.

This would see a drop from around 20,000 tonnes in 2018 to 10,000 tonnes in 2022.

How will it be achieved?

- ***Reduced emissions through the transition to renewably sourced energy at our factories***.

The high-tech chassis factory in Brackley already uses renewably sourced energy to power all its operations, which include facilities like the wind tunnel, data center, digital simulation environment and test benches.

The Brixworth technology center, where Mercedes-AMG High Performance Powertrains (HPP) develops and manufactures the powertrains for Formula 1 and Formula E, produces more than half of its electricity using solar panels and an on-site CCHP plant.

For all externally sourced energy, HPP has committed to switch to renewable power sources in the course of 2020.

- ***Offsetting unavoidable CO2 emissions***

The very nature of Formula One as a motorsport series that races around the world means that there are certain unavoidable CO2 emissions, which they will offset through gold-standard off-setting.

- ***At the race track***

Mercedes' commitments also extend to how they operate at the racetracks, for example single-use plastics will be eliminated from their catering operations, and low-impact hotel stays will be adopted for every team member.

Positive Footprint (Charity)

Charitable Focus

Charitable contributions and donations underline their commitment towards corporate social responsibility, and the team is committed to supporting charitable and community organizations through a program of employee fundraising and corporate donations.

The team and the employees undertake charity work in the following areas:

- Official Team Charities
- Charities supported by Daimler AG and our Team Partners
- Charities supported by the FIA and FOM
- Local charities and organizations within employee catchment areas
- Motor clubs seeking support for specific fundraising activities
- Projects or organizations attached to a charity with which employees are personally involved
- Projects offering opportunities for employee participation

Official Team Charity

Every year, Mercedes appoints an Official Team Charity which is voted for by their own team members and approved by the Management Committee.

From the summer of 2017 through to the end of 2019, their Official Team Charity was Cancer Research UK, for whom they raised a total of £102,628.

For 2020 to 2021, Mercedes' new Official Team Charity will be Alzheimer's Research UK.

Community Initiatives

Mercedes recognize that the team has an important role to play in supporting the local community and work with the local town authorities to support events which bring the community together, including an annual community Firework Display and support for the Brackley Community Carnival and Soapbox Festival.

They also support local charities, schools and community organizations through the donation of prizes and memorabilia for fundraising activities, school visits, factory tours, award presentations and employee support.

Mercedes actively supports Make a Wish and The Starlight Foundation, helping children and their families to escape the routine and reality of their medical treatment and create lasting memories by hosting visits to their factory and at races.

Motorsport Industry

Mercedes supports the following motorsport-related initiatives and charities, the majority of which are designed to encourage young people to discover the thrill of motorsport and through it develop an interest in the core STEM skills.

- F1 in Schools
- Formula Student
- Silverstone University Technical College
- Silverstone Experience
- Grand Prix Trust
- British Motorsport Marshals Club

Women in Formula 1

Mercedes have been working hard in recent years to promote and enhance the role of women in Formula 1.

Whilst Mercedes have seen growth in the number of women in technical roles within the team, and expect these figures to improve further, they recognize that they still have a long way to go and improvements to make to ensure that women are suitably represented.

With the Mercedes-Benz She's Mercedes program leading the way, they are actively involved with sponsoring, promoting and participating in initiatives such as International Women in Engineering Day which they are sponsoring for the third year, the FIA's Girls on Track program, along with many local and national STEM projects to showcase to young women the broad range of opportunities available to them in motorsport.

The Mulberry STEM Academy

Following Mercedes' striking new livery debut in June 2020, the team are committed to building a credible program that will offer greater opportunities for people from minority ethnic backgrounds to work in the motorsport industry, and to accompanying talent from education through to the opportunity to pursue careers in the sport.

Established in November 2020, the Mulberry STEM Academy will give students access to inspirational role models, imaginative teaching, and rich extra-curricular experiences over a five-year period.

Built on core values of high performance, team spirit and the continual desire for new challenges, the partnership between the Mulberry Schools Trust and Mercedes-Benz Grand Prix will provide the foundations on which a lasting commitment can be built.

The Mulberry STEM Academy will be a powerful supplementary provision providing a specialized track for children and young people aged 7 to 18 who have talent, passion and aptitude in STEM education.

Established in Tower Hamlets in 2016, the Mulberry Schools Trust is a flourishing multi-academy trust which includes Mulberry Academy Shoreditch, Mulberry School for Girls and Mulberry UTC. Schools within the Mulberry Schools Trust serve diverse communities: 84% of students speak English as an additional language, 66% are disadvantaged and 85% are from Black, Asian and ethnic minority backgrounds.

However, despite the challenges, the Mulberry Schools Trust has a track record of delivering outstanding achievement, with 81% of students going on to university.

Launched by Lewis and Toto on 5 November 2020 in a virtual event with the three Mulberry schools in East London, our new STEM Academy is a place where: future inventors, designers, analysts, technicians, and capabilities.

- Specialized study includes a wide range of experiences of the world of work and technical practice, including mentoring, networking, access to experts' workshops, webinars and work experience.
- The UK's future inventors, designers, analysts, technicians, and entrepreneurs can further develop their talent, passion and aptitude for STEM and stretch their academic and technical capabilities.

Sustainability

In March 2020, Mercedes-Benz announced a sustainable business strategy for its motorsport activities and ambitious steps towards carbon neutrality. Driven by innovation, efficiency and new technologies, the plan includes a commitment to significantly reduce the carbon footprint of the Mercedes F1 team.

2020 was a unique year owing to the COVID-19 pandemic. A year which saw an extended factory shutdown and a revised race calendar with fewer long-haul races outside Europe led to one-time positive effects on Mercedes' overall carbon footprint. Nonetheless, Mercedes' CO2 emissions show an encouraging trend towards achieving their aim.

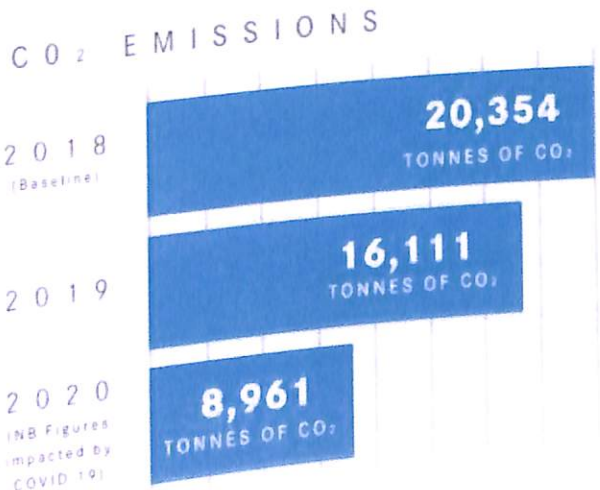


Figure 19 CO2 Emissions

2. "Accelerate 25" Diversity and Inclusion Program

Accelerate 25, a five-year program to mark the formalization of Mercedes' vision to becomea more diverse and inclusive team.

With the launch of their black livery at the start of the 2020 F1 season, Mercedes made a commitment to promoting greater diversity and inclusion within the team and our sport.

A considerable amount of study, research and work has been undertaken at the team in the past months to deepen their understanding in this area and develop their culture and practices.

2020 has been a historic year for the team on track, but also within their core values and ambitions. Mercedes strongly believes a more diverse and inclusive team will not only make them faster, but also inspire others to set ambitious targets in this area.

To begin this new Accelerate 25 program, Mercedes aims to continuously raise theirstandards of entry and until 2025, they aim for at least 25% of all new starters at the team to come from under-represented groups.

To enhance Mercedes' understanding internally, the team is embedding Diversity and Inclusion more deeply within their values and behaviors. They have also begun their educationprogram with around 200 recruiters at the team having completed Unconscious Biastraining, 150 managers completing a program called 'Inclusive Excellence' and all managers will have completed this course by the end of the year.

Every employee will have participated in Diversity and Inclusion training by June 2021 and the team has started a Diversity and Inclusion forum, to encourage input from their employees from under-represented groups – in order to retain, develop and accelerate their progress.

An external specialist, the EW Group, has completed an in-depth analysis of their recruitment and development processes, with action plans underway to reach under-represented groups through mentoring, work experience, sponsorship, and targeted advertising amongst their initiatives.

The team is also partnering with the Association for Black and Minority Ethnic Engineers (AFBE-UK) whose wealth of experience in working with organizations and engineering professionals to encourage and support engineers from black and minority ethnic backgrounds into engineering is a perfect fit, as the team look to widen their appeal and increase the diversity of the talent within the team.

Delivering measurable change is a long-term commitment, and one that begins during the education of the talented young people who will become our team-mates of the future.
So, Mercedes have started to develop targeted education initiatives to encourage and support students from under-represented backgrounds who aspire to reach F1.

This includes the Mulberry STEM Academy, which was announced last month in a partnership between the team and the Mulberry Schools Trust. It is a five-year program to give young people at the Trust and beyond access to inspirational role models, imaginative teaching and extra-curricular experiences to help develop their passion for STEM subjects and encourage them to continue these subjects in higher education.

Mercedes is also delighted to announce a forthcoming partnership with the award-winning UK social enterprise, Stemettes - who work to inspire the next generation of girls, young women and nonbinary young people into STEM fields through programs, events and content platforms.

Collaboration is key to ensuring the changes that they are striving to make at the Mercedes F1 Team can be reflected across the sport and they are very proud to be working closely with Formula One's key stakeholders to improve accessibility.

Both the FIA through its #PurposeDriven campaign, and Formula One through their #WeRaceAsOne activities trackside, have launched campaigns this season to widen the appeal and accessibility of Formula One.

This year, The Hamilton Commission was set up by the seven-time World Champion Lewis Hamilton, alongside The Royal Academy of Engineering, with the aim to identify the key barriers to recruitment and progression of Black people in UK motorsport and provide actional recommendations to overcome them.

The Commission will be a key source of inspiration, knowledge, and support for the team. Both Dr Nike Folayan MBE, Chair of the AFBE-UK, and Dr Anne-Marie Imafidon MBE, Co- founder of the Stemettes is two of the newly appointed Commissioners on the Board of The Hamilton Commission.

Toto Wolff, CEO and Team Principal of the Mercedes F1 Team, said: "Before the start of this Formula One season, we made a commitment to use our global platform in Formula One to make a difference to the world around us through a carefully considered Diversity and Inclusion program.

"Our legacy off the track is just as important to this team as the success that we have achieved with our historic seventh consecutive World Championship this year. We have a real opportunity to drive the change that we all want to see in our sport through strengthening an inclusive and diverse culture at our team and using our platform to take that thinking beyond just our factory.

"I am very proud of the work that has been done over the last few months to take an in-depth look at our practices, to assess our weaknesses and to develop a long-term plan and commitment to take the necessary actions and realize every advantage of becoming a more diverse team; this is the vision expressed by our new program, Accelerate 25."

Lewis added: "In what has been a tough year for everyone, I am incredibly proud of myteam as we reach the end of such an intense season. Not only have we made history on the track, but they have joined me in pushing for change off the track, by working to make our team and our sport more diverse.

"We have made some positive strides this year which I am proud of, however we still have a long way to go and I know Accelerate 25 will give us the platform to deliver more meaningful change. I truly believe this will have a measurable and long-lasting impact on the face of sport for generations to come."

3. "Ignite" Charitable Initiative

The Mercedes-AMG Petronas F1 Team and Sir Lewis Hamilton launch Ignite, a joint charitable initiative to support greater diversity and inclusion in motorsport.

Building on the recommendations of The Hamilton Commission, and as part of the team's shared vision for developing the industry and the team to reflect wider society, Ignite will focus its work on increasing the pipeline of more diverse talent aiming to enter the motorsport industry – and igniting and inspiring enthusiasm for motorsport through STEM education.

The focus of effort for the UK-based initiative will include but not be limited to: developing exciting and stimulating STEM curriculum materials; developing more diverse educators to role model and inspire students from under-represented groups in STEM; enhancing education enrichment opportunities around STEM and motorsport; and providing financial support to talented and motivated students wishing to pursue careers in STEM and motorsport but who don't have the means.

Ignite will initially be funded by a multi-million-dollar fund created by Lewis and the Mercedes-AMG Petronas F1 Team. and will work closely with Lewis's personal foundation, Mission 44, to deliver tangible results for the Mercedes-AMG Petronas F1 Team and the wider UK motorsport industry.

Toto Wolff:

"I am delighted today that we can finally talk about our plans for the Ignite initiative. Since we announced our intention with Lewis at the start of the year to create a joint project, a great deal of work and discussion has taken place in the background to refine our aims and our mission. Opening up motorsport and becoming a more diverse and inclusive team are fundamental to our team's values and, with the full support of Mercedes-Benz, we are committed to making a positive impact on society and building a platform from which future generations can access and enjoy our fantastic sport. Ignite will complement our team's own Accelerate 25 program, and through these platforms we hope to see much more talent from under- represented groups both join our team and take up careers in the wider motorsport industry."

Lewis Hamilton:

"Mercedes have long supported my ambition to improve diversity and inclusion within the motorsport industry. I am so thrilled that, through Ignite, we can formally work together to achieve this. Diverse workforces are not only more successful but are also the morally correct approach for any industry. The findings of The Hamilton Commission have provided us a fantastic base to begin our work, and I am confident that ignite will result in real, tangible change within motorsport. For 15 years, I have remained one of the few Black employees within Formula 1, and I am proud that my work with Mercedes is going to change that for the better."

Chapter 5: Data and Numbers

Williams F1:

Williams is one of a group of five teams that won every Constructors' Championship between 1979 and 2008 and every Drivers' Championship from 1984 to 2008. Its place in the sport's heritage is unquestioned; the team's glory days have shaped the contours of Formula 1 as we know it.

The team's recent travails make for a stark juxtaposition, posed alongside these heady achievements. Williams' last win was in 2012. The win before that was in 2004.

The team founded by Sir Frank Williams in 1977 is now in the hands of Dorilton Capitals. The recent takeover provides needed funds and a change of strategic direction, leading many to ask whether Williams is back on track.

Williams Racing: The Past

Williams has won a total of 9 constructors' championships, second only to Ferrari.

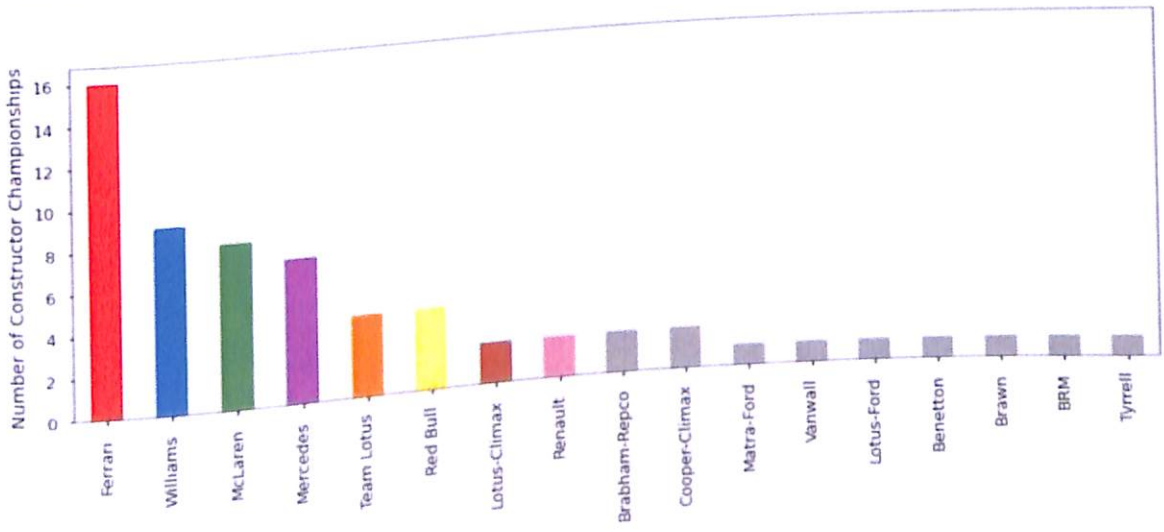
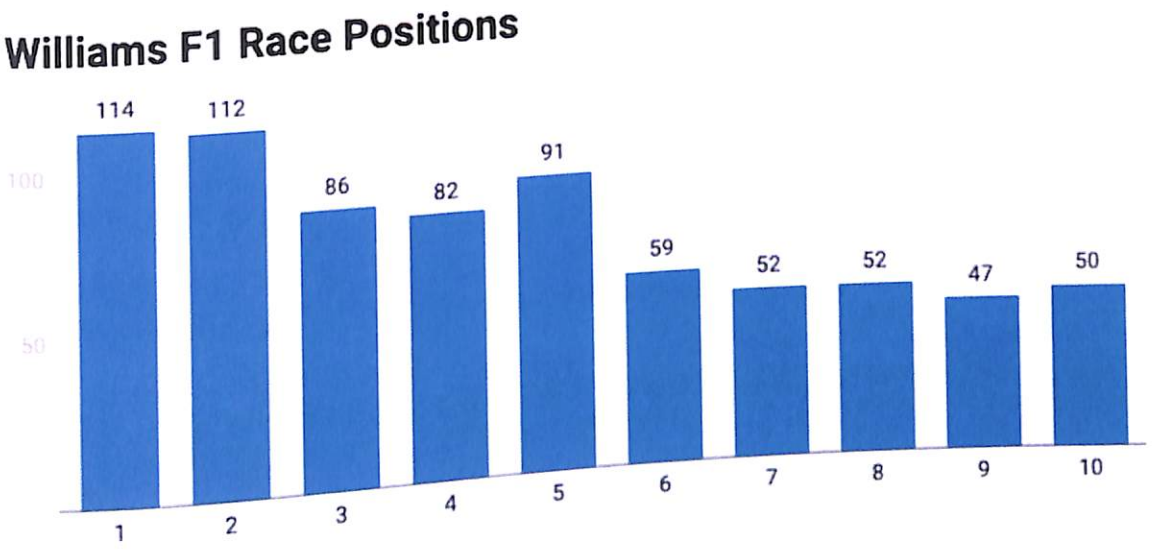


Figure 20 Williams have won 9 Constructors Championships

Williams is clearly part of an élite club here, alongside the likes of Ferrari and McLaren — but the former retains a healthy lead.

Ferrari is the only team to have run a car in every championship since F1's inauguration in 1950, although they did miss the first race due to a dispute with organizers.

Williams has run a car in 754 races since 1977 and, strikingly, they have finished races in 1st position more often than any other position. Williams has 114 race wins, amounting to a 15% race win ratio.



Add in 128 pole positions and the pedigree of the team becomes clearer still.

The chart below shows the cumulative number of championships won by each team over the years, including both drivers' and constructors' titles.

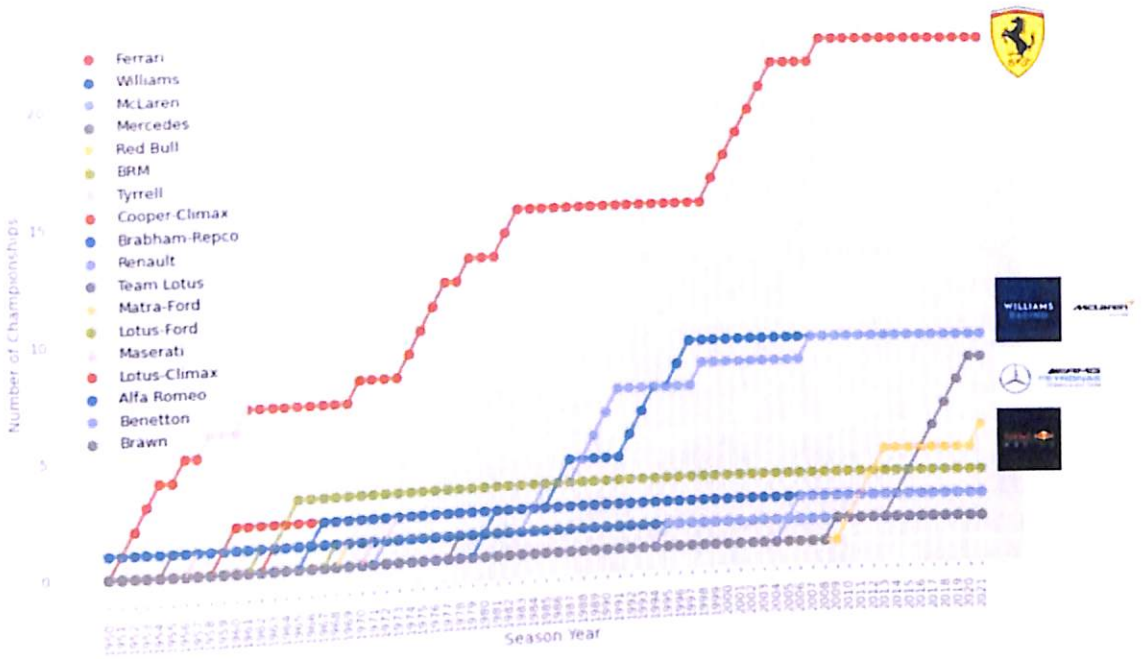


Figure 21 Total number of Championships won by each Constructor

From this chart, we can see a simplified story of F1's past.

Ferrari won multiples driver's championships in the 1950s, but did not win the constructors' title in those years due to its lack of existence. The constructors' championship only came along in 1958. This helps explain its extended count of 22 titles here.

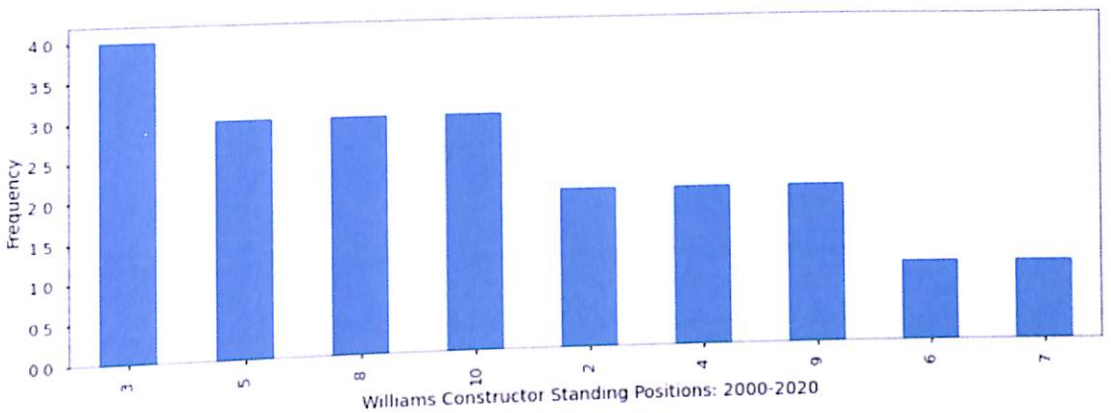
Williams had a very productive period in the 1990s, securing five constructors' titles in the space of six seasons with an engine supplied by Renault.

After 2013, we can see the impressive rise of a Mercedes team that has dominated the v6 turbo era. Between them, Red Bull and Mercedes have won every constructors' title since 2010.

In 2009, Brawn won the title, and then Mercedes bought them to kickstart their F1 entrance.

Ferrari had barren sequences from 1961–1974, 1979–2000, and 2007–2020.

Williams is undoubtedly enduring such a period right now. The chart below shows the frequency of positions the team has held in the constructors' championship this century.



Third is the most common position (4 occasions), with the last third-placed finish coming in 2015:

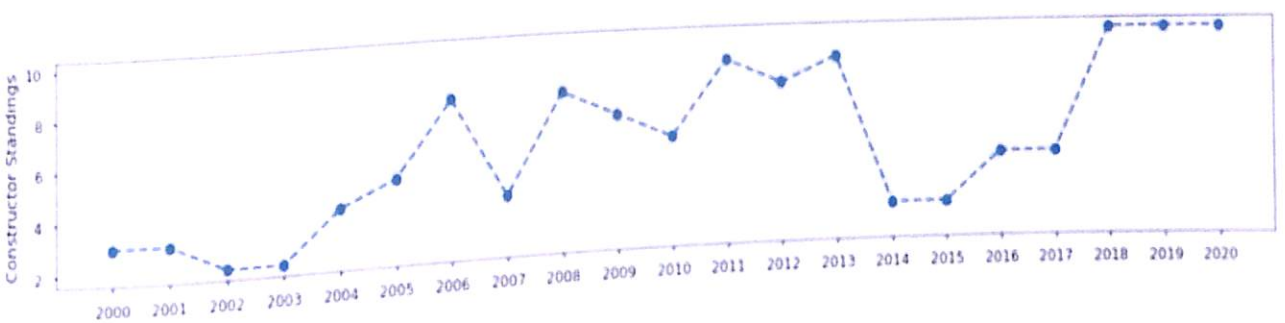


Figure 22 Williams' Constructors standings over the years

This tells only a small part of the story. Two teams (Mercedes and Red Bull) have led the field by such a margin that third place may not mean the team in third is within striking distance.

The chart below shows the percentage point deficit from the leading team each year to Williams:

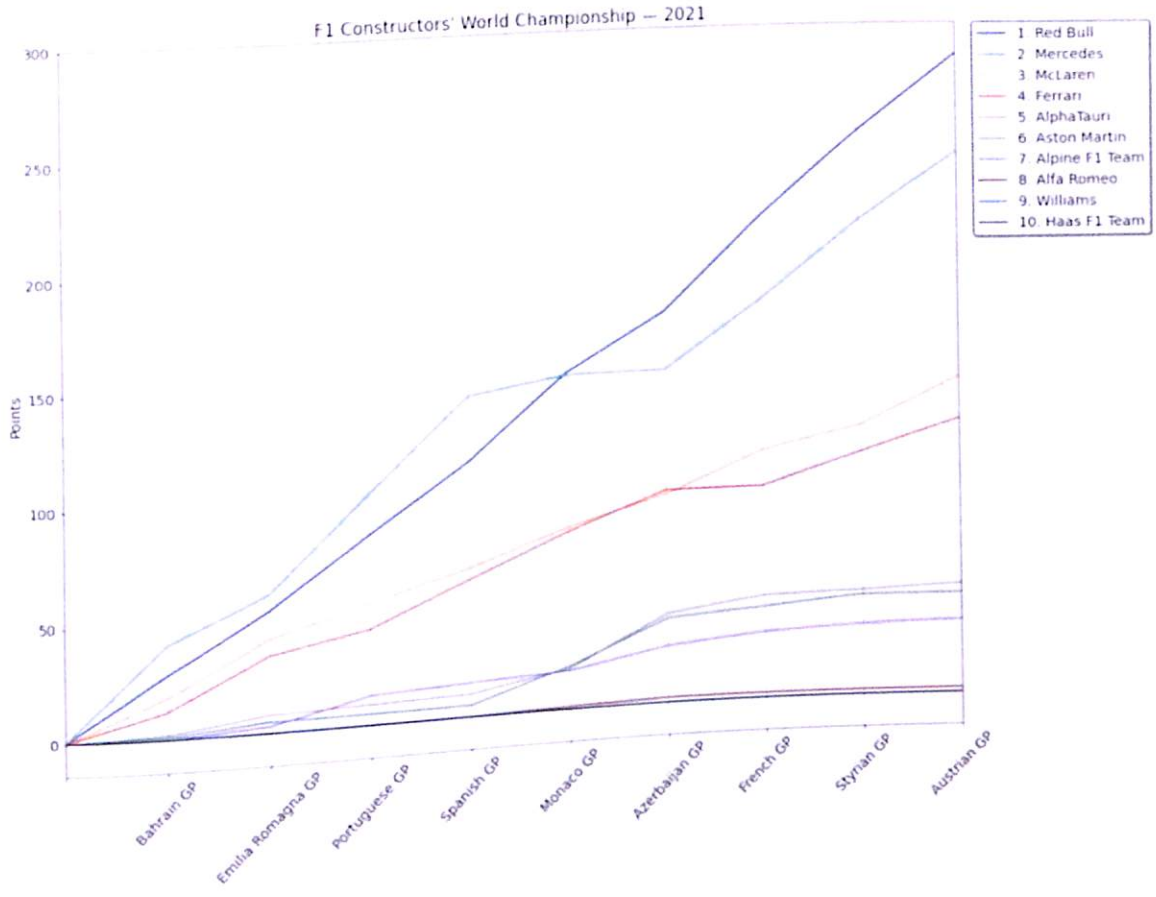


Figure 25 Formula 1 Constructors Championship Points

In recent seasons, Williams has had one of the smallest budgets on the grid and this correlates closely with its performance at the chequered flag.

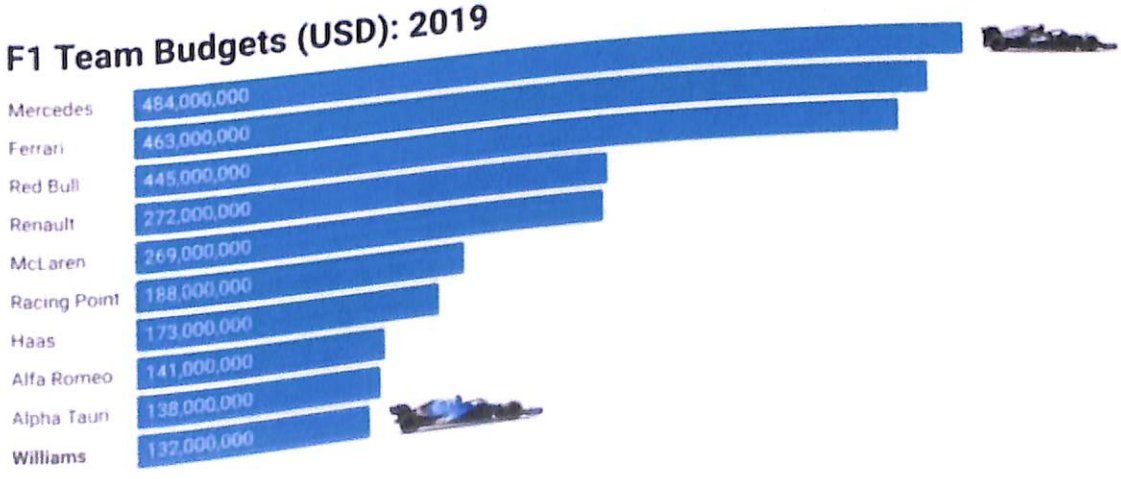
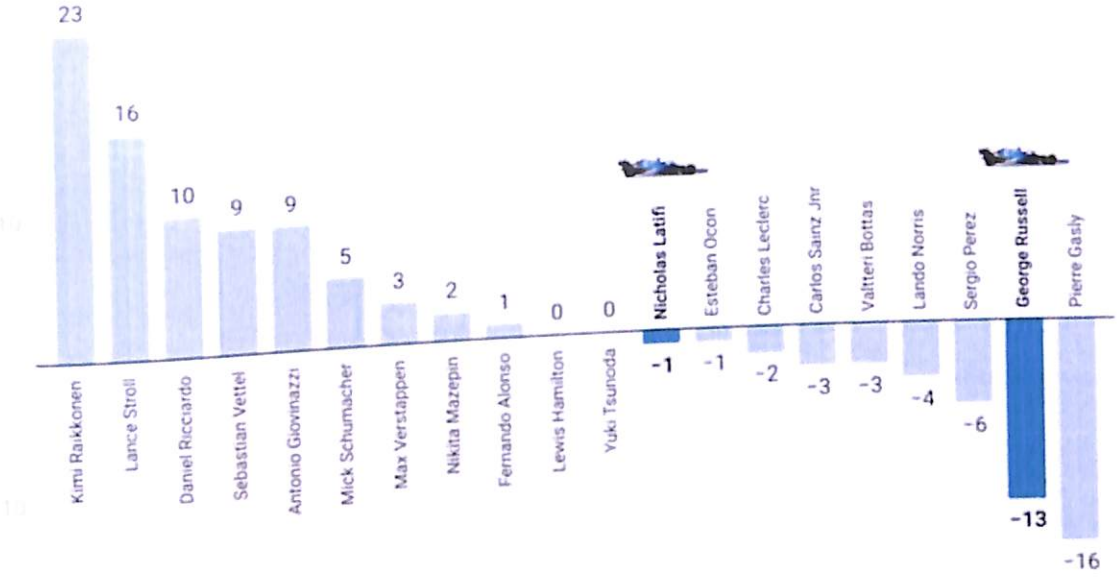


Figure 26 Formula 1 Team Budget.

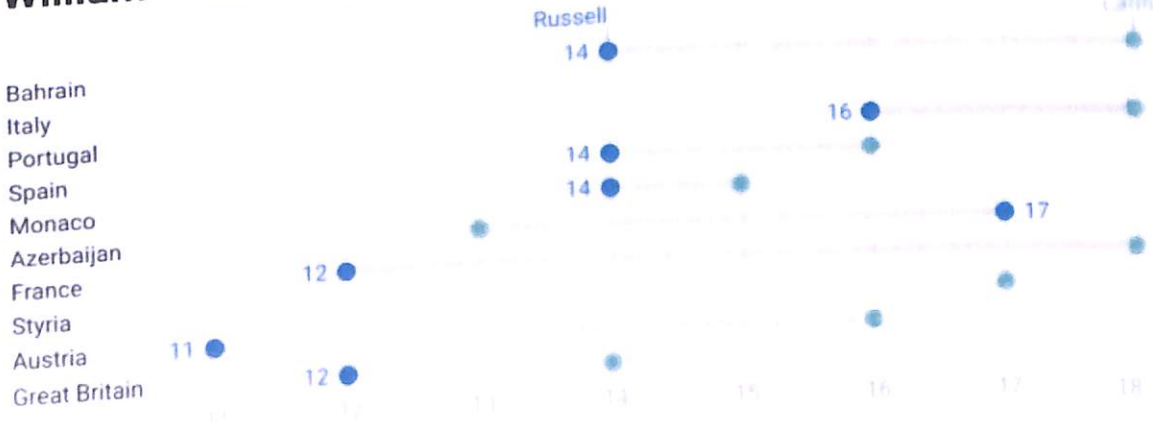
Positions Gained on Lap One - 2021



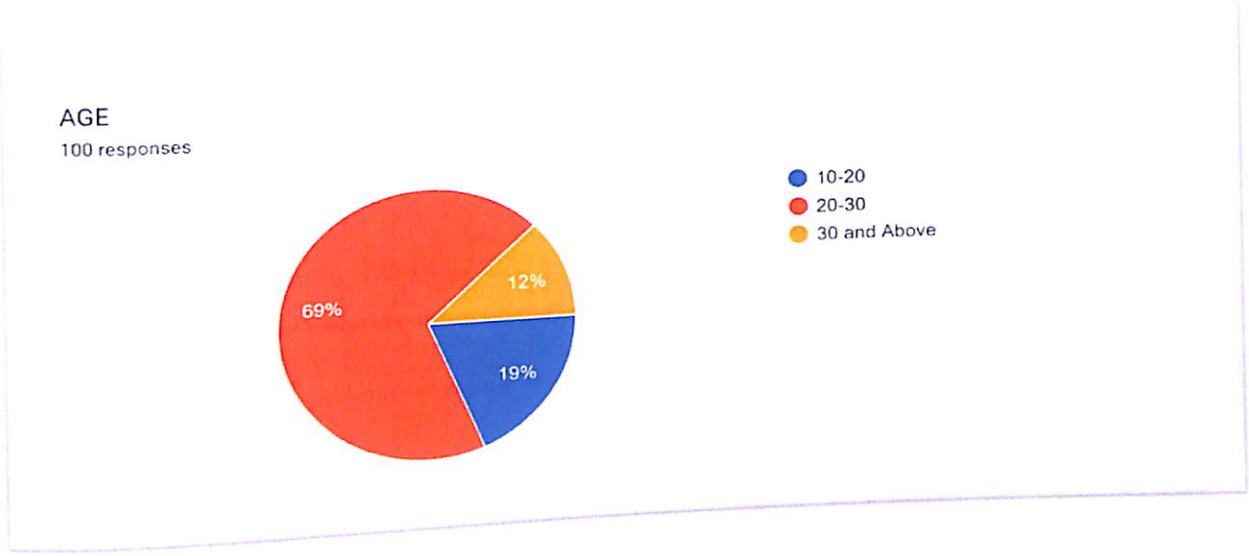
Still, Williams did post the quickest pit stops at the British Grand Prix, so they made up alittle bit of time there.

Further down the order, we see that Russell routinely outperforms his teammate, Latifi. Latifi,26, is rumored to bring in sponsorship money of $20–40 million a year. His father is the founder of the third-largest food company in Canada, Sofina. He is not a bad driver, but Russellis clearly the superior talent.

Williams Finishing Positions - 2021



CHAPTER 6: DATA INTERPRETATION

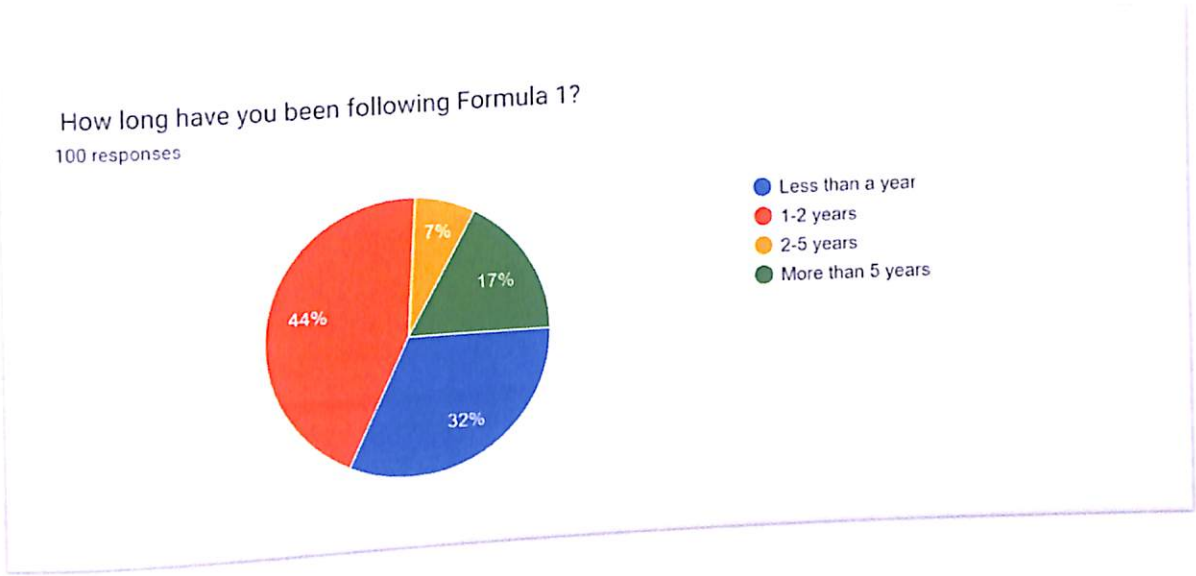


OBJECTIVE

Based on the given research topic "Constructors of Formula 1 with special reference to Petronas Mercedes AMG," the objective could be to examine the key factors that contribute to the success of Petronas Mercedes AMG as a constructor in the Formula 1 racing world. This research topic may aim to know the age groups of people that follow Formula-1, it also investigates the various aspects related to the team's success, such as their technical expertise, team management, engineering skills, and the role of drivers. It could also analyze the impact of Petronas as a sponsor on the team's performance. Overall, the research could provide insights into the strategies and practices adopted by Petronas Mercedes AMG that have made them one of the most successful teams in Formula 1 racing history

DATA INTERPRETATION

From the research conducted of 100 respondents it was derived that Formula-1 is mostly followed by young people between the age group of 20-30 years (69%), followed by the age group of 10-20 years (19%) and the people above 30 years are the last group of people on the list with just 12% following the Formula-1.

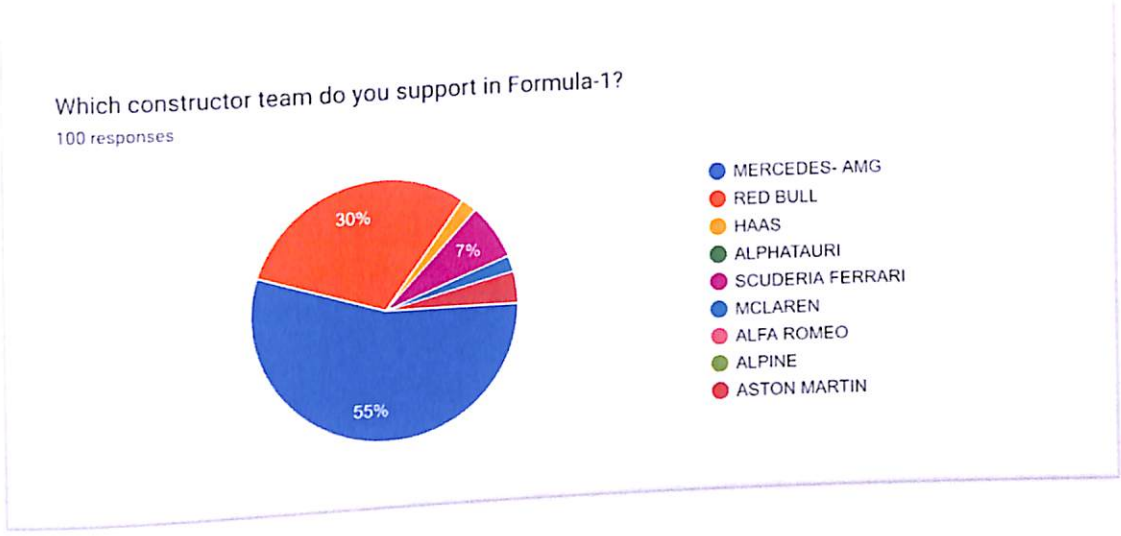


OBJECTIVE

To get the most out of the person with a vast amount of information about Formula 1, including its history, rules, teams, drivers, constructors and statistics. Provide accurate and up-to-date information about the sport.

DATA INTERPRETATION

It was observed that 44% of people have followed Formula-1 since the last two seasons, that is 1-2 years. The crowd of 32% people from the survey are the people who recently started to follow Formula-1 from the year 2023. The people following Formula-1 for more than 5 years are just 17% in this survey. Only 7% of the respondents follow Formula-1 between the timeline of 2-5 years.

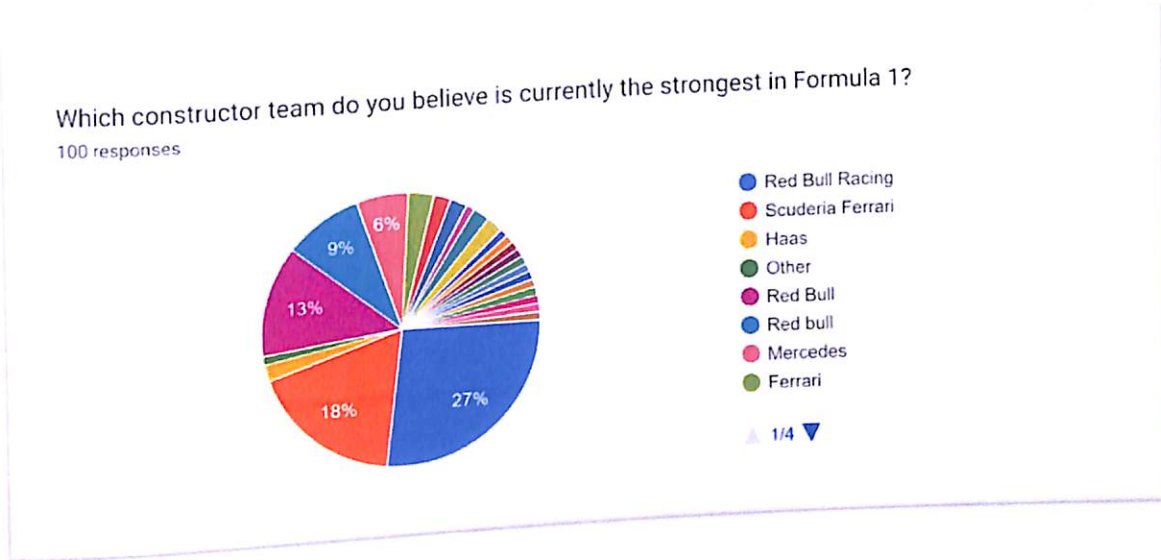


OBJECTIVE

The purpose is to know people's favorite and information based on their knowledge. The information an individual can provide information about all the teams and drivers in Formula 1, their performance, and statistics, without any personal bias according to his/her views.

DATA INTERPRETATION

55% of people voted for Petronas Mercedes AMG as their favorite constructor team in the Formula-1. Red Bull is the second favorite with 30% of people voting for the same. Scuderia Ferrari seems to be the third favorite amongst the respondents with 7% of people choosing it. Constructors like Haas, Aston Martin, Alfa Romeo etcetera do not top the grip because of not being consistent in their performance.

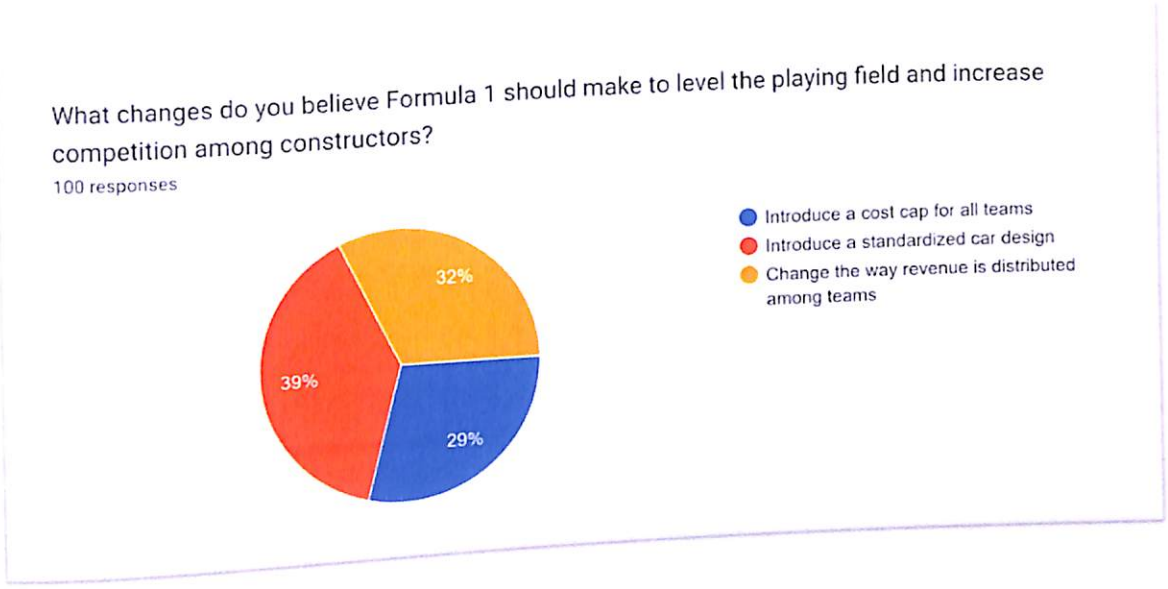


OBJECTIVE

The objective of knowing which constructor in Formula 1 is the strongest is to gain an understanding of the current competitive landscape in the sport. Formula 1 is a highly competitive sport, and teams invest significant resources in research, development, and technology to gain an edge over their rivals. The team that performs the best in terms of results, such as winning races and championships, is often seen as the strongest team. Knowing which constructor is the strongest can provide insights into the team's strengths, weaknesses, and strategies, which can be helpful for fans, journalists, and analysts who follow the sport. However, it is important to note that the strength of a team can vary from season to season and even race to race, as factors such as driver performance, car development, and race strategy can all play a significant role.

DATA INTERPETATION

Red Bull Racing is believed to be the strongest constructor team in Formula-1 racing with 49% of people agreeing with it. Almost 30% of people believe that Scuderia Ferrari is the second strongest team. People now have the perception that it is the beginning of an end for Mercedes because it did not win the championship last year and 10% of people support Mercedes being the strongest constructor. The rest 11% believe teams other than Petronas Mercedes AMG, Red Bull and Scuderia Ferrari are better constructors.

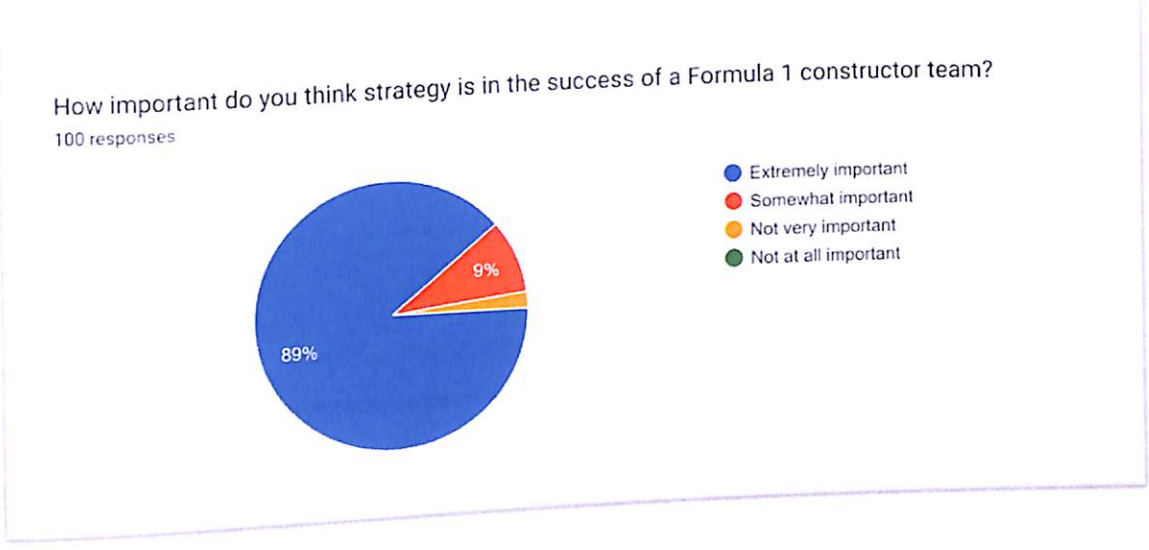


OBJECTIVE

The aim of the question is to generate discussion about potential changes that could be made to Formula 1 to level the playing field and increase competition among constructors. There are just a few potential changes that could be made to increase competition in Formula 1. However, it's important to note that any changes to the sport must be carefully considered, as they can have wide-ranging impacts on the teams, drivers, and fans.

DATA INTERPRETATION

It has always been a critical question for the rich brands investing more in the car than the usual ones to get better results. To set an equal competition for all the constructors in Formula-1 it was suggested by 39% of the people to introduce a standardized car design. 32% of the people want to have an introduction of a cost cap for all teams so that the competition is fair. Revenue distribution among teams has always varied, the rich have always become richer, so 29% of people believe in changing the way revenue is distributed among the teams of Formula-1.

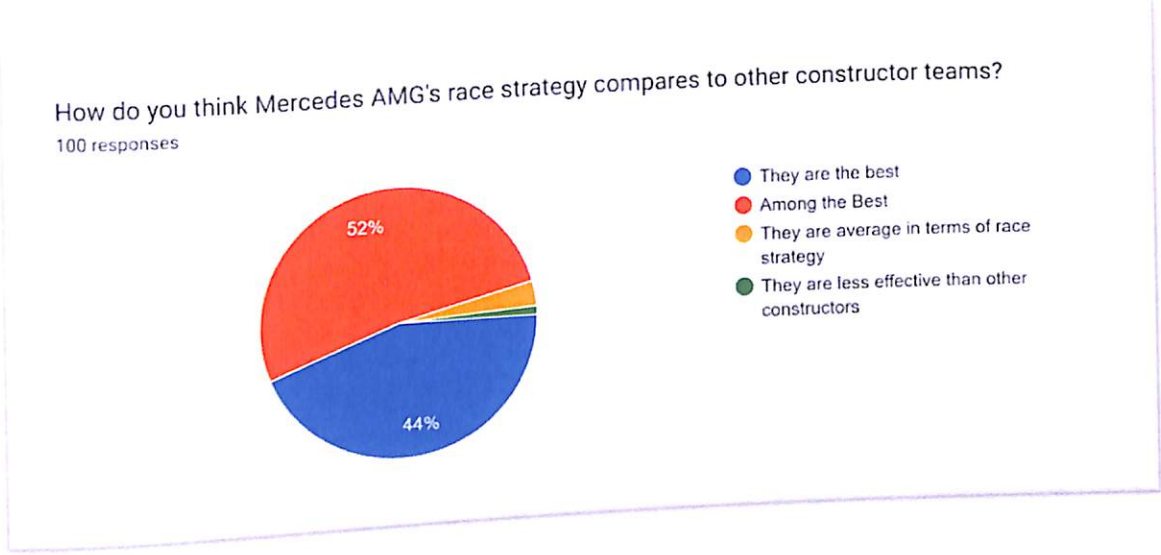


OBJECTIVE

Strategy is an essential element in the success of a Formula 1 constructor team. In Formula 1, teams are constantly looking for ways to gain an advantage over their competitors, and strategy plays a critical role in achieving this. The race strategy can involve a range of decisions, including pit stop timing, tire choices, fuel management, and on-track overtaking or defending. Teams must analyze data from a wide range of sources, including track conditions, weather, and the performance of their car and drivers to make informed decisions. A well-executed race strategy can make the difference between winning and losing a race or championship. Strategy is also important outside of the race. Teams must decide how to allocate resources between performance development, reliability, and cost efficiency to ensure that they are competitive throughout the season. Overall, a well-planned and executed strategy is crucial to the success of a Formula 1 constructor team. While factors such as driver talent and car performance are undoubtedly important, a team's ability to make smart strategic decisions can often be the difference between winning and losing.

DATA INTERPRETATION

89% of the people believe that strategy is extremely important for Formula-1 constructors to achieve what they want. 9% of the people believe that strategy is somewhat important for Formula-1 constructors. The rest 2% believe that strategy is not very important for Formula-1.

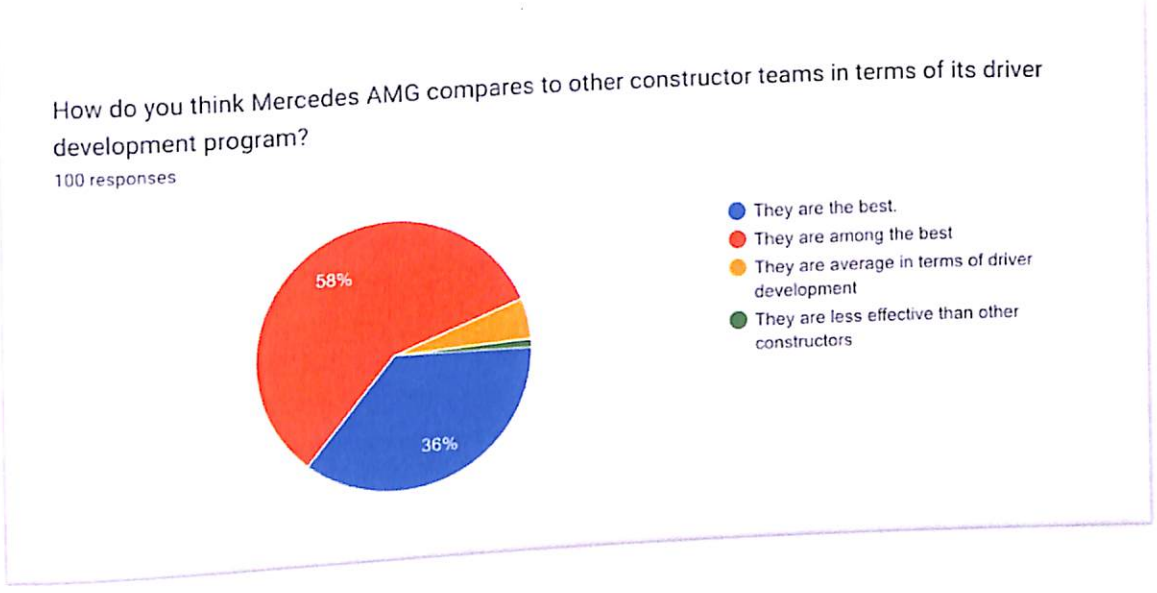


OBJECTIVE

To understand how the race strategy of Mercedes AMG compares to other constructor teams in Formula 1. This requires an analysis of various factors such as the team's approach to race planning, pit-stop timing, tire management, fuel usage, and driver management, among others. It also involves considering the performance of other teams and their respective strategies, as well as the specific characteristics of different racetracks and their impact on race strategy. Overall, the aim is to assess how Mercedes AMG's race strategy contributes to their success on the track and how it compares to their rivals in the highly competitive world of Formula 1.

DATA INTERPRETATION

Most of the respondents believe that Mercedes is one of the best strategic planners which totals 52% of the crowd. 44% of the people have a strong faith that Mercedes is the best strategic team in Formula-1. A very small chunk of the crowd, that is 3%, believes that Mercedes is average in terms of strategic planning for races. 1% of the crowd finds that they are less effective than others in Formula-1.

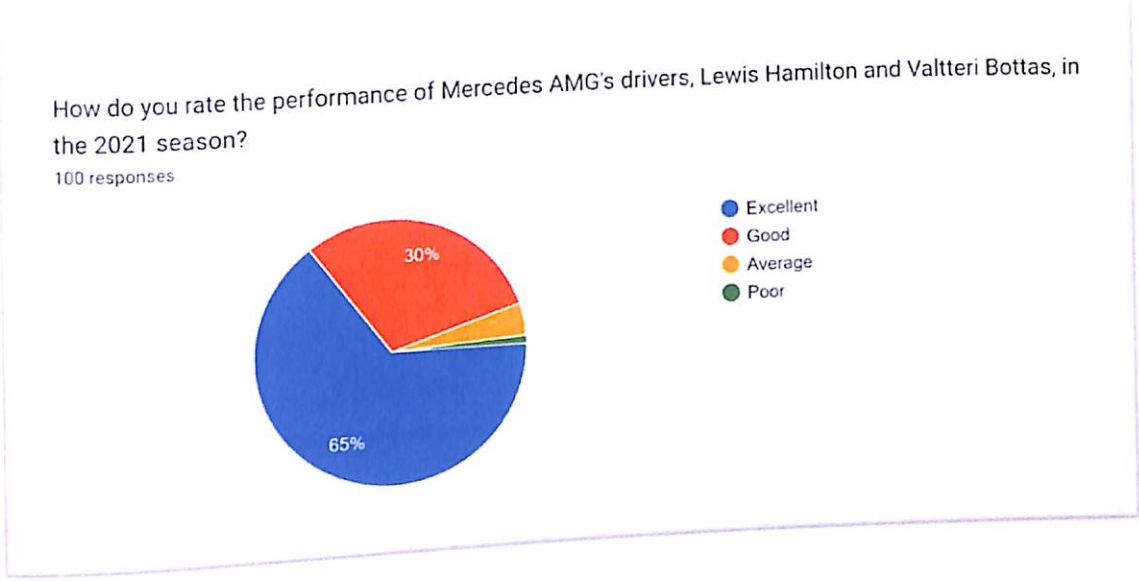


OBJECTIVE

The objective of the question is to ask for an opinion on how Mercedes AMG compares to other constructor teams in terms of its driver development program. Specifically, the question is asking how well Mercedes AMG can develop its drivers compared to other Formula One teams. The answer may involve discussing the resources, strategies, and success rates of Mercedes AMG's driver development program in comparison to other teams.

DATA INTERPRETATION

A strong hold by a majority people of 58% think that Mercedes is among the best constructors in terms of driver development program. 36% of the people agree that Mercedes is the best when it comes to the driver development program. A very sleek percentage of the crowd, 5%, believes Mercedes is average. Mercedes falls under the impression of being less effective than other constructors for just a single percent.

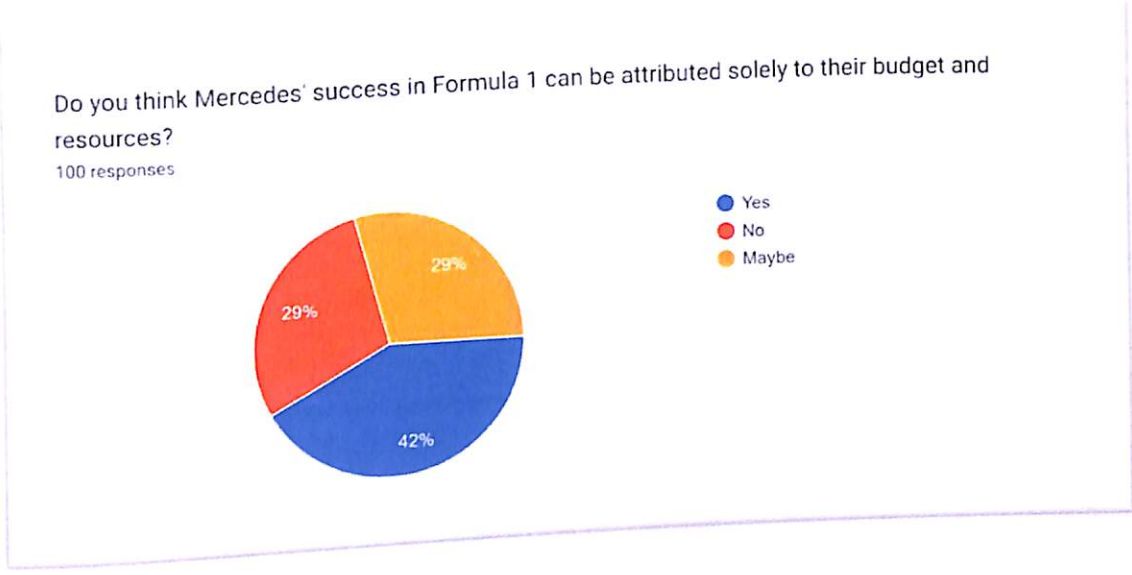


OBJECTIVE

The objective of the topic is to ask for an opinion on the performance of Mercedes AMG's drivers, Lewis Hamilton and Valtteri Bottas, specifically in the 2021 Formula One season. The question aims to assess the drivers' performance relative to each other and to their competitors in the season. The answer may involve discussing the drivers' individual performances, including their race results, qualifying performances, consistency, and ability to handle pressure, among other factors. Additionally, the answer may also touch on how the team's car and strategy may have impacted the drivers' performance.

DATA INTERPRETATION

Most of the people (65%) agree with an excellent performance by the Mercedes drivers Hamilton and Bottas in 2021-22 season. 30% of people believe that the drivers were just good enough for the season. The performance delivered by the drivers is considered average by 4% of the people. 1% of respondents feel that the performance was poor.

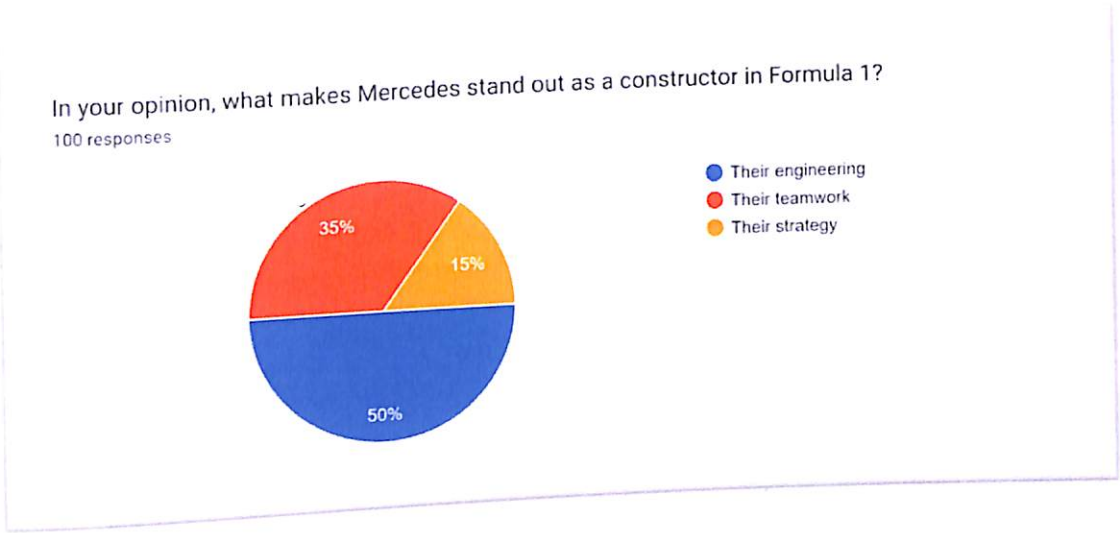


OBJECTIVE

To ask for an opinion on whether Mercedes' success in Formula 1 can be solely attributed to their budget and resources. The question aims to explore the extent to which a team's financial resources and technological capabilities contribute to their success in Formula 1. The answer may involve discussing the role of budget and resources in enabling a team to develop a competitive car and hire top talent, as well as the impact of regulations, strategic decision-making, and teamwork on a team's success. The answer may also consider other successful teams in Formula 1 and how they have achieved success despite having different levels of resources.

DATA INTERPRETATION

Mercedes, being a rich brand, has the upper hand in budget and resources. 42% of the people believe that it is a major reason for their success. 29% do not agree with the fact. The rest of the 29% feel that it can be one of the reasons for their success stories in Formula-1.

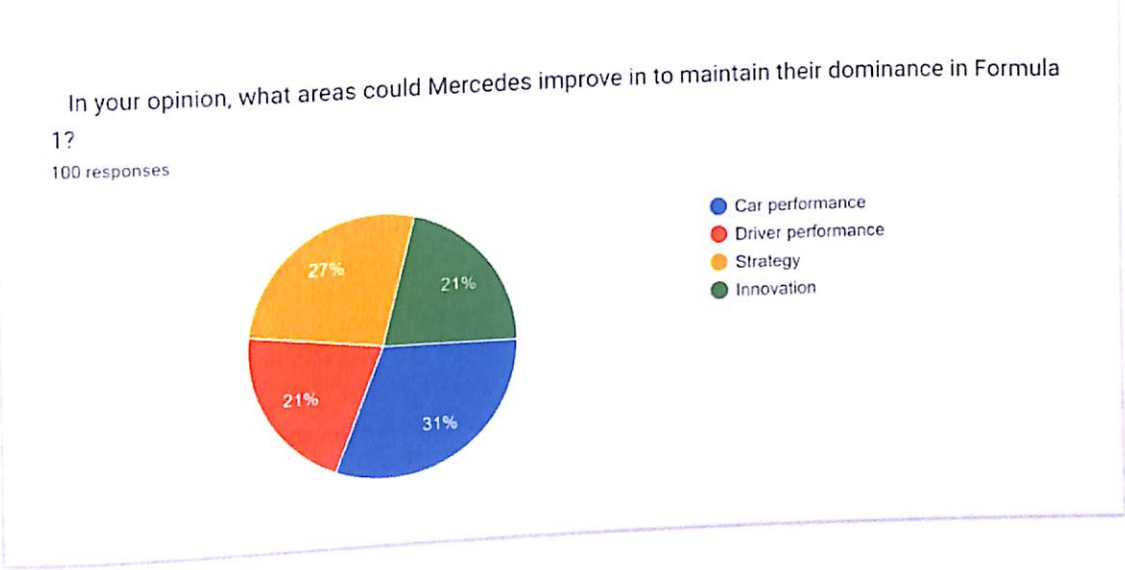


OBJECTIVE

The objective of the question is to ask for an opinion on what makes Mercedes stand out as a constructor in Formula 1. The question aims to explore the unique qualities, strengths, and strategies that have contributed to Mercedes' success in the sport. The answer may involve discussing the team's commitment to innovation, their ability to attract and retain top talent, their focus on teamwork and communication, and their track record of consistent success over the years. Additionally, the answer may also touch on the impact of the team's leadership and culture on their success, as well as how Mercedes compares to other top teams in Formula 1.

DATA INTERPRETATION

50% of people dedicate their standout to Mercedes's engineering from the rest. For 35% of people, it is their teamwork which makes them stand out. 15% of people believe in the strategy of Mercedes.

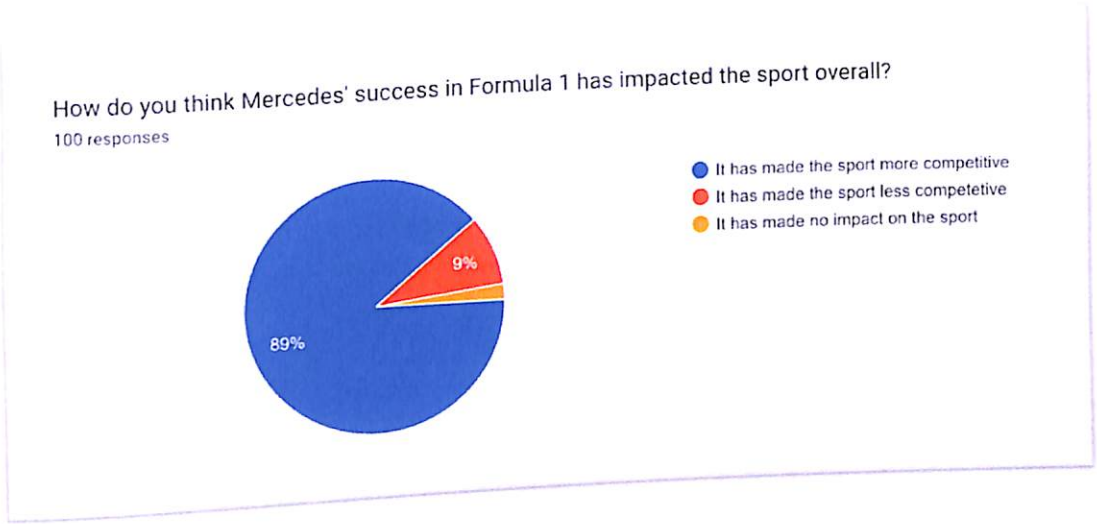


OBJECTIVE

To ask for an opinion on what areas Mercedes could improve in to maintain their dominance in Formula 1. The question aims to explore potential weaknesses or areas of improvement for the team despite their success in the sport. The answer may involve discussing factors such as car development, driver performance, strategic decision-making, teamwork and communication, and the team's overall culture and leadership. Additionally, the answer may also touch on the strengths of other top teams in Formula 1 and how Mercedes could adapt to maintain their position as a dominant force in the sport.

DATA INTERPRETATION

People have various opinions over the area of domination for Mercedes, 31% believe they need to improve their consistency in dominating the car's performance whereas 27% want them to be improved with their strategic dominance. 21% of the people expect Mercedes to improve in their dominance of innovation. The rest of the 21% want Mercedes to improve in driver's performance for domination.

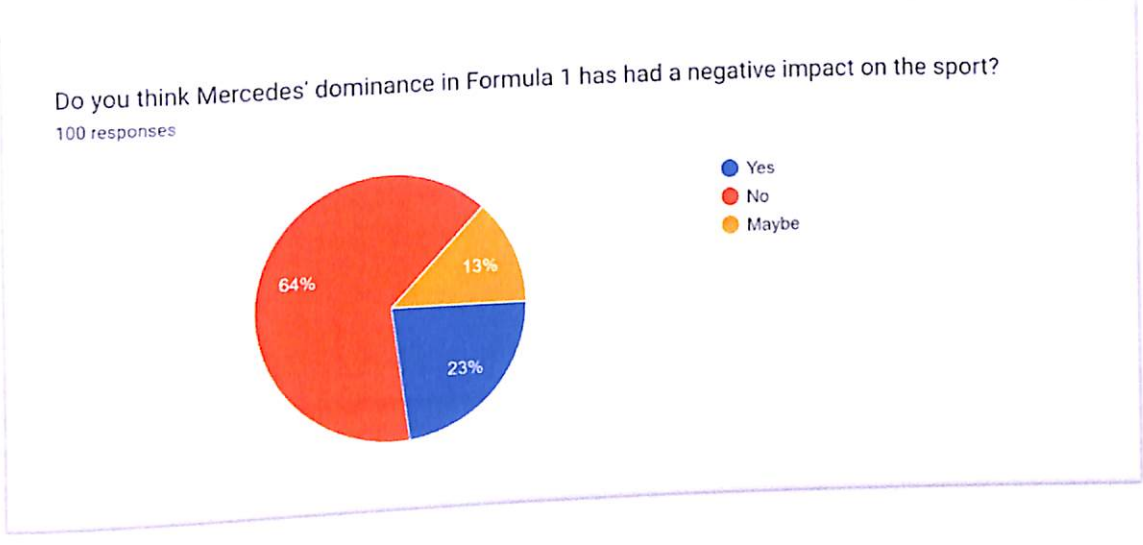


OBJECTIVE

How Mercedes' success in Formula 1 has impacted the sport overall. The question aims to explore the wider implications of Mercedes' dominance in the sport, beyond just their individual success. The answer may involve discussing how Mercedes' success has influenced car design and technological advancements in the sport, the impact on other teams and their strategies, the influence on driver development and performance, and the overall impact on the competitiveness and excitement of the sport. Additionally, the answer may also touch on the impact on the sport's fanbase, sponsorship deals, and media coverage, and how Mercedes' success has contributed to the growth and evolution of the sport over time.

DATA INTERPRETATION

It is majorly accepted by 89% of people that Mercedes has made the sport more exciting, thrilling and competitive at the same time. 9% of the people feel that Mercedes has made the sport less competitive, the rest 2% believe the brand has left no impact on the sport.

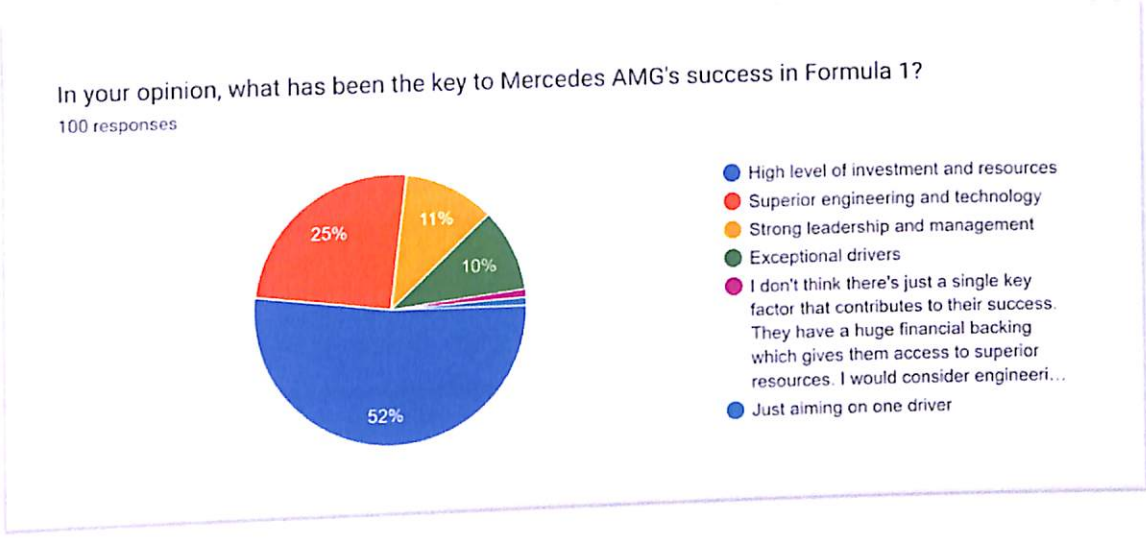


OBJECTIVE

It aims to explore the potential downsides or negative consequences of Mercedes' continued success in the sport, beyond just their individual achievements. The answer may involve discussing how Mercedes' dominance may reduce the competitiveness and excitement of the sport, limit the opportunities for other teams to succeed, or lead to a lack of variety in race results. Additionally, the answer may consider how Mercedes' dominance may affect the fans' interest in the sport, the media coverage and sponsorship deals, and the overall health and sustainability of the sport. The answer may also touch on any potential benefits or positive outcomes of Mercedes' success, as well as how other successful teams in the past have influenced the sport.

DATA INTERPRETATION

It has been accepted by 64% of people that the dominance has not created any negative impact. On the other hand, 23% of people accept the fact that Mercedes has left a negative impact on sport. The rest 13% are in doubt.

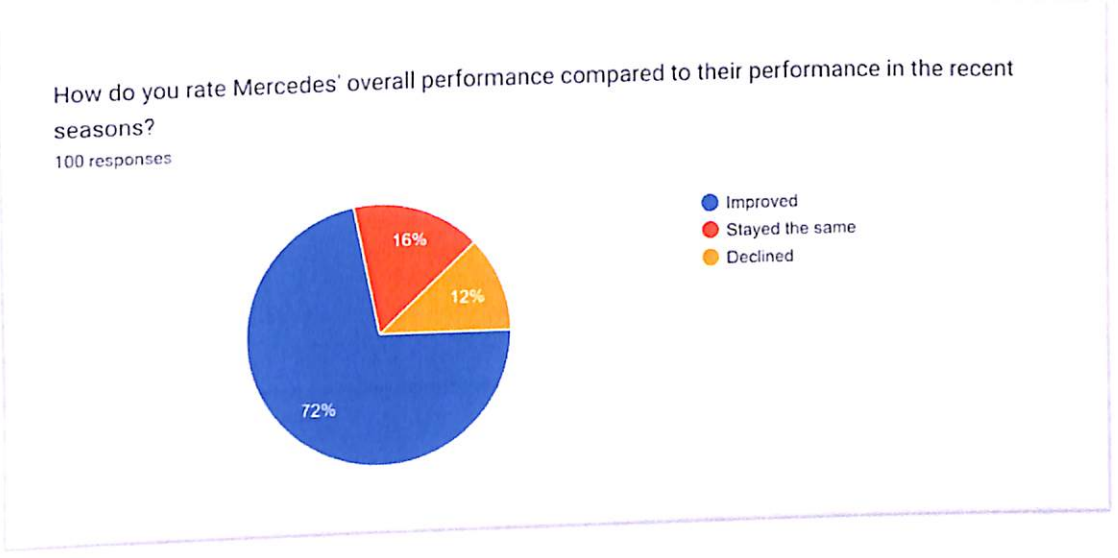


OBJECTIVE

The question aims to explore the factors that have contributed to the team's sustained success in the sport and identify any unique or defining qualities that set them apart from other teams. The answer may involve discussing the team's commitment to innovation and technological advancement, their focus on teamwork and communication, their ability to attract and retain top talent, and their strategic decision-making. Additionally, the answer may consider the impact of the team's leadership and culture on their success, as well as how their success has evolved over time in response to changes in the sport's regulations and competitive landscape.

DATA INTERPRETATION

Mercedes being the one of the richest cars in Formula-1 leaves 52% of people under the thought, that their high-level of investment and resources are the key to their success in the championship. Their exceptional engineering and technology make 25% of people believe that it is their key factor for their success. 11% of people believe that their strong leadership and management is the main reason for their victories. People falling under the 10% bracket believe the reason for Mercedes' success is their drivers.

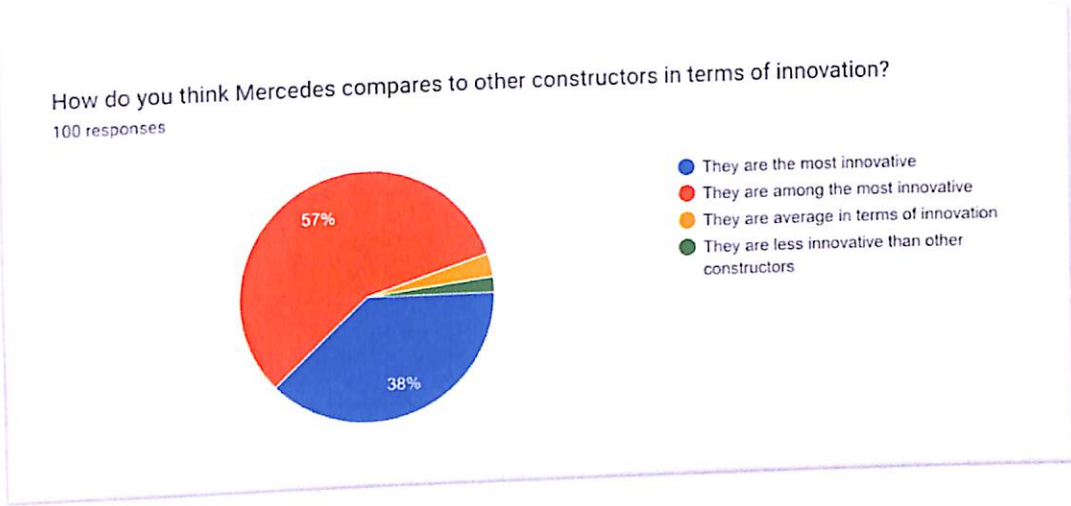


OBJECTIVE

To obtain an opinion or assessment of Mercedes' overall performance in comparison to their performance in recent seasons. The question aims to gather insights into whether Mercedes has improved or declined in terms of their overall performance, and how this has impacted their standing in the racing world. The answer may involve analyzing key metrics such as the number of race wins, championship titles, lap times, and overall team performance, among others, to determine how Mercedes has fared over time.

DATA INTERPRETATION

72% of people strongly agree with the fact that Mercedes' overall performance has consistently increased over the years. 16% of people continue to believe that their performance has stayed the same over the years. 12% of the people in the declination of Mercedes' performance.

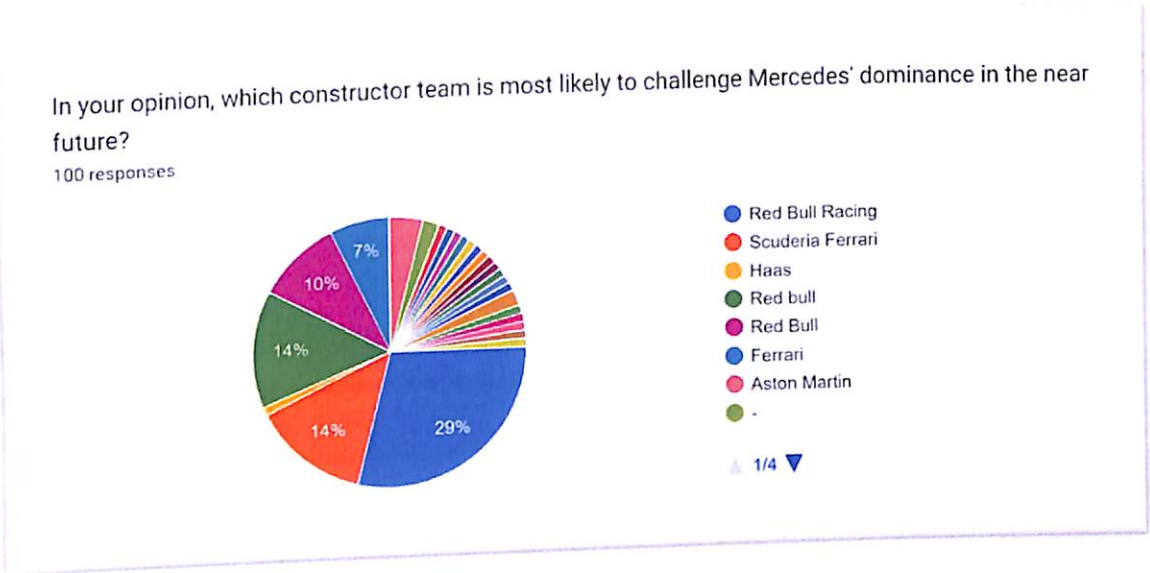


OBJECTIVE

To gather an opinion or assessment of how Mercedes compares to other constructors in terms of their innovation. The question aims to gain insights into whether Mercedes is considered a leader or follower in terms of developing new and innovative technologies or approaches within the racing industry. The answer may involve analyzing Mercedes' history of introducing groundbreaking technologies or ideas, as well as their track record of adapting to new regulations or changes in the sport. Additionally, the answer may involve comparing Mercedes' innovation strategies with those of other constructors, such as Ferrari, Red Bull, or McLaren, among others, to determine how they stack up against each other in terms of innovation. Overall, the objective of the question is to gain a deeper understanding of Mercedes' position in the racing industry and how they are perceived in terms of their innovation.

DATA INTERPRETATION

Mercedes, when compared to other constructors in terms of innovation, is believed to be among the most innovative by 57% of people. 38% of people think Mercedes is the most innovative constructor in Formula-1. 3% of people feel that Mercedes is average in terms of innovation. Just 2% of people believe that Mercedes is the least innovative.

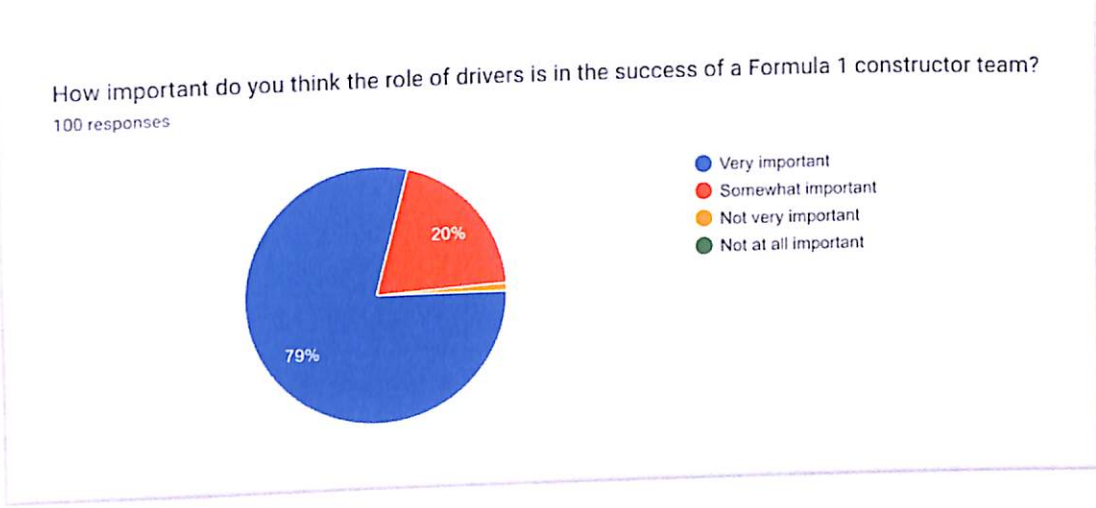


OBJECTIVE

To obtain an opinion or prediction on which constructor team is most likely to challenge Mercedes' dominance soon. The question aims to gain insights into the competitive landscape of the racing industry and how other teams are perceived to be developing in comparison to Mercedes. The answer may involve analyzing the recent performance of other teams, such as Red Bull, Ferrari, or McLaren, and identifying any key drivers, technological advancements, or strategic initiatives that could give them an edge over Mercedes in the future. Additionally, the answer may involve considering the impact of upcoming regulations or changes in the sport, such as the introduction of new power units or aerodynamic rules, on the competitive balance between teams. Overall, the objective of the question is to gain a deeper understanding of the potential challengers to Mercedes' dominance soon and the factors that could influence their success.

DATA INTERPREATATION

People have a strong faith in Red Bull for giving a tough competition to Mercedes with 60% of people agreeing to it. 30% of people think that Ferrari might give it tough competition. 5% of people have faith in McLaren. The rest of the 5% hopes that Haas will compete against Mercedes.



OBJECTIVE

To gain insights into how much credit or responsibility is attributed to the drivers for a team's overall performance and success. The answer may involve analyzing the contributions of past and current drivers, such as Lewis Hamilton, Michael Schumacher, Ayrton Senna, and others, and their impact on their respective teams' success. Additionally, the answer may involve considering the role of drivers in terms of providing feedback to the engineering and technical teams to improve the car's performance, as well as their ability to manage tire wear, fuel consumption, and race strategy. The objective of the question is to gain a deeper understanding of the perceived importance of drivers in Formula 1 and how they are viewed in relation to the success of their respective teams.

DATA INTERPRETATION

It is an important role of a driver in the success of a Formula-1 constructor team as said by 79% of people. The role of a driver is somewhat important when it comes to the success of a constructor team is believed by 20% of people. Only 1% of the people think that the role of the driver is not important.

CHAPTER 7: RESEARCH METHODOLOGY

Research Methodology:

Recently the critical aspect of research, namely research methodology, has received little attention. As a result, much research, particularly in the social sciences, involves an excessive amount of word spinning and quotes. As a result, a lot of research is pointless. In the context of planning and development, it's worth noting that the importance of the study is determined by its quality rather than its quantity. As a result, people involved in research must pay close attention to creating and following suitable techniques throughout the research process to improve the quality of the research. Although the process varies depending on the subject, the essential approach to research stays the same.

What is Research?
Research is a voyage of discovery. Research may also be defined as a scientific and methodical search for relevant information on a particular topic. Research is an art of scientific investigation. According to Clifford Woody, in his own words "Research entails defining and redefining problems, formulating hypotheses or suggested solutions, collecting, organizing, and evaluating data, deducing and arriving at conclusions, and finally carefully testing the conclusions to determine if they fit the formulating hypothesis". The goal of the research is to find answers to problems via the use of scientific processes. The major purpose of research is to uncover the truth that has been suppressed and has yet to be uncovered. Why do people undertake research? Factors such as Government instructions, work conditions, curiosity about new things, desire to comprehend causal linkages, societal thinking and awakening, and other causes may also inspire (or push) people to conduct the research.

Basic types of research are:

1. Descriptive vs Analytical:
Descriptive encompasses several types of surveys and fact-finding inquiries. The most important goal of descriptive research is to describe the current condition of circumstances. The major feature of this approach is that the researcher does not influence the variables; he can only describe what has occurred or is currently occurring. These kinds of studies include attempts by researchers to discover the causes even though they are unable to control the variables. Survey methods of various types, including comparative and correlational approaches, are used in descriptive research. Analytical research, on the other hand, requires the researcher to evaluate facts or information that is already accessible to produce a critical assessment of the material.

2. Applied vs Fundamental:
Applied research tries to identify a solution to a problem that a society or an industrial/business organization is now confronting. "'Pure' or 'basic' research is defined as obtaining data for the sake of gathering knowledge." Fundamental research is primarily focused on making broad generalizations and formulating theories. Fundamental research might include studies of natural phenomena or pure mathematics. The main goal of applied research is to find a solution to an urgent practical problem, whereas fundamental research aims to locate information that has a wide range of applications and thereby contributes to the previously structured body of scientific knowledge.

3. Quantitative vs Qualitative:
Quantitative research is centered on determining the quantity or amount of something. It can be used to describe phenomena that have a numerical value. Qualitative research, on the other hand, is concerned with qualitative phenomena, such as those involving or about quality or kind. In the behavioral sciences, where the goal is to identify the fundamental causes of human behavior, qualitative research is very significant. We may analyze the many elements that push individuals to behave in a certain way or make them like or detest a certain thing through such research.

4. Conceptual vs Empirical:
The term "conceptual research" refers to the study that is concerned with abstract ideas or theories. Philosophers and intellectuals commonly utilise it to build new concepts or reinterpret current ones. An empirical study, on the other hand, depends solely on experience or observation, typically without concern for system or theory. When the proof is needed that some factors impact other variables in some way, an empirical study is a method to go. Experiments and empirical research are now often regarded as the strongest sources of evidence for a particular idea.
All other sorts of research are variants of one or more of the above-mentioned methodologies, dependent on the study's objective, the time it takes to complete it, the environment in which it is conducted, or some other relevant feature.

Primary data:
There are basic approaches to data collections using primary methods:
Quantitative research approach:
The quantitative approach includes the creation of quantitative data that can be submitted to strict quantitative examination in a formal and disciplined manner.
Qualitative research approach:
The subjective assessment of attitudes, views, and behavior is central to the qualitative research approach. In this case, research is based on the researcher's observations and impressions. Such a method of study yields outcomes that are either non-quantitative or have not been submitted to rigorous quantitative analysis. Focus group interviews, projective approaches, and depth interviews are often utilized methodologies.
Research Design:
"A research design is a method, framework, or technique for obtaining an answer to a research topic while controlling variation."

Type of research design:
A descriptive research design was used for this project.

Research Instrument:
The instrument used for gathering data was a questionnaire. To supplement the primary data and to facilitate the process of drawing inference, secondary data was collected from published sources like websites.

Primary data:
The questionnaire aimed at discovering the underlying motives and desires. It was also designed to find out how people feel or what they think about the topic.

Secondary data:
Articles on the basic rules, designs, cars, constructors, regulations and history of association Formula-1 on the internet were the sources to the secondary data. The evolution of the sport along with the achievements of different Formula-1 players were also derived from the articles that were available on the internet.

Sample Design and Size:
In this research project, Descriptive and Applied research design is used. Judgment and convenience sampling methods will be used to get information about people's views and opinions. A structured questionnaire is prepared and a sample of 100 respondents is taken from the age category of 10 & above, wherein respondents in the category 20-30 years of age contributed the most.

Sampling Size:
It indicates the number of people to be surveyed. Though large samples give more reliable results than small samples, due to constraints of time and location, the sample size was restricted to 100 respondents.
The respondents belong to different income groups and professions.

Sampling Unit:
It defines the target population that will be sampled i.e., it answers who is to be surveyed.
In this study, the sampling unit is the people all around India.

Tools and Techniques of Analysis:
The data so far collected will be analyzed through the application of statistical techniques, such as pie charts and percentage method.

CHAPTER 8: CONCLUSION

Formula 1 is a very intense and highly competitive sport. Formula 1 provides the most elite form of Motor Racing at the highest level possible. In Formula 1, there is no dearth of competition in any field. Technology, Data Management, Sports Administration, Operations, Logistics, Engineering, Aerodynamics are all extremely key to the successful functioning of Formula 1.

Formula 1 races span out throughout an entire year. They travel all round the world to conduct races of top quality. Constructors who are already very reputed in the global automobile industry have their own team in Formula 1. Ferrari, Mercedes, McLaren, Aston Martin, Renault to name a few. There are other teams as well who have adapted to the racing fraternity and made their team and cars as competitive as possible to head-to-head with the other giants in thesport.

This study shows the level of technicality that is prevalent in Formula 1. Every team is constantly trying to redefine their machinery (their Formula 1 car) to make it better than that of the competitor's. Though Ferrari and Mercedes are one of the most successful Constructors in Formula 1, this study shows that the other Constructors are not far behind and the level of competition is on the rise. All the Constructors try to do everything possible to get ahead of their competitors and win the prestigious Formula 1 World Constructors Championship.

CHAPTER 9: RECOMMENDATION

This study of Constructors in Formula 1 has a lot of scope for research. This research provided a significant amount of learning in research, collection and identifying primary and secondary data relevant to the study and structuring a report.

This topic can be used for extensive and critical research by anyone else interested in Formula 1. If more data was available, a much closer perspective can be taken at each Constructor in Formula 1. If the study was more technical oriented, getting in touch with someone with expertise in Motorsport can be very useful and can make the study more authentic and detailed.

At an undergraduate level, this research work has been very useful and has helped me go much deeper into analyzing data and information related to Formula 1 and has also provided me with basic knowledge of how a research report should be structured.

CHAPTER 10: BIBLIOGRAPHY & ANNEXURE

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QUESTIONNAIRE

1. NAME

2. AGE

3. How long have you been following Formula-1?
   a. Less than a year
   b. 1-2 Years
   c. 2-5 Years
   d. More than 5 Years

4. Which Constructor team do you support in Formula-1?
   a. Petronas Mercedes-AMG
   b. Red Bull
   c. Haas
   d. Scuderia Ferrari
   e. McLaren
   f. Alfa Romeo
   g. Aston Martin
   h. Alpine

5. Which constructor team do you believe is the strongest in Formula-1?
   a. Red Bull
   b. Scuderia Ferrari
   c. Haas
   d. Other

6. What changes do you believe Formula 1 should make to level the playing field and increase competition among constructors?
   a. Introduce a cost cap for all team
   b. Introduce a standardized car design
   c. Change the way revenue is distributed among teams

7. How important do you think strategy is in the success of a Formula-1 team?
   a. Extremely important
   b. Somewhat important
   c. Not very important
   d. Not at all important

8. How do you think Mercedes AMG's race strategy compares to other constructor teams?
   a. They are the best
   b. They are among the best
   c. They are average
   d. They are less effective than the others

9. How do you think Mercedes AMG compares to other constructor teams in terms of its engineering and technology?
   a. They are the best
   b. They are among the best
   c. They are average in terms of engineering and technology
   d. They are less advanced than the others

10. How do you think Mercedes AMG compares to other constructor teams in terms of its driver development program?
    a. They are the best
    b. They are among the best
    c. They are average in this aspect
    d. They are less effective than the others

11. How do you rate the performance of Mercedes AMG's drivers, Lewis Hamilton and Valtteri Bottas, in the 2021 season?
    a. Excellent
    b. Good
    c. Average
    d. Poor

12. Do you think Mercedes' success in Formula 1 can be attributed solely to their budget and resources?
    a. Yes
    b. No
    c. Maybe

13. In your opinion, what makes Mercedes stand out as a constructor in Formula 1?
    a. Their Engineering
    b. Their Teamwork
    c. Their Strategy

14. In your opinion, what areas could Mercedes improve in to maintain their dominance in Formula 1?
    a. Car Performance
    b. Driver Performance
    c. Strategy
    d. Innovation

15. How do you think Mercedes' success in Formula 1 has impacted the sport overall?
    a. It has made the sport more competitive
    b. It has made the sport less competitive
    c. It has made no impact on the sport

16. Do you think Mercedes' dominance in Formula 1 has had a negative impact on the sport?
    a. Yes
    b. No
    c. Maybe

17. In your opinion, what has been the key to Mercedes AMG's success in Formula 1?
    a. High Level of investment and resources
    b. Superior engineering and technology
    c. Strong leadership and management
    d. Exceptional Drivers

18. How do you rate Mercedes' overall performance compared to their performance in the recent seasons?
    a. Improved
    b. Stayed the same
    c. Declined

19. How do you think Mercedes compares to other constructors in terms of innovation?
    a. They are the most innovative
    b. They are among the most innovative
    c. They are average in terms of innovation
    d. They are less innovative than other constructors

20. In your opinion, which constructor team is most likely to challenge Mercedes' dominance in the near future?
    a. Red Bull Racing
    b. Scuderia Ferrari
    c. Haas
    d. Other

21. How important do you think the role of drivers is in the success of a Formula 1 constructor team?
    a. Very Important
    b. Somewhat Important
    c. Not Very Important
    d. Not At all Important