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F1 Grand Prix, GP Great Britain,Silverstone CircuitNine-time British Grand Prix winner Lewis Hamilton put in a great effort to top the opening one-hour session at the Silverstone circuit. F1Technical's senior writer Balazs Szabo reports on Free Practice 1 at Silverstone.Having failed to put together a good lap on Pirelli's soft tyres, Ferrari's seven-time Lewis Hamilton delivered a 1m26.892s on his third flying lap on the C4 tyres to end up quickest in the opening one-hour session at the British Grand Prix.His fellow countryman Lando Norris was only 23 thousands of a second slowed which was enough for P2 while championship leader Oscar Piastri and Ferrari's Monegasque driver, Charles Leclerc took third and fourth respectively.Having posted strong laps early on, Mercedes driver George Russell followed in fifth for Mercedes ahead of Isack Hadjar, Williams Alex Albon, Liam Lawson.Having caused a collision at Spielberg last Sunday, Andrea Kimi Antonelli will serve a three-place grid penalty at Silverstone. The Italian was two tenths of a second slower than his team-mate Russell which saw him end up ninth fastest.Max Verstappen complained about his car during the session as he rounded out the top 10. His team-mate Yuki Tsunoda sat out the opening one-hour session, with Arvid Lindblad having piloted his RB21. The British driver took 14th, only half a second adrift of Verstappen.The Aston Martin duo of Fernando Alonso and Lance Stroll claimed P11 and P12, while Carlos Sainz ended up 14th quickest after spending a big chunk of the session in his garage.Having collected points at Spielberg, Haas driver Esteban Ocon took only 15th while his team-mate Oliver Bearman, who is completing his first British Grand Prix weekend, ended up a further three places behind.Alpines Franco Colapinto ended up P16 while Paul Aron, who substituted for Nico Hulkenberg, racked up a total of 25 laps, set the 17th quikckest lap,. On the back of a tough Austrian Grand Prix, Pierre Gasly was 19th quickest while Gabriel Bortoleto, who collected his first F1 points last time out at Spielberg, completed the order in P20. Page 2 Formula One's regulations are written and published by the FIA, the governing body of the sport that is also responsible to enforce those rules by checking cars on their legality, handing complaints and hold court cases to decide on penalties when serious rule infringements would occur.F1's current regulations can be found on the FIA website at Official FIA Formula One regulationsRegulations through timeThose technical and sporting regulations have come a long way since 1950, evolving through the need to enforce safety and curb excessive speed increases attained by the ingenuity of the engineers.Each era has its changes and innovations, ranging from turbo charged engines, wings, ground effect or KERS. Click the below timeline to inspect regulation details and modifications of each period.Why limit performance?Imagine Formula one without any restrictions by the FIA whatsoever so that engineers may go their own way. Consider the performance of a wide bodied car with wide slicks running the relatively sophisticated yet unrestricted wings of the mid 1980s, with late 1970s ground effects and side skirts (and maybe even a rear fan!), in conjunction with a fully developed 1.5 litre turbo engine, active suspension, interactive telemetry and the other computer enhancements of the 1990s.Potentially the most lethal combination of technologies would be ground effect and active suspension. The former relies on a very low but consistent even ride height to be maintained by the suspension in order for the air pressure effect to suck the car down onto the road. The latter is designed to produce a very low yet consistent even ride height to maximise the performance of the car's aerodynamics. The combination of the two would be more than just a sum of its parts. Straight-line speed would not necessarily increase, but the gains in cornering speeds would be tremendous and incredibly dangerous. The cars would barely have to brake before turning into a fast corner like the Parabolica at Monza.It sounds great in principle but in reality it would be completely undriveable, and even Gilles Villeneuve would be intimidated by the performance. To even attempt to drive such a car, drivers would have to wear airforce-style pressure suits to avoid blacking out in 6 or 7 G-force corners. They would probably also have to take amphetamines to improve their reflexes and reaction times. Special tracks would have to be built to accommodate the cars. These tracks would have to have the relatively simple design and layout of modern tracks, with only 12-16 corners, but with the immense length of the great tracks of the past to allow the cars to reach their potential in terms of cornering speeds.The speeds and the danger to drivers and spectators would be overwhelming. The consequences of a car cornering at more than 300km/h and crashing would be catastrophic.The brain is the limitThe reason for having such strict technical regulations in F1 is to deliberately limit performance, not to make the racing boring to watch or to participate in, but to make it safe for everyone involved. The real limit of performance in F1 is the human brain and body, which at this point in time cannot be tuned, retuned, modified, turbo-charged, strengthened with the honeycomb construction of composite materials, or otherwise sped up and improved to any significant extent.The F1 technical regulations encourage the achievement of excellence in one area of car performance at a time. This allows F1 to be the pinnacle of car design and technology, thus making it the testing ground of choice of the major car manufacturers, while at the same time keeping a limit on what can be achieved so that performance gains are explored and tested gradually and safely. Once a performance peak or plateau is achieved, it is deliberately limited or banned, with the technology being passed on to other sectors of car design and production, so that F1 can move on to explore the next area of performance excellence.As F1 has periodically been the testing ground of multinational car companies, new regulations are instated frequently to curb the inventiveness of engineers and the companies involved. As technology progresses, cars can potentially become ever faster if no additional rules were in place, a possibility that would severely diminish the current levels of driver safety.The most recent development in F1 regulations however is the urge to keep the sport relevant to road car technology. To prevent it from becoming an aerodynamic development race with no benefit for production cars, the FIA has recently begun to push for a more environmentally friendly set of rules, encouraging more efficient ways of propulsion. As a result, turbo engines are back, engine capacities are reduced and KERS has an increased potential.Combining the FIA research projects and input from the technical working group, ever evolving rules must ensure that F1 has a future as a sport and as a technical exercise in the face of growing governmental regulations of emissions and other environmental concerns.None of this may however limit the spectacle or the charisma of F1. Its place at the pinnacle of automotive, and advanced technological materials and electronics, development, is not in dispute. Neither is its reputation as the most innovative, stylish and sophisticated form of racing. Page 3 The front wing of a Formula One car creates about 25% of the total cars downforce. Although this only occurs in ideal circumstances. When a preceding car runs less than 20m in front, the total downforce generated by the front wing may become as little as 30% of its normal downforce. Although this reduce of drag (because the air pressure is lower behind a car's rear wing), enables higher speeds at the end of straight, it significantly hinders the pursuing car in corners, as he cannot take these at normal speeds. This problem mostly occurs in fast corners, and is one of the most important reasons of the overtaking problem currently in Formula One. It is therefore a hard job to create a performing front wing, even more because disturbing the airflow too much will affect the rest of the car's aerodynamic efficiency too.Regulations3.4 Width ahead of the rear wheel centre line : 3.4.1 Bodywork width ahead of the rear wheel centre line must not exceed 1400mm. 3.4.2 In order to prevent tyre damage to other cars, the top and forward edges of the lateral extremities of any bodywork forward of the front wheels must be at least 10mm thick with a radius of at least 5mm.3.7 Front bodywork height:All bodywork situated forward of a point lying 330mm behind the front wheel centre line, and more than 250mm from the centre line of the car, must be no less than 100mm and no more than 300mm above the reference plane.3.17.1 Bodywork may deflect no more than 5mm vertically when a 500N load is applied vertically to it 700mm forward of the front wheel centre line and 625mm from the car centre line. The load will be applied in a downward direction using a 50mm diameter ram and an adapter 300mm long and 150mm wide. Teams must supply the latter when such a test is deemed necessary. Front wing designA regular front aerofoil is made as a main plane running the whole width of the car (almost at least, limited by FIA regulations) suspended from the nose. Onto this are fitted one or more flaps which are the adjustable parts of the wing. On each end of the mainplane there are endplates. These make sure the airflow passes above and beneath the wing rather than around it. In recent years these endplates have played a crucial role in influencing the airflow around the front tyres, especially after the rule changes at the beginning of 1998 (wheelbase made smaller from 220cm to 180cm). These changes made front wing airflow interfere with the rotating airflow around the front wheels.Article 3.17 has been introduced during 1998, after teams started experimenting with bending front and rear wings. When Ferrari introduced such a front wing at the end of 1997, it was produced in such a way that the wing would flex under aerodynamic loads. This means that as the speed increased, a force was produced that pushed the wing towards the ground. By means of a ground effect, this was particularly interesting for front wings because if would increase downforce at high speeds without an increase of drag. As rear wings began to fail and flew off during races, the FIA thought it was time to act and added 3.17 to the technical regulations of Formula One.At the beginning of 2001, front wing regulations had changed in such a way, that the wing should be 100mm above the ground at least, instead of the 40mm until then. The FIA introduced this change to limit the cornering speeds of the cars. The idea was to decrease the ground effect that was generated by front wings close to the ground, working just like a diffuser.Immediately at the start of the season, Ferrari introduced a front wing that was bent down in the center line or the car. This new concept makes a handy use of a little hole in the regulations. The whole is the result of a rule, added in 1994, where the wooden bottom made it's entry. This wooden plate can be hung up as low as possible to the ground. As this plate is 50 cm wide, it was not foreseen that the front wing may be placed that low to the ground in 25cm at each side of the center of the car. Since the introduction by Ferrari, more and more teams have adopted the idea of curved front wings, with them also McLaren and Renault (see picture).Though the reason that McLaren didn't make any of those changes until 2002, might have to do with the curve of the front wing before the change of regulations. It was namely curved up in the middle, so that the inner side was higher above the ground then both outer sides of the front wing. This type of wing is mostly useful on fast tracks where not much downforce is needed. It is there that airflow in the centre of the car can be more used by the diffuser in the back instead of lifting it up and create downforce in the front.End platesAs some of the air that is needed to generate the front wing's downforce interferes with the rotating air around the front wheels, F1 teams have been developing the end plates from a simple plate to an integral part of the wing. To overcome the main problem of turbulence around the wheel, McLaren, and later Ferrari made in 1998 the inside edges of the front wing endplates curved to direct the air between both front wheels. One year after, all teams had adopted this technique to maintain front wing efficiency. Some other teams decided to decrease the width of the main plane just to the width between the front wheels. This left some room for extra wings and flaps, which caused the beginning of intensive end plate research. In 1998 changes were so radical that Ferrari produced six different designs of front wings throughout 1999, in order to reclaim the lost downforce by regulation changes. Page 4 The basic principle of a formula one wing is exactly the same as with a common aircraft. The greatest difference is the direction air is pressed and how that aerodynamic force is generated. Knowing that an aircraft wing does the opposite of an F1 wing, I'll explain a formula one wing. I will start from the idea that we are testing a single rear wing in a wind tunnel. The main advantage of this theoretical example is that it leaves out some natural factors. With a single wing, we do not have to think about turbulence that is generated by the car itself (the engine cover mainly), neither do we have to take in account the direction and speed of outside wind. It is obvious that both these factors decrease the efficiency of a aerofoil.As you can see in the picture below, air flows onto the rear wing with a straight direction (which is often called clean air) at the speed of the car. The white flaps push the air up. Following Newton's law, an action causes a reaction, which is why the aerofoil is being pushed towards the ground by the air. Having in mind that air flowing onto the flaps is pushed upwards, and under flowing air keeps going its own way, a low pressure area (nearing a vacuum at very high speeds) is created right behind the horizontal aerofoils. This 'vacuum' causes a suck up of the air passing under that flap. The air passing underneath on the other hand again flows faster in an attempt to equalize pressure on both sides of the aileron, and thereby increasing the total wing efficiency. Because of the car's speed this is impossible, which is why the effect is maintained. The force that is created by this type of wing, so that the car is pressed onto the ground, is called downforce. Straight forward gong air at the speed of the car. Rear wingsAbout a third of the car's total downforce can come from the rear wing assembly. The rear wings are the ones that are varied the most from track to track. As the rear wings of the car create the most drag the teams tailor the rear aerodynamic load to suit a particular track configuration.As air flows over the wing, it is disturbed by the shape, causing a drag force. Although this force is usually less than the lift or downforce, it can seriously limit top speed and causes the engine to use more fuel to get the car through the air.From the year 2001, the FIA regulations have changed concerning the rear wing. To increase the ability of overtaking and slipstreaming, the number of rear wing elements is now being limited to 3. This should decrease the downforce and acceleration. The only effect that might have come with this regulation change, is at high downforce circuits, there will be a little more air resistance to produce the same downforce.The pictures below both show David Coulthard in his MP4/17 from 2002. The picture of the left shows him at Monza 2002, whilst the picture on the right was taken at the Nurburgring. You can see that the rear wing profiles are very different. On the left picture, very little of the rear wing can be seen, whilst the Monaco wing has much of the profile visible:The diffuserThe smallest thing which you can count to the wings part is the diffuser. Actually, it does exactly the opposite of a rear or front wings. Instead of pushing the air up, it sucks the air up. The volume of the diffuser increases towards to the end of the car. Where a certain amount of molecules filled for example 1dm under the car, these now fill 2dm. This drop of pressure causes a car to be sucked towards the ground. Driving at a speed of 300 km/h, the groundeffect of the car would be extreme if there was no air under the car itself. Therefore, the FIA has forbidden strokes and sloping car bottoms because of safety reasons. Instead of raising the back of the car, the diffuser sucks the air away from under the car because the low pressure. The diffuser us placed under the rear wing and is actually a sweep up of the car's floor. It consists of many tunnels and splitters which carefully control the airflow to maximize this suction effect. The design of the bottom of the car, and thereby the diffuser is a critical area, because it can greatly influence the car's behaviour in corners. More importantly, the designers have to be careful that the car keeps working good in all circumstances, and at any distance from the ground. Losing all of the diffuser's generated downforce when riding over a curb will greatly generate a nervous behaviour of the car itself. The strokes and flips withing the diffuser have lately become that advanced (curbed and even foreseen by gurney flaps sometimes) that any track distance is insufficient to guarantee good performance. It is still a part where a lot of time can be gained on current F1 cars, partly by pulling more air towards the diffuser by inducing the coke-bottle effect. Page 5 Aerodynamics is the science that studies objects moving through air. It is closely related to fluid dynamics as air is considered a compressible fluid. Nowadays, aerodynamics is the utmost important factor in Formula One car performance. It has even nearly become one of the only aspects of performance gain due to the very marginal gains that can currently be made by engine changes or other mechanic component development. This downforce can be likened to a virtual increase in weight, pressing the car down onto the road and increasing the available frictional force between the car and the road, therefore enabling higher cornering speeds.Furthermore, as Formula One teams have the greatest resources to develop aero efficiency of its cars, the greatest strives are made here. F1 teams have unrivalled CFD computing power and at least one full time wing tunnel, only for validating and improving their designs.While basic aerodynamic methods and formulas can be simply resolved, other properties are verifiable with empirical formulas. More complex shapes such as airplanes or racing cars are however impossible to calculate precisely, rendering computational fluid dynamic systems (CFD applications on super computers) and wind tunnels an absolute requirement to validate designs.Application in Formula OneF1 (and in general, all winged racing cars) can be considered to be canard configurations in the sense that the front and back wings are on opposite sides of the centre of gravity and both are "lifting" (strongly) in the same direction, in this case creating downforce.From a spectator's point of view, a car can be considered in (at least) 3 parts: the front wing, the car's body and the rear wing. Each of the parts can be optimised for the required downforce at a minimum of drag. Practically however, every component has its influence on the behaviour of the car and cannot be regarded as an individual component. As a result, no element is tested individually, but always a complete scale model of a car.Because a complete racing car is a very complex system, teams of engineers usually evolve the car step by step, developing a particular item and check its effect on the car. Such overall effect can then be calculated with Amdahl's law:Here is the fraction of the system (when this fraction generates 5% of the car's drag, then is 0.05) that can be improved, is the improvement factor on this fraction (division of the drag in Newtons and the new drag force after improving that element), and is the overall improvement that will be achieved.After verifying its improvement, the car's efficiency is determined and then simulated on different tracks to see on where it is useful. That usefulness is always theresult of a reduction in drag or an increase in downforce.DragDrag is the aerodynamic force that is opposite to the velocity of an object moving through air (or any other fluid). Its size is proportional to the speed differential between the air and the solid object. It is therefore unimportant if either the air is moving around a static object or if the object is moving at a speed through static air.Drag comes in various forms, one of them being friction drag which is the result of the friction of the solid molecules against air molecules in their neighbourhood. Friction and its drag depend on both the fluid and the solid properties. A smooth surface of the solid for example produces less skin friction compared to a rough one. For the fluid, the friction varies along with its viscosity and the relative magnitude of the viscous forces to the motion of the flow, expressed as the Reynolds number. Along the solid surface, a boundary layer of low energy flow is generated and the magnitude of the skin friction depends on conditions in the boundary layer.Additionally, drag is a form of resistance from the air against the solid moving object. This form of drag is dependent on the particular shape of a wing, and is therefore called form drag. As air flows around a body, the local velocity and pressure are changed, effectively creating a force.Interference drag or induced drag on the other hand is the result of vortices that are generated behind the solid object. Due to the change of direction of air around the wing, a vortex is created where the airflow meets unchanged, straight flow. The size of the vortex, and thereby its drag strength increases with an increasing angle of attack of the aerofoil. As a primary source of possible drag reduction, Formula One teams try to counteract this drag by adding end plates to wings or with fillets at the suspension arms.Other sources of drag include wave drag and ram drag. The first is unimportant for normal racecars as it occurs when the moving object speeds up to the speed of sound. Ram drag on the other hand is the result of slowing down the free airstream, as in an air inlet.The amount of drag that a certain object generates in an airflow is quantified in a drag cofficient. This cofficient expresses the ratio of the drag force to the force produced by the dynamic pressure times the area. Therefore, a of 1 denotes that all air flowing onto the object will be stopped, while a theoretical 0 is a perfectly clean air stream.At relatively high speeds, ie. at high Reynolds number (), the aerodynamic drag force can be calculated by this formula:where is the force of drag (in Newton), the density of the air, the speed of the object relative to the fluid (in m/s), the reference surface and the cofficient of drag. Note the minus sign and the vector which indicate that the resulting drag force is opposite to the movement of the object.DownforceAerofoils in motorsports are often called wings, referring to aircraft wings. In fact they are very similar. F1 wings and winglets aim to generate high downforce, by having a high angle of attack, thus also increasing the drag of the aerofoil.The evolution of aerofoils to what they are now is mainly thanks to the genious and research of a few well known scientists. In 1686, Sir Isaac Newton presented his three laws of motion, one of them being the conservation of energy. He stated that energy is constant in a closed system, although it can be converted from one type to another. Out of that theory, Daniel Bernouilli deducted a formula proving that the total energy in a steadily flowing fluid system is a constant along the flow path. An increase in the fluids speed must therefore be matched by a decrease in its pressure. Adding up the pressure variation times the area around the entire body determines the aerodynamic force on the body.An aerofoil's operation can be easily explained when you consider a wing in a steady, laminar flow of air. As air is a gas, its molecules are free to move around and may have a different speed at different locations in the airstream. As downforce generating aerofoils are mostly designed with more thickness on the lower side, the lower airstream is slightly reduced in surface, hence increasing the flow speed and decreasing the pressure. On top of the wing, the airspeed is lower, and thus the pressure difference will generate a downward force on the wing. Additionally, and in line with Newton's third law of motion, downforce wings are never straight and induce a new turning of the airflow. More specifically, the shape of the wing will turn air upwards and change its velocity. Such speed creates a net force on the body.This shows that a force causes a change in velocity , or also, a change in velocity generates a force. Note that a velocity is a vectorial unit, having a speed and a direction component. So, to change of either of these components, you must impose a force. And if either the speed or the direction of a flow is changed, a force is generated.It is very important to note that the turning of the fluid occurs because the molecules of the fluid stay in contact with the solid body since the molecules are free to move. Any part of the solid body can deflect a flow. Parts facing the oncoming flow are said to be windward, and parts facing away from the flow are said to be leeward. Both windward and leeward parts deflect a flow. Ignoring the leeward deflection leads to the incorrect "skipping stone" theory of lift.You can simulate airflow around a simple aerofoil with NASA's Foilsim toolkit.Downforce is however often explained by the "equal transit time" or "longer path" theory, stating that particles that split ahead of the aerofoil will join together behind it. In reality however, the speed difference of air particles above and below a wing is much larger than what is expected with this theory.While these simplified versions are the basics of lift and downforce generation, the reality can hardly be simplified and is a complex study, requiring high power computer systems. For a gas, we have to simultaneously conserve the mass, momentum, and energy in the flow. Hence, a change in the velocity of a gas in one direction results in a change in the velocity of the gas in a direction perpendicular to the original change. The simultaneous conservation of mass, momentum, and energy of a fluid (while neglecting the effects of air viscosity) are called the Euler Equations after Leonard Euler. Several computer algorithms are based on these equations to make an approximation of the real situation.Because of the complexity, today's Formula One cars are designed with CFD (computational fluid dynamics) and CAD (computer aided design) that allows engineers to design a car, and immediately simulate the airflow around it, incorporating environmental parameters like traction, wind speed and direction, and much more. Page 6 Analysis by Russell Harrison This rear wing design was sent to me by a young budding engineer from Spain named Mr Bernat Carreras. The model was cleaned by Keith Young and further cleaned in CFX. This was his first attempt at wing design and he had limited CAD experience. However, it was agreed to run a CFD analysis on the rear wing design. I believe the airfoils are not based on published designs. There were clearly a number of design issues with the rear wings, including the severity of the camber designed in to the airfoils, which was believed to lead to early flow separation.Image 1 shows the rear wing geometry after geometry cleaning.MeshA mesh picture is currently not available, but will try and post one if anyone wants to see one. The mesh parameters applied to the model included refined inflation layers for more accurate boundary layer analysis. The mesh engine used was the default AFI mesher using triangular surface mesh elements. The mesh data, after volume meshing, is given below: Mesh Modes: Volume = AFI, Surface = Delaunay Total Number of Elements: 1,045,075 Total Number of Tetrahedrons: 851,941 Total Number of Prisms: 191,520 Total Number of Pyramids: 1614 Total Number of Faces: 54,828 Flow ConditionsA simple analysis of the rear wing was carried out, ignoring any body interactions with the Formula 1 vehicle. The results from analysis can therefore only be used for initial design of the wing system, and all body interactions must be included and analyzed in further design modifications. The flow velocity at inlet was set at 62.22 m/s (140 mph, 224 KPH) and this was also applied as an global initialisation velocity . All walls of the fluid domain were set to free slip and a no-slip condition applied to the bodies surface.Fluid Properties: Material: Air Ideal Gas (constant Cp) Molar Mass = 28.96 Kg Kmol -1 Dynamic Viscosity = 1.79e-5 Kg m-1 s -1 Simulation Properties: Domain Motion: Stationary Reference Pressure = 1e5 Pa Fluid Temperature = 288 K (this can be changed and re-run to suit a specific circuit the wing will be run on) Turbulence Model = SST Turbulence = Medium Intensity and Eddy Viscosity Ratio SolutionThe residual target for convergence was set to e-4 at an RMS type. This was achieved during solution. Total Run times was 1 hour, 39 Minutes, 18.468 Seconds.ResultsIt can be seen from the results (image 2 and 3) that the initial concern of wing stall is clearly apparent. The small flap has completely stalled as has the trailing edge of the main top element. This, obviously greatly reducing the negative lift (downforce) also brings the penalty of increased form drag. It is also clearly visible from images 3, 4 and 5 that with the top front element of the wing system only the upper surface is experience downforce producing effects (positive pressure), however, at the lower surface of the element positive pressure is also present (thus canceling out the positive pressure of the top surface). This lower surface positive pressure is caused by the bi-plane phenomenon, in that the wing elements are vertically to close to each other . There is also noticeably early separation of the thin aerofoil profile of the top front wing element (separation occurs around half the chord)The poor design of the end plates and positioning of the wing elements has led to large vortex production, the effects of these vortices is to produce a downwash in the area between the them, which results in reduced negative lift (this is high for low aspect ratio wings, since the vortices are closer to the wing) and small for high aspect ratio wings).Force DataDownforce = 1285.26 N, Drag = 374.543 N, Pitching moment = 122.388 Nm Page 7 Wind tunnels in general are used for testing purposes and aerodynamic optimization. They are specially designed to simulate airflow like in open air and flow velocity as close as possible to reality.It is of great importance to avoid anomalies, because a slight difference in airflow may change the behaviour of the tested object, and furthermore provide false information to the aerodynamicist, who consequently make the wrong decisions.Two main typesThere are in fact two main types of windtunnels. One type is called open circuit tunnels with an air entry open to the atmosphere. The best way to construct such a tunnel is a blower configuration, where a fan is located at the entry of the tunnel, and blows the air into it. Although the entry swirl is a possible problem, blower tunnels are in general much less sensitive to entry conditions than suckdown tunnels. The exit flow from a centrifugal blower is nonuniform and turbulent, but without the low-frequency unsteadiness of flow entering directly from a room. This type of windtunnel will not be further highlighted, because they are not considered to be the first choice for F1 development.The most interesting type of tunnels are the closed circuit windtunnels. Also called "racecourse" or "closed-return", which are usually powered by axial fan. Closed-circuit tunnels have more uniform flow, in principle, than open circuit tunnels. These are the usual choice for large tunnels (thus also for Formula One), but care is needed to maintain good flow at the entrance to the contraction. The flow at exit from the fourth corner (counting from the test section) is typically not much better than the exit flow from a centrifugal blower, although the corner vanes themselves have some effect in reducing turbulence (they can be regarded as honeycombs with walls in one direction only).Windtunnels in F1Aerodynamicists speak of F1 windtunnels as a type of low-speed closed circuit tunnels. This means we are talking of airspeeds between 10 and 100 m/s approximately, and tunnels in which the same air is recirculated. The stream is turned, typically by 4 90° corners, each provided with turning vanes placed aside of each other, to prevent turbulence in the corners.There is always a small vent, called a "breather", somewhere in the circuit so that the internal pressure does not increase as the air heats up during the run. The breather is best located in a part of circuit where inner air is close to atmospheric pressure. Usually that is around the perimeter at the downstream end of the test section. This compensating inflow through the breather is bad for diffuser performance but easy to detect by releasing smoke just outside the breather.Although some older tunnels have "open jet" test sections (part of the tunnel in the observation chamber), with a floor but no walls or roof (attributed from Gustav Eiffel), this type is not recommended for high performance testing.Axial FansAs said before, most closed-circuit tunnels are driven by axial-flow fans, which produce a static pressure rise (with no appreciable change in axial velocity or dynamic pressure). The design of axial fans for tunnels is a very complex matter. It is why F1 windtunnels usually have a specially designed fan to maximize the performance and decrease side effects.Because shockwaves might disturb regular airflow at fans with a high tip-speed (axial speed at the tip of a fan blade), fans are developed to keep to tip-speed as low as possible, not more than two or three times the local axial velocity. This causes the blade arrangements to resemble to an axial-flow compressor, with a stator row in front of the rotor. As a return to uniform, non-swirling flow is necessary, the diameter of the central nacelle ("boss", "hub", in which the engine may reside) is kept relatively small, rarely exceeding 50% of the fan diameter. As a result the space between adjacent blades, measured around the circumference, varies considerably from root to tip.F1 windtunnel fans are usually mounted downstream of the second corner, where the cross-sectional area is two or more times that of the test section. It needs no explanation that a large fan can run at a lower speed to generate the same airflow, thus needing less rpm and reducing vibration, noise and power consumption.An example of such a fan can bee seen in the picture on the left, which shows the fan of the Sauber wind tunnel at Hinwill. Note that the engine is located in the boss of the fan, which only consists of less than half the fan's diameter.More information about axial-flow fan design is given by R. Allan Wallis, Axial Flow Fans and Ducts, Krieger Publishing Company (November 1991).F1 specialtiesBecause of the very need of high performance, F1 wind tunnels have, apart from the fypical extreme optimizations, special features that increase testing abilities: Rolling road: the floor of the windtunnel testing area is made to simulate the track. The idea is to make the track move under the car at the same speed as the air flows around the car. This might seem a worthless feature, but it is in fact far from that. The fact is the simulation is now complete with rotating real tyres. Tyres rotate rapidly at 300km/h, and they are thereby generating a lot of turbulence. The airflow around the wheels is substantially different with rotating wheels compared to a measurement with static floor. Ride height simulation: When testing a formula one car, it is fixed to stay in its position with a carbon bar fixed to the car above the air happer. In most current tunnels, these bars have hydraulic systems that allow engineers to adjust ride height with a precision of 0.01 mm, thereby also measuring the resistance provided by the suspension. F1 windtunnels examples RenaultCompletion 1999Ensonte, UK Where the Ferrari F1-75 and the Mercedes W13 were already vastly different beast when it came to sidepod design, their 2023 contenders are even more contrasting.Taking a quick look at the way they have approached the airbox and engine cover design it is clear that Ferrari's SF-23 has a very slim, triangular airbox that rapidly converges in the flat, black vertical panel required to meet the minimum surface regulations. The bodywork at the back is so closely packaged that you can vi... Read more A clear trend that has been going on even before the current set of regulations is for teams to move components closer towards the car's centreline. This trade-off has everything to do with an attempt to aerodynamically optimise the sidepods. Since most teams now agree the latter need to feature a downward slope towards the rear, components needs to be put elsewhere.Alpine's A523 is no different and also follows the 2023 trend of further enlarging the car's shoulders to guide hot a... Read more Mercedes's F1 W13 car at today's Bahrain pre-season test turned out to be a different beast compared to what the team tested at Barcelona two weeks ago. The team have made it a tradition to use an early version of the development to test first before introducing the latest and greatest aerodynamic developments in the final test before the season kicks off. Eyes turned when the car was revealed with a major development of the sidepods and floor.Though the BCN iteration already featu... Read more Red Bull Racing have once again produced a very interesting car with its RB18, a car that was well hidden until it his the track today at Barcelona. Apart from its particular sidepod shape, the rear end boasts some significant details in an uncharacteristically high downforce set-up, especially compared to what Ferrari is testing on day 1 at Barcelona.The RB18 for instance features sidepods that slope down, creating a ramp for airflow to continue over the diffuser. While some other... Read more Ferrari have gone radical in their approach to this year's F1 75 contender, not least by the design of their sidepods that are very unlike anything else seen so far. A dented upper surface and a flat sidewall are its most intricate details that quickly triggered the aerodynamicists' interest. To validate Ferrari's approach and stop guessing in the dark, forum and F1T team member Vanja#66 made a new car model and ran some CFD analysis, with surprising results!It is clear that Ferrar... Read more Lots of people were stunned by Alpine's decision to fix a bulky airbox on the A521, but the team have already run their new car today with a new, more compact design that sees the rear end of the car considerably slimmed down. Along with the airbox that now tapers down more more quickly, the sidepod air outlets are smaller, leaving a lot more room low above the car's floor for clean airflow.As the image shows, Alpine were focusing on front end aero on Friday morning with a rake fit... Read more Mercedes's secrecy about their car's floor triggered the interest of many ahead of winter testing. Though the team were perhaps most clear about it, others similarly tried to not reveal too much about the floors, as this area is where teams had to adapt their designs to comply with the modified regulations without losing too much downforce.The reduced floor width towards the rear wheels meant teams had to redesign an aerodynamic area that is crucial for the efficiency of the diffus... Read more Even though most teams still use the S-ducts, even when featuring narrow nose likes like on the Renault RS20 or Mercedes W11, it seems like McLaren will once again opt against an S-duct. Last year, with the introduction of the MCL33 car, the team switched to a narrow nose, and at the same time ditched the S-duct. It might be less advantageous to have an S-duct with a narrow nose, but the most likely reason why McLaren opted against is to be able to package things closer, while still... Read more Alfa Romeo have maintained a similar front-end philosophy compared to what featured on its 2019 contender. While many other teams went for narrow noses, Alfa stuck with the regular, flat-top nose cone with apertures at the tip of the nose to feed the S-duct.The picture shows how the new Alfa continues to feature a very wide S-duct outlet, almost the entire width of the nose cone and just a few centimeters in height.Left and right of it are new winglets since the second test at Bar... Read more The second week of pre-season testing at Barcelona saw Red Bull Racing bring a fairly considerable aerodynamic update to its RB16, featuring detail changes on the front wing and the diffuser. The most obvious change was however the change in the barge boards where the team have now joined Mercedes and Ferrari in having louvres as sidepod panels, instead of only vertical deflectors.The new design, at least in this area, is very similar to that from Mercedes with a number of flaps pu... Read more In total there are 833 users online :: 32 registered, 1 hidden and 800 guests (based on users active over the past 5 minutes)Most users ever online was 8132 on 24 Jan 2025, 09:29 Registered users: ADmantX [Bot], Airshifter, Amazon [Bot], AR3-GP, Baidu [Spider], Barkrowler [Crawler], Big Gun, Bing [Bot], BLEX [Bot], Bytespider [Crawler], ChatGPT User [Crawler], Claude [Bot], Clickagy [Bot], Criteo [Bot], Dot [Bot], euv2, Facebook [Crawler], gavingav1, Google Adsense [Bot], Majestic-12 [Bot], Metadata [Scraper], Nutch [Bot], OpenAI Search [Bot], Peer39 [Crawler], Petal [Bot], Proximic [Spider], SEMrush [Bot], TheTradeDesk [Scraper], Tiny Tiny RSS, Trendiction [Bot], Twitter [Bot], Yandex [Bot] Legend: Administrators, Moderators, Writers Page 2 Post here all non technical related topics about Formula One. This includes race results, discussions, testing analysis etc. TV coverage and other personal questions should be in Off topic chat. chrisc90 41 Joined: 23 Feb 2022, 21:22 Post 07 Feb 2023, 23:33 All joined up. Tough budget this year. Especially when Verstappen is ~7million more than anyone else. I have my driver line up planned I think, just struggling with the cars with what I want and whats realistic budget wise. Mess with the Bull - you get the horns. Stu Moderator Joined: 02 Nov 2019, 10:05 Location: Norfolk, UK Post 08 Feb 2023, 11:29 Im going to wait until testing before selecting my squad, if I learned one thing last year it was to carefully select your teams as driver choices can be made within the individual race predictions!! Perspective - Understanding that sometimes the truths we cling to depend greatly on our own point of view. chrisc90 41 Joined: 23 Feb 2022, 21:22 Post 08 Feb 2023, 12:15 Ive gone for MaxAlonsoDe vries Max will bring home some good points - we know that. Alonso is consistent, and I think de vries will do well in a decent midfield car Car wise. Mercedes - reluctantly due to budget but their drivers are consistent top 6 so should get some points there. Aston Martin - generally okAlpha tauri Mess with the Bull - you get the horns. CMC 1 Joined: 01 Feb 2023, 01:17 Post 09 Feb 2023, 18:01 First timer in the Fantasy League here. I read the rules in full, but I have a question after doing so. Does unused budget from a given week carry over and become usable during subsequent weeks?Cheers to everyone for an enjoyable season! Last edited by CMC on 09 Feb 2023, 18:01, edited 1 time in total. chrisc90 41 Joined: 23 Feb 2022, 21:22 Post 09 Feb 2023, 19:32 Your budget will stay with you throughout the season. So if you decide to make a change, you use the 70million budget you started with at the end of the season.From memory, Im not sure if the prices alter with driver performance through the season, so you could lose out, or gain, on budget. But only if you make changes. I THINK! Mess with the Bull - you get the horns. Stu Moderator Joined: 02 Nov 2019, 10:05 Location: Norfolk, UK Post 09 Feb 2023, 20:01 Values do change through the year, so if a driver value increases that can be to your advantage Perspective - Understanding that sometimes the truths we cling to depend greatly on our own point of view. chrisc90 41 Joined: 23 Feb 2022, 21:22 Post 09 Feb 2023, 20:02 Stu wrote: Values do change through the year, so if a driver value increases that can be to your advantage Or disadvantage if you need to change drivers/teams! Mess with the Bull - you get the horns. CMC 1 Joined: 01 Feb 2023, 01:17 Post 09 Feb 2023, 20:27 Thanks for the answer, Chris. I think I have it now, but let me propose an example based on the team you listed, to be sure: Prior to race 1, every contestant has $75M available to build their team (looks like paying to upgrade to a Pro Elite account increases that budget to $80M, but let's never mind that for now). From above, your team at this time is: VER - $27.5MALO - $9MDEV - $4M~~~~~~~~~~~~MB - $20MAM - $8.5MAT - $6M all of which puts you bang-on the $75M budget with no cash left over. After race 1, the valuation of each asset can change, although the price you paid for them didn't change. So let's just say ALO does well in Bahrain and his stock rises, while none of your other assets change in value (for simplicity of the example). If the market value of ALO goes up to $11M after race 1, you could hypothetically sell him from your team, and now you'd have the $0 left over from your original team budget + $11M for releasing ALO. That total of $11M is your available budget to sign another driver to complete your team. Conversely, if ALO's value went down to $7M and you chose to release him, you'd only have that $7M available for a different driver, and your team's market value would then be lower than the original budget. And I see changes are limited after the second race, and making additional changes beyond that limit costs championship points.I think I understand, and it sounds like a good system (other than the paid upgrades, but I understand the site needs to earn money somehow). But please let me know if I've got it wrong! chrisc90 41 Joined: 23 Feb 2022, 21:22 Post 09 Feb 2023, 20:41 Thats how I understand it Mess with the Bull - you get the horns. hollus Moderator Joined: 29 Mar 2009, 01:21 Location: Copenhagen, Denmark Post 10 Feb 2023, 22:25 I think you got it right, CMC. A caveat: Last season they promised, in the rules, that no driver or team value would ever deviate more than 3M from their initial values... only for exactly that to happen. TANSTAAFL CMC 1 Joined: 01 Feb 2023, 01:17 Post 10 Feb 2023, 23:13 hollus wrote: I think you got it right, CMC. A caveat: Last season they promised, in the rules, that no driver or team value would ever deviate more than 3M from their initial values... only for exactly that to happen. Thanks hollus, I appreciate the input.There is a clause like that in this rule set, also, but the way it's stated is that value changes are capped at a maximum of $3M per race (not only relative to their initial value)."Prices will change in increments of $0.5m and any changes are capped at a maximum of $3m per race to avoid wild swings." chrisc90 41 Joined: 23 Feb 2022, 21:22 Post 10 Feb 2023, 23:18 I dont really understand the driver swapping concept.I mean if a driver is underperforming, and you swap him out, then your going to lose money, and there's a very high chance that any budget remaining is going to be either nothing or 1million. I cant see many players not having more than 1million spare. So in reality, if you swap drivers, your going to have to swap for a driver of less 'talent' in-game than the one your selling, as the chances of being able to afford a 'better' one, after you have lost money, and a chance the other driver has increased in value, are very slim. Mess with the Bull - you get the horns. hollus Moderator Joined: 29 Mar 2009, 01:21 Location: Copenhagen, Denmark Post 10 Feb 2023, 23:21 CMC wrote: 10 Feb 2023, 23:13hollus wrote: I think you got it right, CMC. A caveat: Last season they promised, in the rules, that no driver or team value would ever deviate more than 3M from their initial values... only for exactly that to happen. Thanks hollus, I appreciate the input.There is a clause like that in this rule set, also, but the way it's stated is that value changes are capped at a maximum of $3M per race (not only relative to their initial value)."Prices will change in increments of $0.5m and any changes are capped at a maximum of $3m per race to avoid wild swings." Ahh, thanks. Per race. TANSTAAFL hollus Moderator Joined: 29 Mar 2009, 01:21 Location: Copenhagen, Denmark Post 18 Feb 2023, 15:45 A reminder that team changes are free until the third race (is this new? Was it the second race last year?), and then there are 6 free changes for most users.From the rule set:All players benefit from unlimited changes until the lockdown for the third race weekend, to allow some experimentation and then players free changes allocation will be limited, as laid out below: Rookie/Rookie Plus 6 free changes per season Pro 15 free changes per season Pro Elite 40 free changes per seasonEvery change over and above the allocation will cost 10 points. As you will quickly determine, these penalties can quickly add up. TANSTAAFL F1Having lacked long-run pace in the Spa F1 Sprint, Ferraris eight-time F1 race winner Charles Leclerc was left surprised after grabbing third place...F1Assessing his day at Spa-Francorchamps, Mercedes driver George Russell was left to lament his car's performance after failing to challenge any...F1Having bounced back from a difficult Fridays qualifying session at Spa-Francorchamps, McLarens Lando Norris claims that his car has been feeling...F1Having suffered his a shock Q1 exit in Fridays sprint qualifying, Ferraris seven-time world champion Lewis Hamilton endured similar fortunes in t...F1Seven-time Formula One World Champion Michael Schumacher is still the most successful F1 driver in the history of the Belgian Grand Prix, whilst Fe... Ahead of the fifth round of the 2025 F1 season that takes place at Jeddah, F1Technical's senior writer Balazs Szabo takes a look at how many power unit components drivers have used so far during the opening leg of the championship.For the 12th year running, the 2025 F1 cars are powered by V6 hybrid turbo power units with 1.6-litre engines. This season represents the last year the current engine configuration appears before being replaced by a new power unit formula in 2026.Current F1 power units feature seven elements: the internal combustion engine (ICE), motor generator unit-heat (MGU-H), motor generator unit-kinetic (MGU-K), turbocharger, energy store (ES), control electronics (CE) and exhaust.Over the course of the 2024 season, a driver may use no more than four ICEs, MGU-Hs, MGU-Ks and turbochargers, two energy stores and control electronics, and eight of each of the four elements that make up a set of exhaust systems (comprising primaries left-hand side, primaries right-hand side, secondary LHS and secondary RHS).Racing Bulls' Isack Hadjar Red Bull Racing drivers Max Verstappen and Yuki Tsunoda have already used two energy stores, control electronics and exhaust systems while Mercedes' George Russell has also used two ES and CE components which means that they will need to complete the season without any fresh units if they are to avoid any sporting penalties.Haas driver Oliver Bearman has already added the second fresh internal combustion engine, turbocharger, MGU-H, MGU-K and exhaust system to his pool while Racing Bulls Liam Lawson has already started to use the second fresh unit of all seven components that make up the power unit.Despite his improved form in recent races, Alpine's Jack Doohan finds himself in a difficult position in terms of power unit allocation as he has already started to use his second internal combustion engine, MGU-K, MGU-H, turbocharger while he has already added three exhaust systems to his pool.

Page 2 Formula One's regulations are written and published by the FIA, the governing body of the sport that is also responsible to enforce those rules by checking cars on their legality, handing complaints and hold court cases to decide on penalties when serious rule infringements would occur.F1's current regulations can be found on the FIA website at Official FIA Formula One regulationsRegulations through timeThose technical and sporting regulations have come a long way since 1950, evolving through the need to enforce safety and curb excessive speed increases attained by the ingenuity of the engineers.Each era has its changes and innovations, ranging from turbo charged engines, wings, ground effect or KERS. Click the below timeline to inspect regulation details and modifications of each period.Why limit performance?Imagine Formula one without any restrictions by the FIA whatsoever so that engineers may go their own way. Consider the performance of a wide bodied car with wide slicks running the relatively sophisticated yet unrestricted wings of the mid 1980s, with late 1970s ground effects and side skirts (and maybe even a rear fan!), in conjunction with a fully developed 1.5 litre turbo engine, active suspension, interactive telemetry and the other computer enhancements of the 1990s.Potentially the most lethal combination of technologies would be ground effect and active suspension. The former relies on a very low but consistent even ride height to be maintained by the suspension in order for the air pressure effect to suck the car down onto the road. The latter is designed to produce a very low yet consistent even ride height to maximise the performance of the car's aerodynamics. The combination of the two would be more than just a sum of its parts. Straight-line speed would not necessarily increase, but the gains in cornering speeds would be tremendous and incredibly dangerous. The cars would barely have to brake before turning into a fast corner like the Parabolica at Monza.It sounds great in principle but in reality it would be completely undriveable, and even Gilles Villeneuve would be intimidated by the performance. To even attempt to drive such a car, drivers would have to wear airforce-style pressure suits to avoid blacking out in 6 or 7 G-force corners. They would probably also have to take amphetamines to improve their reflexes and reaction times. Special tracks would have to be built to accommodate the cars. These tracks would have to have the relatively simple design and layout of modern tracks, with only 12-16 corners, but with the immense length of the great tracks of the past to allow the cars to reach their potential in terms of cornering speeds.The speeds and the danger to drivers and spectators would be overwhelming. The consequences of a car cornering at more than 300km/h and crashing would be catastrophic.The brain is the limitThe reason for having such strict technical regulations in F1 is to deliberately limit performance, not to make the racing boring to watch or to participate in, but to make it safe for everyone involved. The real limit of performance in F1 is the human brain and body, which at this point in time cannot be tuned, retuned, modified, turbo-charged, strengthened with the honeycomb construction of composite materials, or otherwise sped up and improved to any significant extent.The F1 technical regulations encourage the achievement of excellence in one area of car performance at a time. This allows F1 to be the pinnacle of car design and technology, thus making it the testing ground of choice of the major car manufacturers, while at the same time keeping a limit on what can be achieved so that performance gains are explored and tested gradually and safely. Once a performance peak or plateau is achieved, it is deliberately limited or banned, with the technology being passed on to other sectors of car design and production, so that F1 can move on to explore the next area of performance excellence.As F1 has periodically been the testing ground of multinational car companies, new regulations are instated frequently to curb the inventiveness of engineers and the companies involved. As technology progresses, cars can potentially become ever faster if no additional rules were in place, a possibility that would severely diminish the current levels of driver safety.The most recent development in F1 regulations however is the urge to keep the sport relevant to road car technology. To prevent it from becoming an aerodynamic development race with no benefit for production cars, the FIA has recently begun to push for a more environmentally friendly set of rules, encouraging more efficient ways of propulsion. As a result, turbo engines are back, engine capacities are reduced and KERS has an increased potential.Combining the FIA research projects and input from the technical working group, ever evolving rules must ensure that F1 has a future as a sport and as a technical exercise in the face of growing governmental regulations of emissions and other environmental concerns.None of this may however limit the spectacle or the charisma of F1. Its place at the pinnacle of automotive, and advanced technological materials and electronics, development, is not in dispute. Neither is its reputation as the most innovative, stylish and sophisticated form of racing. Page 3 The front wing of a Formula One car creates about 25% of the total cars downforce. Although this only occurs in ideal circumstances. When a preceding car runs less than 20m in front, the total downforce generated by the front wing may become as little as 30% of its normal downforce. Although this reduce of drag (because the air pressure is lower behind a car's rear wing), enables higher speeds at the end of straight, it significantly hinders the pursuing car in corners, as he cannot take these at normal speeds. This problem mostly occurs in fast corners, and is one of the most important reasons of the overtaking problem currently in Formula One. It is therefore a hard job to create a performing front wing, even more because disturbing the airflow too much will affect the rest of the car's aerodynamic efficiency too.Regulations3.4 Width ahead of the rear wheel centre line : 3.4.1 Bodywork width ahead of the rear wheel centre line must not exceed 1400mm. 3.4.2 In order to prevent tyre damage to other cars, the top and forward edges of the lateral extremities of any bodywork forward of the front wheels must be at least 10mm thick with a radius of at least 5mm.3.7 Front bodywork height:All bodywork situated forward of a point lying 330mm behind the front wheel centre line, and more than 250mm from the centre line of the car, must be no less than 100mm and no more than 300mm above the reference plane.3.17.1 Bodywork may deflect no more than 5mm vertically when a 500N load is applied vertically to it 700mm forward of the front wheel centre line and 625mm from the car centre line. The load will be applied in a downward direction using a 50mm diameter ram and an adapter 300mm long and 150mm wide. Teams must supply the latter when such a test is deemed necessary. Front wing designA regular front aerofoil is made as a main plane running the whole width of the car (almost at least, limited by FIA regulations) suspended from the nose. Onto this are fitted one or more flaps which are the adjustable parts of the wing. On each end of the mainplane there are endplates. These make sure the airflow passes above and beneath the wing rather than around it. In recent years these endplates have played a crucial role in influencing the airflow around the front tyres, especially after the rule changes at the beginning of 1998 (wheelbase made smaller from 220cm to 180cm). These changes made front wing airflow interfere with the rotating airflow around the front wheels.Article 3.17 has been introduced during 1998, after teams started experimenting with bending front and rear wings. When Ferrari introduced such a front wing at the end of 1997, it was produced in such a way that the wing would flex under aerodynamic loads. This means that as the speed increased, a force was produced that pushed the wing towards the ground. By means of a ground effect, this was particularly interesting for front wings because if would increase downforce at high speeds without an increase of drag. As rear wings began to fail and flew off during races, the FIA thought it was time to act and added 3.17 to the technical regulations of Formula One.At the beginning of 2001, front wing regulations had changed in such a way, that the wing should be 100mm above the ground at least, instead of the 40mm until then. The FIA introduced this change to limit the cornering speeds of the cars. The idea was to decrease the ground effect that was generated by front wings close to the ground, working just like a diffuser.Immediately at the start of the season, Ferrari introduced a front wing that was bent down in the center line or the car. This new concept makes a handy use of a little hole in the regulations. The whole is the result of a rule, added in 1994, where the wooden bottom made it's entry. This wooden plate can be hung up as low as possible to the ground. As this plate is 50 cm wide, it was not foreseen that the front wing may be placed that low to the ground in 25cm at each side of the center of the car. Since the introduction by Ferrari, more and more teams have adopted the idea of curved front wings, with them also McLaren and Renault (see picture).Though the reason that McLaren didn't make any of those changes until 2002, might have to do with the curve of the front wing before the change of regulations. It was namely curved up in the middle, so that the inner side was higher above the ground then both outer sides of the front wing. This type of wing is mostly useful on fast tracks where not much downforce is needed. It is there that airflow in the centre of the car can be more used by the diffuser in the back instead of lifting it up and create downforce in the front.End platesAs some of the air that is needed to generate the front wing's downforce interferes with the rotating air around the front wheels, F1 teams have been developing the end plates from a simple plate to an integral part of the wing. To overcome the main problem of turbulence around the wheel, McLaren, and later Ferrari made in 1998 the inside edges of the front wing endplates curved to direct the air between both front wheels. One year after, all teams had adopted this technique to maintain front wing efficiency. Some other teams decided to decrease the width of the main plane just to the width between the front wheels. This left some room for extra wings and flaps, which caused the beginning of intensive end plate research. In 1998 changes were so radical that Ferrari produced six different designs of front wings throughout 1999, in order to reclaim the lost downforce by regulation changes. Page 4 The basic principle of a formula one wing is exactly the same as with a common aircraft. The greatest difference is the direction air is pressed and how that aerodynamic force is generated. Knowing that an aircraft wing does the opposite of an F1 wing, I'll explain a formula one wing. I will start from the idea that we are testing a single rear wing in a wind tunnel. The main advantage of this theoretical example is that it leaves out some natural factors. With a single wing, we do not have to think about turbulence that is generated by the car itself (the engine cover mainly), neither do we have to take in account the direction and speed of outside wind. It is obvious that both these factors decrease the efficiency of a aerofoil.As you can see in the picture below, air flows onto the rear wing with a straight direction (which is often called clean air) at the speed of the car. The white flaps push the air up. Following Newton's law, an action causes a reaction, which is why the aerofoil is being pushed towards the ground by the air. Having in mind that air flowing onto the flaps is pushed upwards, and under flowing air keeps going its own way, a low pressure area (nearing a vacuum at very high speeds) is created right behind the horizontal aerofoils. This 'vacuum' causes a suck up of the air passing under that flap. The air passing underneath on the other hand again flows faster in an attempt to equalize pressure on both sides of the aileron, and thereby increasing the total wing efficiency. Because of the car's speed this is impossible, which is why the effect is maintained. The force that is created by this type of wing, so that the car is pressed onto the ground, is called downforce. Straight forward gong air at the speed of the car. Rear wingsAbout a third of the car's total downforce can come from the rear wing assembly. The rear wings are the ones that are varied the most from track to track. As the rear wings of the car create the most drag the teams tailor the rear aerodynamic load to suit a particular track configuration.As air flows over the wing, it is disturbed by the shape, causing a drag force. Although this force is usually less than the lift or downforce, it can seriously limit top speed and causes the engine to use more fuel to get the car through the air.From the year 2001, the FIA regulations have changed concerning the rear wing. To increase the ability of overtaking and slipstreaming, the number of rear wing elements is now being limited to 3. This should decrease the downforce and acceleration. The only effect that might have come with this regulation change, is at high downforce circuits, there will be a little more air resistance to produce the same downforce.The pictures below both show David Coulthard in his MP4/17 from 2002. The picture of the left shows him at Monza 2002, whilst the picture on the right was taken at the Nurburgring. You can see that the rear wing profiles are very different. On the left picture, very little of the rear wing can be seen, whilst the Monaco wing has much of the profile visible:The diffuserThe smallest thing which you can count to the wings part is the diffuser. Actually, it does exactly the opposite of a rear or front wings. Instead of pushing the air up, it sucks the air up. The volume of the diffuser increases towards to the end of the car. Where a certain amount of molecules filled for example 1dm under the car, these now fill 2dm. This drop of pressure causes a car to be sucked towards the ground. Driving at a speed of 300 km/h, the groundeffect of the car would be extreme if there was no air under the car itself. Therefore, the FIA has forbidden strokes and sloping car bottoms because of safety reasons. Instead of raising the back of the car, the diffuser sucks the air away from under the car because the low pressure. The diffuser us placed under the rear wing and is actually a sweep up of the car's floor. It consists of many tunnels and splitters which carefully control the airflow to maximize this suction effect. The design of the bottom of the car, and thereby the diffuser is a critical area, because it can greatly influence the car's behaviour in corners. More importantly, the designers have to be careful that the car keeps working good in all circumstances, and at any distance from the ground. Losing all of the diffuser's generated downforce when riding over a curb will greatly generate a nervous behaviour of the car itself. The strokes and flips withing the diffuser have lately become that advanced (curbed and even foreseen by gurney flaps sometimes) that any track distance is insufficient to guarantee good performance. It is still a part where a lot of time can be gained on current F1 cars, partly by pulling more air towards the diffuser by inducing the coke-bottle effect. Page 5 Aerodynamics is the science that studies objects moving through air. It is closely related to fluid dynamics as air is considered a compressible fluid. Nowadays, aerodynamics is the utmost important factor in Formula One car performance. It has even nearly become one of the only aspects of performance gain due to the very marginal gains that can currently be made by engine changes or other mechanic component development. This downforce can be likened to a virtual increase in weight, pressing the car down onto the road and increasing the available frictional force between the car and the road, therefore enabling higher cornering speeds.Furthermore, as Formula One teams have the greatest resources to develop aero efficiency of its cars, the greatest strives are made here. F1 teams have unrivalled CFD computing power and at least one full time wing tunnel, only for validating and improving their designs.While basic aerodynamic methods and formulas can be simply resolved, other properties are verifiable with empirical formulas. More complex shapes such as airplanes or racing cars are however impossible to calculate precisely, rendering computational fluid dynamic systems (CFD applications on super computers) and wind tunnels an absolute requirement to validate designs.Application in Formula OneF1 (and in general, all winged racing cars) can be considered to be canard configurations in the sense that the front and back wings are on opposite sides of the centre of gravity and both are "lifting" (strongly) in the same direction, in this case creating downforce.From a spectator's point of view, a car can be considered in (at least) 3 parts: the front wing, the car's body and the rear wing. Each of the parts can be optimised for the required downforce at a minimum of drag. Practically however, every component has its influence on the behaviour of the car and cannot be regarded as an individual component. As a result, no element is tested individually, but always a complete scale model of a car.Because a complete racing car is a very complex system, teams of engineers usually evolve the car step by step, developing a particular item and check its effect on the car. Such overall effect can then be calculated with Amdahl's law:Here is the fraction of the system (when this fraction generates 5% of the car's drag, then is 0.05) that can be improved, is the improvement factor on this fraction

(division of the drag in Newtons and the new drag force after improving that element), and is the overall improvement that will be achieved.After verifying its improvement, the car's efficiency is determined and then simulated on different tracks to see on where it is useful. That usefulness is always theresult of a reduction in drag or an increase in downforce.DragDrag is the aerodynamic force that is opposite to the velocity of an object moving through air (or any other fluid). Its size is proportional to the speed differential between the air and the solid object. It is therefore unimportant if either the air is moving around a static object or if the object is moving at a speed through static air.Drag comes in various forms, one of them being friction drag which is the result of the friction of the solid molecules against air molecules in their neighbourhood. Friction and its drag depend on both the fluid and the solid properties. A smooth surface of the solid for example produces less skin friction compared to a rough one. For the fluid, the friction varies along with its viscosity and the relative magnitude of the viscous forces to the motion of the flow, expressed as the Reynolds number. Along the solid surface, a boundary layer of low energy flow is generated and the magnitude of the skin friction depends on conditions in the boundary layer.Additionally, drag is a form of resistance from the air against the solid moving object. This form of drag is dependent on the particular shape of a wing, and is therefore called form drag. As air flows around a body, the local velocity and pressure are changed, effectively creating a force.Interference drag or induced drag on the other hand is the result of vortices that are generated behind the solid object. Due to the change of direction of air around the wing, a vortex is created where the airflow meets unchanged, straight flow. The size of the vortex, and thereby its drag strength increases with an increasing angle of attack of the aerofoil. As a primary source of possible drag reduction, Formula One teams try to counteract this drag by adding end plates to wings or with fillets at the suspension arms.Other sources of drag include wave drag and ram drag. The first is unimportant for normal racecars as it occurs when the moving object speeds up to the speed of sound. Ram drag on the other hand is the result of slowing down the free airstream, as in an air inlet.The amount of drag that a certain object generates in an airflow is quantified in a drag cofficient. This cofficient expresses the ratio of the drag force to the force produced by the dynamic pressure times the area. Therefore, a of 1 denotes that all air flowing onto the object will be stopped, while a theoretical 0 is a perfectly clean air stream.At relatively high speeds, ie. at high Reynolds number (), the aerodynamic drag force can be calculated by this formula:where is the force of drag (in Newton), the density of the air, the speed of the object relative to the fluid (in m/s), the reference surface and the cofficient of drag. Note the minus sign and the vector which indicate that the resulting drag force is opposite to the movement of the object.DownforceAerofoils in motorsports are often called wings, referring to aircraft wings. In fact they are very similar. F1 wings and winglets aim to generate high downforce, by having a high angle of attack, thus also increasing the drag of the aerofoil.The evolution of aerofoils to what they are now is mainly thanks to the genious and research of a few well known scientists. In 1686, Sir Isaac Newton presented his three laws of motion, one of them being the conservation of energy. He stated that energy is constant in a closed system, although it can be converted from one type to another. Out of that theory, Daniel Bernouilli deducted a formula proving that the total energy in a steadily flowing fluid system is a constant along the flow path. An increase in the fluids speed must therefore be matched by a decrease in its pressure. Adding up the pressure variation times the area around the entire body determines the aerodynamic force on the body.An aerofoil's operation can be easily explained when you consider a wing in a steady, laminar flow of air. As air is a gas, its molecules are free to move around and may have a different speed at different locations in the airstream. As downforce generating aerofoils are mostly designed with more thickness on the lower side, the lower airstream is slightly reduced in surface, hence increasing the flow speed and decreasing the pressure. On top of the wing, the airspeed is lower, and thus the pressure difference will generate a downward force on the wing. Additionally, and in line with Newton's third law of motion, downforce wings are never straight and induce a new turning of the airflow. More specifically, the shape of the wing will turn air upwards and change its velocity. Such speed creates a net force on the body.This shows that a force causes a change in velocity , or also, a change in velocity generates a force. Note that a velocity is a vectorial unit, having a speed and a direction component. So, to change of either of these components, you must impose a force. And if either the speed or the direction of a flow is changed, a force is generated.It is very important to note that the turning of the fluid occurs because the molecules of the fluid stay in contact with the solid body since the molecules are free to move. Any part of the solid body can deflect a flow. Parts facing the oncoming flow are said to be windward, and parts facing away from the flow are said to be leeward. Both windward and leeward parts deflect a flow. Ignoring the leeward deflection leads to the incorrect "skipping stone" theory of lift.You can simulate airflow around a simple aerofoil with NASA's Foilsim toolkit.Downforce is however often explained by the "equal transit time" or "longer path" theory, stating that particles that split ahead of the aerofoil will join together behind it. In reality however, the speed difference of air particles above and below a wing is much larger than what is expected with this theory.While these simplified versions are the basics of lift and downforce generation, the reality can hardly be simplified and is a complex study, requiring high power computer systems. For a gas, we have to simultaneously conserve the mass, momentum, and energy in the flow. Hence, a change in the velocity of a gas in one direction results in a change in the velocity of the gas in a direction perpendicular to the original change. The simultaneous conservation of mass, momentum, and energy of a fluid (while neglecting the effects of air viscosity) are called the Euler Equations after Leonard Euler. Several computer algorithms are based on these equations to make an approximation of the real situation.Because of the complexity, today's Formula One cars are designed with CFD (computational fluid dynamics) and CAD (computer aided design) that allows engineers to design a car, and immediately simulate the airflow around it, incorporating environmental parameters like traction, wind speed and direction, and much more. Page 6 Analysis by Russell Harrison This rear wing design was sent to me by a young budding engineer from Spain named Mr Bernat Carreras. The model was cleaned by Keith Young and further cleaned in CFX. This was his first attempt at wing design and he had limited CAD experience. However, it was agreed to run a CFD analysis on the rear wing design. I believe the airfoils are not based on published designs. There were clearly a number of design issues with the rear wings, including the severity of the camber designed in to the airfoils, which was believed to lead to early flow separation.Image 1 shows the rear wing geometry after geometry cleaning.MeshA mesh picture is currently not available, but will try and post one if anyone wants to see one. The mesh parameters applied to the model included refined inflation layers for more accurate boundary layer analysis. The mesh engine used was the default AFI mesher using triangular surface mesh elements. The mesh data, after volume meshing, is given below: Mesh Modes: Volume = AFI, Surface = Delaunay Total Number of Elements: 1,045,075 Total Number of Tetrahedrons: 851,941 Total Number of Prisms: 191,520 Total Number of Pyramids: 1614 Total Number of Faces: 54,828 Flow ConditionsA simple analysis of the rear wing was carried out, ignoring any body interactions with the Formula 1 vehicle. The results from analysis can therefore only be used for initial design of the wing system, and all body interactions must be included and analyzed in further design modifications. The flow velocity at inlet was set at 62.22 m/s (140 mph, 224 KPH) and this was also applied as an global initialisation velocity . All walls of the fluid domain were set to free slip and a no-slip condition applied to the bodies surface.Fluid Properties: Material: Air Ideal Gas (constant Cp) Molar Mass = 28.96 Kg Kmol -1 Dynamic Viscosity = 1.79e-5 Kg m-1 s -1 Simulation Properties: Domain Motion: Stationary Reference Pressure = 1e5 Pa Fluid Temperature = 288 K (this can be changed and re-run to suit a specific circuit the wing will be run on) Turbulence Model = SST Turbulence = Medium Intensity and Eddy Viscosity Ratio SolutionThe residual target for convergence was set to e-4 at an RMS type. This was achieved during solution. Total Run times was 1 hour, 39 Minutes, 18.468 Seconds.ResultsIt can be seen from the results (image 2 and 3) that the initial concern of wing stall is clearly apparent. The small flap has completely stalled as has the trailing edge of the main top element. This, obviously greatly reducing the negative lift (downforce) also brings the penalty of increased form drag. It is also clearly visible from images 3, 4 and 5 that with the top front element of the wing system only the upper surface is experience downforce producing effects (positive pressure), however, at the lower surface of the element positive pressure is also present (thus canceling out the positive pressure of the top surface). This lower surface positive pressure is caused by the bi-plane phenomenon, in that the wing elements are vertically to close to each other . There is also noticeably early separation of the thin aerofoil profile of the top front wing element (separation occurs around half the chord)The poor design of the end plates and positioning of the wing elements has led to large vortex production, the effects of these vortices is to produce a downwash in the area between the them, which results in reduced negative lift (this is high for low aspect ratio wings, since the vortices are closer to the wing) and small for high aspect ratio wings).Force DataDownforce = 1285.26 N, Drag = 374.543 N, Pitching moment = 122.388 Nm Page 7 Wind tunnels in general are used for testing purposes and aerodynamic optimization. They are specially designed to simulate airflow like in open air and flow velocity as close as possible to reality.It is of great importance to avoid anomalies, because a slight difference in airflow may change the behaviour of the tested object, and furthermore provide false information to the aerodynamicist, who consequently make the wrong decisions.Two main typesThere are in fact two main types of windtunnels. One type is called open circuit tunnels with an air entry open to the atmosphere. The best way to construct such a tunnel is a blower configuration, where a fan is located at the entry of the tunnel, and blows the air into it. Although the entry swirl is a possible problem, blower tunnels are in general much less sensitive to entry conditions than suckdown tunnels. The exit flow from a centrifugal blower is nonuniform and turbulent, but without the low-frequency unsteadiness of flow entering directly from a room. This type of windtunnel will not be further highlighted, because they are not considered to be the first choice for F1 development.The most interesting type of tunnels are the closed circuit windtunnels. Also called "racecourse" or "closed-return", which are usually powered by axial fan. Closed-circuit tunnels have more uniform flow, in principle, than open circuit tunnels. These are the usual choice for large tunnels (thus also for Formula One), but care is needed to maintain good flow at the entrance to the contraction. The flow at exit from the fourth corner (counting from the test section) is typically not much better than the exit flow from a centrifugal blower, although the corner vanes themselves have some effect in reducing turbulence (they can be regarded as honeycombs with walls in one direction only).Windtunnels in F1Aerodynamicists speak of F1 windtunnels as a type of low-speed closed circuit tunnels. This means we are talking of airspeeds between 10 and 100 m/s approximately, and tunnels in which the same air is recirculated. The stream is turned, typically by 4 90° corners, each provided with turning vanes placed aside of each other, to prevent turbulence in the corners.There is always a small vent, called a "breather", somewhere in the circuit so that the internal pressure does not increase as the air heats up during the run. The breather is best located in a part of circuit where inner air is close to atmospheric pressure. Usually that is around the perimeter at the downstream end of the test section. This compensating inflow through the breather is bad for diffuser performance but easy to detect by releasing smoke just outside the breather.Although some older tunnels have "open jet" test sections (part of the tunnel in the observation chamber), with a floor but no walls or roof (attributed from Gustav Eiffel), this type is not recommended for high performance testing.Axial FansAs said before, most closed-circuit tunnels are driven by axial-flow fans, which produce a static pressure rise (with no appreciable change in axial velocity or dynamic pressure). The design of axial fans for tunnels is a very complex matter. It is why F1 windtunnels usually have a specially designed fan to maximize the performance and decrease side effects.Because shockwaves might disturb regular airflow at fans with a high tip-speed (axial speed at the tip of a fan blade), fans are developed to keep to tip-speed as low as possible, not more than two or three times the local axial velocity. This causes the blade arrangements to resemble to an axial-flow compressor, with a stator row in front of the rotor. As a return to uniform, non-swirling flow is necessary, the diameter of the central nacelle ("boss", "hub", in which the engine may reside) is kept relatively small, rarely exceeding 50% of the fan diameter. As a result the space between adjacent blades, measured around the circumference, varies considerably from root to tip.F1 windtunnel fans are usually mounted downstream of the second corner, where the cross-sectional area is two or more times that of the test section. It needs no explanation that a large fan can run at a lower speed to generate the same airflow, thus needing less rpm and reducing vibration, noise and power consumption.An example of such a fan can bee seen in the picture on the left, which shows the fan of the Sauber wind tunnel at Hinwill. Note that the engine is located in the boss of the fan, which only consists of less than half the fan's diameter.More information about axial-flow fan design is given by R. Allan Wallis, Axial Flow Fans and Ducts, Krieger Publishing Company (November 1991).F1 specialtiesBecause of the very need of high performance, F1 wind tunnels have, apart from the fypical extreme optimizations, special features that increase testing abilities: Rolling road: the floor of the windtunnel testing area is made to simulate the track. The idea is to make the track move under the car at the same speed as the air flows around the car. This might seem a worthless feature, but it is in fact far from that. The fact is the simulation is now complete with rotating real tyres. Tyres rotate rapidly at 300km/h, and they are thereby generating a lot of turbulence. The airflow around the wheels is substantially different with rotating wheels compared to a measurement with static floor. Ride height simulation: When testing a formula one car, it is fixed to stay in its position with a carbon bar fixed to the car above the air happer. In most current tunnels, these bars have hydraulic systems that allow engineers to adjust ride height with a precision of 0.01 mm, thereby also measuring the resistance provided by the suspension. F1 windtunnels examples RenaultCompletion 1999Ensonte, UK Post here all non technical related topics about Formula One. This includes race results, discussions, testing analysis etc. TV coverage and other personal questions should be in Off topic chat. organic 1120 Joined: 08 Jan 2022, 02:24 Location: Cambridge, UK Post 19 May 2025, 19:40 Mystery technical directive was issued on 12th May 2025 according to Telegraaf The FIA came out with a 'technical directive' the Monday before the race in Imola, but McLaren denies it had any influence. There are also no such signs from the FIA as yet. It is stated within the article that areas concerning the treatment of tyres and wheel bodywork design were subject to the TD Issued on 12 May, i.e. last Monday, and in force since the first European race of the season. Such an adjustment to the regulations is made following technical meetings held with the 10 teams.This time, the wheel bodywork design and tyre handling were also highlighted. Of course, in a world like Formula 1, that immediately creates speculation ... Last edited by organic on 19 May 2025, 19:42, edited 1 time in total. chrisc90 41 Joined: 23 Feb 2022, 21:22 Post 19 May 2025, 19:41 Any overview as seems the article is behind a paywall. Mess with the Bull - you get the horns. organic 1120 Joined: 08 Jan 2022, 02:24 Location: Cambridge, UK Post 19 May 2025, 19:42 chrisc90 wrote: Any overview as seems the article is behind a paywall. Key part Another sound in the Formula 1 paddock last weekend was a so-called technical directive from the FIA. Issued on 12 May, i.e. last Monday, and in force since the first European race of the season. Such an adjustment to the regulations is made following technical meetings held with the 10 teams.This time, the wheel bodywork design and tyre handling were also highlighted. Of course, in a world like Formula 1, that immediately creates speculation that McLaren may have had to adjust in that area. McLaren denies this, pointing mainly to Red Bull's improvement and thinking that the win in Miami may have been a bit of a distortion of the real balance of power. It is also believed within the FIA that McLaren did not have to adjust anything. marcel171281 30 Joined: 22 Feb 2020, 12:08 Post 19 May 2025, 19:53 Mmmm, bit speculative, but after Miami they checked the rear brakes assembly of the McLaren. A mysterious TD pops up a week later, allegedly concerning that area and the first race after, the McLaren has worse tyre deg than the RB. Interesting.Why am I thinking about the not illegal 2019 Ferrari engine? organic 1120 Joined: 08 Jan 2022, 02:24 Location: Cambridge, UK Post 19 May 2025, 19:58 marcel171281 wrote: 19 May 2025, 19:53Mmmm, bit speculative, but after Miami they checked the rear brakes assembly of the McLaren. A mysterious TD pops up a week later, allegedly concerning that area and the first race after, the McLaren has worse tyre deg than the RB. Interesting.Why am I thinking about the not illegal 2019 Ferrari engine? Also this interview by wach "I'm not sure it was a big improvement. But there has been growth in the right direction. Maybe we were surprised that the others didn't do better than that." The asphalt was warmer and it affected our opponents more than us. And we were surprised by that. They play down their own improvement in the interview and suggest maybe others were too slow and were hurt by the hotter temperatures more and they are surprised. ... /10724213/ Rikhart 23 Joined: 10 Feb 2009, 20:21 Post 19 May 2025, 20:03 I am also inclined to believe something was said about rear wings. Mercedes suddenly dropped massively and their RW is suddenly looking much more solid... Do we have Mclaren rear view? AR3-GP 383 Joined: 06 Jul 2021, 01:22 Post 19 May 2025, 20:13 To play devil's advocate, it's weird that the first stories are coming from EvH (Verstappen adjacent) and Thomas Maher (Horner adjacent). I don't doubt that the TDs exist, but something seems off. No Italian sources caught wind of this? I don't really agree with Wache's take either. The RB21 is more balanced. They underestimate the effect. There improvement is logical. Last edited by AR3-GP on 19 May 2025, 20:15, edited 1 time in total. It doesn't turn. Vaexa 6 Joined: 24 Jun 2021, 18:58 Post 19 May 2025, 20:15 AR3-GP wrote: To play devil's advocate, it's weird that the first stories are coming from EvH (Verstappen adjacent) and Thomas Maher (Horner adjacent). I don't doubt that the TDs exist, but something seems off about it all. EvH is also a very well informed, reliable source and I sincerely doubt he would stake his reputation on a bogus report like this. marcel171281 30 Joined: 22 Feb 2020, 12:08 Post 19 May 2025, 20:18 Vaexa wrote: 19 May 2025, 20:15AR3-GP wrote: To play devil's advocate, it's weird that the first stories are coming from EvH (Verstappen adjacent) and Thomas Maher (Horner adjacent). I don't doubt that the TDs exist, but something seems off about it all. EvH is also a very well informed, reliable source and I sincerely doubt he would stake his reputation on a bogus report like this. Exactly. His reports are very reliable! AR3-GP 383 Joined: 06 Jul 2021, 01:22 Post 19 May 2025, 20:19 Vaexa wrote: 19 May 2025, 20:15AR3-GP wrote: To play devil's advocate, it's weird that the first stories are coming from EvH (Verstappen adjacent) and Thomas Maher (Horner adjacent). I don't doubt that the TDs exist, but something seems off about it all. EvH is also a very well informed, reliable source and I sincerely doubt he would stake his reputation on a bogus report like this. I trust EvH about the existence of the TDs. It's moreso the connection to Mclaren which I am doubting (EvH did not mention Mclaren, but everyone is going to assume it). EvH and Maher are basically Red Bull insiders so it's tempting to make a connection to Mclaren. EvH is by no means a RB insider. He is a general journalist specialised in F1, with no connections to any of the teams. Last edited by AR3-GP on 19 May 2025, 20:25, edited 2 times in total. It doesn't turn. marcel171281 30 Joined: 22 Feb 2020, 12:08 Post 19 May 2025, 20:21 AR3-GP wrote: 19 May 2025, 20:19Vaexa wrote: 19 May 2025, 20:15AR3-GP wrote: To play devil's advocate, it's weird that the first stories are coming from EvH (Verstappen adjacent) and Thomas Maher (Horner adjacent). I don't doubt that the TDs exist, but something seems off about it all. EvH is also a very well informed, reliable source and I sincerely doubt he would stake his reputation on a bogus report like this. I trust EvH about the existence of the TDs. It's moreso the connection to Mclaren which I am doubting (EvH did not mention Mclaren, but everyone is going to assume it). EvH and Maher are basically Red Bull insiders so it's tempting to make a connection to Mclaren. EvH is by no means a RB insider. 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It doesn't turn. chrisc90 41 Joined: 23 Feb 2022, 21:22 Post 19 May 2025, 20:23 Well well well. What a massive coincidence. Mess with the Bull - you get the horns. organic 1120 Joined: 08 Jan 2022, 02:24 Location: Cambridge, UK Post 19 May 2025, 20:25 marcel171281 wrote: 19 May 2025, 20:21AR3-GP wrote: 19 May 2025, 20:19Vaexa wrote: 19 May 2025, 20:15 EvH is also a very well informed, reliable source and I sincerely doubt he would stake his reputation on a bogus report like this. I trust EvH about the existence of the TDs. It's moreso the connection to Mclaren which I am doubting (EvH did not mention Mclaren, but everyone is going to assume it). EvH and Maher are basically Red Bull insiders so it's tempting to make a connection to Mclaren. EvH is by no means a RB insider. He is a general journalist specialised in F1, with no connections to any of the teams But he is one of Verstappen's inner circle. Verstappen uses Telegraaf, Horner uses planetf1, Austrian side of red bull use Motorsport-total etc

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