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Chapter 1 : - Anatomy and Development of the Formula One Racing Car from by Sal Incandela

The first half is an overview of the racing seasons for several years either side of the season in the title, with mentions of drivers and teams, and the evolution of I loved it for the period photos and the discussion of the early days of F1's turbo era.

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Mathematics can prove that reducing aerodynamical downforce increases safety. In contrast, FIA president Max Mosley says that mathematics proves that grooves in tyres increase the safety of Grand Prix racing, because I the energy of an impact is proportional to the grip of the tyres and II whatever its speed, a car spins for exactly half the radius of the curve it is when control is lost. The faster a car is going at the point it starts to spin, the faster it will be at all points during deceleration, as it always stops in the same place. Therefore, if it hits a barrier on the way, the faster the car was going when it started to spin the harder it will hit the barrier. The greater grip of the tyres, the faster the car would have been immediately before the spin. Hence, says Mosley, reduced grip equals increased safety, everything else being equal. However, his mathematical model ignores one point: When a car spins, it looses is aerodynamical downforce, and thus grip. For safety reasons, FIA wants to prevent that cornering speed increases. There is an ongoing discussion on whether limiting the corning speed should be by cutting more and more grooves in tyres or by reducing aerodynamical downforce, e. We explain those arguments in detail and discuss the assumptions that are made in the analysis. By making a sharp distinction between aerodynamical grip and mechanical grip, we derive an equation that reveals that reducing the aerodynamical downforce in fact leads to more safety. Consider a racing car that drives through a corner, for simplicity a circle. Let the letter V stands for the velocity of the car, let R be the radius of the circle see Figure 1 and m symbolises the mass weight of the car. Old Isaac Newton showed that if an object turns in a circle, it must be subjected to a force pointing to the centre of the circle if there was no centre force the direction of car would be a straight line. Denote the centre force Fc. The side force that a tyre can deliver depends on the tyre compound and construction and on how hard it is pressed against the ground. In the mathematical language, tyres with high grip have a high value of m. The energy that the car possess due to its velocity is called the kinetic energy, Ekin. The energy absorbed is the work of the frictional force. As an approximation, assume that the frictional force is constant all the time. These are the basic equations. Now we combine them. Thus, in equation 3 we can substitute m V2 by m N R. Distance a car slides before it stops Imagine now that the car spins off, as shown in Figure 2. The car stops when all the kinetic energy has lost by the frictional force. Actually, energy is also lost to aerodynamical drag. This is neglected in the simple model described here. The product m N appears on both sides, so it cancels out. The car stops exactly half the radius of the curve it is on when control is lost. Separating effects of mechanical and aerodynamical grip To derive the equations above, it was assumed that the friction force from the tyres, Ffric, was the same all the time. Let us take a closer look at that assumption. How well does it fit to reality? A car that spins off onto grass or gravel may experience a smaller friction than when it ran on the tarmac, simply because the friction between rubber and tarmac is higher than between rubber and grass. If the friction during the spin is lower, the sliding distance increases, i. A racing car that drives through a circle having a radius R at a velocity V requires a central force Fc. As long as the tyres roll, they deliver a side force Ffric shown in blue colour. Another very important issue is aerodynamics. Before the car spins, it fully utilises the aerodynamical downforce created by the underbody and wings. The normal force on the tyres is higher than what would result for a car with no downforce. Therefore the maximum frictional force equation 2 will be higher. But when the car spins, the direction of airflow will no longer reach the wings from the frontal direction. Also, the downforce that is produced by the underbody and diffuser at the rear end of the car is lost it is well known that the underbody aerodynamics is very sensitive to the ride height. As a result, most of the aerodynamical downforce disappears during a spin. Only the gravity force contributes to the normal force on the tyres. The frictional force during breaking is thus lower than the frictional force during cornering. This can be brought into the mathematics as follows. The racing car spins off when the required centre force Fc exceeds the maximum side force that the tyres can provide. The car spins off a distance d before it stops. When the tyres are locked up, the frictional force from the tyres Ffric blue colour now acts in the opposite direction of sliding. Before the spin , the normal force on the tyres, N, comes from two sources, the gravity force weight of the car and the aerodynamical downforce. During the spin , most of the aerodynamical downforce is lost. In fact, for this particular example the distance to stop the car, d, equation 15 is now twice as long as if there was no aerodynamical downforce equation In conclusion, increasing the aerodynamical downforce increases the spinning distance, d. The faster a car is going at the point it starts to spin, the faster it will be at all points during deceleration. We can now add the following: The higher the downforce, the faster the car can drive through a curve. If it subsequently spins, the distance it slides before it stops is longer. Therefore, if the car hits a barrier on the way, it will hit the barrier harder. Increasing tyre grip and reducing aerodynamical downforce? Some drivers have suggested that the mechanical grip should be increased e. In mathematical terms this is equivalent to an increase in m and a decrease in Faero. If Faero is sufficiently low, such that the product m N remains lower than before, the kinetic energy equation 7 may still be lower than before. The mathematics shows that the drivers are right: Reducing the aerodynamical grip and increasing the mechanical grip will increase safety. In addition, this approach is likely to allow closer racing, since the current cars looses their aerodynamical downforce, because the airflow is disturbed when following another car closely. If most of the grip came from the mechanical grip of the tyres, this loss of grip would not appear and closer racing would be possible. Reducing aerodynamics and using slick tyres is the direction chosen in the Champ Cars series. On super speedways a specially designed low-downforce, high drag rear wing, called "Handford Wing", is mandatory. List of symbols distance the car spins before it stops g.

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Chapter 8 : Mosley's Equations

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