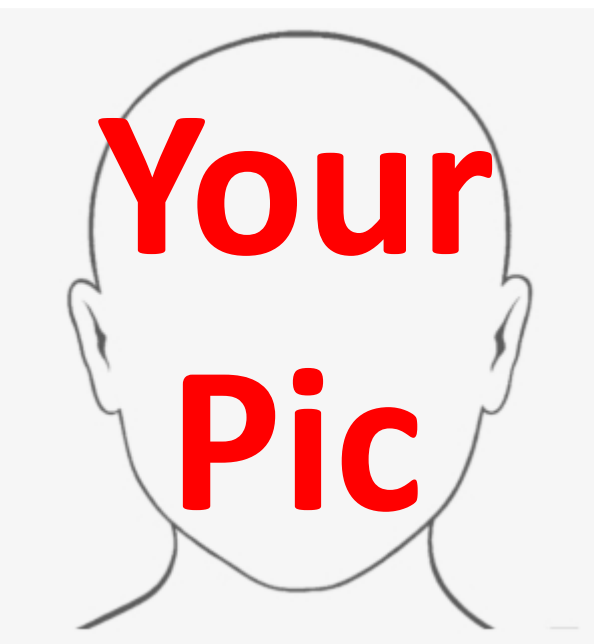




Aerodynamics in Motorsport: Active Aerodynamics

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Introduction

Active Aerodynamics, a relatively new innovation which dynamically adjusts aerodynamic features of a vehicle for optimal performance. Systems such as rear wings and front splitters adapt to speed, braking, corner forces to enhance agility and efficiency. While extremely effective a high price is resulted.

My interest for researching active aerodynamics was after seeing the Koenigsegg One:1 with it's unique set of active aero that draws eyes from across the motorsport world

With that said I will be looking at how active aerodynamics are developed and used but also how it could have a future in motorsport

Background Research

Active vs Passive

Passive aerodynamics are aerodynamic features on a vehicle that cannot be changed unless manually adjusted such as the angle of attack on a wing. Although on an active aerodynamic system the angle of attack could be changed autonomously.

Active Front Splitter

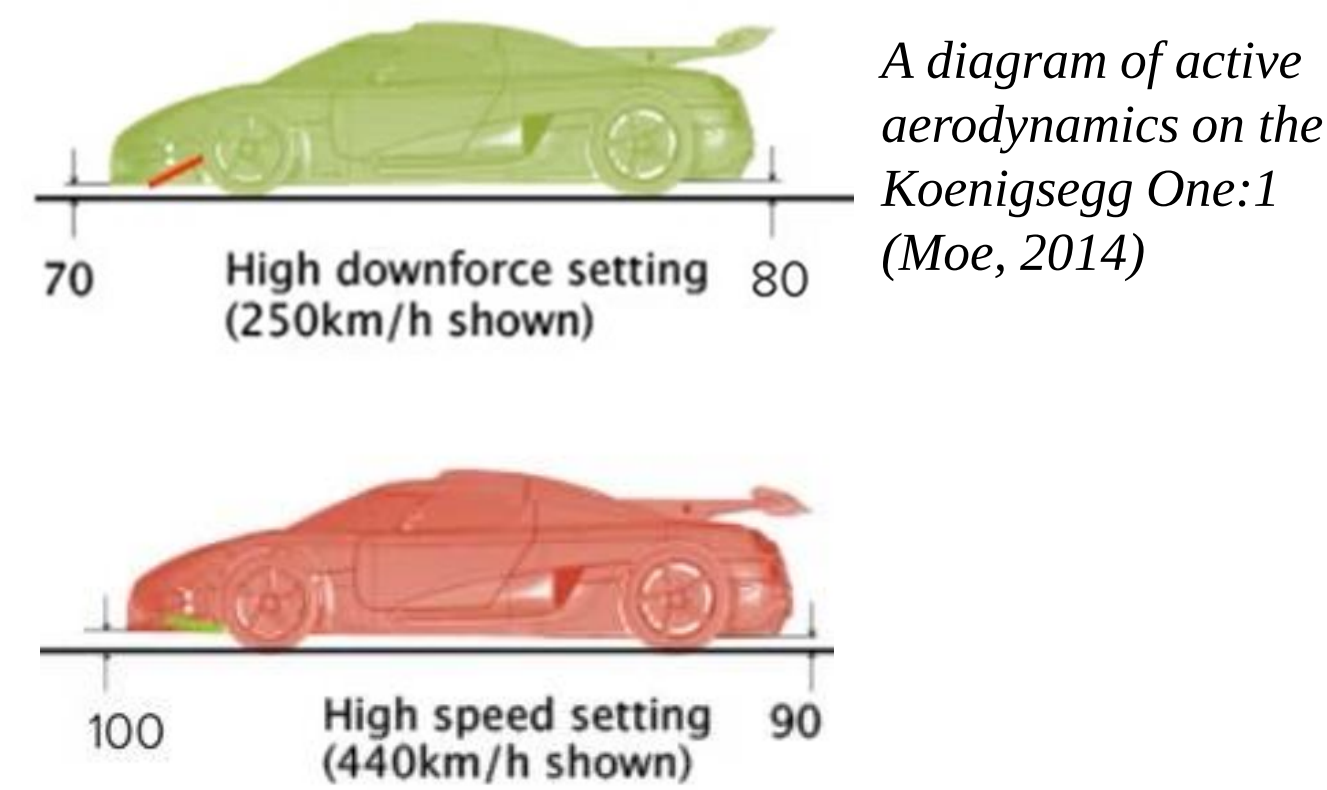
Having an active front splitter gives the vehicle access to dynamic rake control and functions through a series of actuators.

Active Rear Wing

An active rear wing creates possible functions such as being at low speed the wing stays tight to the body to reduce drag, deploying the wing at a higher speed to increase downforce and even being used as an air brake.

Active Diffuser

A recent innovation the active rear diffuser system coupled with a rear wing which can increase downforce by up to 50% on such models like the T50



A diagram of active aerodynamics on the Koenigsegg One:1 (Moe, 2014)

A table showing the influence of DRS in F1.

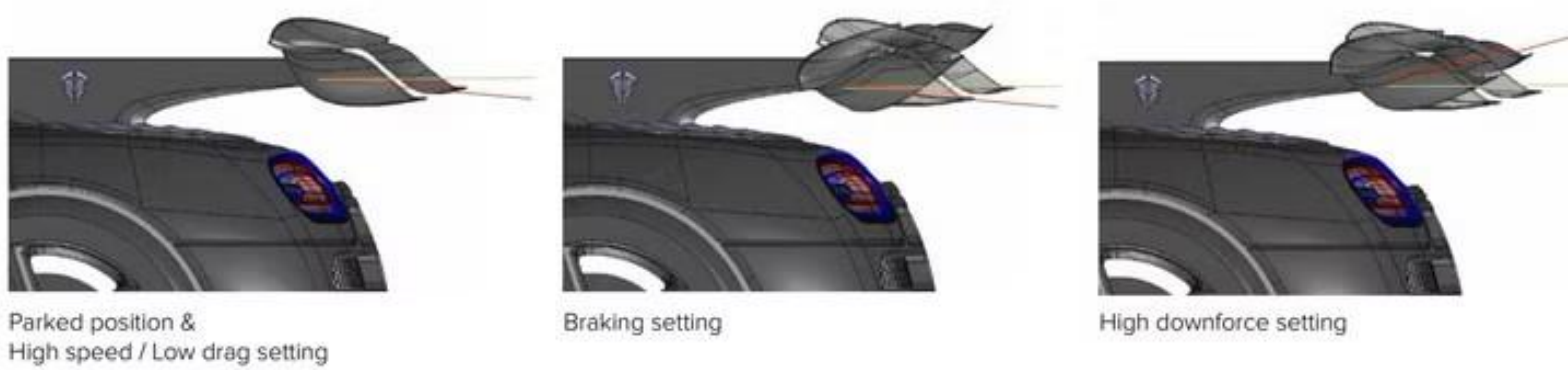
Metric	2011 (Pre-DRS)	2021 (DRS Era)
Overtaking moves per race	33	56
% of overtakes using DRS	N/A	54%

Industrial Importance

A well renowned active aero feature is the DRS in F1. It has changed the sport since being introduced with an increase of overtaking ability of around 50% on most tracks and with an increase of 70% in 2021 overtakes compared to 2011.

With every teams own individually designed rear wing comes a different style of DRS. Watching F1 at the moment Red Bull are seen to have the best results with the DRS due to their amazing passive aerodynamics complimenting the system.

Systems such as DRS is important to industry as it contributes to a trickledown effect that reaches the automobile market, and with such high competition in the sport the race to get the best technology for attracting a different market for companies wishing to invest into similar technology. The race for the best technology also means that the developments of new technology is much faster than the standard automobile market.



A diagram showing how an active rear wing works. (Moe, 2014)

Theory

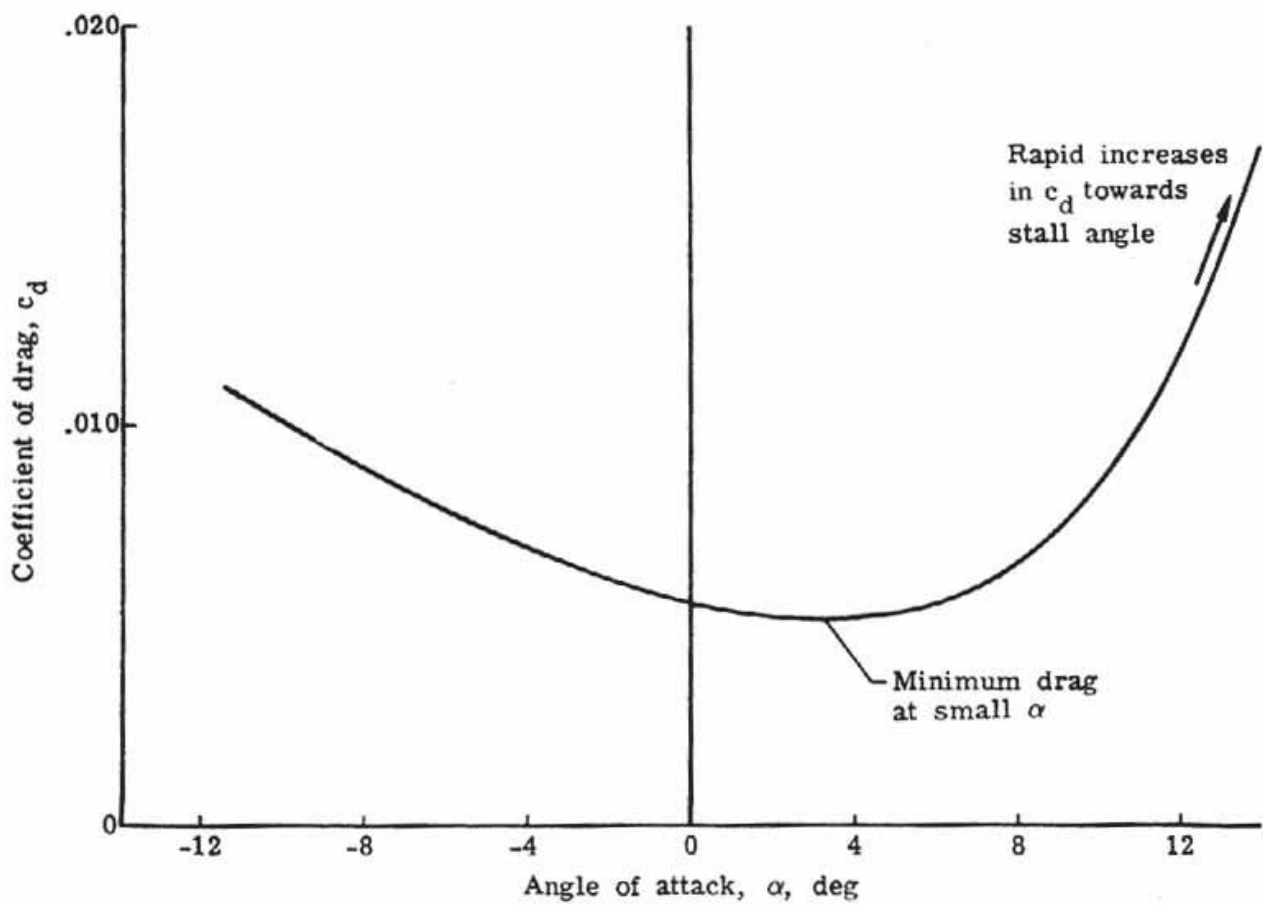
$$C_D = \frac{F_D}{\frac{\rho V^2}{2} A}$$

The coefficient of drag

This is a perfect example of why active aero is good innovation as with a change of A the drag coefficient will change to benefit the vehicle in different situations

$$C_D = 2 (\sin(a))^3$$

Another way to find drag is to compare it with the angle of attack. The graph below shows where the best angle of attack is to minimise drag but also where the stall angle begins. (this is useful for the air brake)



A graph comparing the coefficient of drag and angle of attack (NASA, n.d)

Conclusion

Overall, active aerodynamics are a huge innovation which is taking motorsport by storm over recent years, having a huge impact on racing which it will continue to do so for years to come.

References

Moe, C. (2014). The Koenigsegg One:1 has Some Seriously Advanced Active Aerodynamics. [online] TopSpeed. Available at: <https://www.topspeed.com/cars/car-news/the-koenigsegg-one-1-has-some-seriously-advanced-active-aerodynamics/>.

CarExpert. (2021). Active aerodynamics explained. [online] Available at: <https://www.carexpert.com.au/car-news/active-aerodynamics-explained>.

www.33rdsquare.com. (2023). Demystifying the Drag Reduction System: An F1 Fan's Guide to Understanding DRS - 33rd Square. [online] Available at: <https://www.33rdsquare.com/demystifying-the-drag-reduction-system-an-f1-fans-guide-to-understanding-drs/> [Accessed 18 Apr. 2024].

www.centennialofflight.net. (n.d.). Coefficient of drag vs angle of attack. [online] Available at: https://www.centennialofflight.net/essay/Theories_of_Flight/Two_dimensional_coef/TH14G5.htm [Accessed 19 Apr. 2024].