Evolution of Aerodynamics in Formula One

Degree programme: BSc in Automotive Engineering
Specialisation: Design and mechanics
Thesis advisor: Prof. Sebastian Tobler

This work reviews the evolution of Formula One aerodynamics, which constitutes the broader topic of the bachelor thesis, from early low-downforce cars relying on mechanical grip to the adoption of wings, ground-effect underbodies, and increasingly complex multi-element wings, diffusers, and vortex devices. It highlights how successive technical regulations over several decades shaped downforce, aerodynamic efficiency, vehicle stability, and overtaking performance.

Samuel Flumet
076 701 55 33
samuel@flumet.ch

Aerodynamic Milestones in F1

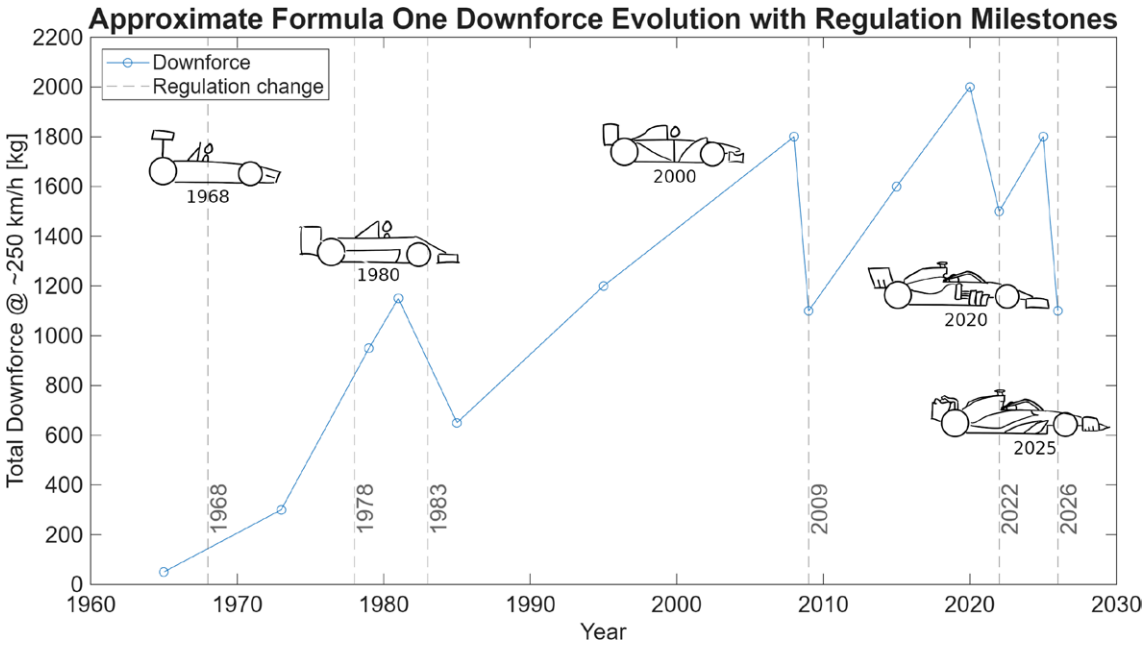
In early Formula One, aerodynamic effects were minimal, with cars shaped primarily to reduce drag rather than generate downforce. Vehicles featured narrow body shapes, and cornering relied almost entirely on mechanical grip.

The first major innovation came in 1968 with wings, pioneered by Lotus, which increased tire loads and cornering capability. High-mounted wings maximized aerodynamic efficiency but created structural risks, prompting the International Automobile Federation (FIA) to mandate attachment to the chassis for safety.

Ground-effect aerodynamics emerged in the late 1970s, when Lotus introduced Venturi-shaped underbodies and sliding skirts to seal airflow beneath the car, dramatically increasing downforce while keeping drag moderate. The design made cars faster in corners but sensitive to ride height, where small changes could sharply reduce downforce, leading to the FIA's 1983 flat-floor regulation, which limited underbody effects and shifted emphasis back to wings.

From the 1990s onward, aerodynamic complexity increased with multi-element wings, diffusers, and vortex-generating devices, producing downforce exceeding vehicle weight. The 2009 aerodynamic reset simplified bodywork to reduce downforce and wake turbulence, while the 2011 introduction of the Drag Reduction System (DRS) improved straight-line speed and overtaking.

The 2022 regulations reintroduced controlled ground effect, with underfloor tunnels producing most downforce and reducing wake sensitivity, allowing cars to follow more closely through corners. Planned 2026 rules will add active aerodynamic elements and revised floor geometries to further improve efficiency, stability, and overtaking potential.



This plot shows the evolution of Formula One aerodynamic downforce, highlighting the impact of regulatory changes