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# Aerodynamics Design of the Underbody of an MCR Racecar for the British Hillclimb & Sprint Championship


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## Introduction

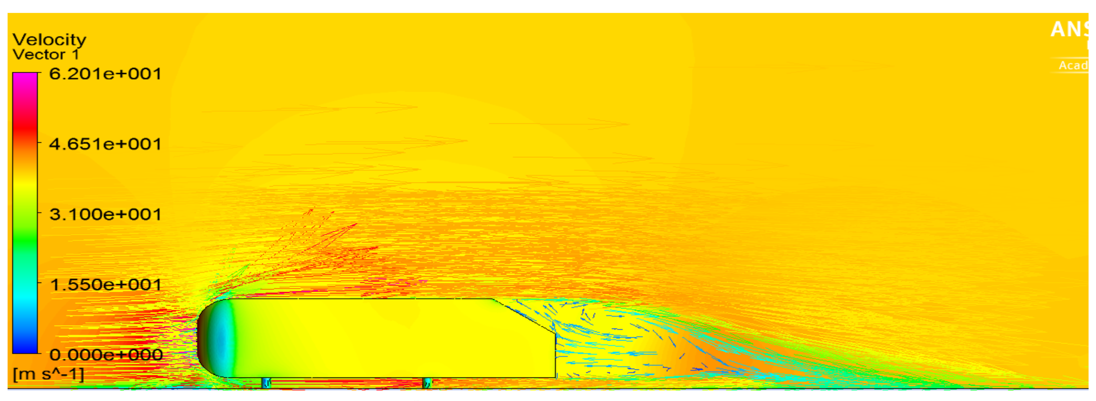
This project centred around the design of the underbody for an MCR Racecar for the British Hillclimb and Sprint Championship. Using Ansys CFD and Solidworks CAD several designs were produced to balance frontal downforce of a newly designed splitter by John Iley (1).

## Project Aims

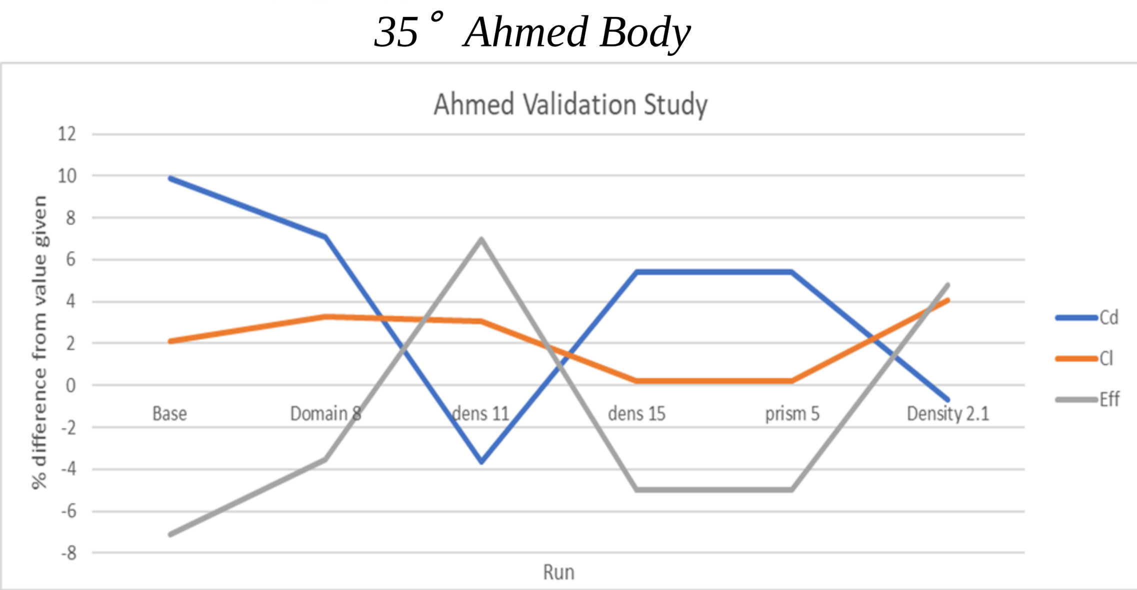
- Bring centre of pressure back to a value similar to the original Car
- Increase overall downforce
- Keep the drag coefficient below 0.5

## Validation

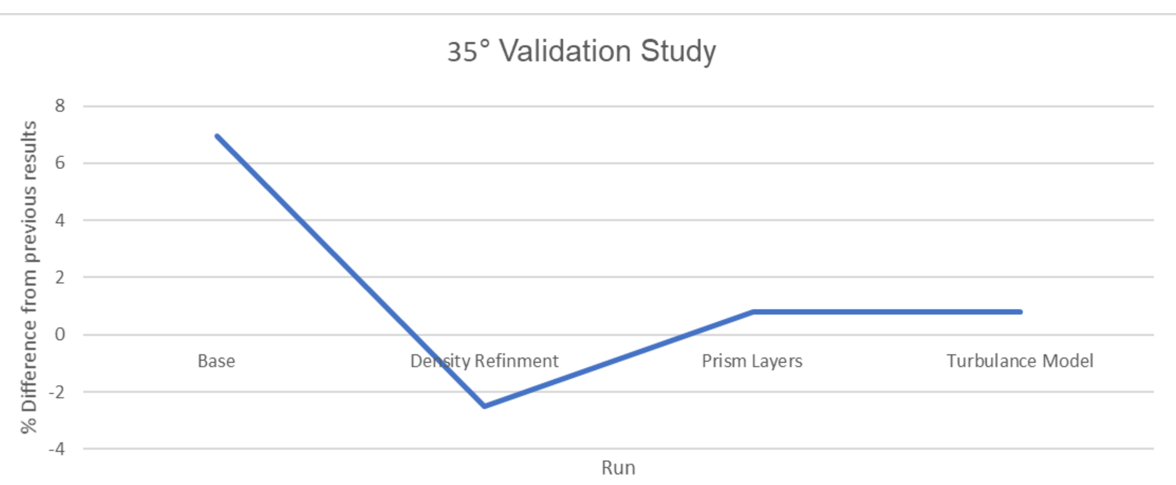
First using the Ahmed Body as a case study, two versions were validated against it to gain an accurate CFD methodology compared to results from (2) at 40m/s.




*35° Ahmed Body*



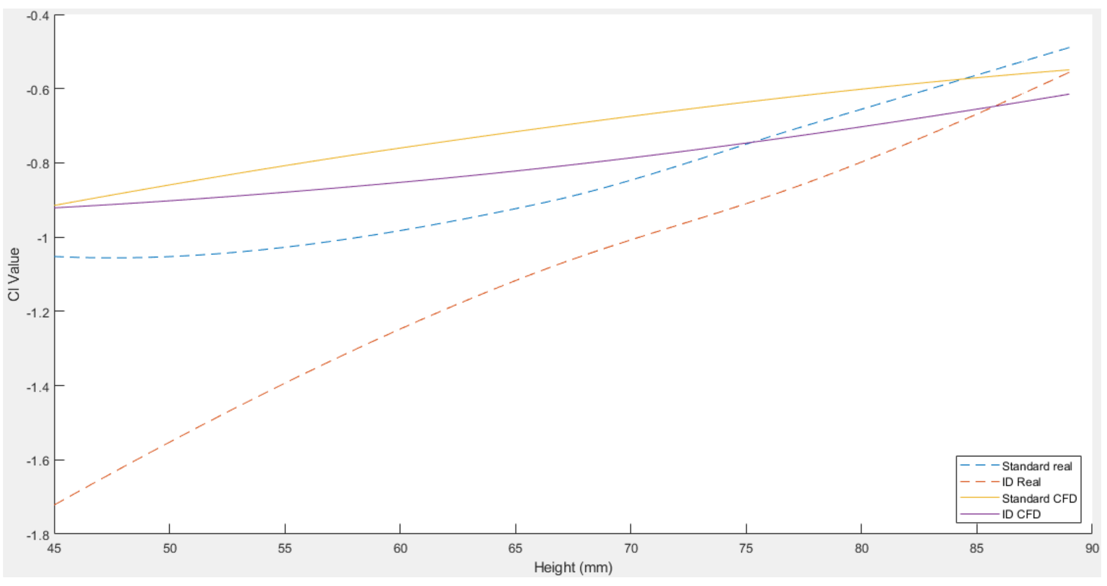

*Graph-1 25° Ahmed Study*




*Graph-2 35° Ahmed Study*

An improvement was gained at each stage as the methodology progressed. Improved correlation could be seen with the 25° (Cl-0.66%, Cd-4%) as there was less separation and therefore less complex flow.

Then a study on the MCR Car itself was made against straight line testing data. An initial mesh was used which gave poor performance and was hard to run. So, the geometry was simplified, and the mesh strategy changed.



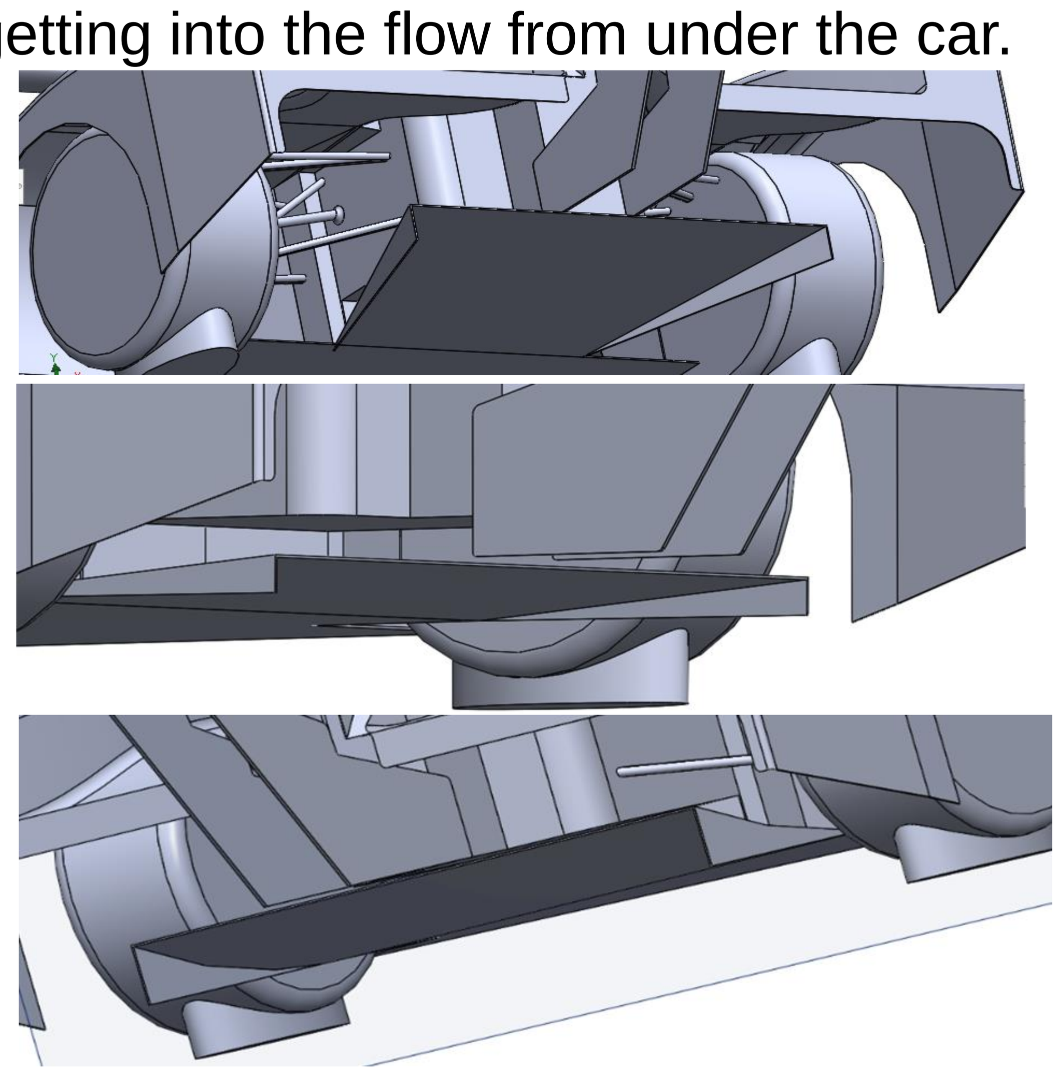

*Graph-3 MCR Validation Study Results of the 2nd Method used*

K-epsilon realizable was used as the turbulence model and with a non-equilibrium wall function which has a y+ (a non dimensional viscous sublayer thickness) of between 30 and 300. The model was run at 32.5m/s with moving road and wheels so that it was comparable to the straight-line data.

The second mesh performed better than the 1st but there was still room for improvement but due to time constraints it was not able to be explored.

## Design Iterations

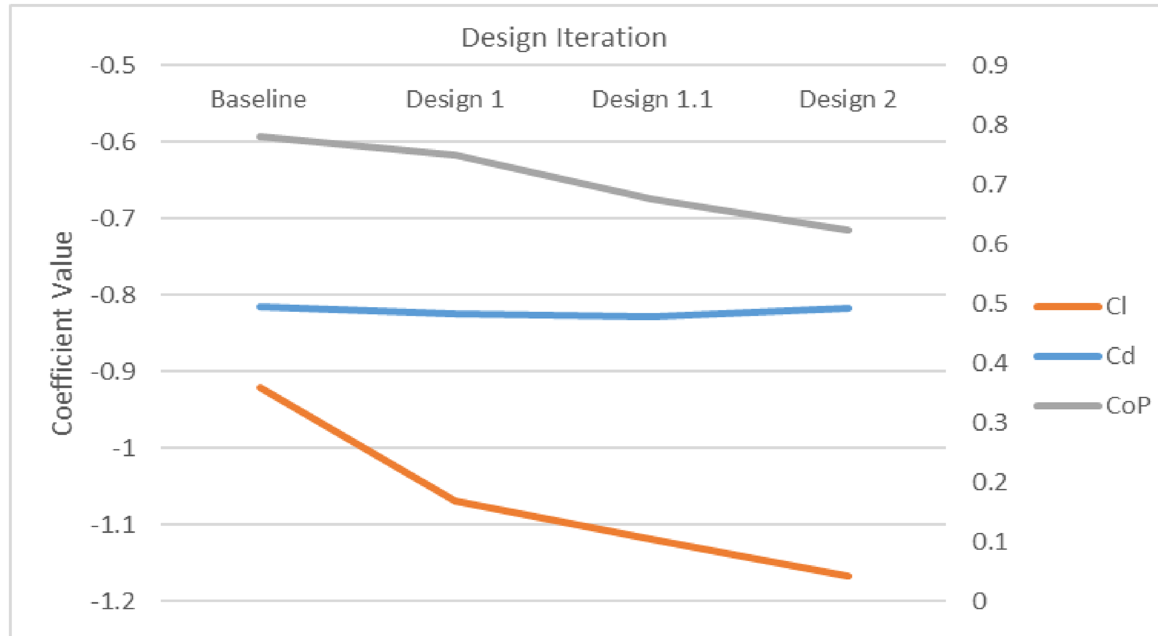
Four Designs were created with three results being obtained. First was a diffuser which had an expansion ratio of 3.2 and an angle of 7°(3). A development from that was a straight diffuser which was full width and at 7°. The final iteration was a full width curved diffuser as (4) showed promise of around 22% increase in efficiency over a straight diffuser. All designs had strakes on the edges to prevent the pressure from bleeding out and to prevent turbulence from getting into the flow from under the car.



*Design Iterations*

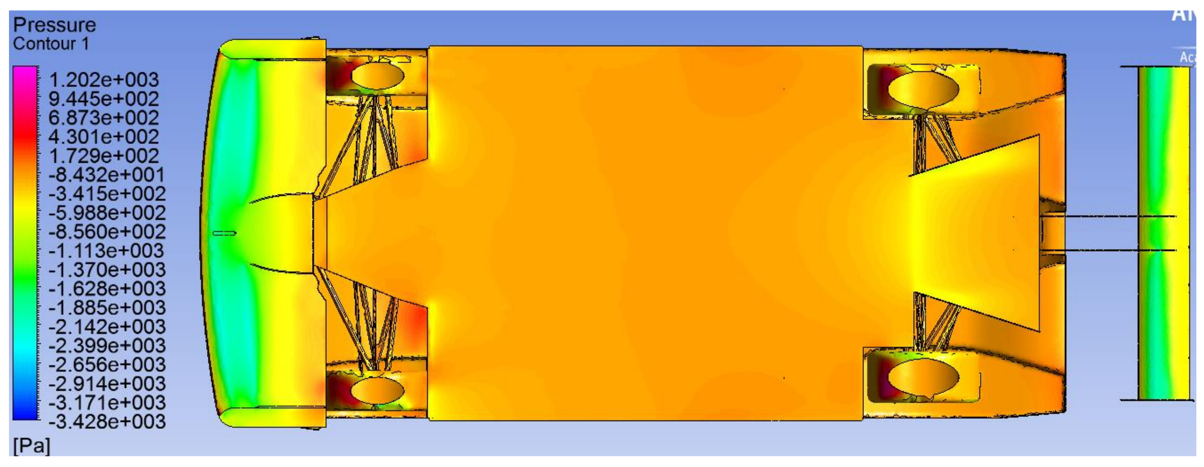
*Photo Courtesy of Max Hart*

## Results

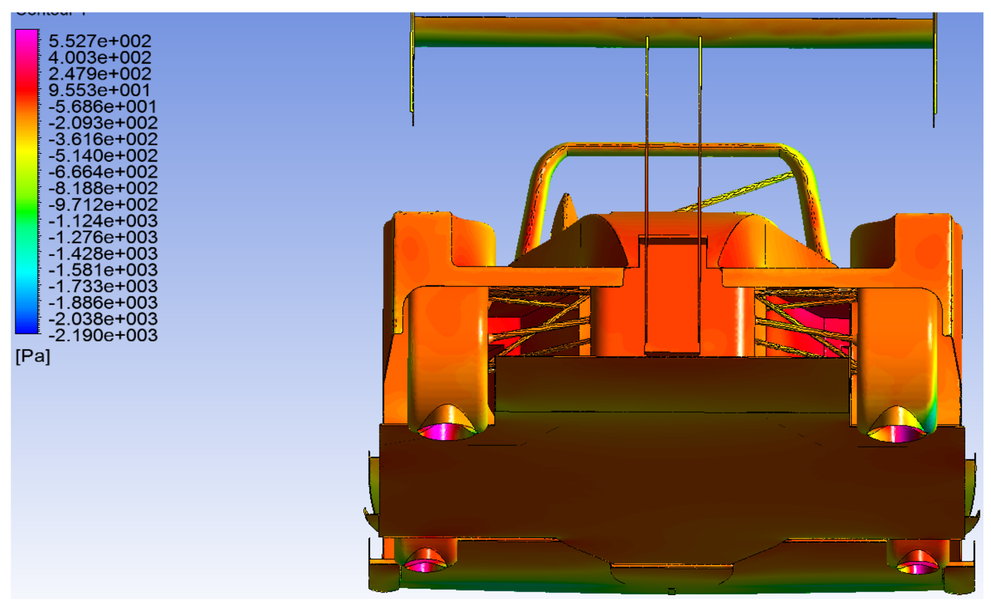



*Graph-4 Results from Development of Design 2nd methodology*

The curved diffuser was in fact the best design with a centre of pressure of 62.25% which is close to the required 64%. This could be brought closer by further development of the diffuser by moving the kick point. It also had the best lift and drag efficiency of 2.39 compared to the standard 1.8. Additionally it had a Cd of 0.49 which is below the threshold stated in the project aims.




*Pressure Contour of Floor of First Design*



*Pressure Contour of Final Design*

## Conclusions

The project found that a curved diffuser has the largest downforce producing capabilities for the least amount of extra drag. Also a full width diffuser worked better than a smaller expanding diffuser as it drops the pressure across a larger section of the floor. It also appears that the vanes on the end of the diffuser can have an assist in controlling the flow out of the diffuser. It was also found that there was very little wing interaction with the floor at the current wing position on the vehicle.

## References


(1) Iley, J., 2019. *John Illey Design splitter.* s.l.:s.n

(2) Meile, W. et al., 2010. *Experiments and numerical simulations on the aerodynamics of the Ahmed body,* Graz: s.n.

(3) Toet, W., 2017. *Race Tech Motorsport Engineering.* [Online] Available at: https://www.racetechmag.com/2017/08/willem-toet-explains-motorsport-diffusers/
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(4) Huminic, A. & Huminic, G., 2019. Computational Study of Curved Underbody Diffusers. *XII International Conference on Computational Heat, Mass and Momentum Transfer (ICCHMT 2019)*, 08 November, 128(E3S Web Conferences)


Ansys MCR RACE CARS SOLIDWORKS ILEY DESIGN School *of* **Engineering**