FLUID DYNAMIC ANALYSIS OF A FAIRING FOR A RACING MOTORCYCLE: DESIGN OF THE WINDSHIELD AND DYNAMIC AIR INTAKE TO REDUCE THE AERODYNAMIC DRAG AND INCREASE THE MASS FLOW

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Introduction

The fairing is the part of a motorbike that is most exposed to the wind, so it has an important influence on the aerodynamic forces. The most important force which acts on the fairing is the aerodynamic drag. By decreasing it, the consumption of fuel can be reduced and the maximum velocity can be increased. With the right design of the fairing, the aerodynamic drag can be reduced and the air mass flow, which enters in the airbox, can be increased.

Targets

- **Reduce the aerodynamic drag**
- **Increase the air mass flow**

Methods

The evaluation of the aerodynamic forces and the mass flow is conducted by considering a Computational Fluid Dynamic (CFD) analysis based on Reynolds Averaged Navier-Stokes (RANS) equations and k-ω SST turbolence model.
Aprilia provided us the mass flow at the inlet and the pressure drop due to the air filter in the airbox, so it was made a validation on these data.
The flowchart shown in Figure 1 was followed to perform the design process.
In the first phase, a parameter (1) was defined, whose contour on the fairing shows the zone which is most penalized by aerodynamic drag. That zone is the windshield. Some geometries were simulated without considering the effect of the airbox.

Specific Drag = Pressure * Cell Area * Normal X **(1)**

In the second phase, different geometries for the duct were created and simulated to reproduce the value of the pressure drop for the standstill motorbike provided by Aprilia.
Once found the correct duct length, the moving motorbike is considerated in the baseline geometry. By imposing the value of air mass flow at the end of the duct, Figure 2, the value of pressure in that section was calculated. This value was adopted to simulate the new geometries of dynamic air intakes.

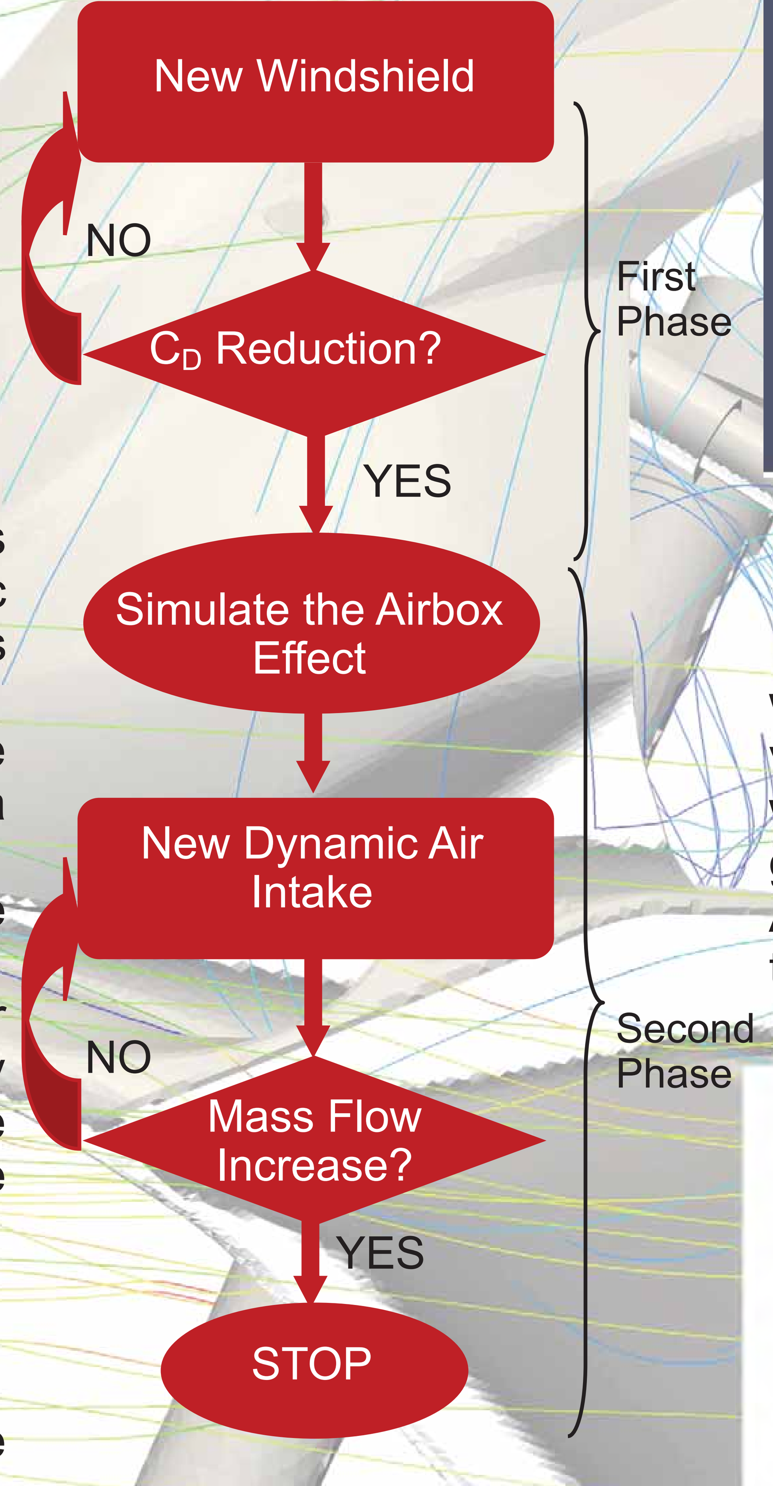

Figure 1: Flowchart of the design process.

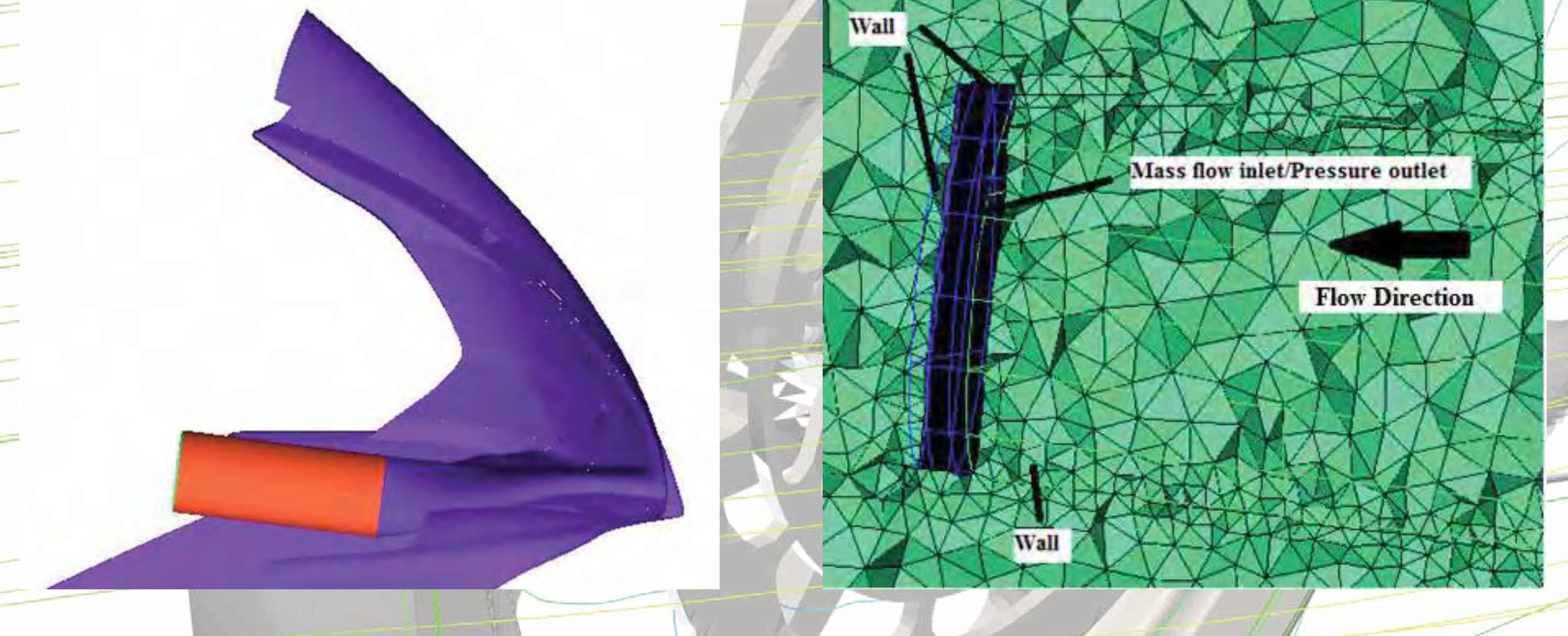

Figure 2: Duct added to the fairing (left), final part of the duct with the conditions imposed (right).

Results

Figure 3a shows the contour of the specific drag on the baseline fairing. The most critical zone is the lower part of the windshield.
The first step is represented in Figure 3, where the reduction of the specific drag is obtained by changing the geometry of the windshield.

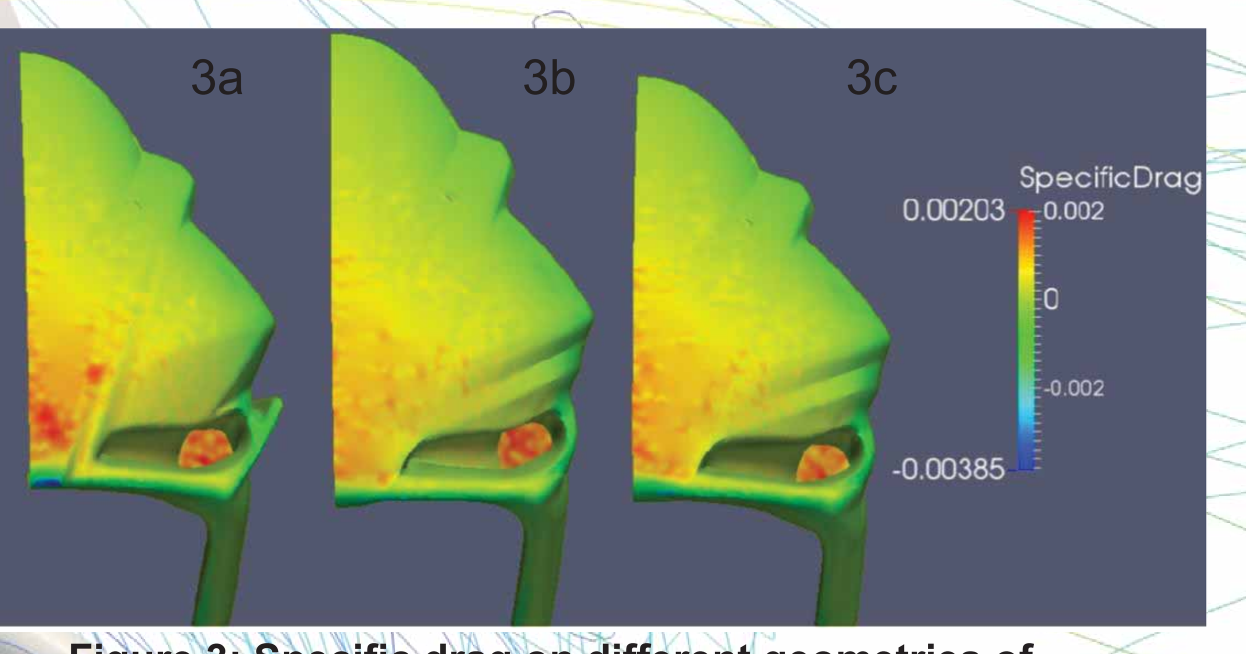

Figure 3: Specific drag on different geometries of windshield

In Figure 4, the result of the validation process is shown, with the various geometries of ducts: three ducts with various length (2.5D, 5D, 7D) and two ducts (5Da, 5Db) with a porous zone inside. The porous zone gives greater value of pressure drop than the value from Aprilia. The most suitable duct has a length of five times the diameter, providing an error of 17,5 %.

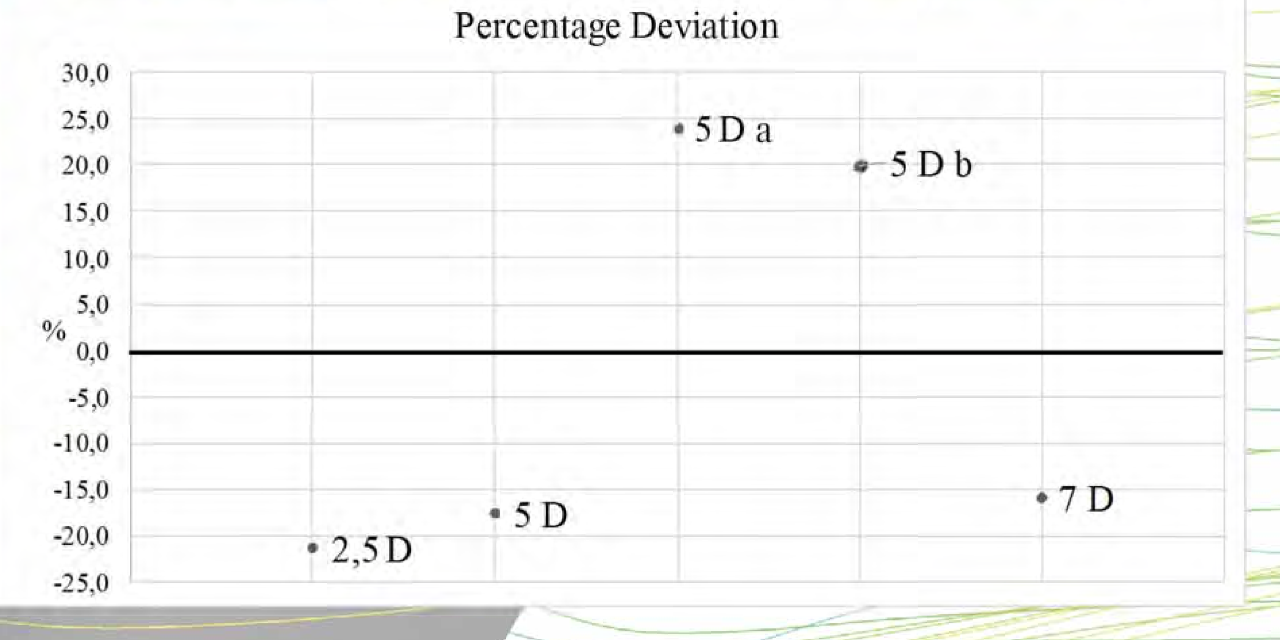

Figure 4: Comparison between different ducts.

The main result, according to the second phase of Figure X, is a fairing with a reduction of the drag coefficient of 2,70 % and an increase of the mass flow of 0,46 % compared with the baseline.
This geometry is shown in Figure 5 in comparison with the baseline, where it is represented the contour of the pressure coefficient.

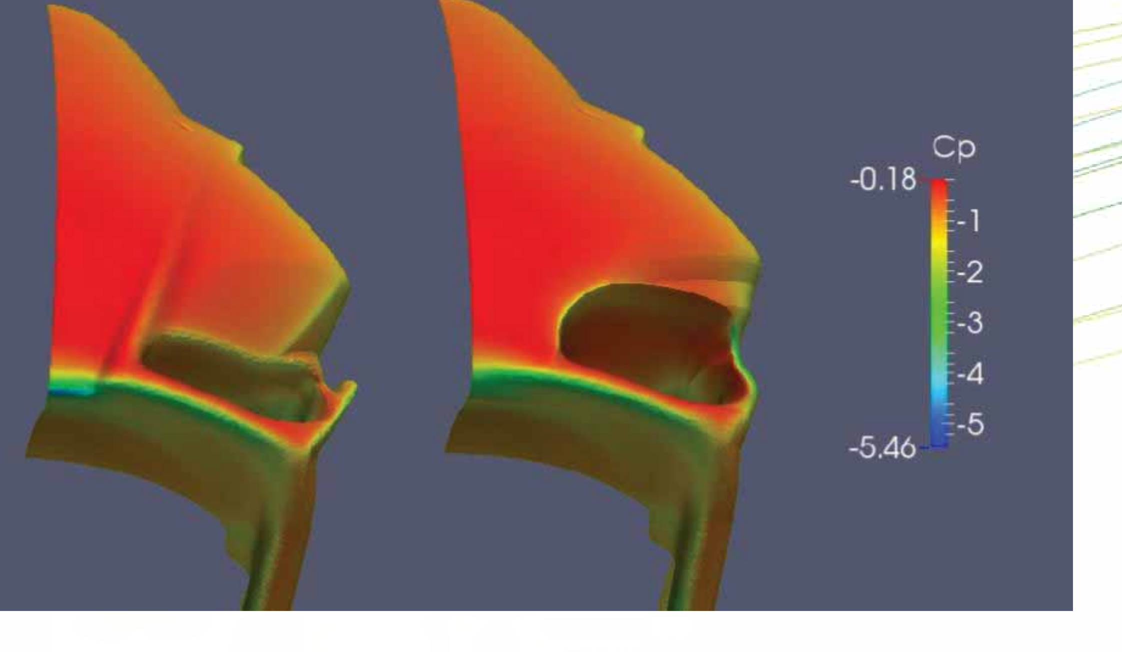

Figure 5: Contours of the pressure coefficient in baseline fairing (left), optimized fairing (right).

Conclusions and Future Developments

A fluid dynamic analysis and a redesign operation was conducted on a fairing of an Aprilia motorbike in order to reduce the aerodynamic drag and increase the air mass flow. The lower part of the windshield and the profile of the dynamic air intake were modified. The targets were reached, and the results provides: a reduction of 2,70 % of the drag coefficient and an increase of 0,46 % of the air mass flow.

Some possible future developments include the validation of the pressure field and the reduction of the discrepancy between the Aprilia pressure drop value and the duct.