**SHAPE OPTIMIZATION OF TURBULENT TRANSONIC INTERNAL FLOWS**

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The exhaust phase of a four stroke cycle is investigated, in order to improve the total efficiency of an internal combustion engine. Main parameters influencing this efficiency during the exhaust stroke are the mass flow rate and pressure loss in the exhaust valve nozzle. The flow quality is optimized by local geometrical changes, using the commercial optimization tool modeFRONTIER. A multi-objective optimization is performed for minimal total preesure drop and maximal mass flow, and the pareto front has been identified.

This first optimization processes concerned the coupling of the optimizer with the in-house CFD solver *THOR*. In this setup, planar and axisymmetric optimization campaigns have been performed, with steady operating conditions and fixed valve opening. With these optimizations, it has been proven that it is possible to improve efficiency of the exhaust process for any of studied openings. An example is shown in Figure 1, comparing the original valve configuration with one solution optimized for the 2 objectives over the area indicated in the figure.

Accomplishing of more complex optimizations, capturing unsteady effects, can be done using the new CFD code *COOLFluiD*. This new tool needed to be improved by implementing and validating the proper turbulence models. In the scope of this project three models of turbulence have been implemented: Wilcox's $k$ - $\omega$ Menter's Baseline (BSL) and Shear Stress Transport (SST) model. These models have been fully validated for 2D flat plate and Naca airfoil. First computations on the so called Délery bump (shock wave/boundary layer interaction) have also been performed, showing promising results. Nevertheless the convergence of this testcase still needs some improvements. Besides, first steady and unsteady results have been yielded on the valve geometry. For steady computations, a good agreement with the THOR solver has been achieved at results with $2^{nd}$ order accuracy. Consequently, after the unsteady computations will be validated against some reference testcases, the fully unsteady optimizations can be realized.

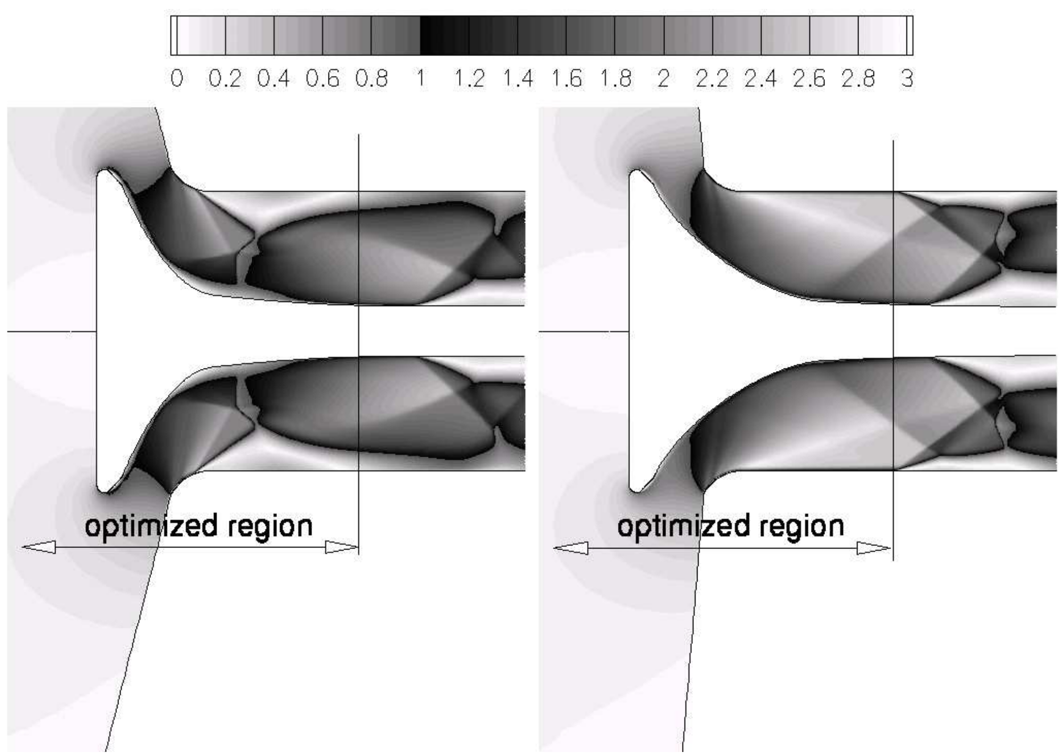


*Figure 1: Engine exhaust valve, original configuration (left), optimized shape (right), contours of Mach number*