3D OPTIMIZATION OF AN AXIAL COMPRESSOR ROTOR

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The increase of turbomachinery efficiency has become one of the main targets of current engineers. One way is by reducing the losses due to the secondary flows that accumulate in the corner between suction side and hub endwall, inside the blade passage. A large decrease of total pressure, which may lead to corner stall, can be measured in those regions.

Leaning the blade spreads that low energy fluid along the blade span and if well done may decrease the losses. The objective of the optimization was to improve an existing design by finding the best way of leaning the blade. The lean was introduced by the tangential displacement of 11 equally spaced sections along the span and the blade surface is generated by linear interpolation between the sections.

The optimizer consists of a genetic algorithm that searches for the optimum blade shape in between the limits that define the design space. The fitness of each shape is decided by accounting for the efficiency improvement and penalizing deviations from the required mass flow. In a first step, efficiency and mass flow are predicted by an artificial neural network. The predicted performance of the blade found by the genetic algorithm is then checked with the results from a Navier-Stokes computation. The optimum is reached when both predicted and computed performances are sufficiently close.

An application to the VITAL subsonic compressor stage in VKI test bench R4 was done. The secondary losses were found to be strongly dependent from the inlet casing boundary layer thickness. No improvement could be obtained with thin inlet boundary layer. A reduction of 4.6 % in losses was achieved when an artificially enlarged inlet boundary layer was imposed. The mass flow was accurate within 0.4 %.

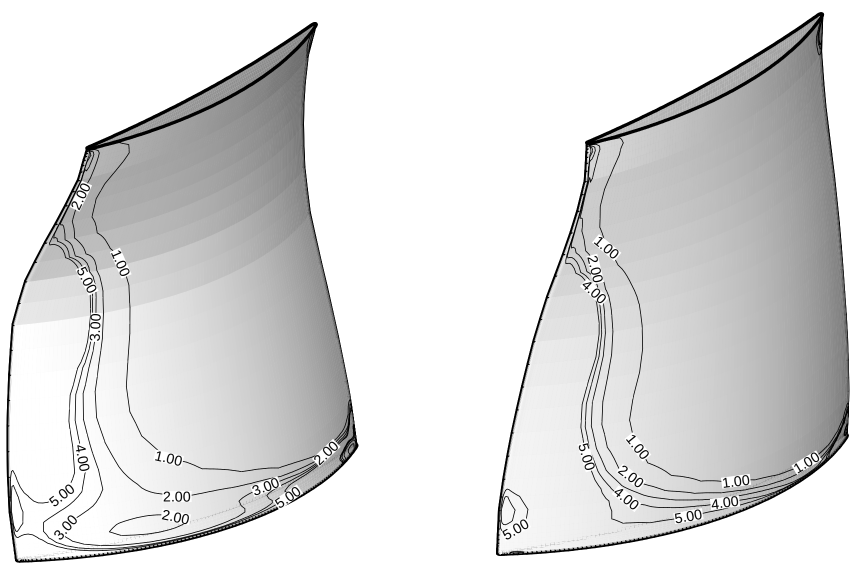

Figure 1: Loss iso-lines ($\omega \cdot 10^5$) on the suction side of baseline design (right) and optimized blade (left). The trailing edge is on the left