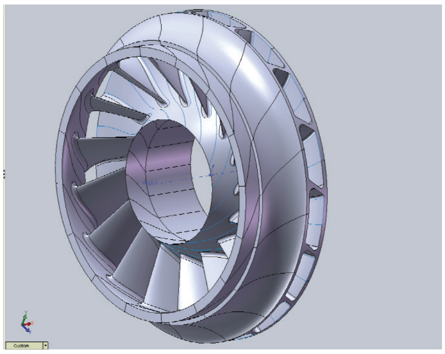
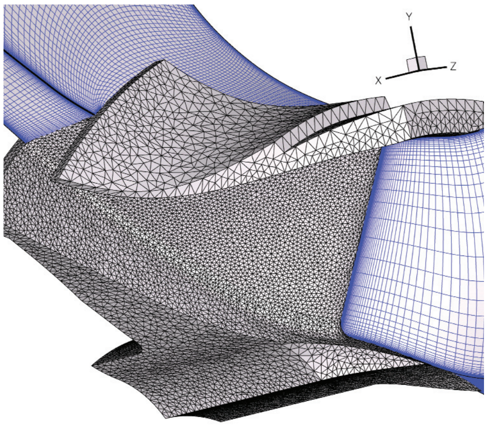
COMPUTER AIDED DESIGN OPTIMIZATION OF TURBOMACHINERY COMPONENTS

The VKI has been actively involved in the design of turbo-machinery components ranging from micro gasturbines, axial/radial compressors/turbines, fans, pumps to internal cooling channels for industrial clients and governmental agencies.

To help the designer in his design process, the VKI has developed over several years of experience a Computer Aided Design Optimization (CADO) tool using numerical optimization algorithms based on evolutionary algorithms, surrogate models and high fidelity evaluation tools such as Computational Fluid Dynamics (CFD) and Computational Structural Mechanics (CSM). It is the perfect tool to improve the performance of existing designs or for designing new components. Innovative designs are produced in a reduced time to market.



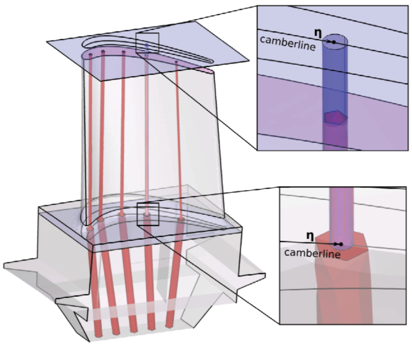
CAD model of a radial compressor



Structural (gray) and fluid (blue) grid for a radial compressor

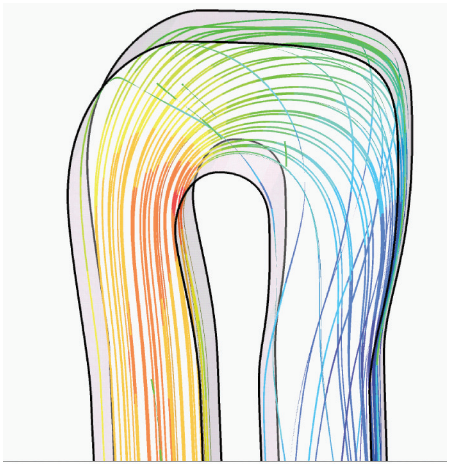
MULTIDISCIPLINARY OPTIMIZATION

Designing turbomachinery components consists in the evaluation of conflicting requirements emerging from different disciplines. As one of the projects investigated at the von Karman Institute, the optimization of internal cooling channels in a high-pressure turbine is an example of complex design work involving trade-offs between fluid process and structural integrity evaluated by conjugate heat transfer computations.



Optimization of internal cooling channels of a turbine blade

Traditional design approaches in industry operate with several iterations between different engineering departments, each one evaluating design changes to improve the performances in their specific disciplines. Multi-disciplinary optimization techniques enable to reach a global optimum considering simultaneously the conflicting requirements of all the different disciplines. By limiting iterative design changes, an interactive design optimization process reduces the time to market cost.



U-bend optimized for minimal pressure losses

The current capabilities include aerodynamics, aero acoustics, structural mechanics, vibrational mechanics and conjugate heat transfer. Typical objectives include efficiency, range, and emitted noise, while constraints are imposed on stall behavior, mechanical stress limits due to centrifugal forces, thermal stresses and/or pressure forces, etc.

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