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Optimization of 3-D Multi-Element High-Lift Device Configuration

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ABSTRACT

The presentation will show the successful application of numerical optimization for 3D high-lift design of transport aircraft configurations. It will outline the requirements for an achievement of acceptable turn around times. Special focus will be set on the grid generation strategy, since the reduction of grid points is a key issue for affordable RANS calculations within numerical optimization. Based on the chosen grid strategy adjoint methods for gradient calculation are applied in order to use fast gradient based methods for optimization.

Two different grid strategies have been applied for the use within numerical optimization, a purely structured grid (Figure 1) and a mixed mesh approach (Figure 2). Both grid strategies allow the generation of computational grids with about 2 Million grid points around a complete high-lift wing-body transport aircraft configuration. This is approximately only 10 percent of the points usually generated with standard unstructured hybrid grid generation strategies, without degrading the accuracy of the obtained CFD result.

This prerequisite makes RANS calculations of 3D high-lift configurations affordable for numerical optimization purposes. Under special additional conditions also the discrete viscous adjoint could be applied for gradient calculation. This additionally is able to speed up the optimization process, resulting in a minimum achieved turn-around time of less than 3 days for a complete 3D high-lift configuration (Figure 3).

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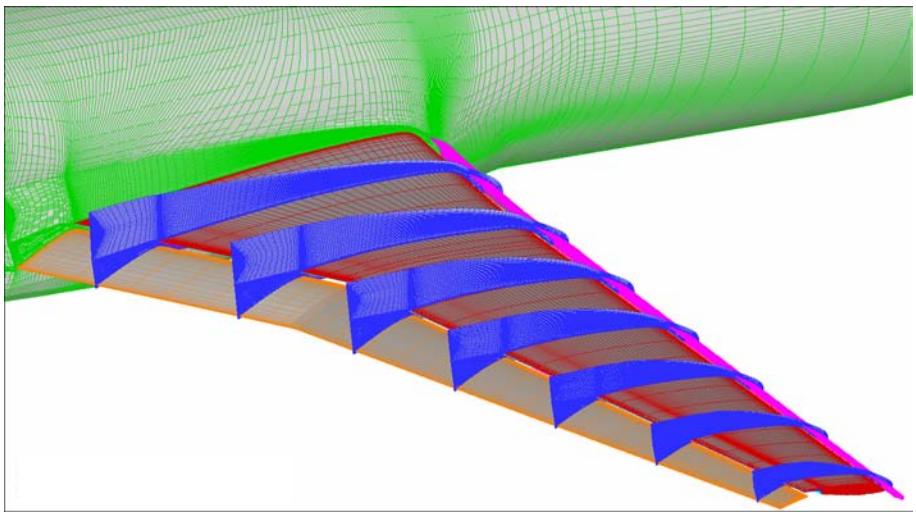

Figure 1: Detail of structured mesh around DLR F11 high-lift configuration

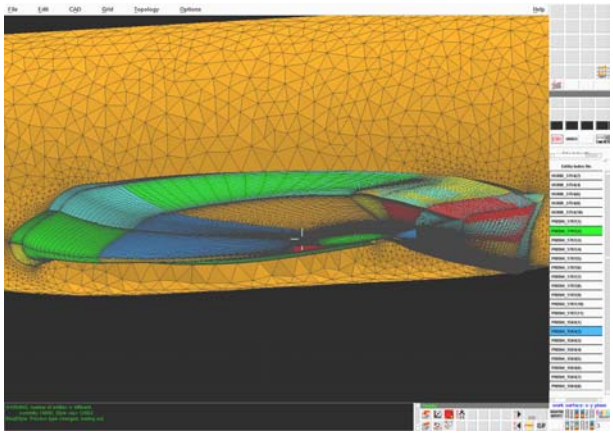

Figure 2: Mixed structured-unstructured grid around generic transport aircraft high-lift configuration

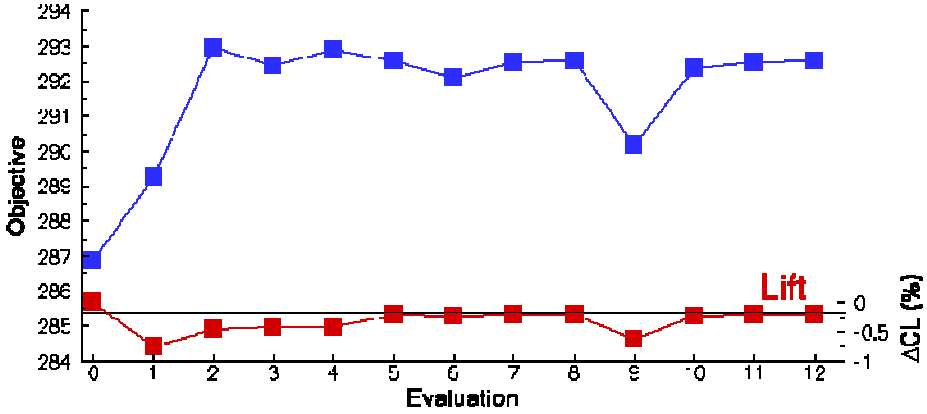

Figure 3: Optimization history of 3D high-lift optimization (maximization) using adjoint method