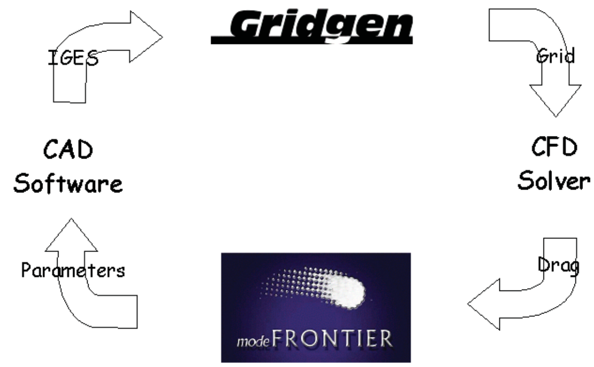
Gridgen
Reliable CFD Meshing

Sirehna's Use of Gridgen to Streamline CFD

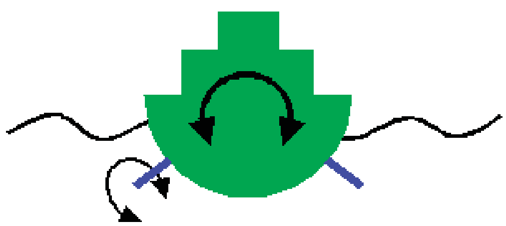
Sirehna has been developing and promoting optimal design approaches, especially involving CFD, for a long time. Our current policy is to combine the advantages of the most efficient flow pre and post-processors tools (Gridgen and Fieldview) together with Frontier, an advanced tool for design space investigation and optimization. The process is kept independent from the flow solver. Fluent is used in the two following applications. Others have been developed using ICARE, a dedicated solver for free surface flows in viscous fluid around a ship hull.

The first application is a simple case; the aim being to set up the whole optimization chain on a 2D case. The second one is 3D shape optimization of a ship hull.



1st study: SHIP STABILIZING FIN

We chose a very simple case since our interest was not in the parametric modelling or in the solver calculation but in the validation of the optimization chain.



The case of study was the optimization of the profile of a fin. This kind of fin is used to stabilize ships by inducing a moment opposite to roll, as shown above.

The objectives of this optimization process were to:

- maximize lift
- minimize drag
- minimize risk of cavitation

For each design, the process consisted of three parts taking place on different computers and different systems. All computers and systems were running in batch mode and controlled by Frontier:

Frontier sends the four shape control parameters to Gridgen, which then creates a mesh around the new profile. Gridgen Version 14 runs in batch mode using its new Glyph scripting language to control operation. The mesh is created by extrusion from the profile. Gridgen, running on a PC, then exports the mesh in the CFD solver format.

The second step was the flow calculation made on a UNIX station. The solution was then exported in Fieldview format.

Finally, Fieldview was used to integrate to find forces on the profile and to calculate the minimum pressure value.

A typical optimization process starts with an initial population of 70 designs. The results obtained for these designs are used by Frontier to set up response surfaces using neural networks, which are used by a multi-objective genetic algorithm to mix real calculations and virtual calculations in order to accelerate the process. Then we use the multi-criteria decision-making tools provided by Frontier to detect the Pareto frontier and to sort solutions.

2nd study: OPTIMIZATION OF A SHIP HULL FORM.

Once we validated the optimization chain during the first study, we wanted to test it on a 3D calculation; the integration of an appendage on a ship hull.

For this case, the parameterization was not done in Gridgen, but in the CAD software. For each design, an IGES file was input as geometry for Gridgen. An IGES file from Pro/ENGINEER was input as geometry for Gridgen. A Glyph script, obtained by journaling, was used to automatically create a 3D structured multi-block mesh, comprising approximately 300,000 cells, around the hull of the vessel. Structured grids benefited from the grid quality improvement provided by the elliptic solver. More than 70 meshes of different designs were generated automatically thanks to this script.

In order to reduce the computation time in the flow solver, the calculation for each design was started with a flow field already converged on another design. Moreover, the flow field was restricted to a region around the appendage. Boundary conditions were deduced from a solution obtained on a larger flow field. Thanks to these two tricks, the computation time was decreased by 60%.

Response surfaces were used in conjunction with multi-objective genetic algorithm in order to get quick convergence. In less than 110 hours of computing, a minimum for drag was reached.

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