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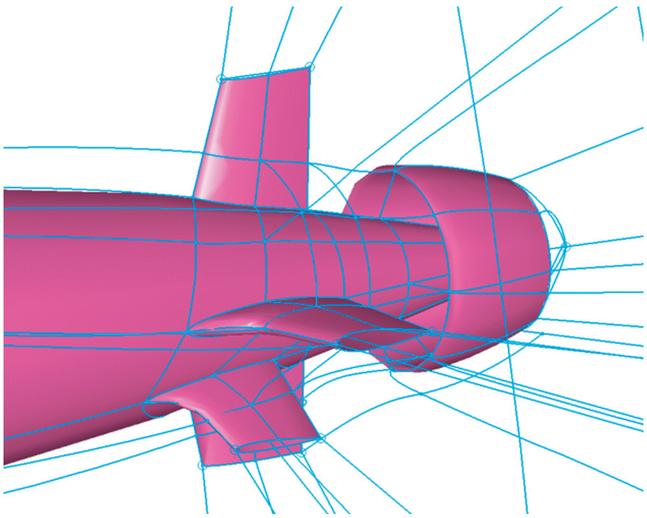
Gridgen Reliable CFD Meshing

Naval Hydrodynamics Benefits from Using CFD



Engineers at NSWC used Gridgen to make this block structure around a submarine propulsor.

In response to the need for better designs in less time, Computational Fluid Dynamics (CFD) is becoming an integral part of the Navy's design process. Coupled with faster computers and computational algorithms, Reynolds Averaged Navier-Stokes (RANS) calculations are more feasible than ever for support of design studies. In the Propulsion and Fluid Systems Department of the Naval Surface Warfare Center / Carderock Division (NSWC/CD), high quality experimental data is being used to validate these emerging computational tools for both submarines and surface ships. This work is being done in cooperation with the Hydrodynamic/Hydroacoustic Technology Center (H/HTC), also located at NSWC/CD.

The CFD process consists of 6 interconnected steps: 1) geometry definition, 2) surface grid generation, 3) volume grid generation, 4) flow calculation, 5) data reduction, and 6) experimental validation. In Step 1, the geometry being studied may be a new design or a current design needing improvement. Typically, these geometries are in electronic form developed with a CAD system or extracted from drawings. In Steps 2 and 3, Gridgen is the primary tool being used to produce the computational grid for the RANS calculations. Currently, a structured, multi-block grid system is used for most of the calculations, but as unstructured solvers and gridding techniques become more efficient and reliable, they are also becoming part of the process. In Step 4, the RANS solution is computed using one of a number of computer codes which have been validated and have demonstrated good results for similar problems. Often, intermediate results obtained in Step 4 will require a return to Step 2 or 3 for a refinement or modification of the grid so that the flow field is sufficiently resolved. In Steps 5 and 6, pertinent flow features, such as pressure and velocity, are extracted from the solution and compared with measured quantities.

The figure on the left shows the blocking structure generated with Gridgen at the stern of a modern submarine. To properly analyze the flow in this region and predict the forces acting on the submarine, all surfaces must have adequate boundary-layer resolution. The generation of such a complex grid system is often the most labor-intensive part of the problem. Shown at the bottom is a RANS flow field computed about a submarine with pitch and yaw. Vortices typically consist of necklace vortices from hull/appendage junctions, tip vortices from the appendages, and vortices generated directly from the hull due to angles of attack. Large vortices or flow separations can contribute to undesirable noise generation which is a very important consideration for submarines. RANS solutions are also useful in analyzing the performance of ships moving through a free surface. The figure below shows from below the computed axial velocity contours for a generic integrated propulsor/hull form. In this calculation, vortices generated by the sonar dome flow unobstructed along the hull and into the propulsors.

This is an exciting time for naval hydrodynamics. RANS computations allow designers to evaluate new concepts before models are built and tested while also providing a means for improving existing ship performance through a better understanding of the physics involved.

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