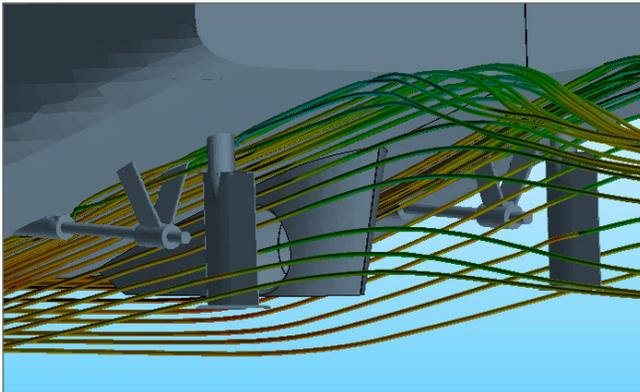


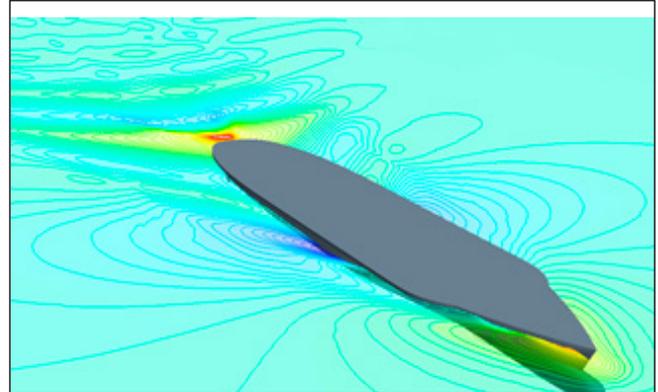
CFD analysis

WHAT IS CFD?

Computational fluid dynamics (CFD) is a computer-based method to analyze fluid mechanics. CFD is a finite element type of solution that solves fundamental equations of fluid flow numerically within an analysis domain. Many different aspects of fluid flow are able to be examined, resulting in an in-depth understanding of the underlying fluid mechanics. EBDG uses an advanced form of CFD that accounts for fluid viscosity effects including turbulence and flow separation.



Streamline Visualization



Free Surface Elevation Plot

APPLICATIONS OF CFD

CFD analysis is a powerful tool in its ability to be applied to a vast range of fluid flow regimes. EBDG applies CFD to such marine industry analyses as:

- Still Water Resistance
- 6 Degree of Freedom Motions
- Hull Resistance and Appendage Drag Prediction
- Ventilation and Piping System Performance
- Gas Dispersion Studies
- Superstructure Aerodynamics
- Rudder and Propeller Studies
- Exhaust Plume Analysis
- Dynamic Vessel Tow Characteristics
- Anti-Roll Tank and Cargo Tank Sloshing
- Dynamic Motion Modeling and Seakeeping
- Flow Induced Vibration
- Vessel Operating Trim Optimization

EBDG'S APPROACH

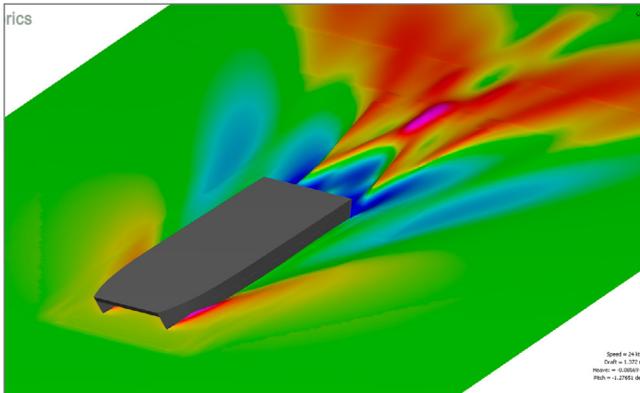
Our CFD strategy is to apply cutting edge analysis capabilities to both new-build vessel designs and existing structures. With the exponential increase in computing power available from technologies such as cloud computing, and development of in-house tools and procedures, we can affordably and efficiently perform advanced analysis with accuracy and speed.

EBDG views CFD as a synergistic part of our design toolkit. We have applied CFD both as an alternative and as a complement to physical model testing, saving our clients substantial money and time. Our CFD analysis has guided both physical design as well as the operating conditions of vessels to obtain improved fuel economy for operators. This approach results in tangible benefits for our clients.

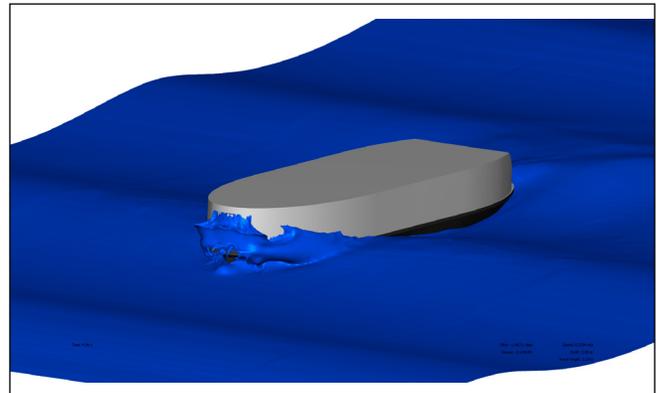
CFD analysis

SUMMARY OF EXPERIENCE

EBDG views CFD as a synergistic part of our design toolkit. Our CFD analysis has guided both physical design as well as the operating conditions of vessels to obtain improved fuel economy for operators.



EBDG performed a resistance analysis for a high-speed ferry as part of a project with Sandia National Laboratory. CFD allowed EBDG to determine the planing dynamics and resistance of the vessel with much more accuracy than with traditional parametric analysis.



EBDG performed a time-domain seakeeping analysis of the M/V WOODS HOLE for The Steamship Authority. The vessel response in extreme wave events was analyzed to determine if the operating limits of the vessel could be increased. The use of CFD allowed EBDG to accurately examine green water and spray on the bow of the vessel.

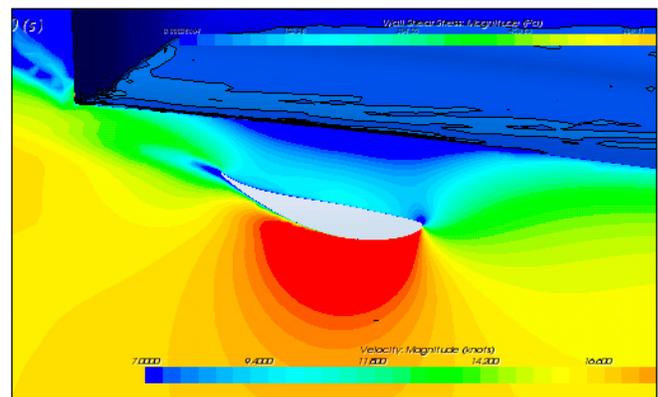
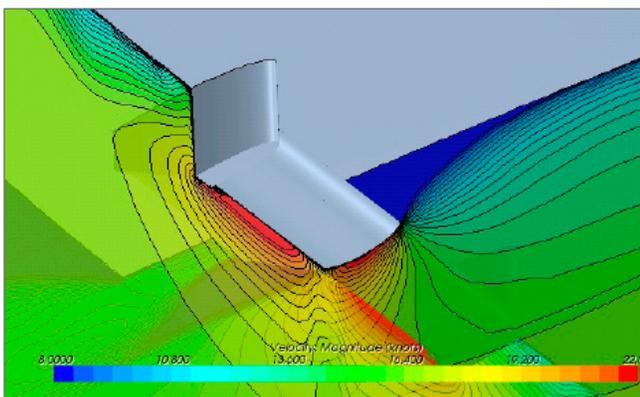
PROJECTS

- Hullform optimization for extreme shallow water and resistance analysis for a new river class ferry for North Carolina Department of Transportation
- Resistance analysis of a high-speed catamaran ferry for Sandia National Laboratory
- Hullform optimization and resistance analysis of a high-speed planing catamaran for North Carolina Department of Transportation
- Thermal analysis with convection of a heated product barge for Harley Marine Services
- Seakeeping analysis of the M/V WOODS HOLE in extreme head seas for The Steamship Authority
- Comparative analysis of a ship-shaped and a spoon-shaped bow for an 83,000 BBL ATB tank barge for Harley Marine Services
- Hull optimization and resistance analysis for a new passenger ferry for Staten Island Ferries
- Hull optimization, resistance and spray analysis for the M/V WOODS HOLE for The Steamship Authority
- Optimization of the tug-barge interface for an 83,000 BBL ATB tank barge for Harley Marine Services
- Resistance analysis for an electric tug for North American Shipbuilding
- Resistance analysis for a 3,000 M3 LNG ATB for North American Shipbuilding

CFD analysis

PROJECTS (CONT.)

- Running trim adjustment foil design and analysis for a 211' yacht for Delta Marine Industries
- N Class trim optimization study for the WESTWOOD RAINIER for Westwood Shipping Lines, Inc.
- Hull optimization and resistance analysis for the Day Boat ACF for the Alaska Marine Highways System
- Bulbous bow design and optimization study for the 250 EDF OSV for Hornbeck Offshore Services
- Rudder optimization study for the 250 EDF OSV for Hornbeck Offshore Services
- Transducer inference study for the 250 EDF OSV for Hornbeck Offshore Services
- Hull optimization and resistance analysis for a new offshore supply vessel
- Dynamic positioning load analysis for a new offshore supply vessel
- Dynamic planing pressure analysis for the United States Coast Guard R-BM
- Bow thruster tunnel and bulbous bow analysis for the M/V COHO for Black Ball Line
- Forensic analysis for the OLYMPIC SPIRIT for Harley Marine Services
- Analysis of the SWATH pilot boat BAYOU CITY for Kvichak Marine Industries, Inc.
- Forensic dynamic motion analysis of the John Day Locks
- Analysis of the tug PHILLIP C GEORGE for Southwest Shipyard
- Towing analysis of the 250 EDF OSV and SSBN for Hornbeck Offshore Services
- Resistance analysis of the M/V HIGMAN #10 for Southwest Shipyard



EBDG designed a foil for adjusting the running trim of a 211' yacht for Delta Marine Industries. CFD made it possible to rapidly analyze multiple concepts for the foil design. EBDG employed CFD not only to determine the performance of the individual foil, but to examine the interaction between the foil and the vessel to attain a realistic prediction of the vessel performance.