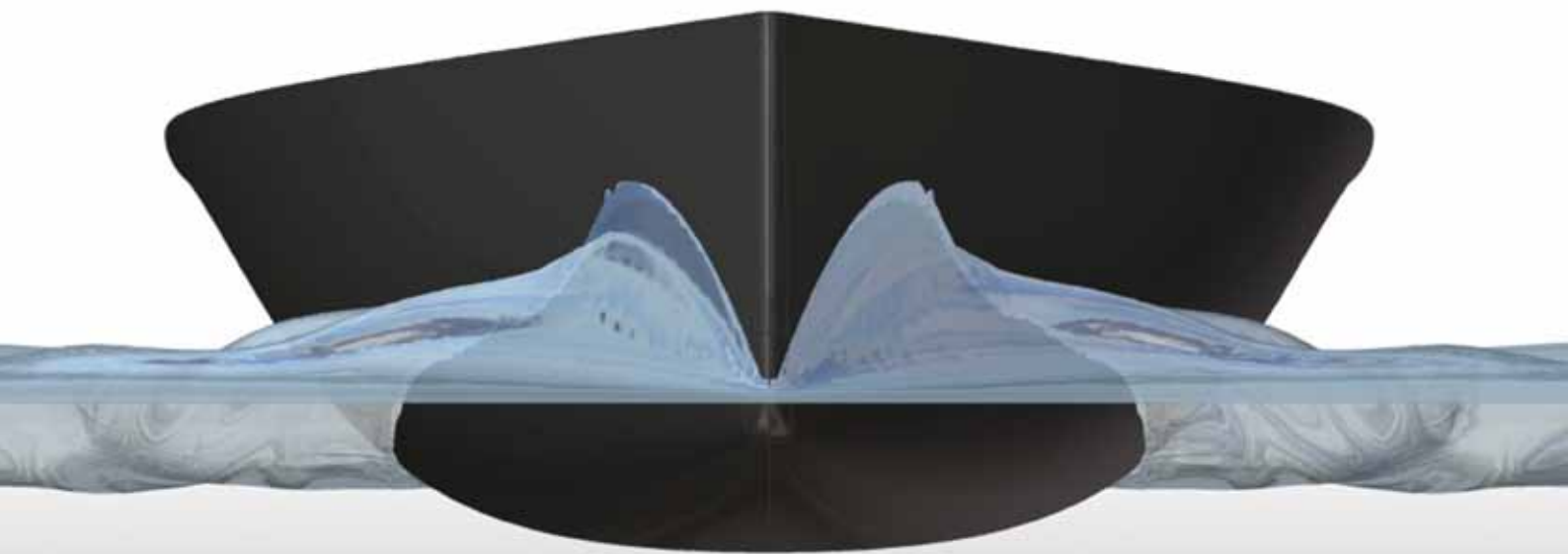


# **FINE™/Marine**

CFD Suite for Marine Applications



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**Advanced Development for Better Products**

[www.numeca.com](http://www.numeca.com)

# FINE™/Marine: the leading CFD package for naval architects

**Computational Fluid Dynamics** (CFD) offers the capability to bring innovative, efficient solutions into the **design process** of the marine industry. In comparison to experimental testing facilities, CFD offers clear technical advantages including **full-scale modeling** and in-depth analysis of flow phenomena. Furthermore, overall project **costs** and **turnaround times** can be significantly **decreased** when a CFD analysis is incorporated into the design cycle.

State-of-the-art RANS CFD approaches predict the flow not only **qualitatively** ('delta-s'), but also on a **quantitative** level (for both **low** and **high Froude** number flows). And as computer hardware costs continue to decrease, CFD analysis is now an economically attractive option for numerous marine applications including resistance & propulsion analysis, seakeeping, manoeuvring, optimization studies, and hydraulics.

Rather than using CFD as a verification tool alone, close integration of CFD as early as possible in the design loop is bringing **large added value** to the **engineering process**. This approach provides a relatively cheap but reliable tool to identify the best candidate models, even at the concept phase, leading to more **efficient designs at reduced costs** and thus minimizing costly design changes at later project stages.

To provide an **optimal CFD solution** to these marine specific problems, NUMECA has released **FINE™/Marine**, considered the leading CFD package for **naval architects**.



## *Services*

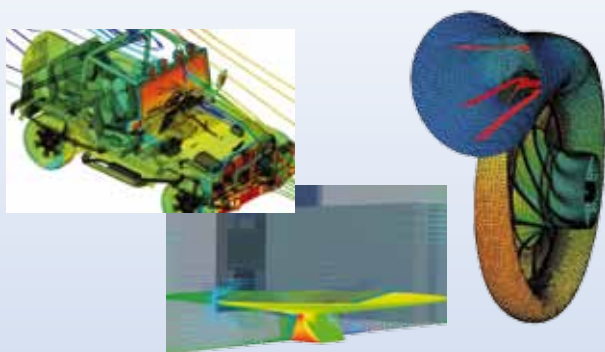
NUMECA has a team of highly qualified engineers providing a wide variety of services to the marine industry, ensuring that your organization makes use of our tools in the best and most efficient way. We offer:

- Consulting
- Adaptation and customization of FINE™/Marine towards user's specific requests
- Integration of NUMECA suite into the customer's CFD workflow
- Development of interfaces towards in-house CFD tools

## Also available at NUMECA

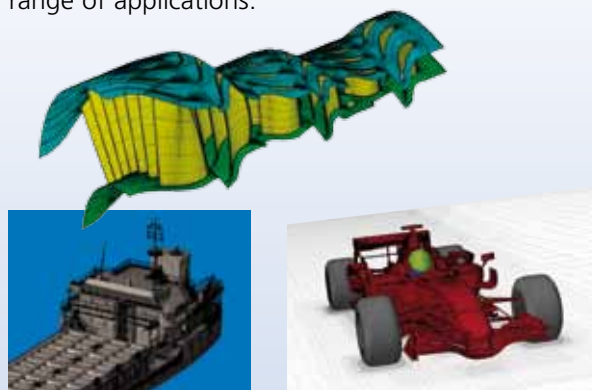
### FINE™/Hexa :

FINE™/Hexa is a Flow Integrated Environment dedicated to complex geometries and multiphysics phenomena covering a large range of industrial applications such as automotive, aerospace, combustion, etc.



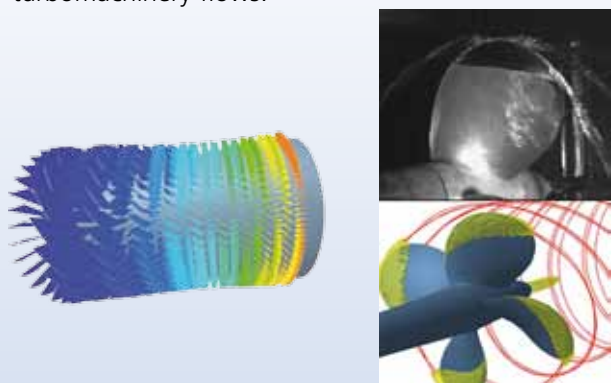
### AutoMesh-4G™ :

AutoMesh-4G™ combines the fully hex or hex dominant grid generation systems developed by NUMECA, providing high quality grids for a whole range of applications.



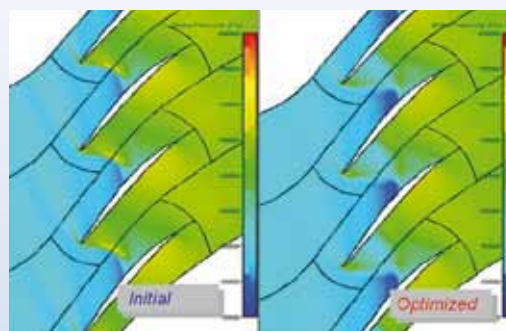
### FINE™/Turbo :

FINE™/Turbo is a Flow Integrated Environment available for the simulation of internal, rotating and turbomachinery flows.



### FINE™/Design3D :

FINE™/Design3D is a Flow Integrated Environment for the design and optimization of rotating and turbomachinery blades.

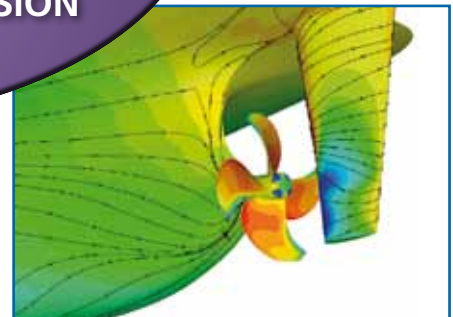
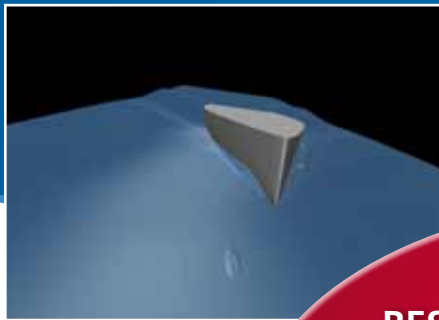


# FINE™/Marine

## An Overview



FINE™/Marine is NUMECA's multi-fluid suite tailored to marine applications.

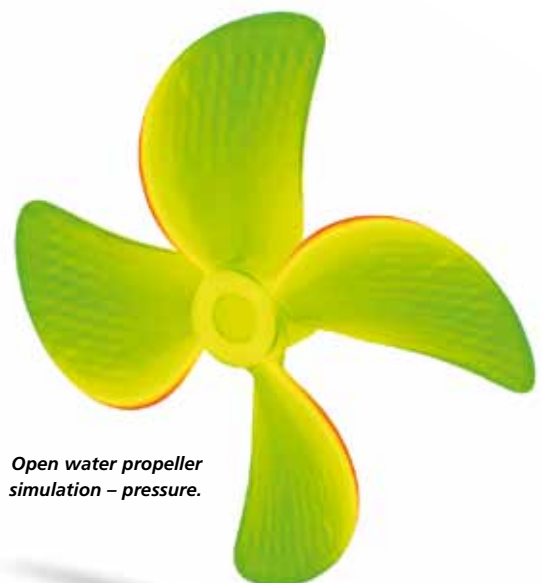


FINE™/Marine's capabilities extend beyond standard marine applications into the fields of **hydro-acoustics**, **wind effects** and **hydraulics**, providing users with a CFD tool suitable for wide range of fluid dynamics problems.

### The FINE™/Marine package consists of

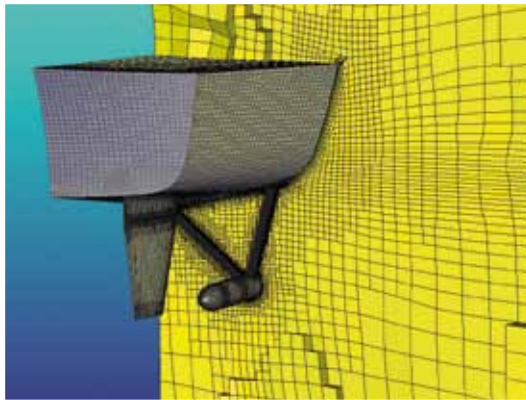
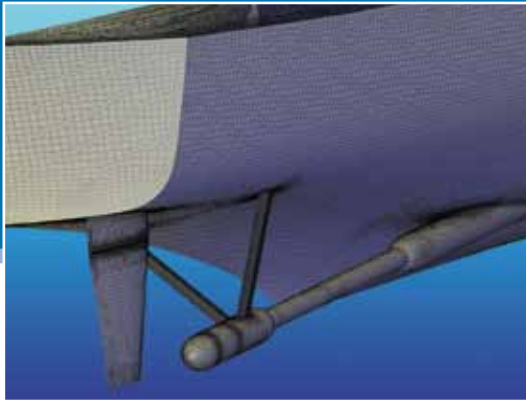
- A fully hexahedral non-conformal, highly automated mesher HEXPRESS™
- An advanced free surface solver ISIS-CFD with marine specific implementations
- A versatile flow visualization system CFView™
- A user-friendly Graphical User Interface (GUI) providing continuity between applications

The steps of this integrated package are also executable in batch mode and are fully scriptable in python.



*Open water propeller simulation – pressure.*

Zoom-in of HEXPRESS™ mesh on appended DTMB5415 (1.5 million cells).



Transversal cut of HEXPRESS™ mesh on appended DTMB5415. Note the smooth transition from viscous layers to outer mesh.



HEXPRESS™ is capable of meshing **complex geometries**, including **fully appended** ships, within the timeframe of a few hours. Meshes with **high quality viscous layers** can be generated using a novel inflation method which produces a continuous transition between viscous layers and the neighboring mesh.

### Key features include:

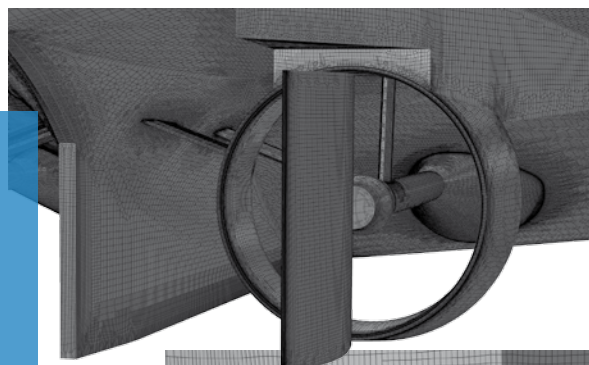
- Full hexahedral, non-conformal grids
- Direct CAD import from parasolid, (colored) STL, CATIAv5, & other formats via CADfix™
- CAD manipulation and decomposition tools
- 5-step mesh wizard for rapid mesh set-up of complex geometries
- Specific mesh refinement criteria individually applied on edges, surfaces or boxes
- Multidomain meshing capabilities
- High quality viscous layers with inflation method
- Direct export to major commercial and open source packages

### Customization to user specific features:

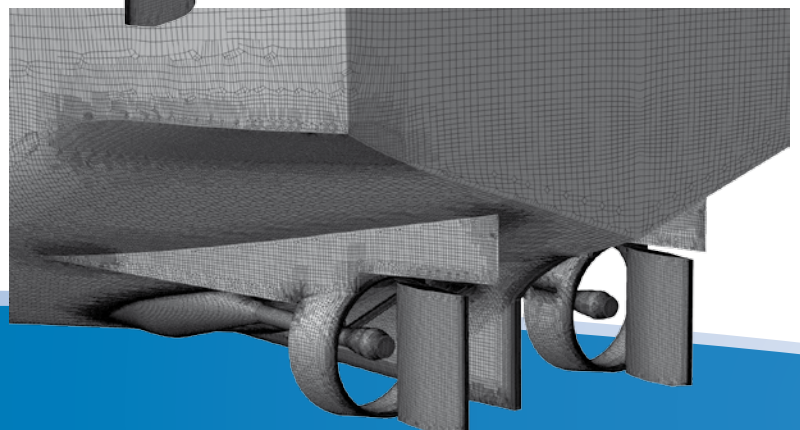
- All commands accessible through python functions to allow complete scripting
- Plug-in concept to link user-defined scripts with GUI capabilities within HEXPRESS™

*“For the last 8 years, we have been using 3 different CFD codes. FINE™/Marine is the first code that gave us confidence in the use of CFD tools, with results never differing much from experimental values. Meshing with HEXPRESS™ is a pleasurable experience – much more advanced than common meshing tools.”*

Dr. Piet Van Oossanen,  
Van Oossanen & Associates b.v.



Details on mesh of stern appendages of a hopper-dredger (Courtesy IHC Holland Dredgers b.v.).



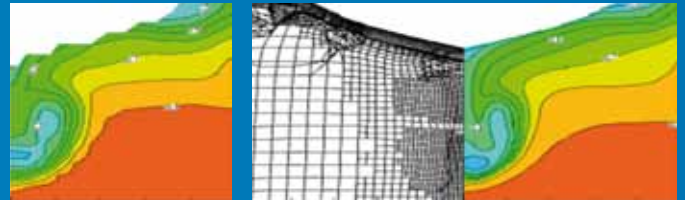
# FINE™ Marine Solver: ISIS-CFD

High Accuracy Free Surface Solver

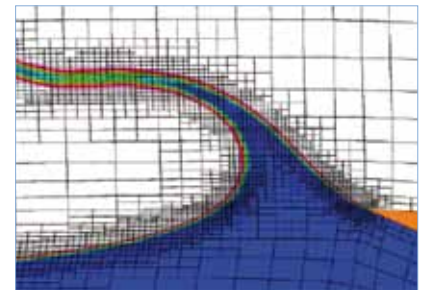
At the core of FINE™/Marine lies a state-of-the-art free surface solver.

## Key features of FINE™/Marine solver include:

- Unique unsteady adaptive grid refinement with load balancing
- 6 DOF motion solver with grid deformation (also for shallow water)
- Quasi-static and sub-cycling approach to drastically reduce CPU time
- Predefined and user-defined motion laws (PMM, gyration, etc.)
- Advanced turbulence modeling including anisotropic & DES models
- Propeller modeling, including ventilation & cavitation, with actuator disk & sliding grids
- Cavitation and transition modeling

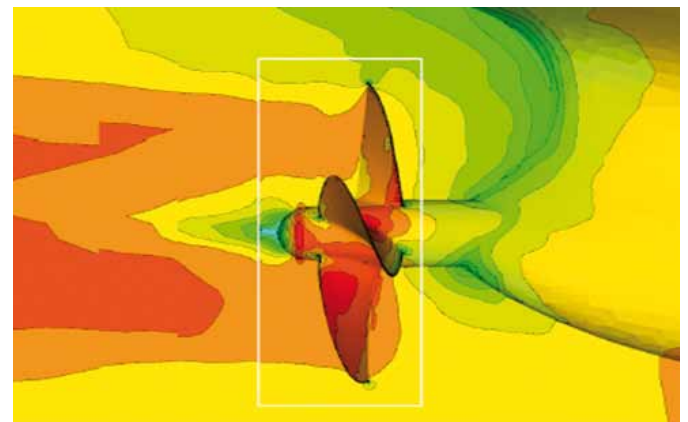


Isowake at propeller plane with Explicit Algebraic Stress Model (EASM) and grid refinement versus KRISO experiments.

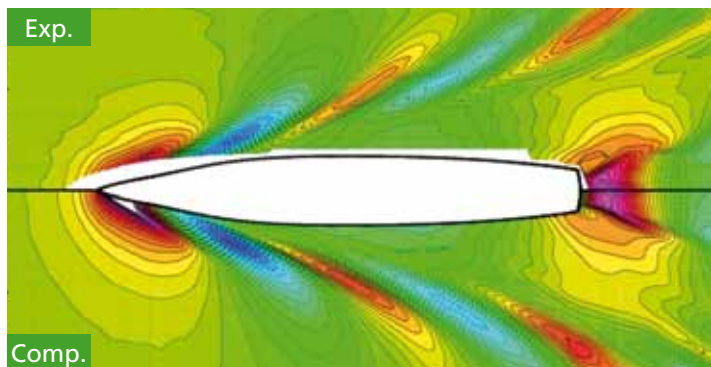


Oblique wedge impact – adaptive grid refinement illustration.

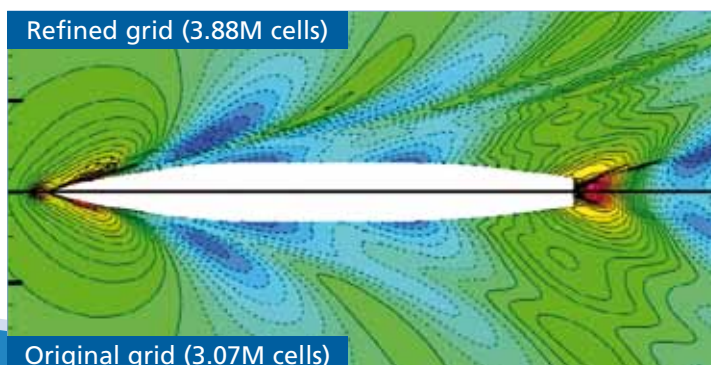
Thanks to the **advanced grid deformation** and **projection** algorithms in FINE™/Marine, optimization studies can be done **without** the need to **remesh**, thus saving valuable engineering time. Furthermore, an **integrated CFD optimization solution** is provided with FRIENDSHIP-SYSTEMS: FINE™/Marine (as CFD solver) is integrated in the Framework (parameterization and optimization) allowing for **automatic optimizations**.



Iso-contours of streamwise velocity - sliding grid computation on Hamburg test case with INSEAN propeller.



Temporal mean of wave elevation – fixed DTMB5415 in head waves (exp. by IIHR).

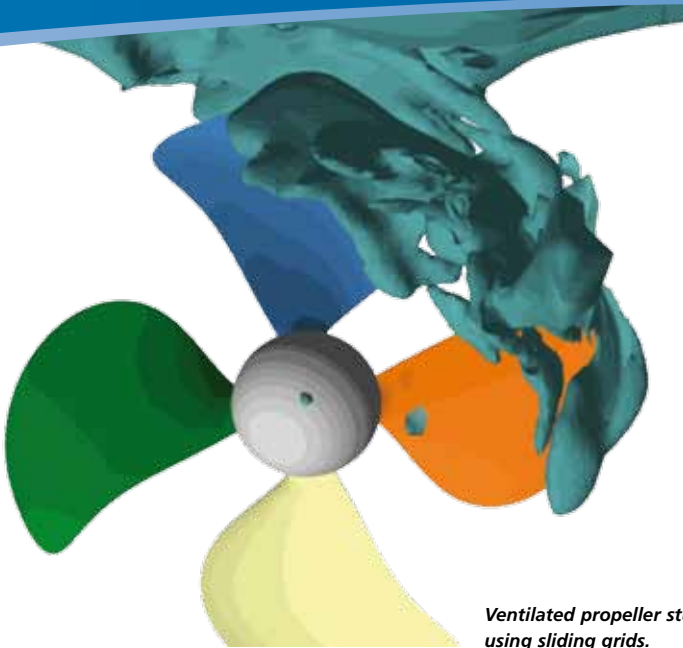


Example of adaptive grid refinement – Virtue Container Ship (Froude 0.272).

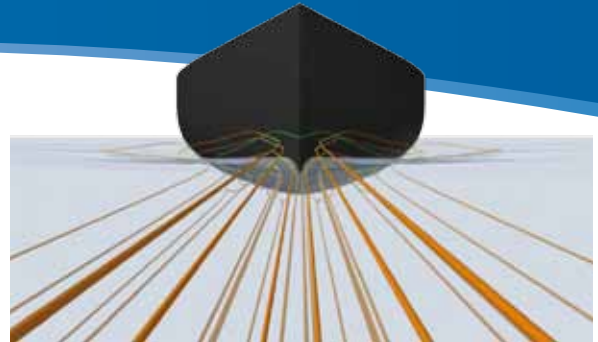
“After considering various free-surface capturing CFD tools for hydrodynamic analysis applications involving high performance racing yachts, Emirates Team New Zealand (ETNZ) has selected NUMECA’s FINE™/Marine as the unique Navier-Stokes based simulation suite to serve in that capacity during ETNZ’s 34th America’s Cup design campaign. We believe that in comparison to alternatives, FINE™/Marine produces consistently higher fidelity solutions across a very broad range of sailing conditions thereby making it the analysis tool of choice.”

Dr. Len Imas,  
Emirates Team New Zealand

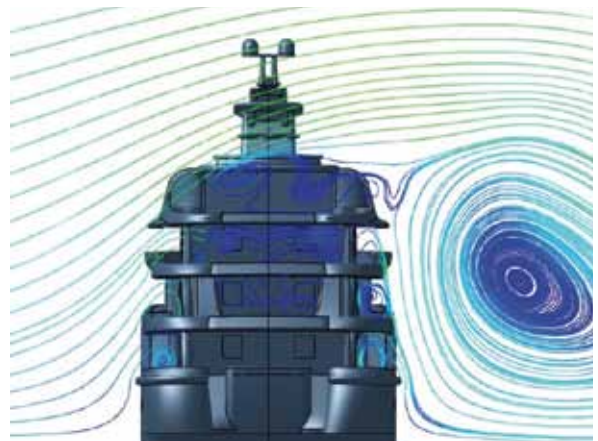
CFView™ is a visualization system offering qualitative and quantitative graphical analysis for 2D and 3D scalar and vector fields. Steady or unsteady data can be loaded to generate steady-state or transient animations. CFView™ supports parametric visualization scripts and includes an extensive macro system allowing users to easily replay post-processing routines on any data set.



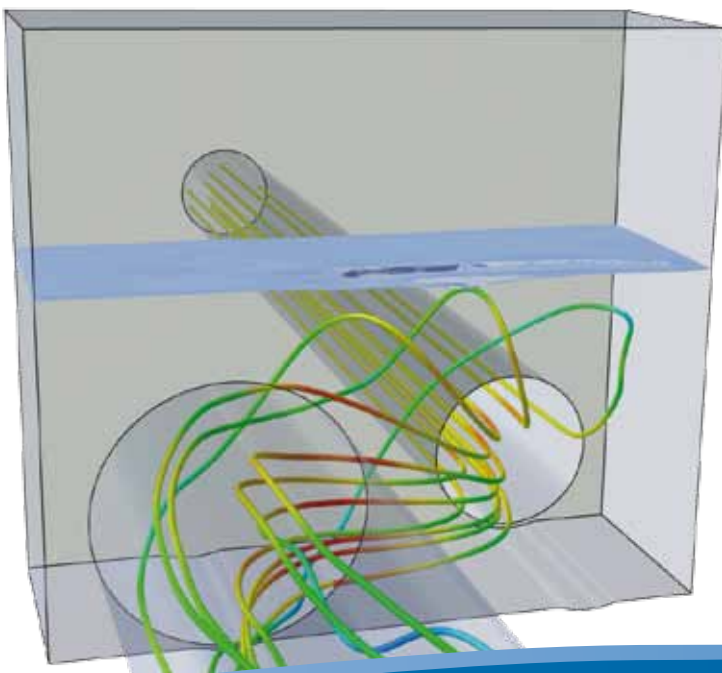
*Ventilated propeller study  
using sliding grids.*



*Flow visualization of high performance sailing yacht  
(Courtesy Ker Design)*



*Wind effect study on mega yacht  
(Courtesy Van Oossanen and Associates b.v.)*



*Visualization of free surface result  
in surge chamber.*

**FINE™/Marine is available on most Windows and Linux platforms including:**

- **WINDOWS:** WIN XP SP3 (32 bits), WIN XP, WIN Vista, WIN7
- **LINUX:** Suse 10 & 11, (K)Ubuntu 8-10, Fedora Core 8 & 12, Enterprise 4 & 5, CentOS

FINE™/Marine has also been extensively validated on AMD and Intel **cluster systems**, supporting (Gigabit) Ethernet, InfiniBand and Myrinet interconnects. Cluster queuing system templates are provided in the package.

## **NUMECA International**

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