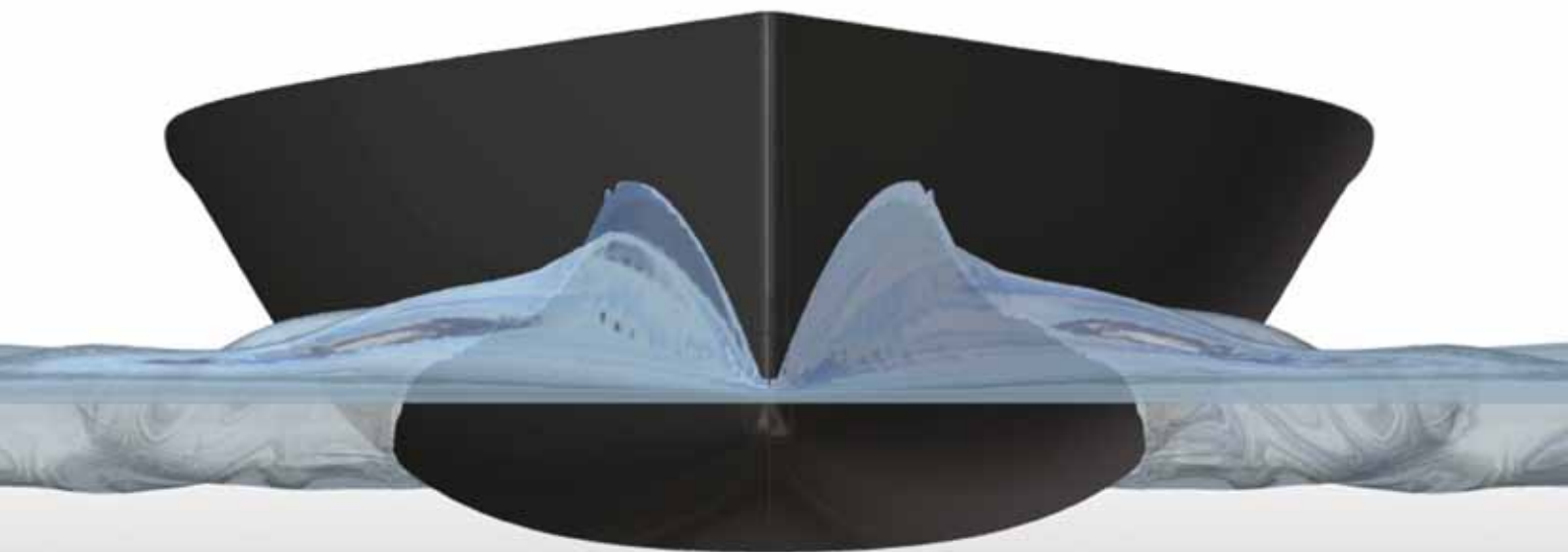


FINE™/Marine

CFD Suite for Marine Applications



Advanced Development for Better Products

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:

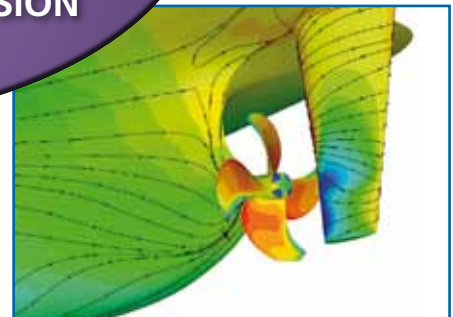
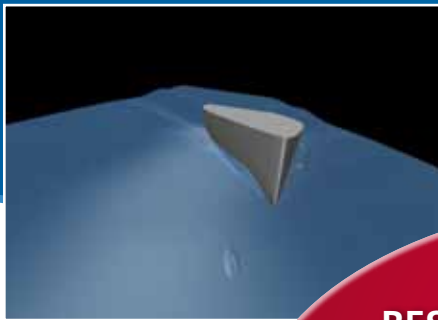
- Consulting
- Adaptation and customization of FINE™/Marine towards user's specific requests
- Integration of NUMECA suite into the customer's CFD workflow
- Development of interfaces towards in-house CFD tools

FINE™/Marine

An Overview



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

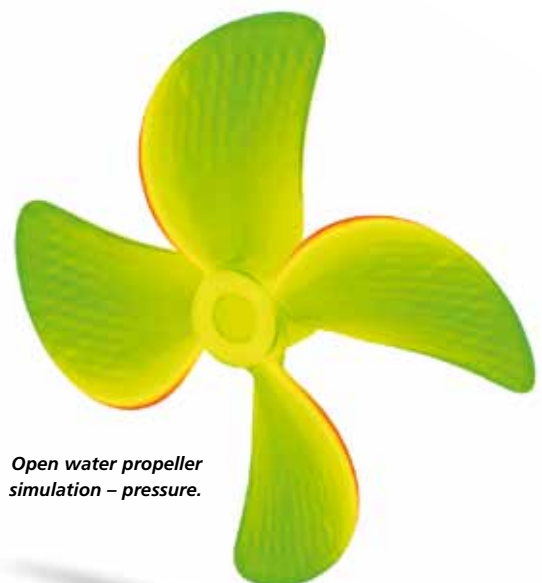


FINE™/Marine's capabilities extend beyond standard marine applications into the fields of **hydro-acoustics**, **wind effects** and **hydraulics**, providing users with a CFD tool suitable for wide range of fluid dynamics problems.

The FINE™/Marine package consists of

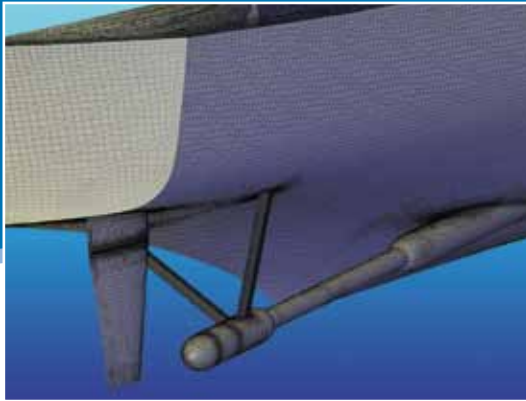
- A fully hexahedral non-conformal, highly automated mesher HEXPRESS™
- An advanced free surface solver ISIS-CFD with marine specific implementations
- A versatile flow visualization system CFView™
- A user-friendly Graphical User Interface (GUI) providing continuity between applications

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).



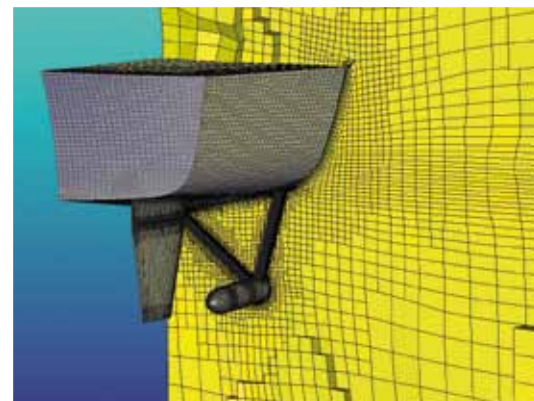
✓ HEXPRESS™ is capable of meshing **complex geometries**, including **fully appended** ships, within the timeframe of a few hours. Meshes with **high quality viscous layers** can be generated using a novel inflation method which produces a continuous transition between viscous layers and the neighboring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

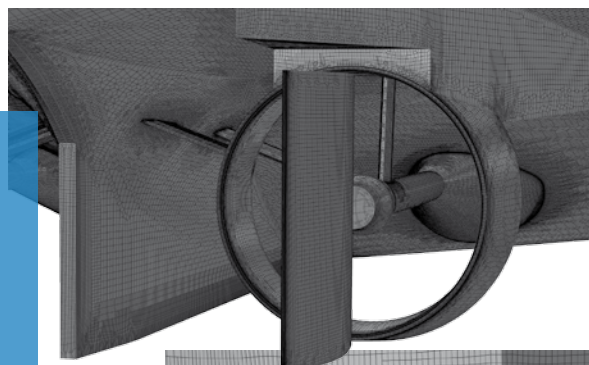
- All commands accessible through python functions to allow complete scripting
- Plug-in concept to link user-defined scripts with GUI capabilities within HEXPRESS™



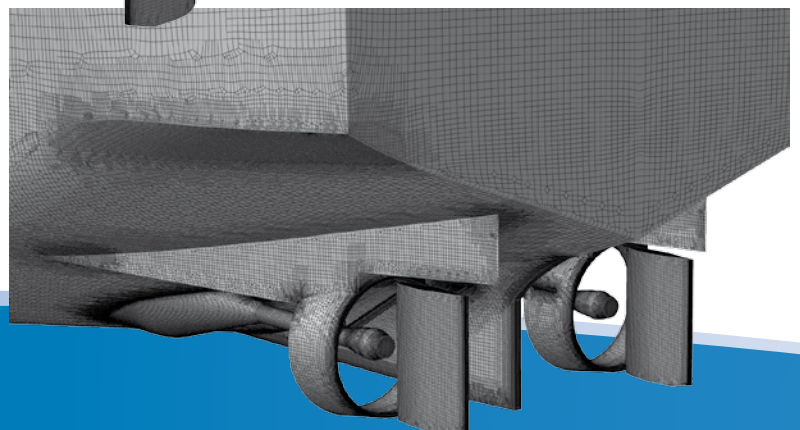
Transversal cut of HEXPRESS™ mesh on appended DTMB5415. Note the smooth transition from viscous layers to outer mesh.

“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.).



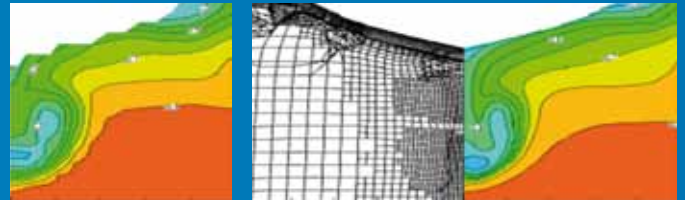
FINE™ Marine Solver: ISIS-CFD

High Accuracy Free Surface Solver

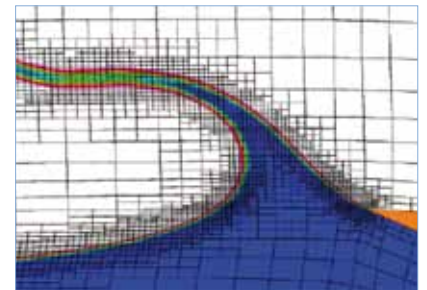
At the core of FINE™/Marine lies a state-of-the-art free surface solver.

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

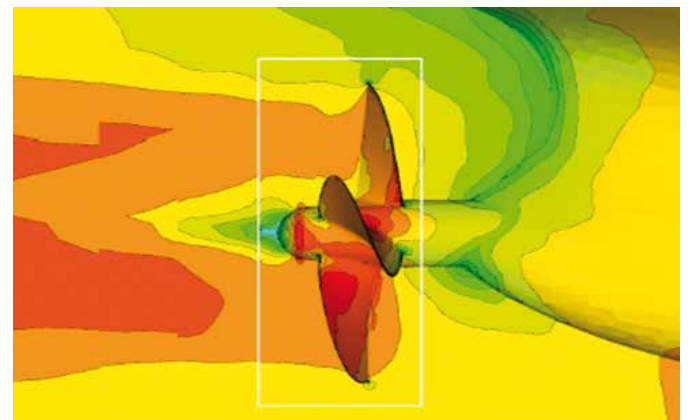


Isowake at propeller plane with Explicit Algebraic Stress Model (EASM) and grid refinement versus KRISO experiments.

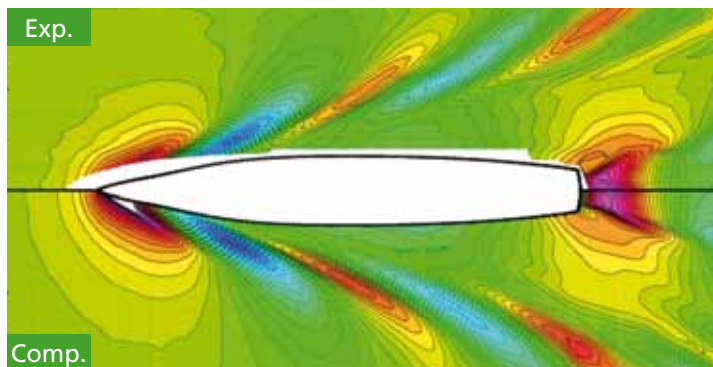


Oblique wedge impact – adaptive grid refinement illustration.

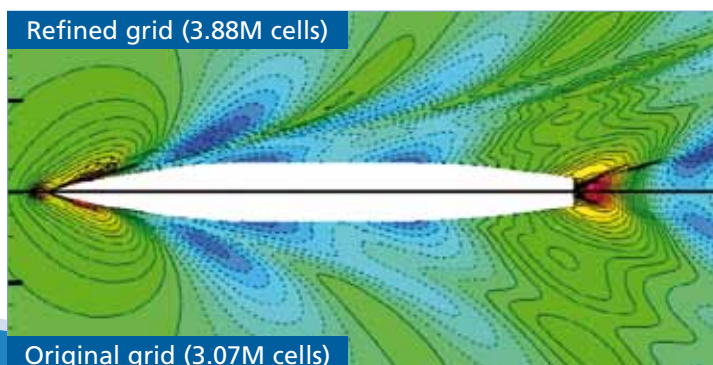
Thanks to the **advanced grid deformation** and **projection** algorithms in FINE™/Marine, optimization studies can be done **without** the need to **remesh**, thus saving valuable engineering time. Furthermore, an **integrated CFD optimization solution** is provided with FRIENDSHIP-SYSTEMS: FINE™/Marine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

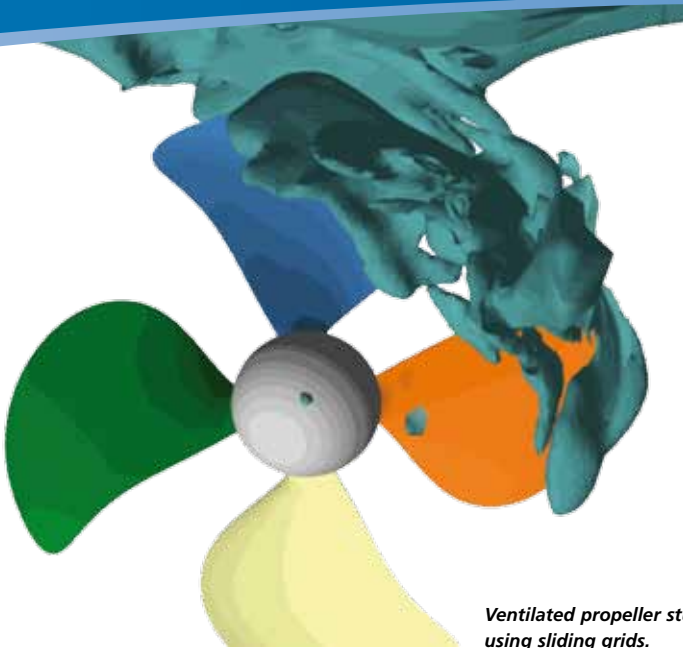


Example of adaptive grid refinement – Virtue Container Ship (Froude 0.272).

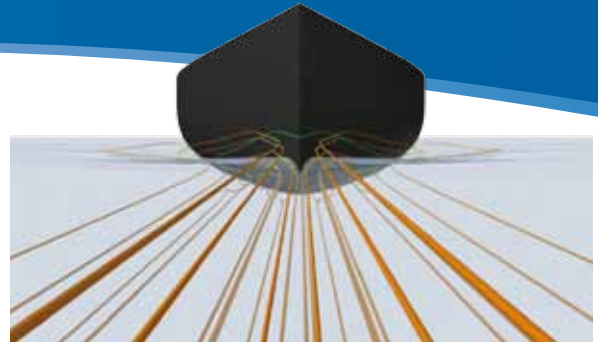
“After considering various free-surface capturing CFD tools for hydrodynamic analysis applications involving high performance racing yachts, Emirates Team New Zealand (ETNZ) has selected NUMECA’s FINE™/Marine as the unique Navier-Stokes based simulation suite to serve in that capacity during ETNZ’s 34th 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

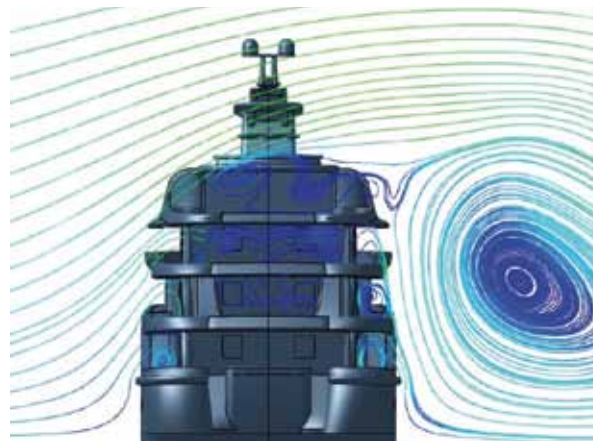
CFView™ is a visualization system offering qualitative and quantitative graphical analysis for 2D and 3D scalar and vector fields. Steady or unsteady data can be loaded to generate steady-state or transient animations. CFView™ supports parametric visualization scripts and includes an extensive macro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



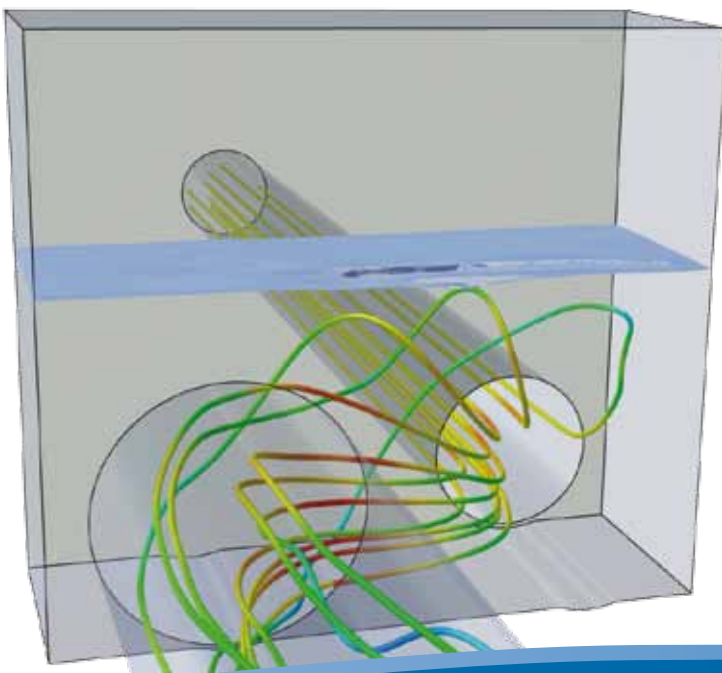
*Ventilated propeller study
using sliding grids.*



*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:

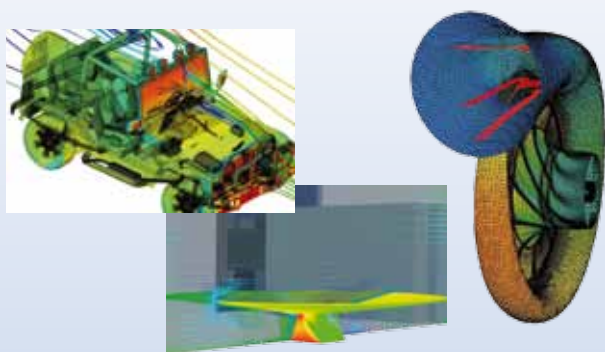
- **WINDOWS:** WIN XP SP3 (32 bits), WIN XP, WIN Vista, WIN7
- **LINUX:** Suse 10 & 11, (K)Ubuntu 8-10, Fedora Core 8 & 12, Enterprise 4 & 5, CentOS

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.

Also available at NUMECA

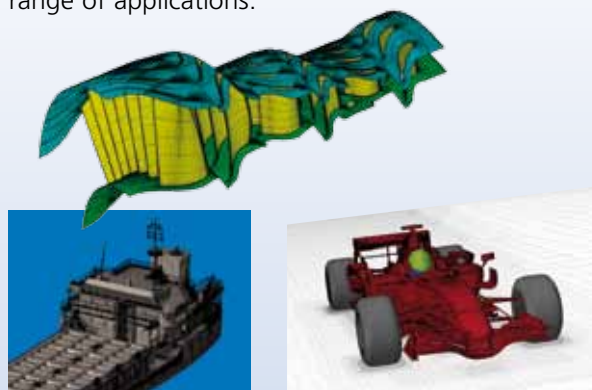
FINE™/Open :

FINE™/Open 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.



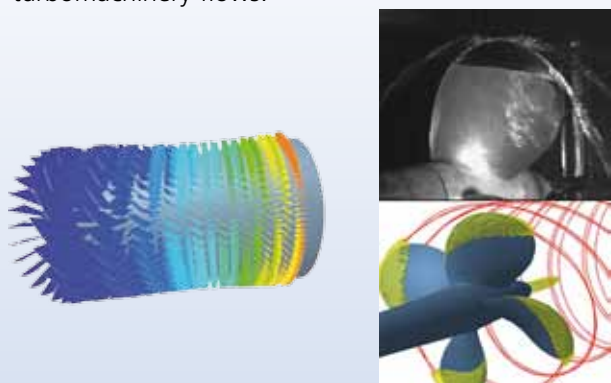
AutoMesh-4G™ :

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.



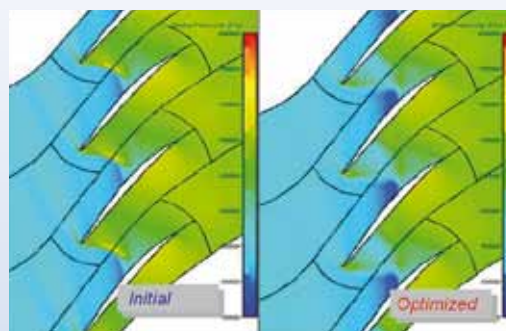
FINE™/Turbo :

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.



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