

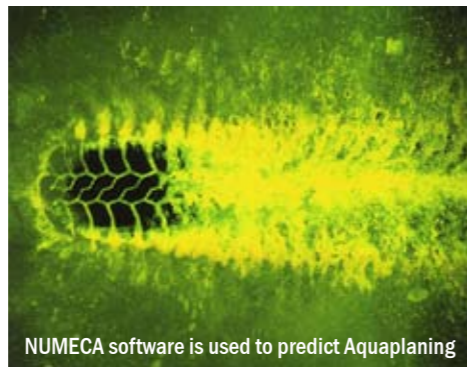
NUMECA Uses ClusterVision's Compute Clusters for Computational Fluid Dynamics

Several compute clusters based on Intel® Xeon® architecture help NUMECA International to develop and test their broad range of Computational Fluid Dynamics (CFD) software and to run extensive simulations for their customers.

Air flow around aircraft, cars and buildings; fluid and gas flow through pumps, compressors, turbines and around yachts are but a few of the applications of Computational Fluid Dynamics (CFD). NUMECA International is a leading provider of CFD software and consulting services worldwide and has chosen ClusterVision to supply its in-house compute clusters to develop their range of CFD programs and to run simulations for customers that do not have the compute power, skills or software to perform those simulations.

"Our partnership with ClusterVision opens the door to large-scale CFD simulations within short industrial timeframe. The new cluster will bring large additional calculation power to NUMECA and support our customer and partner demands to run challenging multi-physics and multi-disciplinary simulations." — Marc Tombroff

NUMECA's clusters are based on 32-bit and 64-bit Intel® Xeon® processors, combined with Gigabit Ethernet and InfiniBand networks for high-bandwidth and low-latency communication. The clusters together provide more than 1.5 TeraFLOPs of raw compute



NUMECA software is used to predict Aquaplaning

power. The cluster runs the Linux-based ClusterVisionOS™ cluster operating system and software environment which includes all software required to effectively use and manage the clusters.

Predicting Aquaplaning

Research has shown that more than 15% of all car accidents are caused by the use of tyres that are unsuitable for rainy weather conditions. In the past, new tires were developed on the basis of experimental results. Nowadays, more and more of the research is done numerically. However, the simulation of aquaplaning is extremely complex and requires both linear and non-linear calculations. An international project funded by the European Commission brought NUMECA, MSC Software and the Fraunhofer Institute together to develop new methods to reliably predict aquaplaning. NUMECA's FINE™/Hexa CFD software was used to simulate the flow of water around the tyre and inside the grooves; MSC's MSC.Marc Finite Element Analysis (FEA) software was used to simulate the contact between the tyre and the road; and Fraunhofer's Mesh-based parallel Code Coupling Interface (MpCCI) software was used to take care of



Marc Tombroff, General Manager of NUMECA International

About NUMECA International

NUMECA International is a pioneering provider of computational fluid dynamics (CFD) software and consulting services worldwide. NUMECA software is used for the simulation, design and optimisation of fluid flow and heat transfer. It is used by product developers, design and research engineers, allowing them to reach superior product quality and performances, at reduced engineering cost.

World-wide manufacturers such as Honda, Honeywell, Kawasaki, Pratt & Whitney, Rolls-Royce, Siemens, Snecma, Solar Turbine trust NUMECA for the superior performance, reliability and easy-of-use of its software and professional services.

NUMECA corporate headquarters are located in Brussels, with offices, resellers and service centres in Brazil, China, Germany, India, Italy, Japan, Korea, Russia, Spain and the USA. The company won the "Grand Prix Entrepreneurs 2000" from the Brussels Chamber of Commerce and Industry, for its success in exporting hightech products worldwide.

As a center of excellence, NUMECA International participates in a large number of research projects with university departments, research laboratories and leading industrial partners, allowing them to offer the latest technology breakthrough to our customers.

the data exchange between the two programmes.

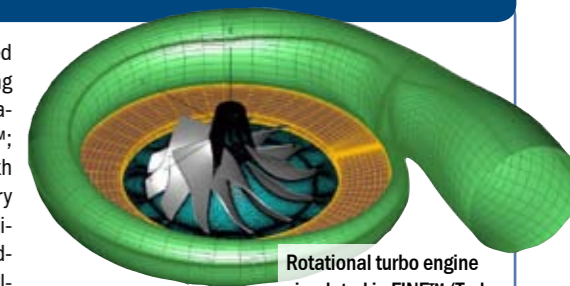
Prof. dr ir Charles Hirsch, president at NUMECA sums up several factors playing a role in the analysis of aquaplaning: "Firstly, the increase of speed generates a wedge of water that propagates in the leading edge and underneath the tyre footprint, increasing the lift force on the tyre and resulting in a reduction of the contact area. Secondly, free-stream friction in and around the tyre as well as free-stream turbulence play an important role. Turbulence affects the deformation of the tyre. Each stream becomes turbulent above a certain speed. Consequently, free stream

no longer moves in smooth and regular layers, but in turbulent, irregular swirls. Finally, multiphase flow aspects, as air entrainment, bubbly flow in the water flowing around the tyre, and detachment of liquid fragments and droplets from the liquid surface have a non-negligible impact on hydroplaning. The rate of air entrainment and the rate of liquid and bubble detachment determines the air content in the bow wave. In this project it is our job to simulate and predict these aspects."

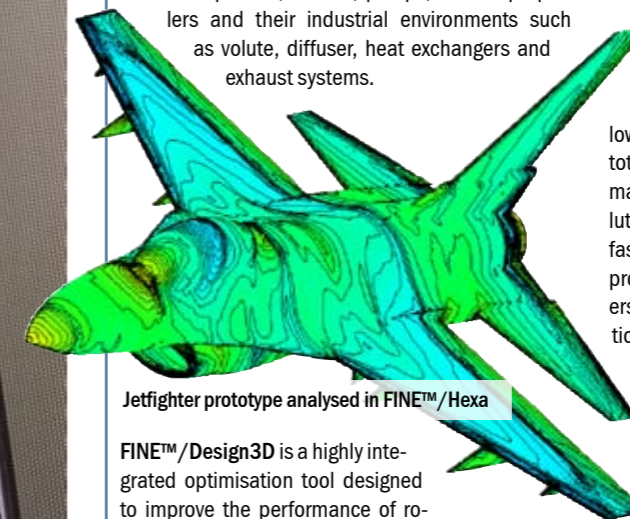
It is expected that this new method of simulating aquaplaning will be widely adopted by the tire manufacturing industry and result in better and safer tyres.

NUMECA Applications

FINE™/Turbo is a fast and accurate Flow Integrated Environment for the simulation of internal, rotating and turbomachinery flows. It integrates a fully hexahedral, highly automated grid generator, AutoGrid™; advanced density-based numerical algorithms with local preconditioning; and automated summary reports. FINE™/Turbo covers a large range of applications such as multi-stage axial, radial and mixed-flow compressor, turbine, pumps, fans or propellers and their industrial environments such as volute, diffuser, heat exchangers and exhaust systems.



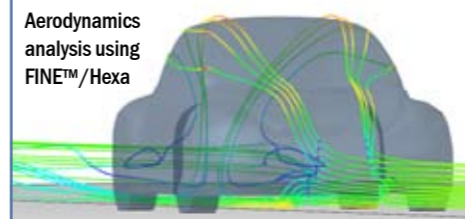
Rotational turbo engine simulated in FINE™/Turbo



Jetfighter prototype analysed in FINE™/Hexa

FINE™/Design3D is a highly integrated optimisation tool designed to improve the performance of rotating and turbomachinery blades. It integrates in a user-friendly interface, a powerful parametric blade modeller, advanced artificial intelligence and efficient optimisation algorithms. Its all-in-one structure allows direct integration in the design cycle for immediate use. No time is needed to couple and

Aerodynamics analysis using FINE™/Hexa



validate heavy optimisation software with computer-aided engineering tools. FINE™/Design3D covers a large range of applications including multi-stage axial, radial and mixed-flow compressor, turbine, pumps, fans or propellers.

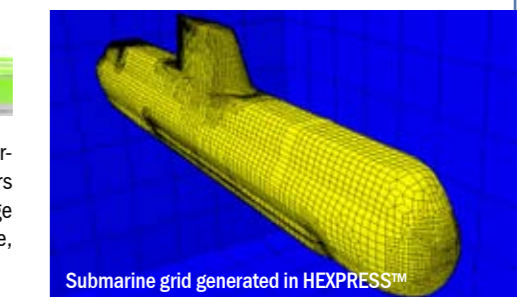


Blades generated in AutoBlade™

AutoBlade™ is a powerful, advanced and easy-to-use parametric modeler dedicated to the design of rotating- and turbo-machinery blades. AutoBlade™ can convert any CAD model to a fully parametric design. It provides a multi-view layout including a fully customisable 3D view, allowing graphical edition of the design parameters with full undo/redo capability. In addition, any blade and meridional contour can be analysed thanks to a new embedded graphical tool.

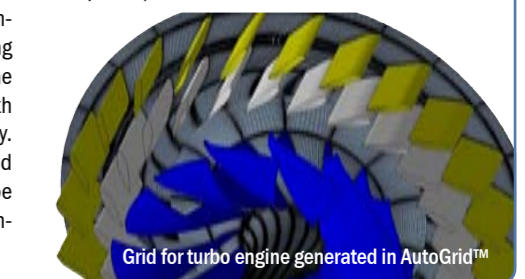
FINE™/Hexa is a full hexahedral, highly automated and integrated software package designed to quickly analyse design products. It allows the engineer access to the power of virtual prototyping in fluid flow and heat transfer engineering to make rapid design decisions. Sharing the same solution algorithm as FINE™/Turbo, it allows extremely fast turnaround and significantly increases design process productivity. FINE™/Hexa covers a large range of applications such as complete aircrafts with engines, pylon, wings and flaps, cooled turbine blade and disk, automotive aerodynamics and environmental flows.

HEXPRESS™ is a fully automatic grid generator for complex geometries. HEXPRESS™ uses full hexahedral unstructured technology. It allows considerable time and cost saving in the grid generation of fluid dynamics and structural mechanics simulation related task.



Submarine grid generated in HEXPRESS™

AutoGrid™ is a highly powerful, automatic, fully hexahedral grid generation software for turbomachinery. It allows designers and engineers to mesh their complex axial, radial and mixed-flow configurations with a single click. AutoGrid™ takes only minutes for a single blade row and just an hour for a 10 million cells 19 stage axial compressor (tested on standard computers).



Grid for turbo engine generated in AutoGrid™