FF4EuroHPC Success Story

Topology Optimization of Micro-Channel Heat Exchangers

Organizations

Aidro is an Italian high-tech SME specialized in the design and manufacturing of hydraulic parts and metal devices by both traditional technologies and Additive Manufacturing.

OPTIMAD was founded in 2006 as a Spin-Off company of the Department of Mechanical and Aerospace Engineering of the Politecnico di Torino and is specialized in the development of numerical simulation codes for scientific computing.

CINECA is the largest Italian supercomputing centre with an HPC environment equipped with cutting-edge technology and highly qualified personnel which cooperates with academia and industrial partners.

End User

aidro
Desktop Metal Company

ISV

OPTIMAD

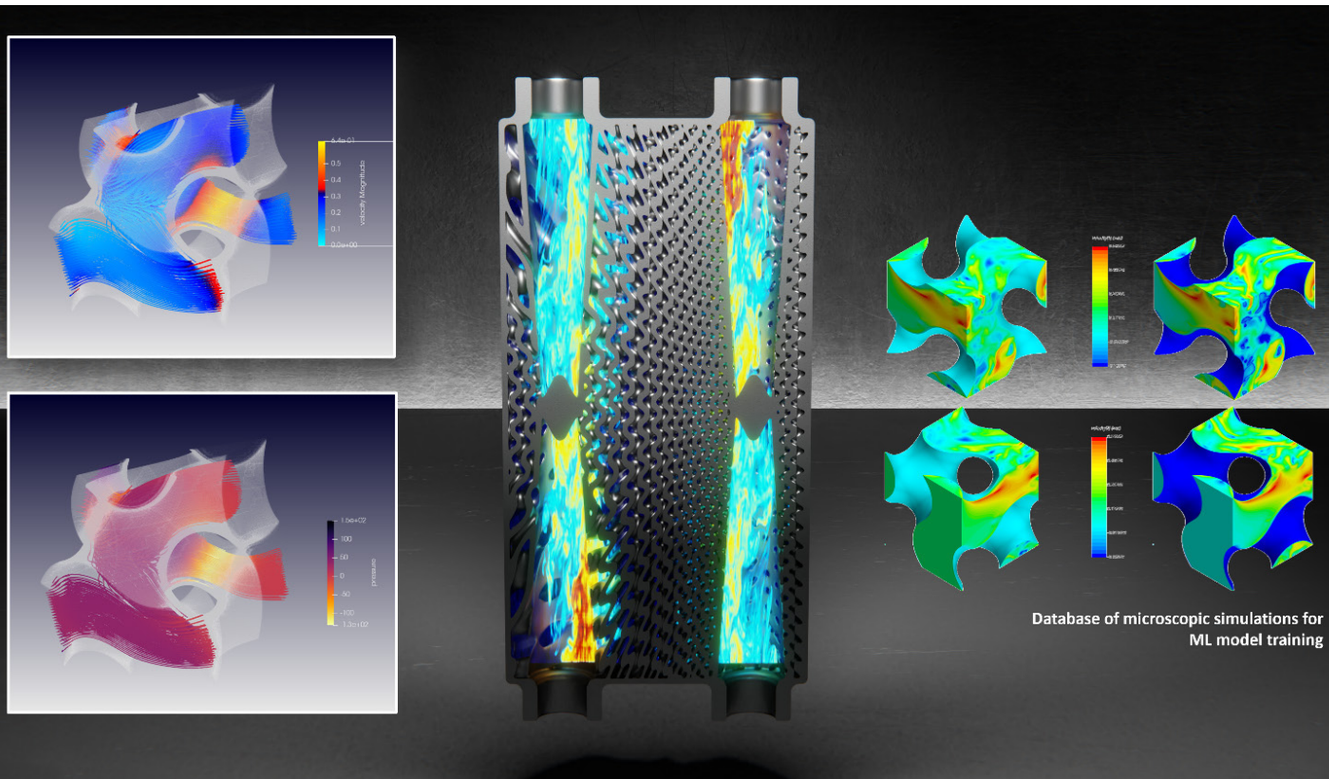
HPC Centre & Provider

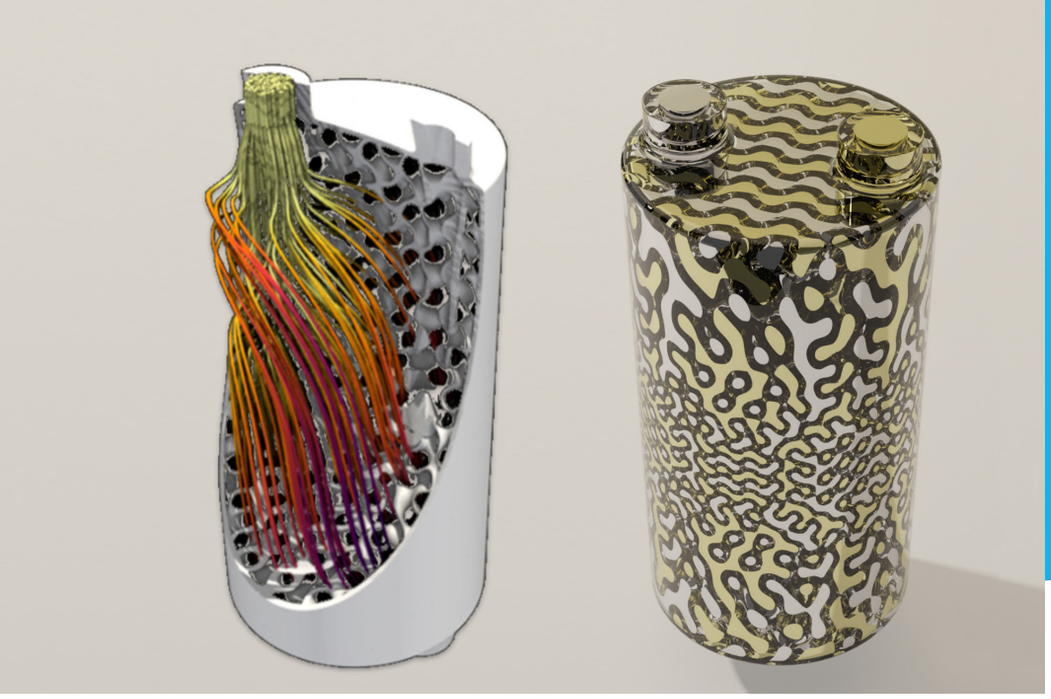
CINECA

Partner CINECA is part of the NCC Italy.

The Challenge

Micro Channel Heat Exchangers (MCHX) are heat exchangers in which the fluid flows in lateral confinements with dimensions of millimetres. The design of MCHX requires balancing many competing design constraints, including weight reduction and manufacturability. Topology Optimization (TO) is a promising design paradigm for finding an optimal design which meets all requirements. However, geometries resulting from TO are impossible to manufacture using standard techniques such as Computerized Numerical Control machining or vacuum casting. Instead, the design and production paradigm of combining Topology Optimization with Additive Manufacturing has enormous potential but requires the solution of key technical challenges to provide accurate results at speeds consistent with industrial design cycles. Lastly, the requirement of accuracy maps directly to the need for accurate multi-scale models and robust automated computational pipelines to be executed on high-performance computing resources.





Industry Sector
Manufacturing

Technology used:
HPC,
CFD Simulation

The Solution

The TOLOMHE platform was conceptualized and developed as a SaaS platform, which integrates a set of computational tools for topology optimization of MCHX in an HPC-centric framework. TOLOMHE represents the first step towards cloud services for topology optimization and generative design offered to SMEs specialized in AM for MCHX. This innovative solution is based on coupling a standard CFD solver (immerFLOW by Optimad), an ML model, and a parametrized topology (mimic by Optimad). Thanks to the synergic deployment of the ML model and the CFD solver, multiscale CHT simulations can be performed without the burden of simulating high-resolution models during the online phase. TOLOMHE is deployed on the CINECA HPC infrastructure to fully leverage the high scalability of genetic algorithms during topology optimization to guarantee a short time to solution.

The Impact

TOLOMHE represents an easy-to-use platform for generative design and product optimization. The ultimate goal is to alleviate problems and barriers encountered by SMEs specialized in the design of high-performance MCHX.

TOLOMHE has the potential to become a technology enabler and will allow a user to target high-value applications, improve the design of existing products, and ultimately increase market competitiveness. Thanks to the adoption of TOLOMHE, the end-users are expected to accelerate the transition from a build-to-print to a build-to-spec business model by reducing R&D costs and time-to-market for new products.

The first applications at Aidro foreseen for the TOLOMHE platform are an oil-air heat exchanger project for the transmission system of helicopters, and a sea water-natural gas heat exchanger project for off-shore gas platforms.

Benefits

- Automation of the design workflow has the potential to reduce time-to-design by 75%, time-to-market by 50%, and time-to-prototype by 90%.
- For Aidro, End-user savings can potentially add up to €100k by redirecting skilled labor to other added-value activities.
- For OPTIMAD, TOLOMHE can generate a stream of revenue of approximately €250,000-500,000 in the first 36 months.
- For CINECA, sales of CPU cycles can generate up to €40,000 per year.