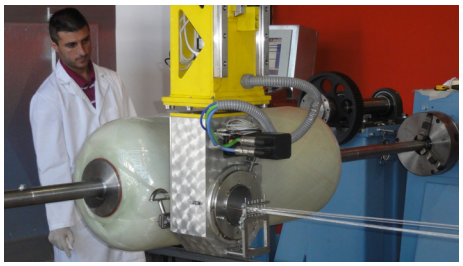
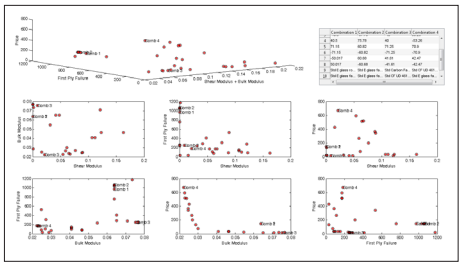
FORTISSIMO

HPC-Cloud-based design of high-pressure vessels

Fortissimo Experiment Facts:
- Segment: Composites
- Application Domain: CFD
- Application: OpenFOAM





The Company

Founded in 1990, Mikrosam is an SME which manufactures equipment and associated software for the production of artefacts from composite materials. Mikrosam is the only company that offers custom-made solutions for all core, composite technologies: filament/tape winding, prepreg making, prepreg slitting, automated fibre placement, tape laying (AFP/ATL), and composite machining. Mikrosam's portfolio covers, amongst others, solutions for the design and manufacturing of composite pressure vessels for transportation and storage of gas as an automotive fuel. Mikrosam develops the cylinder and the composite laminate of pressure vessels and subsequently adapts the design and the construction of the filament winding equipment on which the vessels are to be produced.

Advanced composite material products are significantly lighter (60-80% lighter than steel, and 20-50% lighter than aluminium), but as strong as or even stronger than widely used metal counterparts. By choosing an appropriate combination of matrix and reinforcement material, specific composite laminates, that meet particular application requirements, can be produced. Advanced composites provide design flexibility and can be moulded into complex shapes. Composite pressure vessels can take full advantage of the extremely high tensile strength and high elastic modulus of the fibres from which they are made.

Composite design is a painstaking process which was previously done by Mikrosam on a desktop computer. This involved many time-consuming computations and physical tests of potential designs. Such simulations require significant computing resources and need to be carried out using an HPC system in order to get results in a reasonable time frame.

The Challenge

The challenge was to develop a model for the simulation of composite materials and to implement it on an HPC system. The goal was to improve Mikrosam's capability to satisfy the principal ISO 11439 standard and the ECE R 110 normative for Gas cylinders "High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles" by developing a model for the design and simulation of composite laminates that could be implemented on an HPC system and obtain accurate results in an acceptable time.

The Solution

A computer model was developed to design composite laminates and simulate their properties using an open-source software package, Octave. This model was adapted to be run on an HPC system. HPC-based simulations reduce both computation time and the number of physical tests, which need to be made in the design of composite laminates. This case study has shown that using parallel computation on an HPC system can reduce composite-design time by about 30% and testing time by nearly 10%. Through this case study, Mikrosam had the opportunity to use and benefit from HPC for the first time.

Fortissimo Experiment Partners:
- Mikrosam (End User)
- Arctur (HPC Provider)

More Information:
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The Benefits

For each filament winding machine used in the production of high-pressure vessels, different combinations of materials and winding angles for the composite, need to be considered. With the simulation code developed in this case study it is possible to shorten the design time and to reduce the number of physical tests and prototyping costs. As a result of the FORTISSIMO experiment, MIKROSAM will be able reduce its production costs by a total of about €150,000 over the next 5 years. More importantly its product offering (production machines for high-pressure vessels) will give each of its customers an advantage in production costs of around a total €1.5 million per machine over the next 5 years for machines that are currently on the market. The considerable advantage of MIKROSAM's products over those of its competitors will, as a conservative estimate, lead to an increased revenue for the company of a total of around €2 million over the next 5 years. This is a significant amount for this SME. The experience gained in this experiment together with reduced production costs for both Mikrosam and its customers constitutes a base for further growth of the company and the resultant creation of new jobs.

Organisations involved

End User: Mikrosam
HPC Provider: Arctur

The Fortissimo Project

Fortissimo is a collaborative project that enables European SMEs to be more competitive globally through the use of simulation services running on a High Performance Computing cloud infrastructure. The project is coordinated by the University of Edinburgh and involves 123 partners including Manufacturing Companies, Application Developers, Domain Experts, IT Solution Providers and HPC Cloud Service Providers from 14 countries. These partners are engaged in 53 experiments (case studies) where business relevant simulations of industrial processes are implemented and evaluated. The project is funded by the European Commission within the 7th Framework Programme and is part of the I4MS Initiative.

I4MS Fortissimo is part of I4MS ICT Innovation for Manufacturing SMEs: www.i4ms.eu

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