EXCELLERAT P2

The European Centre of Excellence for Engineering Applications

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WHAT IS EXCELLERAT?

The EXCELLERAT project is a single point of access for expertise on how data management, data analytics, visualisation, simulation-driven design and co-design with high-performance computing (HPC) can benefit engineering, especially in the aeronautics, automotive, energy and manufacturing sectors.

WHAT IS THE GOAL?

EXCELLERAT aims to tackle the ever-rising complexity of scientific and development endeavours. Thus, Exascale computing is our focus, which will solve highly complex and costly engineering problems, and create enhanced technological solutions even at the development stage. The goal of EXCELLERAT is to enable the European engineering industry to advance towards Exascale technologies and to create a single entry point to services and knowledge for all stakeholders (industrial end users, independent software vendors, technology providers, HPC providers, academics, code developers, engineering experts) of HPC for engineering. In order to achieve this goal, EXCELLERAT brings together key players from industry, research and HPC to provide all necessary services.

HOW CAN EXCELLERAT PROVIDE THE BENEFITS OF HPC TO THE ENGINEERING INDUSTRY?

The biggest benefit of HPC is to increase the processing speed, which enables businesses to deliver faster results and save more money.
Some examples of the work that HPC can handle include:

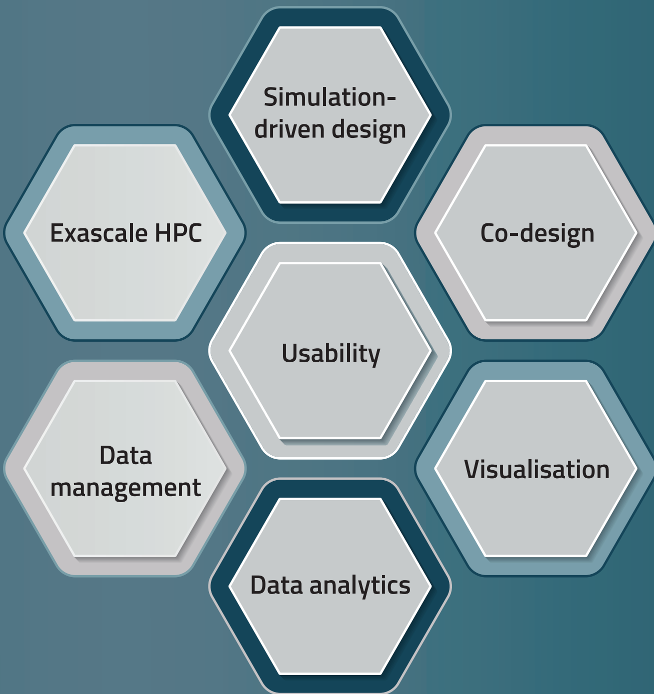
- Enhanced Design and Manufacturing Process
- Enhanced Streamline Processes
- Enhanced Supply and Demand Processes

EXCELLERAT P2 partners

Knowledge Hub & Expertise

EXCELLERAT brings together the necessary European expertise to establish a Centre of Excellence in Engineering with a broad service portfolio, paving the way for the evolution towards Exascale. By Exascale computing, we refer to computing systems that are capable of at least one exaflop, or quintillion calculations per second.

EXCELLERAT is part of the European HPC Strategy realisation, just pushed forward with the activities on the EuroHPC Joint Undertaking.



EXCELLERAT P2

Advancing Engineering with Exascale Computing

EXCELLERAT P2 applies high-performance computing to solve complex engineering challenges in aerodynamics, propulsion, noise reduction, and energy. Our use cases drive innovation by enhancing efficiency, accuracy, and sustainability.

External Aircraft Aerodynamics

Simulations of aircraft aerodynamics are essential for future aircraft's performance, safety, and efficiency. Transonic speeds are particularly challenging due to the complex aerodynamic phenomena that occur near the speed of sound. This use case computes the airflow around a passenger aircraft with typical characteristics such as density, velocity and pressure using the CODA CFD software and the FlowSimulator framework. This allows users to investigate the distribution of lift and drag forces on the surface of the aircraft.

Hydrogen Combustion for Propulsion

Future gas turbines will transition from fossil fuels to hydrogen. In this use case, partners are focusing on optimising hydrogen combustion for propulsion systems. In support of the EU's clean energy goals, they employ high-fidelity simulations to facilitate the transition of turbines from fossil fuels to hydrogen.

Mitigation of Aeroacoustic Noise

High-fidelity numerical simulations are required to accurately predict jet noise and nozzle thrust from chevron nozzle shapes. Shape modifications for noise reduction can lead to thrust loss, necessitating constrained optimisation. Exascale computing is essential due to the large number of evaluations needed to identify the optimal solution. The execution of this use case thus supports future noise reduction goals, improves flight comfort, and has applications in other fields, such as automotive engineering.

Fully Integrated Aircraft Simulations with Emissions Models

Simulating the complete aerodynamics of an aircraft, while integrating accurate emissions models, is extremely compute-intensive. A key challenge in these simulations is predicting emissions without compromising the estimation of aircraft performance metrics such as fuel efficiency, speed, range, and payload. To tackle this challenge, BSC researchers have been conducting integrated simulations of aircraft to predict aerodynamics and pollutant dispersion. This approach supports the design of low-emission aircraft with better aerodynamic characteristics, contributing to more efficient and cleaner aviation technologies.

High-fidelity Simulations of Rotating Parts

This use case focuses on conducting high-fidelity CFD simulations of a drone rotor with moderately complex geometry. Modelling turbulent flows at high Reynolds numbers is both challenging and costly, requiring large meshes to capture all flow features. Advanced mesh refinement and in-situ data analysis are employed to enhance the accuracy and efficiency of aerodynamic simulations.

Active Control for Drag Reduction of Transonic Airfoils

Improving the aerodynamic efficiency of a wing can result in significant fuel savings. This use case addresses a key challenge: reducing drag by controlling airflow around wing surfaces. Using high-fidelity simulations, our project partners aim to gain deeper insights into airflow behaviour under the influence of active flow control techniques.

Engineering Design and Digital Twin of the First Wall of a Tokamak Fusion Reactor

Plasma power deposition on the first walls of magnetically confined devices presents fundamental challenges, including the risk of overheating the reactor and potentially damaging key components. Advanced diagnostic systems that monitor the plasma are crucial to addressing these issues. This use case is crucial for advancing nuclear fusion technology, providing insights into plasma behaviour and improving reactor design and safety.

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