

## What can Cenaero offer to your company?

### → Consulting services:

- > manufacturing processes modeling,
- > structural integrity analysis,
- > composite structure design and optimization,
- > aerodynamic and aero-acoustic analysis,
- > fluid-structure interaction modeling,
- > turbomachinery aerodynamics and design optimization,
- > high performance computing,
- > project management.

### → Software products:

- > **Morfeo** - A new generation manufacturing software
- > **Minamo** - The right tool to reach your optimum
- > **Argo** - Your aerodynamic flow solution for multi-physics problems
- > **Hea-P** - A dedicated tool for grooved heat pipes design

## How to contact us

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[www.cenaero.be](http://www.cenaero.be)

## Cenaero Headquarters

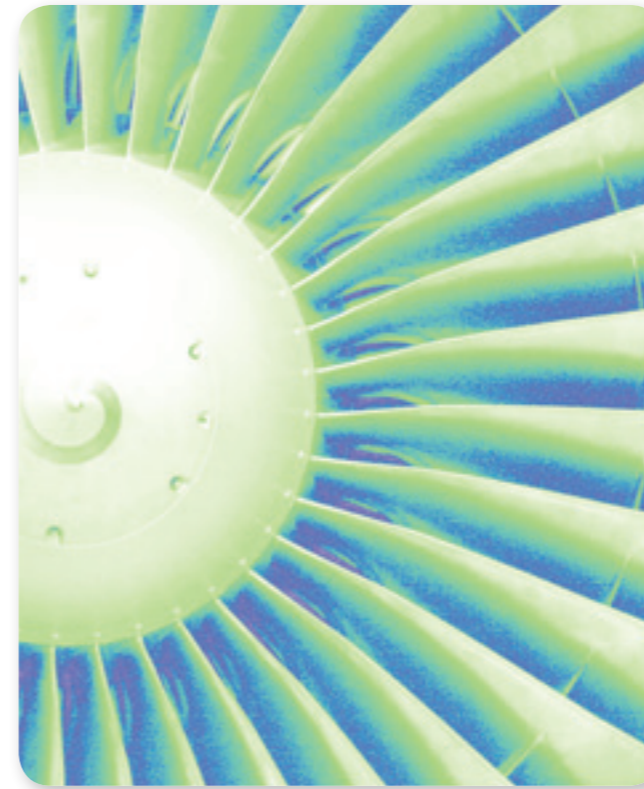
Bâtiment Eole  
Rue des Frères Wright 29  
B-6041 Gosselies (Belgium)



The European Regional Development Funds  
and the Walloon Region are investing in your future



European Union

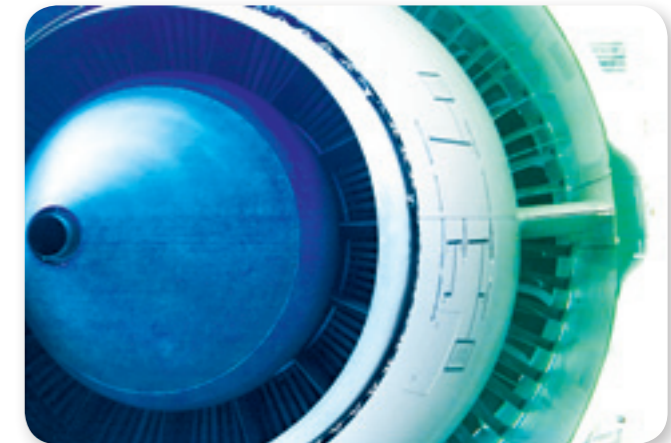


## Cenaero

Your trustworthy R&T partner  
in numerical simulation

## Vision, Values & Strategy

Cenaero is a **Belgian research company** specialized in aeronautics, space, energy, transport, biomedical and civil engineering sectors. Cenaero provides state-of-the-art expertise in numerical simulation and modeling on a day-to-day basis to SMEs and large companies.



Cenaero develops **software and numerical methods** to model complex problems in applied mechanics focusing on industrial applications. Cenaero is today a **leading reference in advanced multi-disciplinary simulation** in Europe.

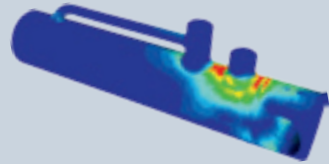
Cenaero commits to work on a long term basis with its partners supporting them in their innovation process. Our research and engineering teams focus on modeling of manufacturing processes (welding, machining, etc), structures and high-tech materials design and integrity analysis, computational fluid dynamics (CFD) and multi-disciplinary optimization (MDO). Besides we have a team specially dedicated to Collaborative Project Management.

Leader in Research and Development, Cenaero is involved in many European framework program projects. Cenaero also maintains close relationship with universities as it is clearly vital to constantly remain at the cutting-edge of our scientific developments.

# Advanced consulting services

## Manufacturing processes modeling

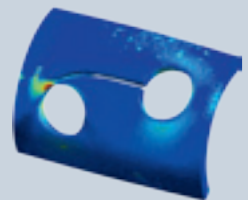
- > Assessment the feasibility of part manufacturing or parts assembly
- > Optimization and qualification of manufacturing processes
- > Reduce trial and errors cycle to process set-up (cost saving)
- > Prediction of part distortions, residual stresses, materials, defects, ...
- > Chaining of multiple processes, close cycle design, manufacturing, assembly
- > Solid state welding processes (IFW, DFW, FSW, FSSW)
- > Fusion welding processes (TIG, EBW, LBW)
- > Machining processes
- > Hot forming, Heat treatments, Explosive forming, etc.
- > Structural in-service behavior of parts after forming
- > Ability to handle large and complex mechanical components
- > Automatic process optimization using Minamo
- > Use and development of Morfeo/welding and Morfeo/machining



Structural response of an automotive part during a Laser Beam Welding process  
Courtesy ROQUET, Spain

## Structural integrity analysis

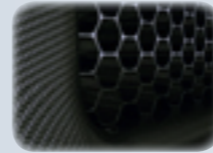
- > Expertise in fracture mechanics and damage tolerant analyses
- > Prediction of 3D crack paths with major topology changes
- > Time-efficient crack simulations on real and complex industrial cases
- > Simultaneous handling of multiple cracks
- > Computation of stress intensity factors and prediction of fracture
- > Prediction of the number of cycles to failure for parts with propagating cracks
- > Cost-effective solution, very low lead time
- > Use and development of Morfeo/crack



Automated propagation of a 3D crack in a hollow cylinder submitted to inner cyclic pressure.

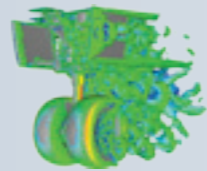
## Composite structure design and optimization

- > Design, analysis and optimization of multi-material and composite structures
- > Computation of cost-mass-performance trade-off curves in the concurrent design phase
- > Multi-scale modeling of damage and failure
- > Design and analysis of adhesively bonded structures
- > Modeling and optimization of manufacturing processes (draping, curing, ...)
- > Numerical design, analysis and calibration of damage detection systems (structural health monitoring)



## Aerodynamics, aero-acoustics and fluid structure interaction

- > Expertise in CFD oriented numerical analysis
- > RANS, LES and RANS/LES approaches for turbulent flows simulations
- > Massively parallel computations for large scale industrial problems
- > Aero-thermal and aero-elastic simulations using Argo coupled through MpCCI to commercial FEA software (ABAQUS, SAMCEF)
- > Aero-acoustic simulations using Argo coupled to commercial acoustic software (ACTRAN/LA, SYSNOISE)
- > Unstructured mesh generation around complex geometries
- > Use and development of Argo

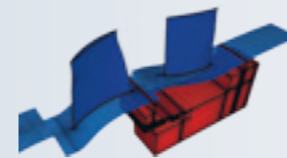


Flow field around a landing gear geometry  
Messier-Dowty (Safran Group)

## Turbomachinery aerodynamics and design optimization

- > Multi-disciplinary shape optimization for fan, compressor and turbine components
- > Qualification and validation of aerodynamic computational tools
- > CAD model parameterization
- > Robust automated mesh generation
- > Aero-thermal flows (turbine cooling, air cooled oil cooler system)
- > Technological effects integration in the design loop (casing treatments, blow/bleed devices, non-axisymmetric handles)
- > Unsteady flows

- > Real geometry effects (fillets, welded joints, surface roughness, seal leakage flows)
- > Multi-physics multi-criteria designs (aerodynamics, mechanics and acoustics)
- > Design methodology development
- > Use and development of Argo
- > Use and development of Minamo coupled to CFD solvers
- > Modeling of turbomachinery equipment systems (lubrication, heat exchangers, ...)



Multi-block structured mesh for the simulation of the seal leakage flow in a compressor  
Techspace Aero (Safran group)

## High performance computing

- > Proven experience in reliable and efficient operation of world-class supercomputers
- > Expertise in HPC solutions definition suited for CAE applications
- > Implementation of tailored simulation platforms providing remote HPC resources
- > Demonstrated experience in industry-level handling of security and confidentiality requirements
- > Scientific applications benchmarking and requirements specifications
- > Customer-oriented support service

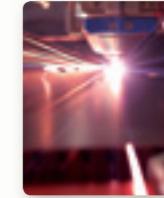


## Project management

- > Collaborative projects set-up and support (assistance in proposals and project management)
- > R&D management consultancy (technology audit, SWOT analysis, etc)
- > Technical competitive positioning analysis (state-of-the-art and benchmark study)
- > Assistance and consultancies to the project managers
- > Ad hoc technical expertise
- > Project Management trainings
- > Administration of a collaborative & communication website



# Software products



**Morfeo** - A new generation manufacturing simulation software: the reference in simulation of welding, machining processes and fracture mechanics for large size components and within a reasonable computational time.



**Minamo** - A multi-disciplinary multi-objective optimization platform which can be connected to any computational tools and able to efficiently treat problems using a large number of continuous and discrete variables with complex constraints.



**Argo** - A massively parallel unstructured CFD solver for RANS, URANS, LES and DES modelling of large scale compressible and incompressible flow problems, including FSI and aeroacoustics capabilities.



**Hea-P** - A leading edge software dedicated to the thermo-hydraulic modeling of grooved heat pipes.

