CNT
Center of New Technologies

institute of aviation
warsaw, since 1926

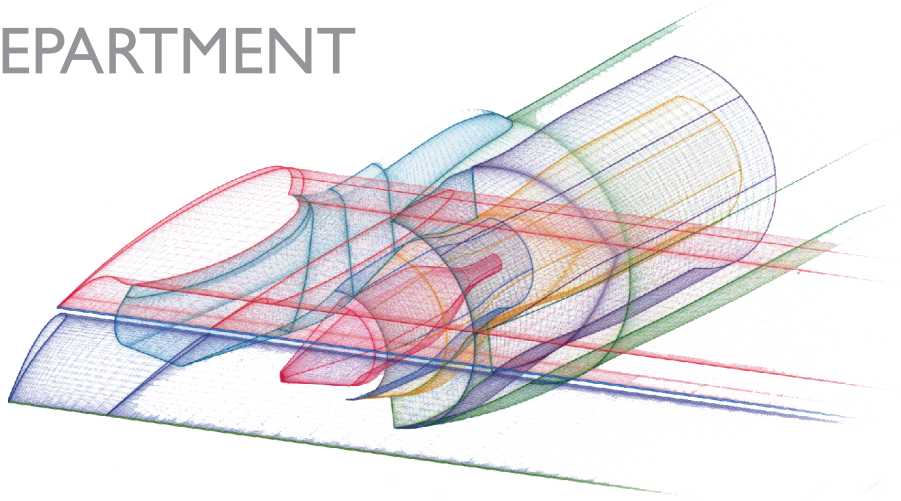
COMPUTATIONAL FLUID DYNAMIC AND FLIGHT MECHANICS GROUP

research for future

AERODYNAMIC DEPARTMENT

Computational Fluid Dynamic and Flight Mechanics Group

The Computational Fluid Dynamic and Flight Mechanics Group is a leader among research centers in Poland in the area of aerodynamic design and CFD analysis.
Our staff comprises highly qualified engineers specializing in CFD as well as airframe design and optimization.
For research and development work, both commercial and in-house developed software is employed according to the scope of work and its specification.



Grid model of installed high bypass ratio engine nozzle

Design and Optimization

Basic tools for design and optimization are in-house developed and implemented methods of:
- parameterization of geometries for design and optimization purposes,
- multicriterial and multidisciplinary design and optimization based on genetic algorithms,
- design of Experiment (DoE) methodology.

Capabilities:
- design of parametrical models of objects for research and optimization (airfoil, wing, inlet ducts for jet and turboprop engines, engine nozzles etc.),
- airfoil design,
- multicriterial and multidisciplinary design of aircraft and its elements,
- aerodynamic design of ducts,
- aerodynamic design of helicopter rotors,
- design of propellers, rotors, wind turbines etc.,
- design of parametric models for non-aviation applications and CAD design.

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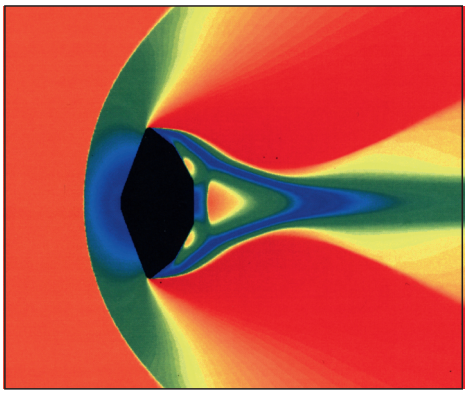
Analysis

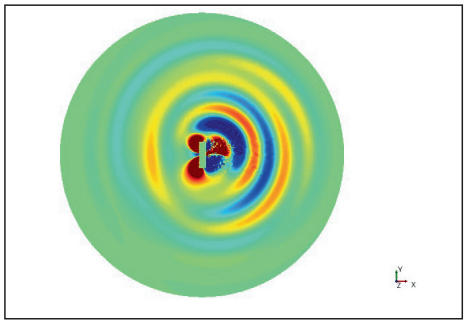
For computational analysis of flowfield, both commercial and in-house developed software is employed. In collaboration with other research facilities, our group takes part in developing new software for academic purposes.

Capabilities:
- simulation of flow around an aircraft and parts of the airframe,
- simulation of flow around a helicopter and parts of the airframe, and interference with surrounding objects,
- unsteady flows in shape shifting domain and around such geometries,
- fully three-dimensional simulation of flow around the main rotor of a helicopter (in forward flight and in hover) based on the URANS (Unsteady Reynolds Averaged Navier Stokes) solution,
- fluid structure interaction for modeling nonrigid blades of helicopter rotors including blade flapping,
- flow simulation in ducts (e.g. air intake ducts in aircraft engines),
- spaceship re-entry atmosphere flow simulation,
- aeroacoustic analyses.

Flow issues related to non-aviation areas:
- flow in land and water based transport,
- flow in civil engineering (buildings, stadiums, bridges etc.),
- simulation of air movement in urban areas; safety issues in high altitude rescue actions,
- flow and load analysis for constructions, subject to aerodynamic and hydrodynamic forces (e.g. strong gusts of wind),
- flow in turbines, fans etc.,
- multiphase flows,
- supersonic and hypersonic flows including heat and radiation modeling,
- phase changing and chemical reactions simulation,
- performance and stability analysis.



Velocity field for the space probe for M = 2.0



CAA study to simulate propeller - wing interaction tonal noise generation, propagation and radiation to the far-field

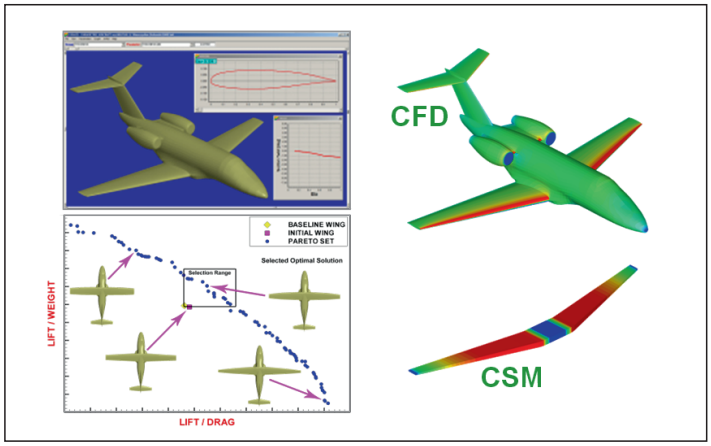
Our Partners

The CFD and Flight Mechanics Group collaborates with many research centers and businesses in Poland and abroad, including:

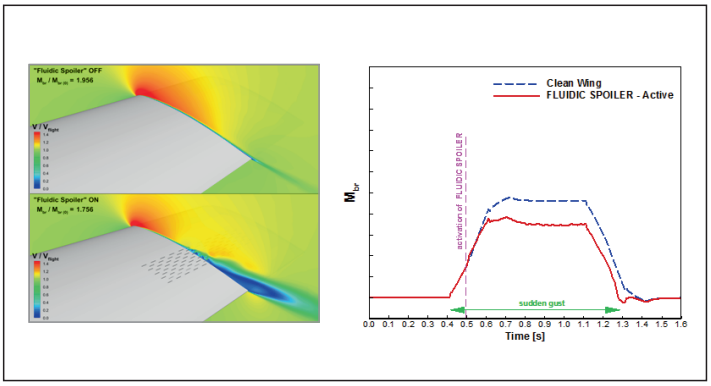
- EADS-CASA
  aerodynamic Study of A400M Air-intake.
- Warsaw Technical University
  1. *High Efficient 3D CFD Codes for Industrial Application High Reynolds Number Tools and Techniques For Civil Transport Aircraft.*
  2. *Design Modeling and Design of Advanced Wing Tip Devices.*
  3. *New Aircraft Concepts Research Computational method for determining flow around main rotor blades.*
- Institute of Turbomachinery
  Developing and implementing new generation design, technology, and material solutions for the main rotor and airframe elements of the PZL W-3A Sokol helicopter.
- PZL-Świdnik S.A.
  Developing and implementing the generation design, technology, and material solutions for the main rotor and airframe elements of the PZL W-3A Sokol helicopter, 2007-2011.

Our researchers actively participate in many international projects including:

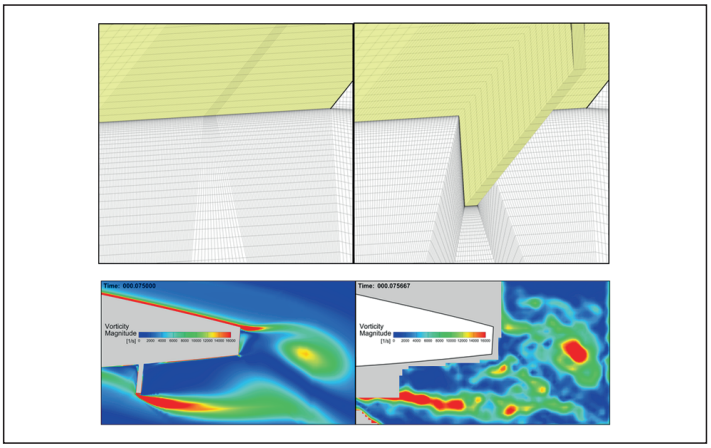
- CESAR: „Cost effective small aircraft" (2006-2010), Project led by VZLU (Czech Republic), 6th Framework Programme,
- MOSUPS: „The joined wing scaled demonstrator" (2013-2015), Research Project funded by National Centre of Research and Development,
- ESTERA: Multi-level Embedded Closed-Loop Control System for Fluidic Active Flow Control Actuation Applied in High-Lift and High-Speed Aircraft Operations (Clean Sky, grant agreement no. CSJU-GAM-SFWA-2008-001, 2011-2013),
- NACRE: New Aircraft Concept Research (2005-2010), 6th Framework Programme, project led by Airbus,
- TFAST: Transition Location Effect on Shock Wave Boundary Layer Interaction (2012-2016, 7th Framework Programme),
- STARLET: Basic wind tunnel investigations to explore the use of Active Flow Control technology for aerodynamic load control (Clean Sky project no. 296345, 2012-2014),
- COMROTAG: Development and Testing of Computational Methods to Simulate Helicopter Rotors with Active Gurney Flap (Clean Sky project no. 619627, 2013-2016),
- HELIX: Innovative Aerodynamic High Lift Concepts, Projekt KE G4RD-CT-2001-00516, 2002-2004,
- HISAC: Environmentally Friendly High Speed Aircraft, Projekt KE Nr AIP4-CT-2005-516132, 2005-2009,
- AEROFAST: Aerocapture for Future Space Transportation, Project KE 218797, 2009-2011.



Example of wing optimization results achived in CESAR project



Example of load reduction system investigated in STARLET project



Comparison of results of flow simulation of a helicopter blade equipped with active Gurney flap conducted in COMROTAG project with results of wind-tunnel experiment

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