MULTI PHYSICS FLOW MODELING

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Master's Degree in Digital Automation Engineering

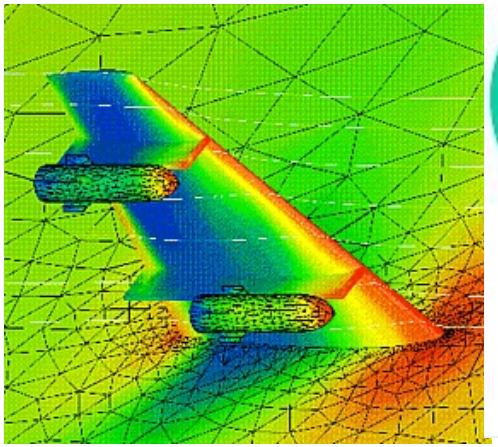
Curriculum: Digital Design

Semester: 2023-2024 Fall

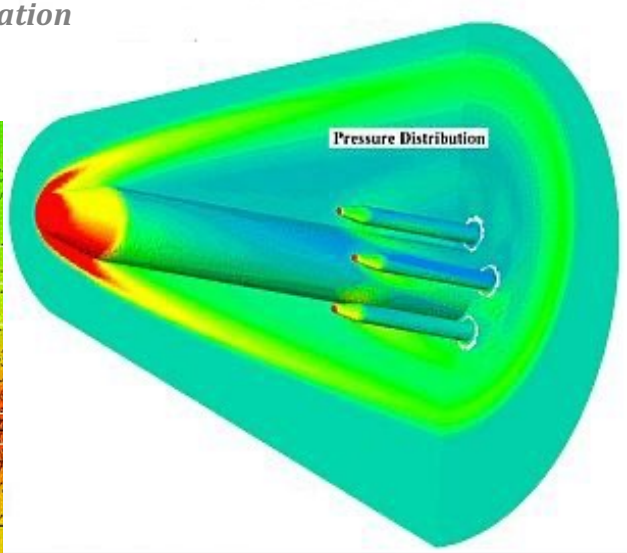
Where is MULTI PHYSICS FLOW MODELING used?

- Industrial sectors:
  - ***Aerospace***
  - Appliances
  - Automotive
  - Biomedical
  - Chemical Processing
  - HVAC&R
  - Hydraulics
  - Marine
  - Oil & Gas
  - Power Generation
  - Sports

F18 Store Separation



Wing-Body Interaction



Hypersonic Launch Vehicle

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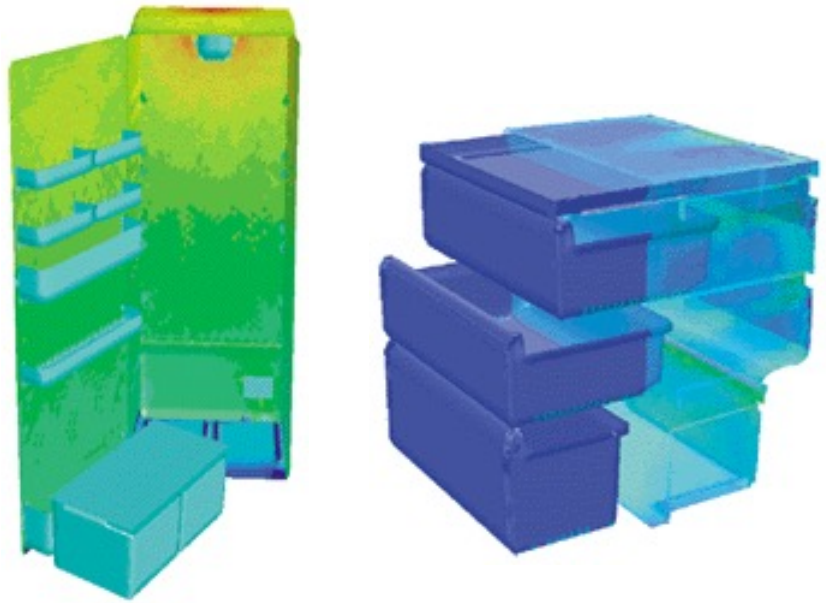

Surface-heat-flux plots of the No-Frost refrigerator and freezer compartments helped BOSCH-SIEMENS engineers to optimize the location of air inlets.

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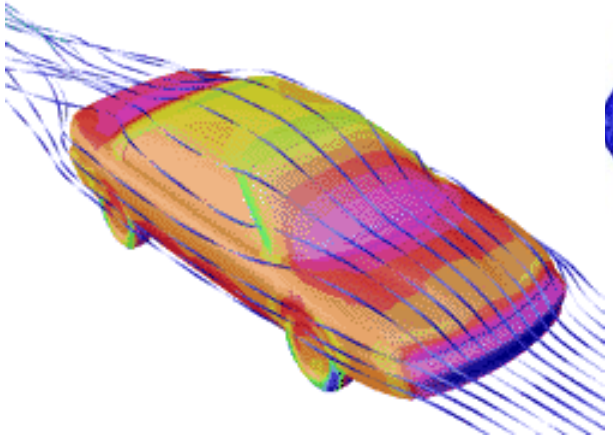
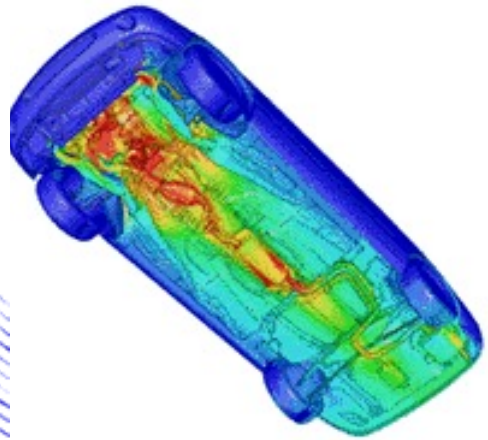
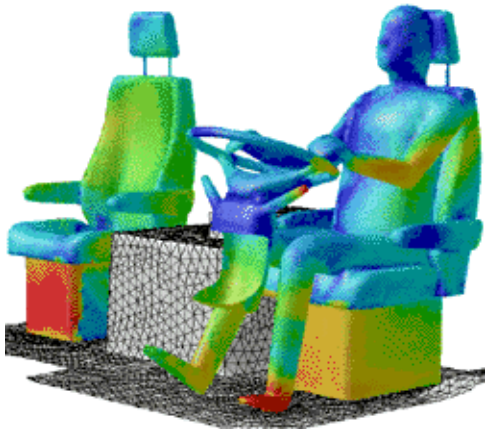


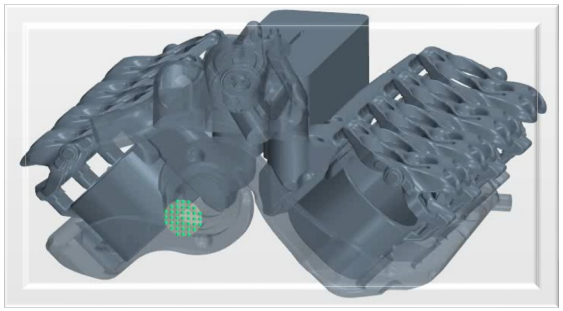
External Aerodynamics



Undercarriage Aerodynamics



Interior Ventilation



Engine Cooling

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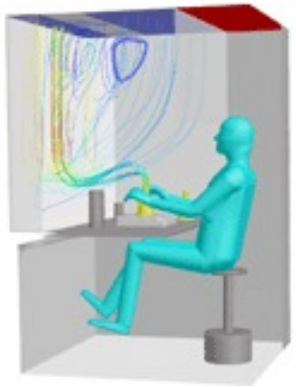
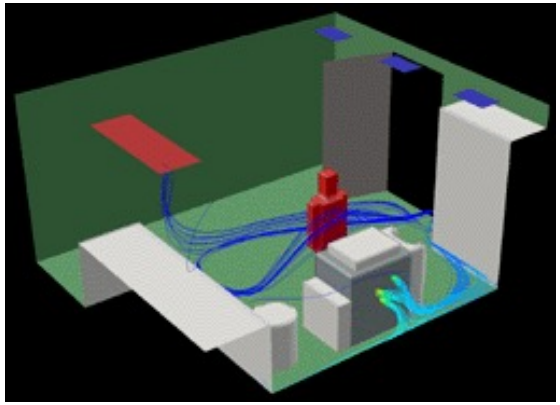
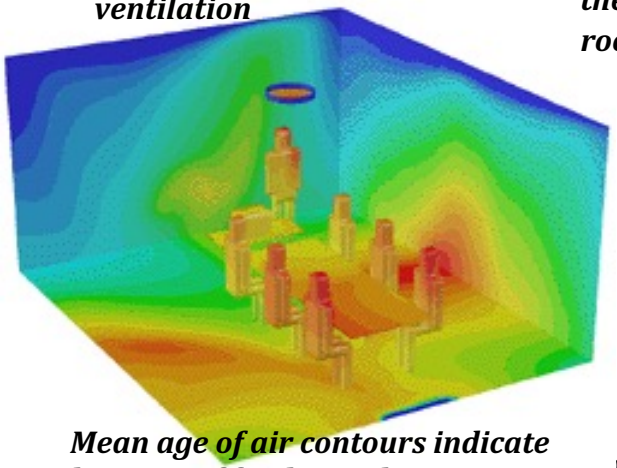


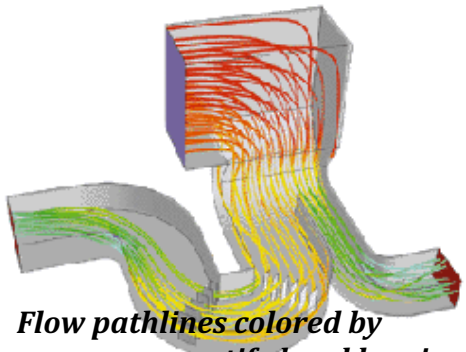
Streamlines for workstation ventilation



Particle traces of copier VOC emissions colored by concentration level fall behind the copier and then circulate through the room before exiting the exhaust.



Mean age of air contours indicate location of fresh supply air



Flow pathlines colored by pressure quantify head loss in ductwork

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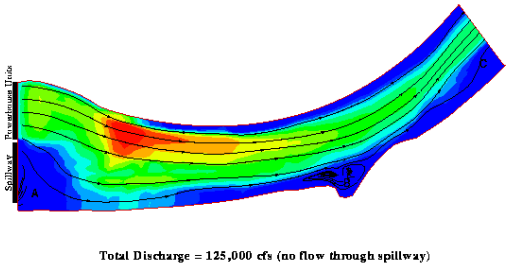
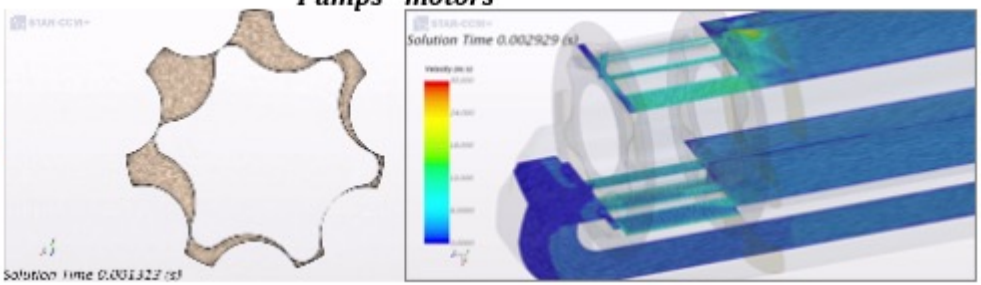
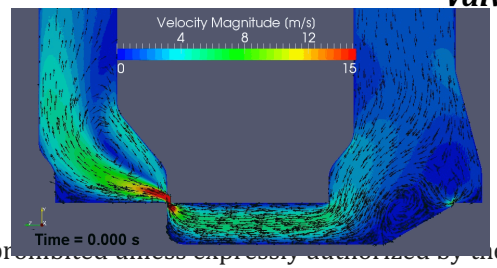
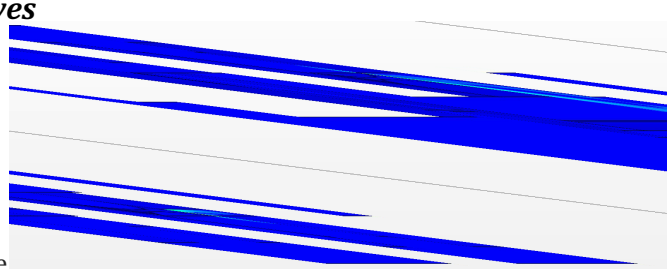


Pumps - motors



Valves





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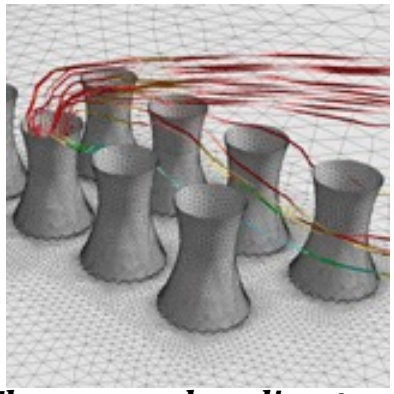
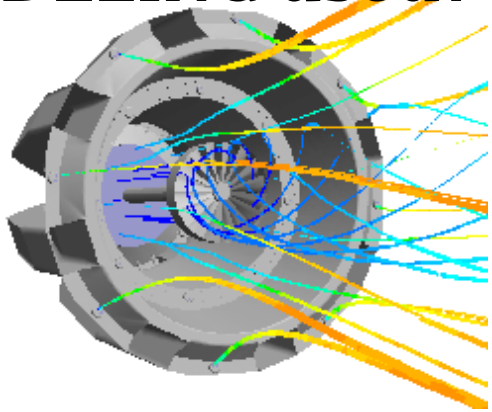
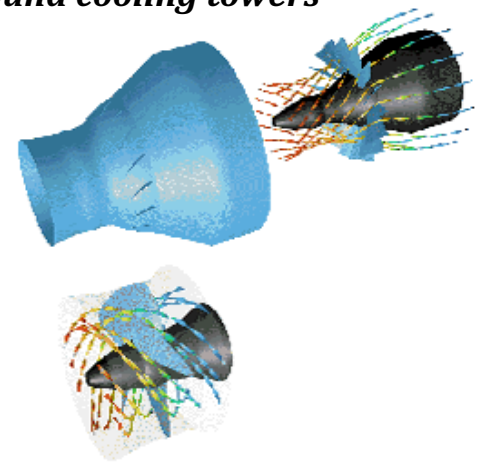


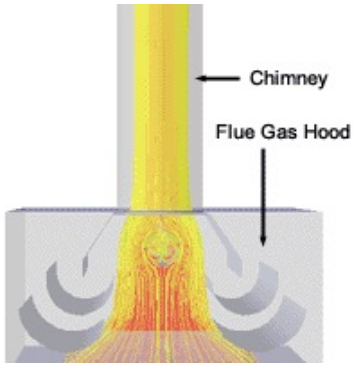
Flow around cooling towers





Flow pattern through a water turbine.

Flow in a



Pathlines from the inlet colored by temperature during standard operating conditions

- Why use CFD?
  - Analysis and Design
    - Simulation-based design instead of "build & test"
      - More cost effectively and more rapidly than with experiments
      - CFD solution provides high-fidelity database for interrogation of flow field
    - Simulation of physical fluid phenomena that are difficult to be measured by experiments
      - Scale simulations (e.g., full-scale ships, airplanes)
      - Hazards (e.g., explosions, radiation, pollution)
      - Physics (e.g., weather prediction, planetary boundary layer, stellar evolution)
  - Knowledge and exploration of flow physics

- Syllabus

- Meshing: Methodologies for the creation of a computational fluid domain of complex geometries (0.5 ECTS)
- Turbulence: Numerical approaches for modeling turbulent flows. (1 ECTS)
- Compressible flows: Numerical approaches for the simulation of compressible flows. (1 ECTS)
- Multi-phase flows: Description of numerical models for the simulation of flows including different phases (gaseous - liquid - solid). (1.5 ECTS)
- Multi physics: numerical approaches for the integration of physical phenomena in the thermo-fluid dynamics simulation (reactive flows, fluid-structure interaction, electromagnetic fields). (2 ECTS)

Hands-on classes (SIEMENS Siemcenter STAR-CCM+)

- Evaluation

– Each student is required to develop a **project** by means of the **CFD STAR-CCM+ software**. The project is assigned to the students during the course and the student will present the results of their project during the exam.

– Timing. The time foreseen for the presentation of the project is 30 minutes followed by Q&A time.

– Method for assigning the score for the final grade: average of the evaluation reached for the quality of the project, presentation of the project and answers provided. The final mark will be notified at the end of the discussion of the project.

– Eight exam dates will be established during the academic year for the presentation of the student project. Students must register for the exams through the ESSE3 platform.