Engineering Project Portfolio

Lorenzo Cappello

Graduate Aeronautical Engineer

lorenzocappello90@gmail.com | +61 494 396839
LinkedIn | Web Page
GitHub | ORCID

About Me

I am an **Aeronautical Engineer** who is passionate about **sustainable aviation, flight testing, and innovative aircraft design**. My goal is to contribute to the development of future aerospace systems that are efficient and environmentally responsible.

I am driven by curiosity and a commitment to keep learning, whether through hands-on testing, simulation-based design, or interdisciplinary approaches. I believe that great engineering is achieved through **cooperation, data-driven decisions**, and a commitment to **continuous improvement**.

My **greatest motivation** is the direct impact that engineering has on the world and I aim to use my skills to contribute to meaningful change in the aerospace sector. I bring a solution-oriented approach, attention to detail, and a focus on bridging theory with practical implementation and testing in areas such as aeroelasticity, flight testing, and aircraft climate impact assessment.

Key Skills

- **Programming Languages:** Python, MATLAB, R
- **Engineering Software:** Autodesk Fusion CAD, ANSYS Fluent and Mechanical, Excel, Fidelity Pointwise, OpenFOAM, SHARPy, ParaView, COMSOL Multiphysics
- **Technical Skills:** Flight Testing, Aircraft Climate Impact Assessment, Finite Element Analysis, Aerodynamic Analysis and Solver Development, Aircraft Design, Aircraft Systems Analysis, CAD Design.
- **Project Management:** Risk Assessment, Project Planning, Technical Documentation & Reporting, Problem Decomposition, Security Management
- **Soft Skills:** Teamwork, Technical Communication, Problem Solving

Key Projects

1. Aeroelastic Model Development and Analysis of Flexible Wings

Duration: August 2024 - February 2025

With the growing use of high-aspect-ratio wings and composite materials in modern aircraft design, aeroelastic effects have become increasingly important, even in early design stages. As part of my Master's thesis, I developed a Python-based computational tool for aeroelastic analysis of lifting surfaces in conceptual and preliminary design. The solver, integrated into a custom graphical user interface, couples two aerodynamic and two structural solvers through a two-way coupling approach. The tool

was validated using the benchmark Pazy Wing and compared against solvers including SHARPy and ANSYS Fluent/Mechanical.

2. Aircraft Angle of Attack Estimation Using an Inertial Measurement Unit

Duration: August 2024 - October 2024

Reliable and accurate angle of attack estimation plays an important role in the performance analysis and safety monitoring of an aircraft. In this project, I developed and validated a MATLAB-based algorithm to estimate the aircraft angle of attack using data from an Inertial Measurement Unit and a Garmin G5 flight instrument. The algorithm was tested using flight data collected during a flight testing campaign in Nordholz, Germany in August 2024.

3. Climate Impact Assessment of Single Flights

Duration: January 2023 - July 2023

As part of my Bachelor thesis, I worked in a team to develop an Excel-based tool for estimating the climate impact of single flights, including both CO_2 and non-CO_2 emissions. The tool encompasses a database of global airports, aircraft types, and engine models, and calculates flight-specific emissions and their contribution to global warming using different climate metrics. The project aimed to make aviation climate impact assessment accessible at a single-flight level and increase awareness on the importance of also reducing non-CO_2 jet engine emissions with future propulsion technologies.

4. Internship in Aircraft Maintenance and Ground Handling

Duration: March 2019 - April 2020

During my internship at Zurich Airport, I assisted in routine piston aircraft maintenance tasks and gained hands-on insight into operational procedures and technical inspections. Additionally, I supported ground handling activities for arriving and departing aircraft, including turnaround coordination, aircraft refuelling, billing, and communication with flight crews and maintenance personnel. This experience marked my first professional exposure to aviation operations and fulfilled one of the requirements for admission to my aeronautical engineering studies.

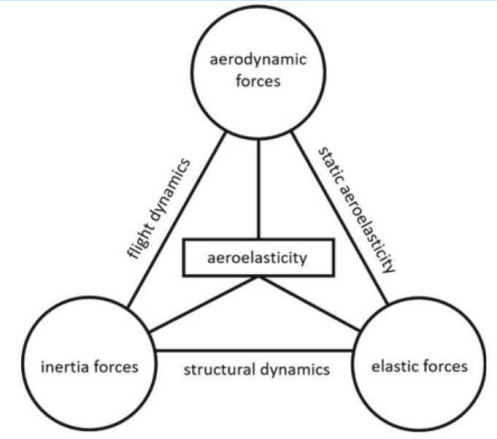
Detailed project descriptions follow on subsequent pages.

Project 1: Aeroelastic Model Development and Analysis of Flexible Wings

Aeroelastic Model Development and Analysis of Flexible Wings

Role: Master student | **Objective:** Development of a novel aeroelastic solver for wing design support

Aeroelasticity interaction diagram



Description

The Centre for Aviation of the university tasked me with the development of a novel aeroelastic solver for use in wing design studies.

Problem: No aeroelastic solver was available at the Centre for Aviation with the characteristics: open-source, user-friendly, fast, and conservative.

Solution: Two aeroelastic solvers were developed and integrated into a GUI, meeting all the outlined requirements.

Impact: The Centre for Aviation has a new, well-documented aeroelastic software that can be used in projects and continuously upgraded.

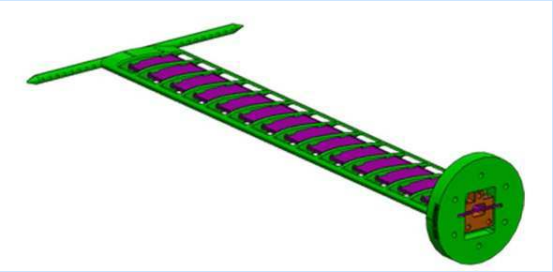
Technical Details

Technologies: Lifting-line theory, structural beam model, vortex-lattice method, finite-element analysis, computational fluid dynamics

Key Challenges:
- Software development strategies
- Effective combination of solver requirements
- Efficient solver coupling for fast computation time and low-cost

Approach: I developed two medium-fidelity aerodynamic and structural solvers and coupled them in two-way coupling. The CAD model of the benchmark wing used for the solver validation case study is shown on the bottom right.

Benchmark wing model used in the solver validation case study



Skills Obtained: Software development, fluid-structure interaction, aerodynamic and structural analysis
Tools Used: Python, SHARPy, Fidelity Pointwise, Paraview, ANSYS, Autodesk Fusion CAD, Zotero, Overleaf

Project 2: Aircraft Angle of Attack Estimation Using an Inertial Measurement Unit

Aircraft Angle of Attack Estimation Using an Inertial Measurement Unit

Role: Flight Test Student | **Objective:** Development of an algorithm to estimate the aircraft angle of attack

Flight test aircraft with students

Description

An alternative method to estimate the aircraft angle of attack, as opposed to traditional mechanical devices, was investigated.

Problem: Traditional mechanical angle of attack measurement devices are often costly, require proper calibration, and are subjected to aerodynamic interference.

Solution: I developed an algorithm to estimate the angle of attack from the aircraft equations of motion, using data from inertial measurement units as input.

Impact: The proposed algorithm produced promising results and is currently undergoing further development.

Technical Details

Technologies: Linearised aircraft equations of motion, Garmin and SBG inertial measurement units, flight test cards

Key Challenges:
- Noise reduction in flight test data
- Accounting for wind effects on flight test data
- Measurement system reliability & redundancy

Approach: I developed an algorithm in MATLAB to estimate the aircraft angle of attack from the linearised aircraft equations of motion. The algorithm takes flight data from an inertial measurement unit as input and computes the angle of attack time series.

Installed inertial measurement unit

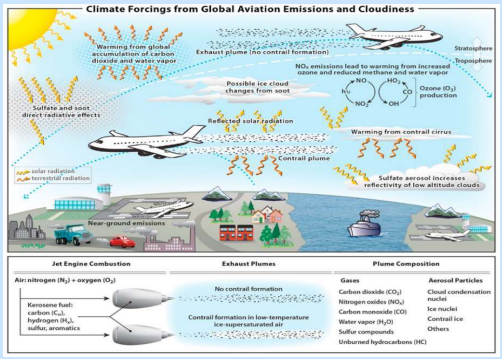
Skills Obtained: Flight test preparation and conduction, instrument installation, risk assessment, algorithm development
Tools Used: MATLAB, SBG software for data post-processing, Zotero, Overleaf

Project 3: Climate Impact Assessment of Single Flights

Climate Impact Assessment of Single Flights

Role: Bachelor student | **Objective:** Propose an approach to estimate the climate impact of single flights

Aircraft emissions and climate forcing



Description

We proposed an updated method to calculate the climate forcing of each emission for single flights, including both CO_2 and non-CO_2 emissions.

Problem: Assessing the impact of non-CO_2 emissions is significantly more challenging than the effects of CO_2 alone.

Solution: We developed an Excel tool that allows users to estimate the climate forcing of single flights of their choosing.

Impact: The developed tool positively contributed to the awareness of the aviation faculty on the necessity to account for non-CO_2 emissions and their effect on the climate.

Technical Details

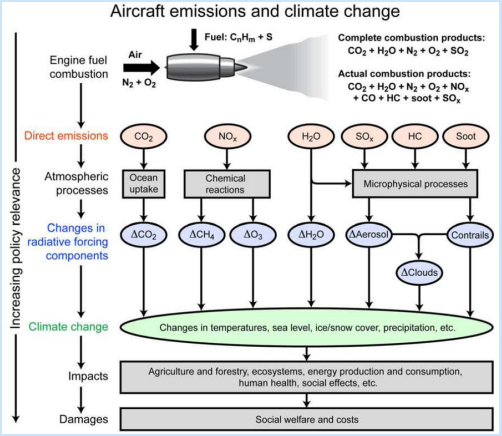
Technologies: Boeing fuel-flow method, nvPM estimation methodology, global warming potential, jet engine combustion model

Key Challenges:

- Estimation of quantity and effect of non-CO_2 emissions
- Conversion of mass emission to climate forcing index

Approach: We integrated different emission estimation methodologies, propulsion models, as well as aircraft and airport databases into an Excel tool that allows the user to compute an estimate of the climate forcing of single flights.

Jet engine emissions and climate impact



Skills Obtained: Aircraft climate impact assessment, jet engine emission calculation, software development, teamwork

Tools Used: Microsoft Excel and Word, Zotero

Project 4: Internship in Aircraft Maintenance and Ground Handling

Internship in Aircraft Maintenance and Ground Handling

Role: Intern | **Objective:** Gain experience in aircraft maintenance and ground operations at a commercial airport

A Diamond DA40 during a yearly inspection in the maintenance hangar

Description

Before my studies, I completed a one-year long internship at the flying club *Motorfluggruppe Zürich* situated at Zurich airport.

Problem: After high-school graduation and civil service, I wanted to gather a first practical understanding of the aviation world and needed proven work experience to be admitted to university.

Solution: Consequently, I decided to do an internship at the general aviation flying club of Zurich airport.

Impact: During the internship I accumulated my first experience in aircraft maintenance operations and ground handling procedures.

Technical Details

Technologies: EASA maintenance procedures, workman tools, electric aircraft tows, fuel trucks

Key Challenges:

- Safe towing and refuelling of aircraft
- Meticulous aircraft inspection and safe handling of tools around aircraft
- Multitasking and maintaining a calm mindset

Approach: I mastered aircraft inspection following checklists, developed a strong safety awareness, and learnt how to safely tow aircraft of different sizes and configurations. Most importantly, I learnt about safety culture and how to report mistakes and learn from them.

An aircraft mechanic and myself in a Diamond DA42 during an engine test in the silencer of the airport

Skills Obtained: Aircraft maintenance and inspection, aircraft towing and refuelling, customer service, aircraft ground operations, safety culture and awareness
Tools Used: ADsoftware for CAMO, EasyBill, Zurich airport slot management system, workman tools