First Public Workshop:
Novel Tools for Novel Aircraft

eVTOLUTION

Project overview

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Novel aircraft require novel design tools

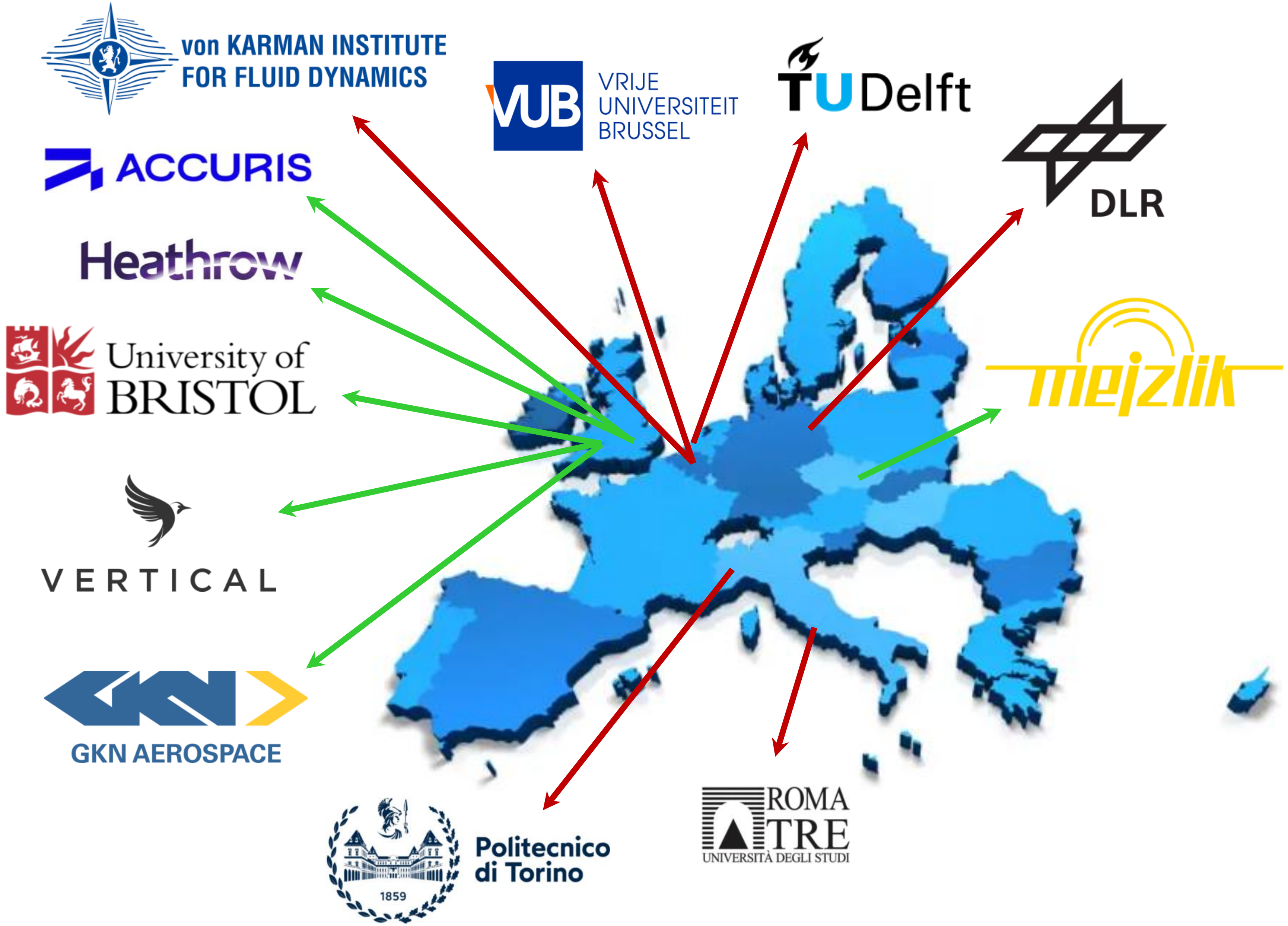
- Flightpath 2050 objectives
  - reduced pollutant emissions
  - lower noise footprint

  → disruptive technologies and aircraft architectures

- Electrification
  → drastic opening of design space
  - Boundary Layer Ingestion
  - Distributed Electric Propulsion
  - New transportation paradigm: **Urban Air Mobility**

Who are we?

6 Partners
+
6 Associated Partners



Hybrid multi-fidelity eVTOL design platform

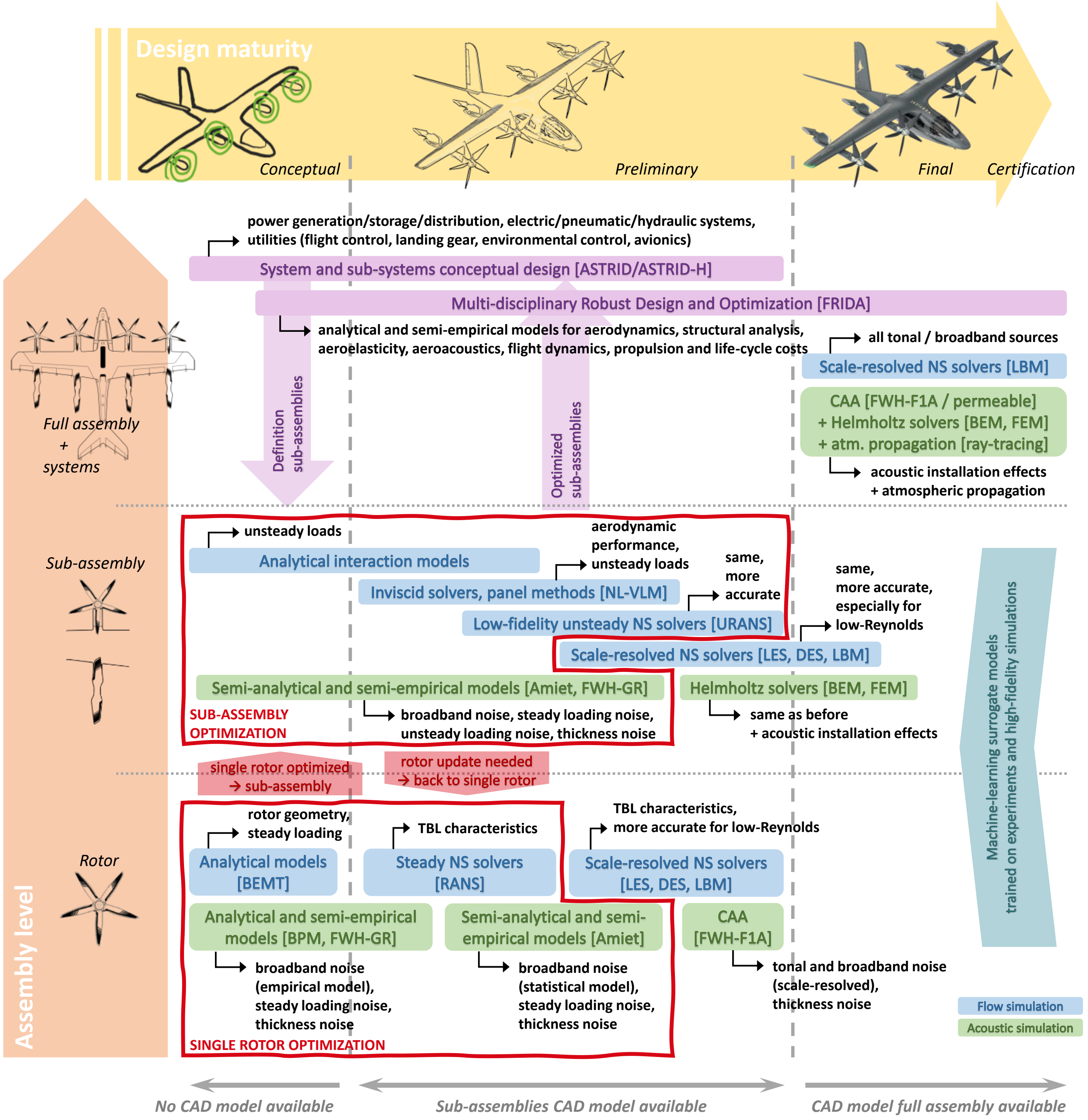
- HORIZON-CL5-2023-D5-01-09 Topic description:

  "*innovative hybrid numerical/experimental procedures, tools and methodologies that will advance further the industrial aircraft design capabilities*"

- Hybrid
  - Physics-based and data-driven models
  - Simulations and experiments for cross-validation and training surrogate models for fast and robust design / optimization
- Multi-fidelity
  - Model complexity / accuracy tailored to each step of the design process
  - Early stages: need for quick evaluation of many options, little info available
  - Later stages: need for accuracy on performance and eventually virtual certification

Design concept

- From isolated components to full assembly & systems
- From conceptual design (no CAD available) to final design (full CAD available)
- Concurrent evaluation of aerodynamic performance and acoustic emissions
- Cross-talk between assembly and simulation levels



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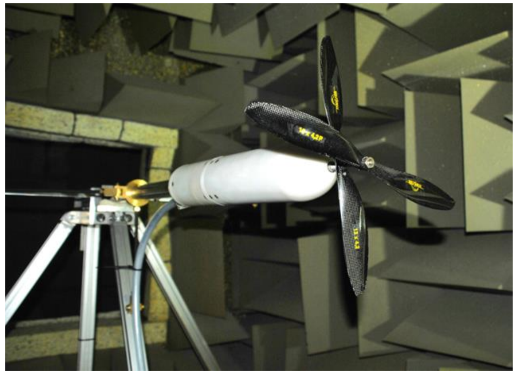
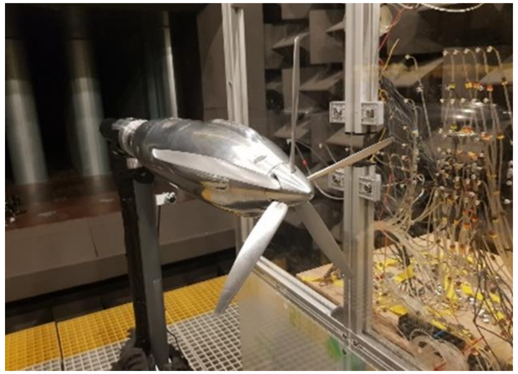
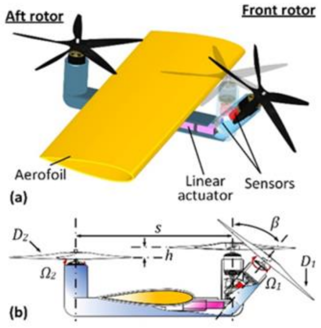
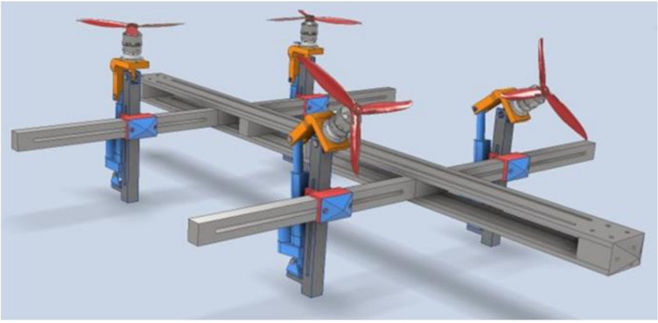
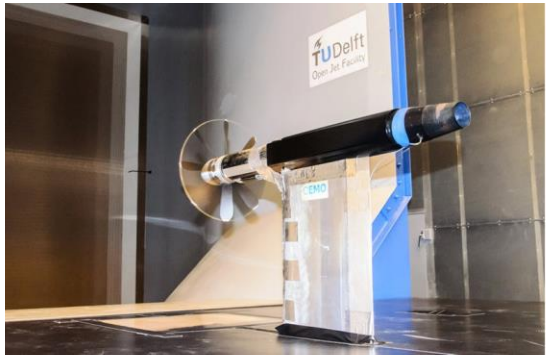
Objectives

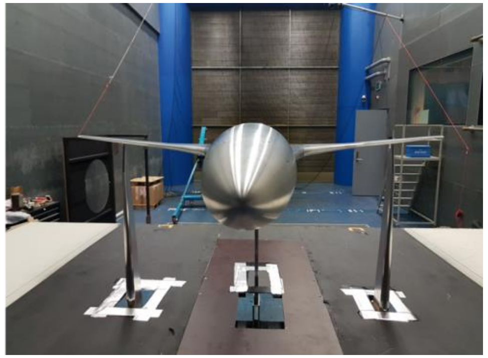
- **Accelerate the optimization** cycle and improve its robustness thanks to **machine learning surrogate models**.
- Improve the **accuracy and robustness** of the design and optimization using advanced **experimental/numerical cross-validation and training** methodologies.
- Assess the **relative importance** of rotor self-noise, rotor-rotor interaction noise, and rotor-rotor-airframe interaction noise in eVTOLs.
- Mitigate the noise emissions of optimized rotors and rotor-airframe assemblies using **flow and noise control technologies**.
- Reduce the **noise footprint** of eVTOL aircraft during departure and approach thanks to **optimized and safe trajectories**.
- Support the elaboration of **noise certification procedures** for eVTOL.
- Increase the **social endorsement** of new aircraft architectures and on-demand urban air mobility.
- Support **future research** aimed at improving the aerodynamic performance and noise emissions of novel aircraft architectures.

Experimental configurations

- Configurations A (VKI, UBRI):
  isolated rotors, no flight effect
  - A1: single rotors
  - A2: tandem side-by-side, co- and contra-rotating
  - A3: tandem coaxial, co- and contra-rotating
  - A4: single rotor + strut / airfoil
- Configurations B (UBRI, GKN):
  isolated / installed (tilt) rotors with flight effects
  - B1: single rotor + (mis-)aligned incoming laminar/turbulent flow
  - B2: tandem rotors (1 tilt) + airframe
  - B3: multi (4-6) rotors with tilt and yawed inflow
- Configuration C (TUD): full assembly
  - Half-aircraft, 4 rotors, finite span, realistic airframe



WP1 (TUD)
Management, exploitation, dissemination and communication

WP2 (UR3) Integration of design/optimization tools, experimental testing and flow/noise control

- Task 2.1 (DLR) Multi-disciplinary and multi-fidelity design and analysis
- Task 2.2 (UBRI) Design & upgrade experimental mockups for rapid design cycles
- Task 2.3 (UR3) Machine-learning and surrogate models
- Task 2.4 (UBRI) Gradient-based and evolutionary optimization
- Task 2.5 (UR3) Airworthy flow and noise control technologies

WP3 (POLITO)
Mission profile, aircraft requirements and constraints

- Task 3.1 (VAERO) Mission profile
- Task 3.2 (VAERO) Reference vehicle
- Task 3.3 (POLITO) Energy mgt & cooling
- Task 3.4 (TUD) Noise regulations
- Task 3.5 (GKN) Safety
- Task 3.6 (GKN) Certification

WP4 (DLR)
Multi-fidelity hybrid optimization of low-noise and efficient aircraft

- Task 4.1 (DLR) Isolated rotor with clean inflow conditions
- Task 4.2 (VKI) Rotor-rotor potential and viscous interferences
- Task 4.3 (UBRI) Rotor-airframe potential and viscous interferences
- Task 4.4 (TUD) Propeller-atmosphere interferences
- Task 4.5 (UR3) Active and passive flow / noise control

WP5 (TUD)
Aircraft performance and noise impact analysis

- Task 5.1 (POLITO) Mission fulfilment & compliance with the design constraints
- Task 5.2 (UR3) Safe and quiet trajectories and maneuvers
- Task 5.3 (TUD) Near-field noise prediction
- Task 5.4 (TUD) Urban noise footprint and certification
- Task 5.5 (DLR) Sound quality and psycho-acoustic annoyance

WP6 (UBRI)
Experimental testing, training databases and cross-validation

- Task 6.1 (VKI) Single rotor, rotor-rotor and rotor-airframe interferences without flight effects
- Task 6.2 (UBRI) Single rotor and tandem rotors - airframe interferences with flight effects
- Task 6.3 (TUD) Full aircraft interferences with flight effects

WP7 (VKI)
Data management, digital twin, guidelines and roadmap

- Task 7.1 (VKI) Databases management
- Task 7.2 (UR3) Digital twin
- Task 7.3 (TUD) Final conclusions and guidelines
- Task 7.4 (VAERO) TRL assessment and RTD roadmap

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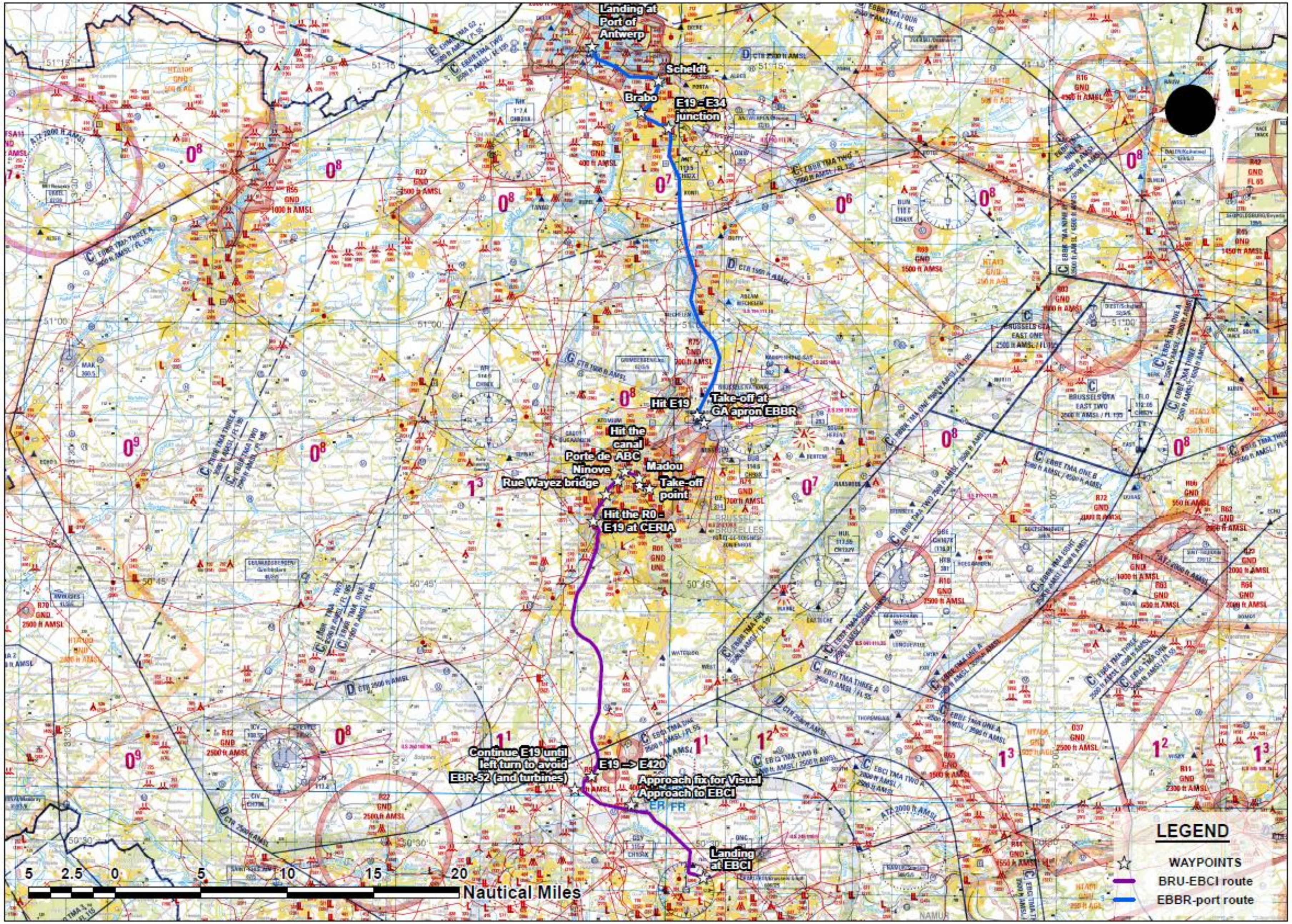

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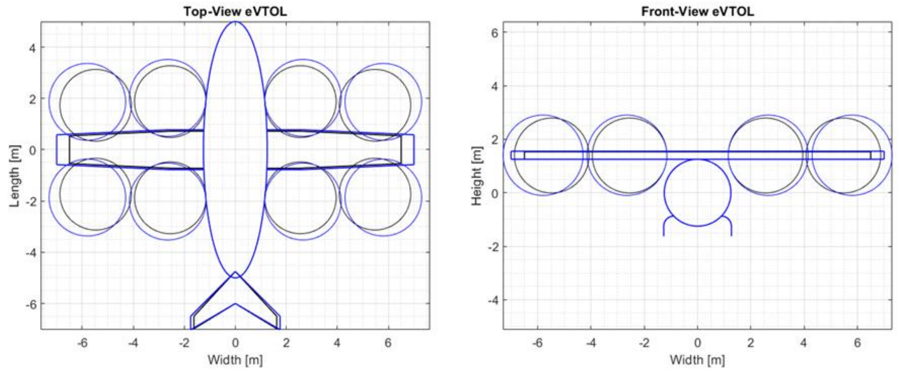

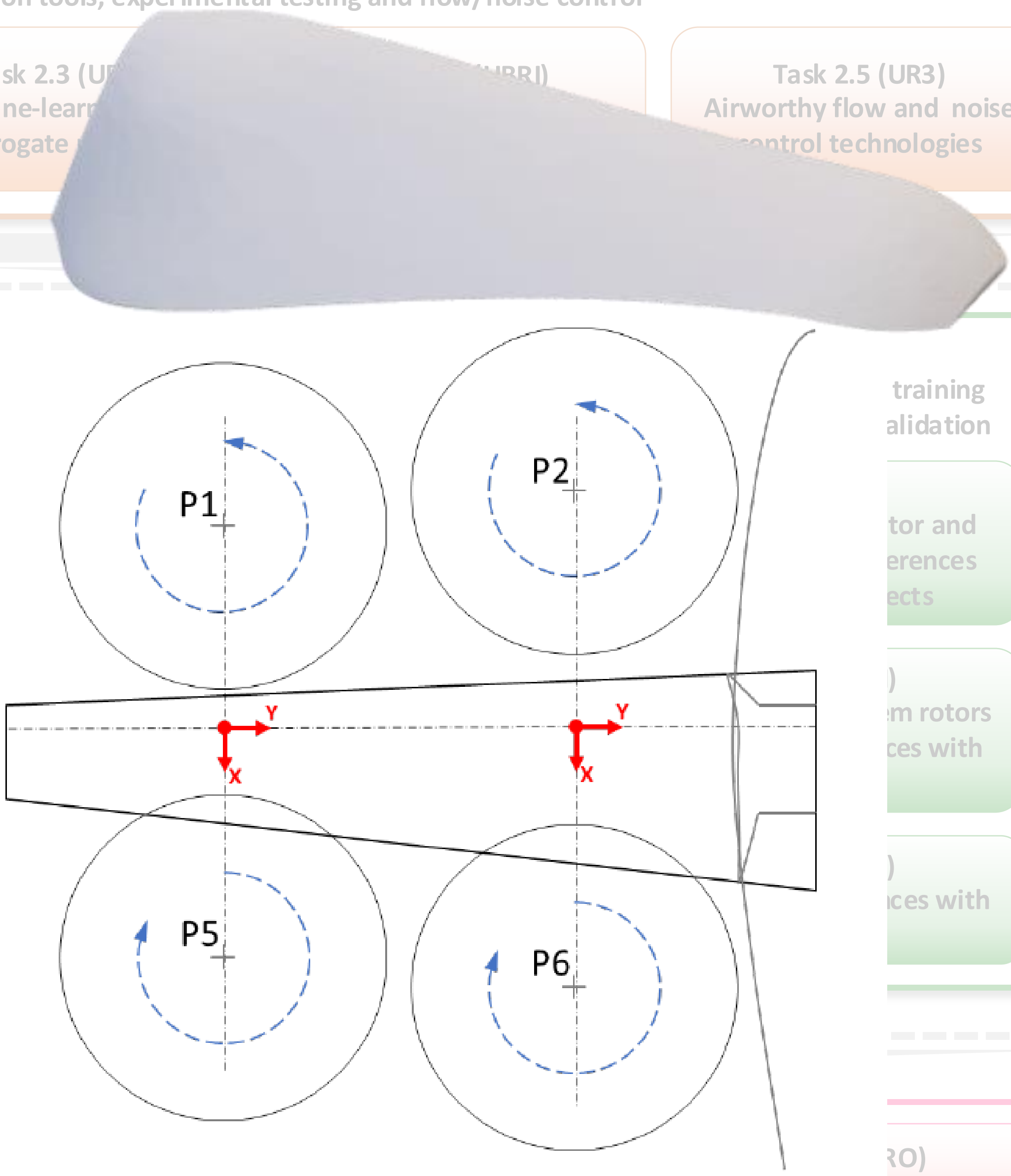

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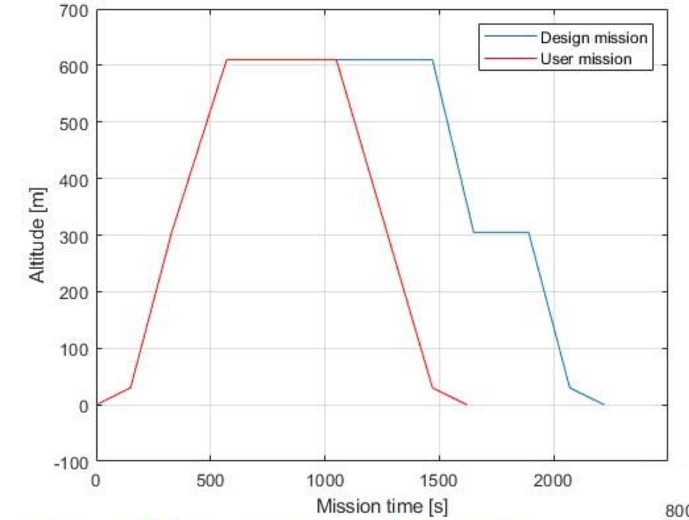

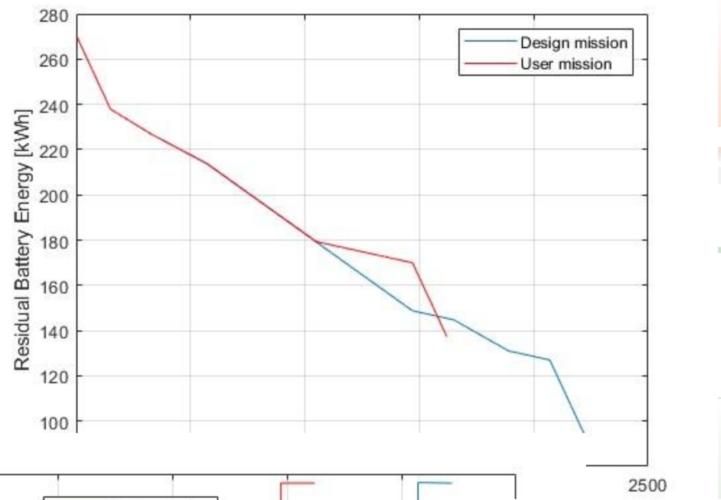

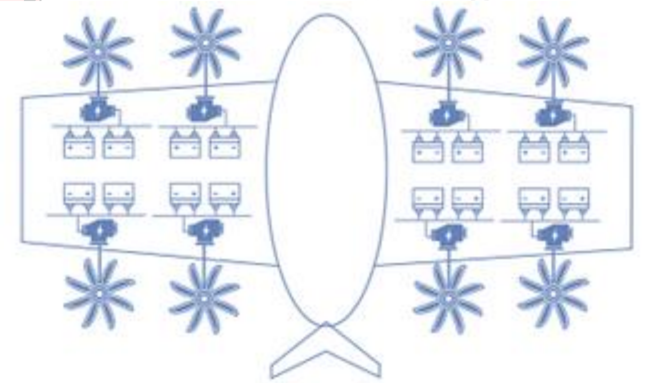

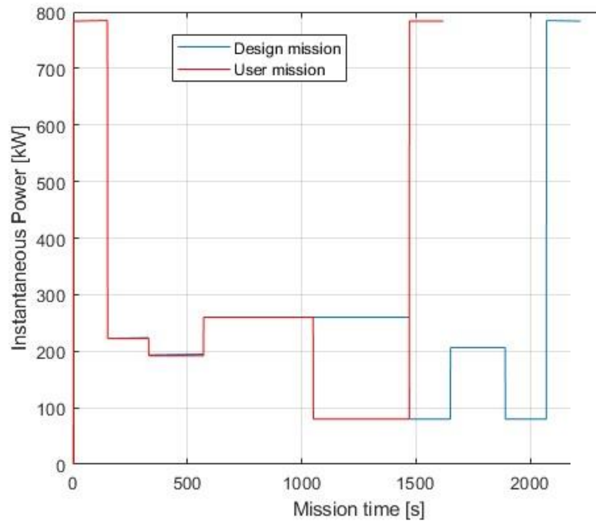

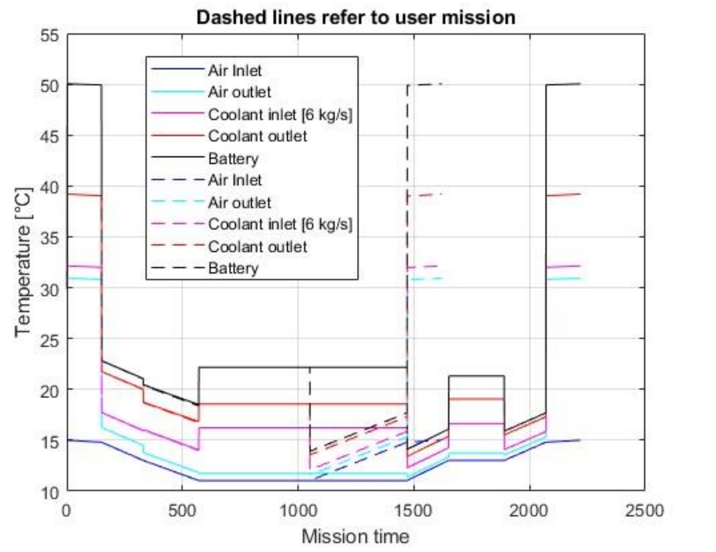

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Questions?

Enjoy your Workshop!