Optimum Vehicle Selection for Multi-Point Missions

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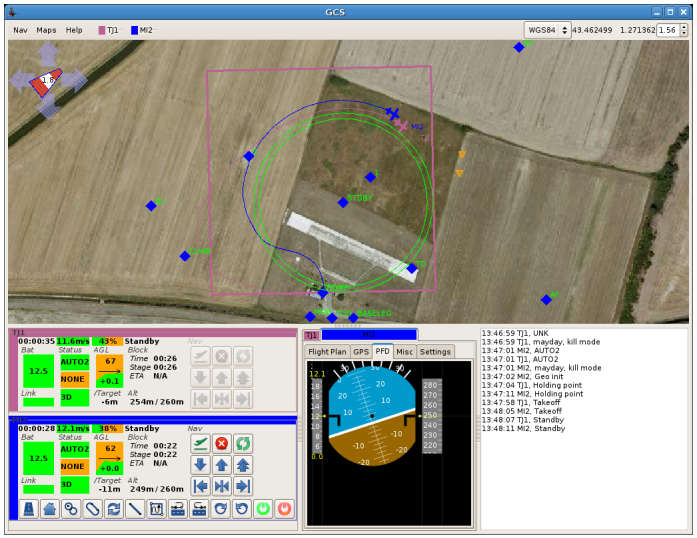
ENAC PAPARAZZI UAV LAB

- Open-Source Software and Hardware
- Widely used around the world (≈ 500 users)
- Mostly dedicated to research missions

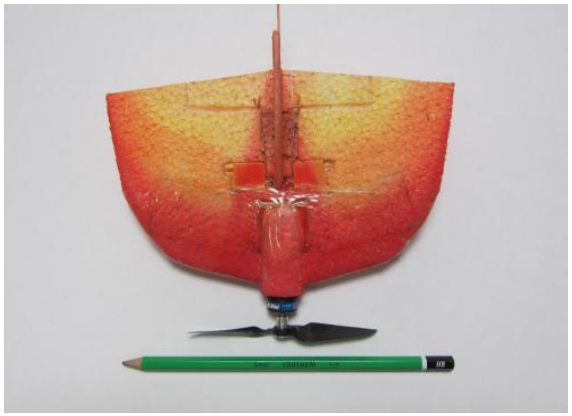
PAPARAZZI APOGEE
Autopilot Board V1.0

Ground Control Station



VEHICLE DESIGN AT ENAC UAV LAB

QUARK



- ENAC
- 18 *cm*
- +20 *min* of flight

SOLAR-STORM

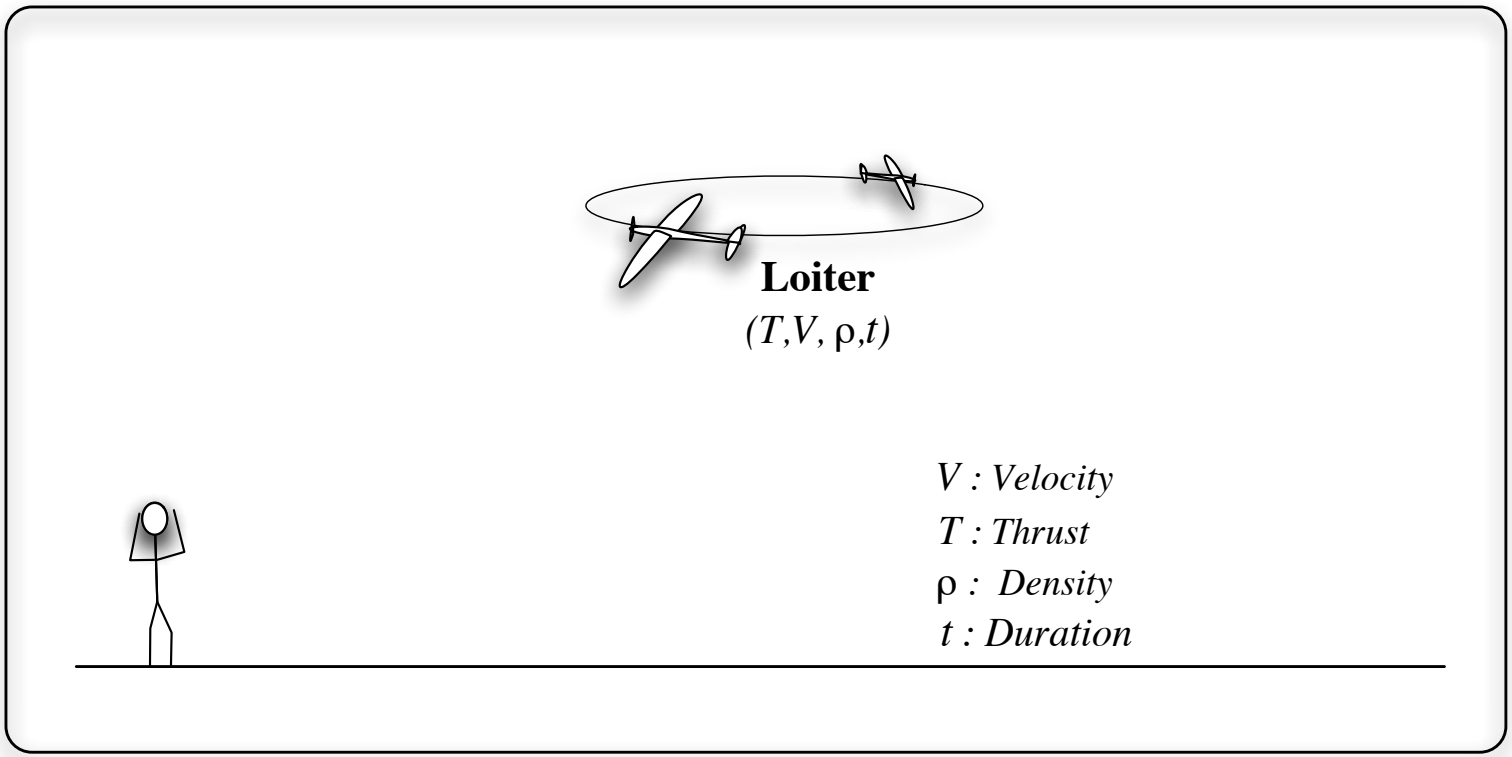
- ENAC-ISAE
- 50 *cm*
- +100 *min* of flight

ETERNITY

- ENAC-ISAE
- 100 *cm*
- +4 *h* of flight

Mostly consantrated on *Low Fidelity Methods* for *Low Reynolds Aerodynamics* calculations for conceptual design.

OPTIMISATION



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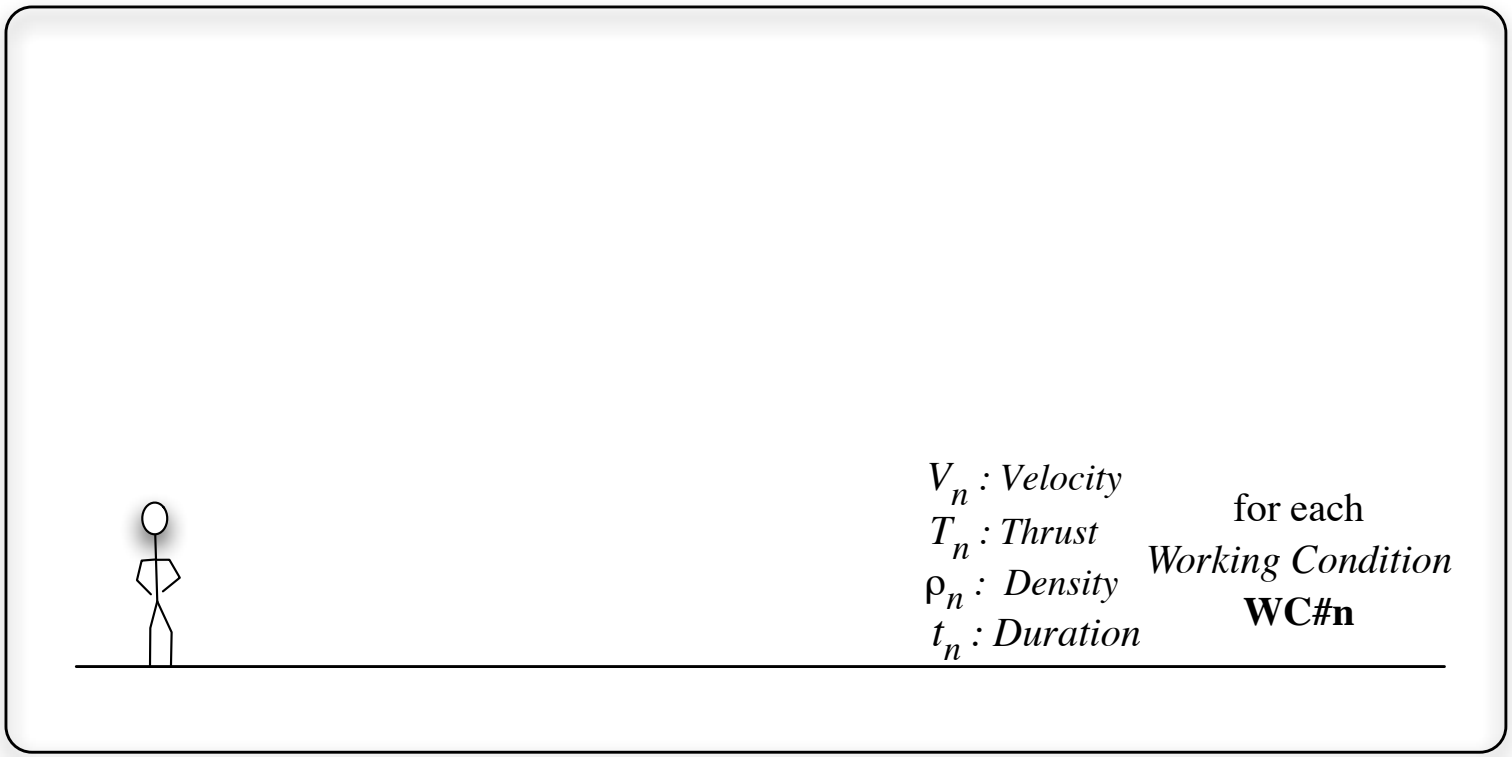

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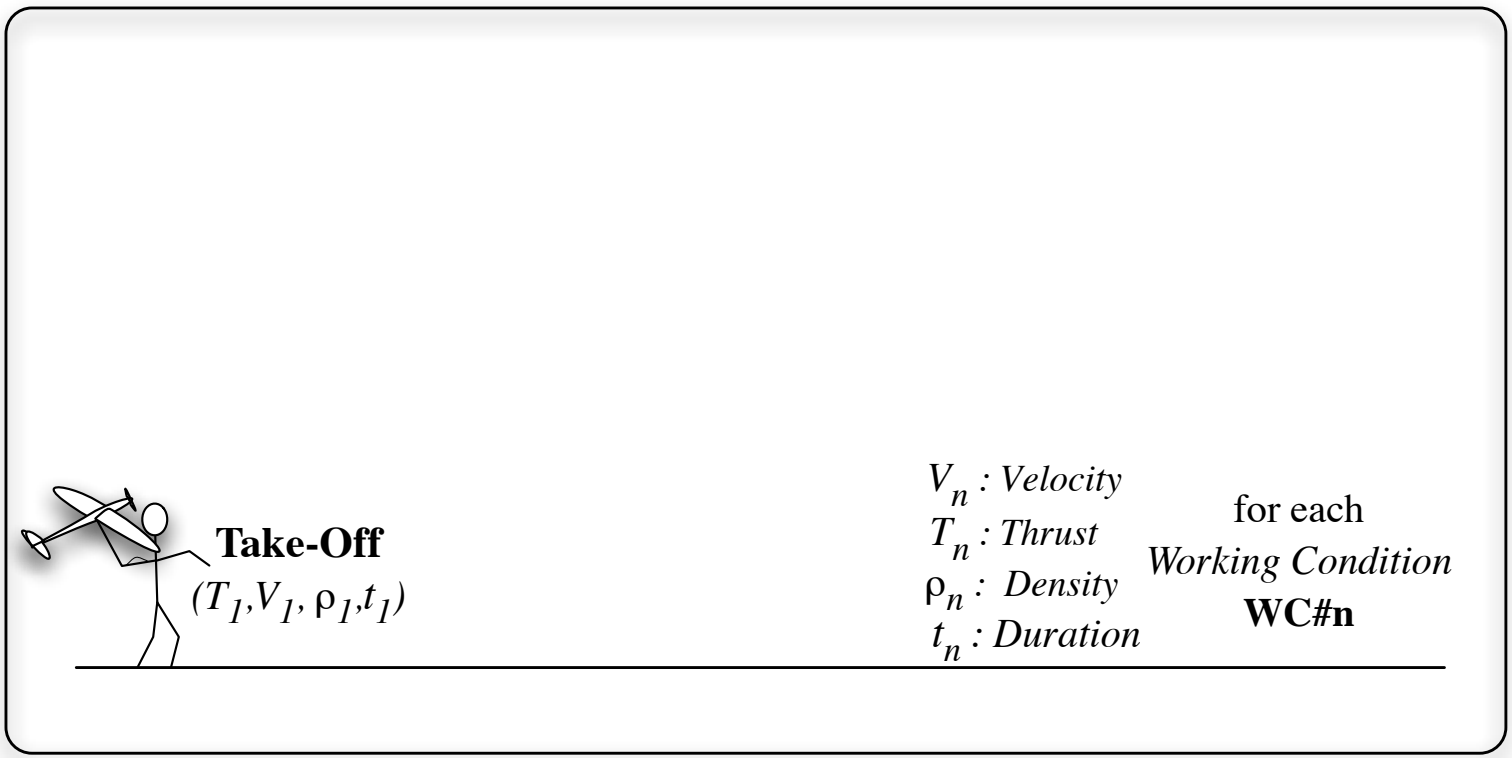

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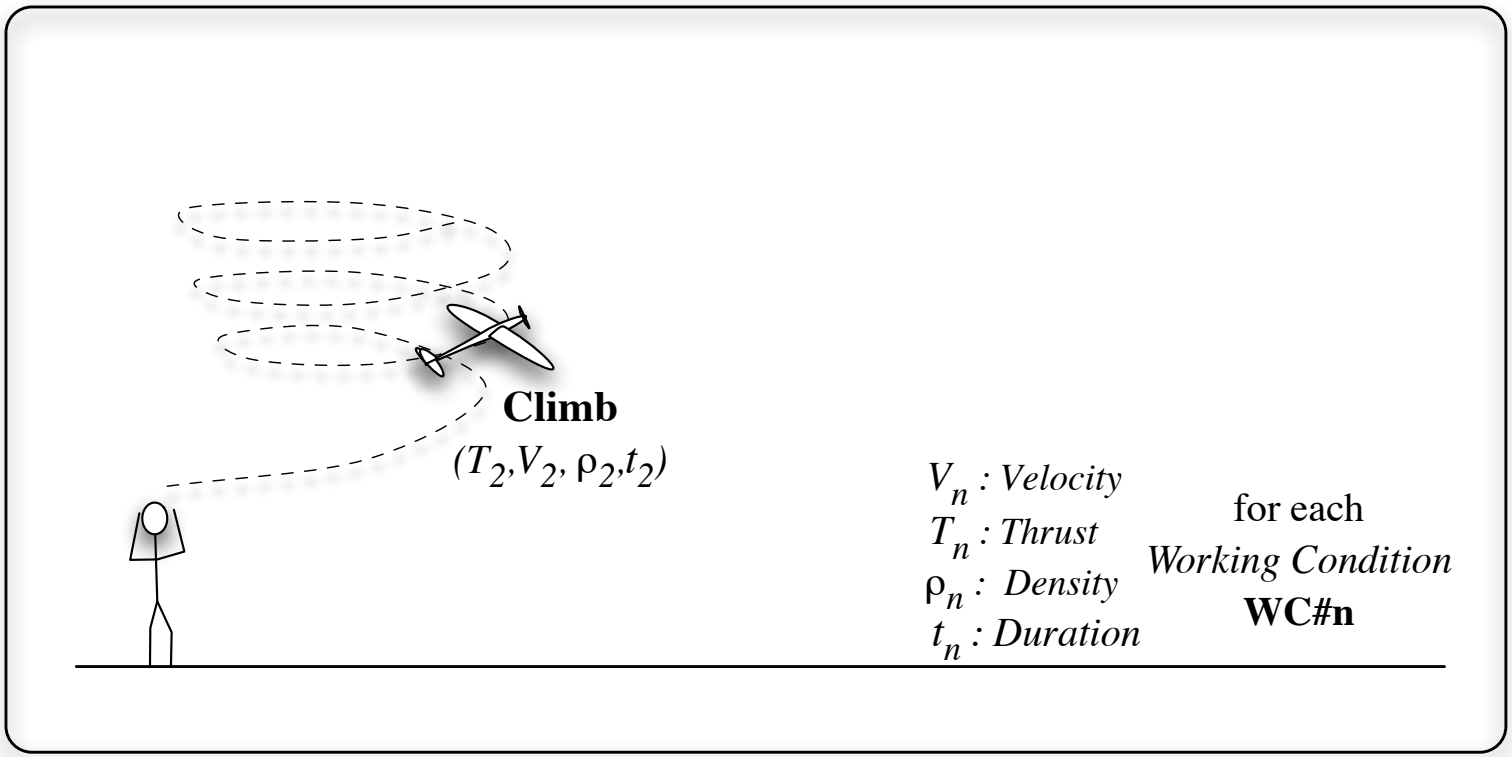

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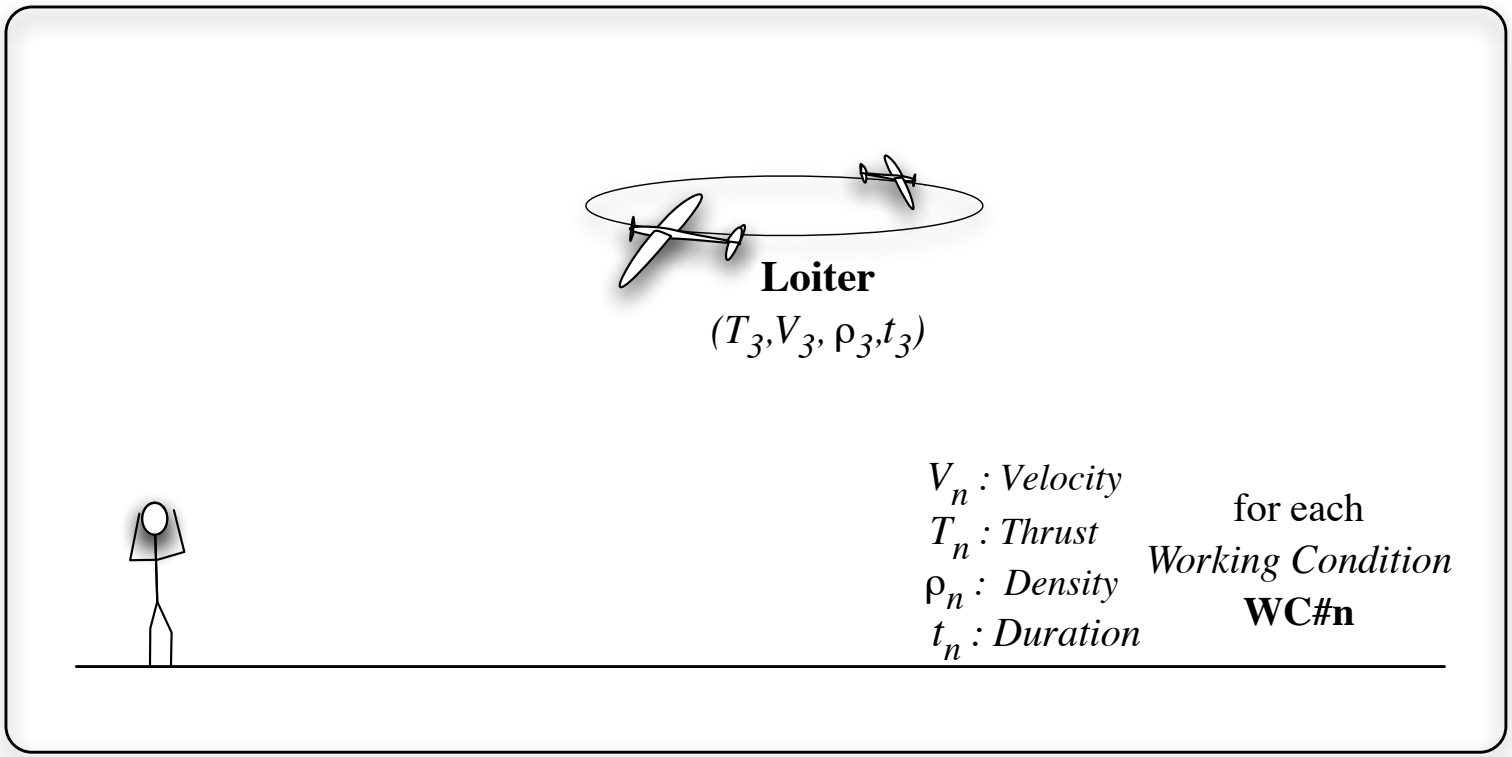

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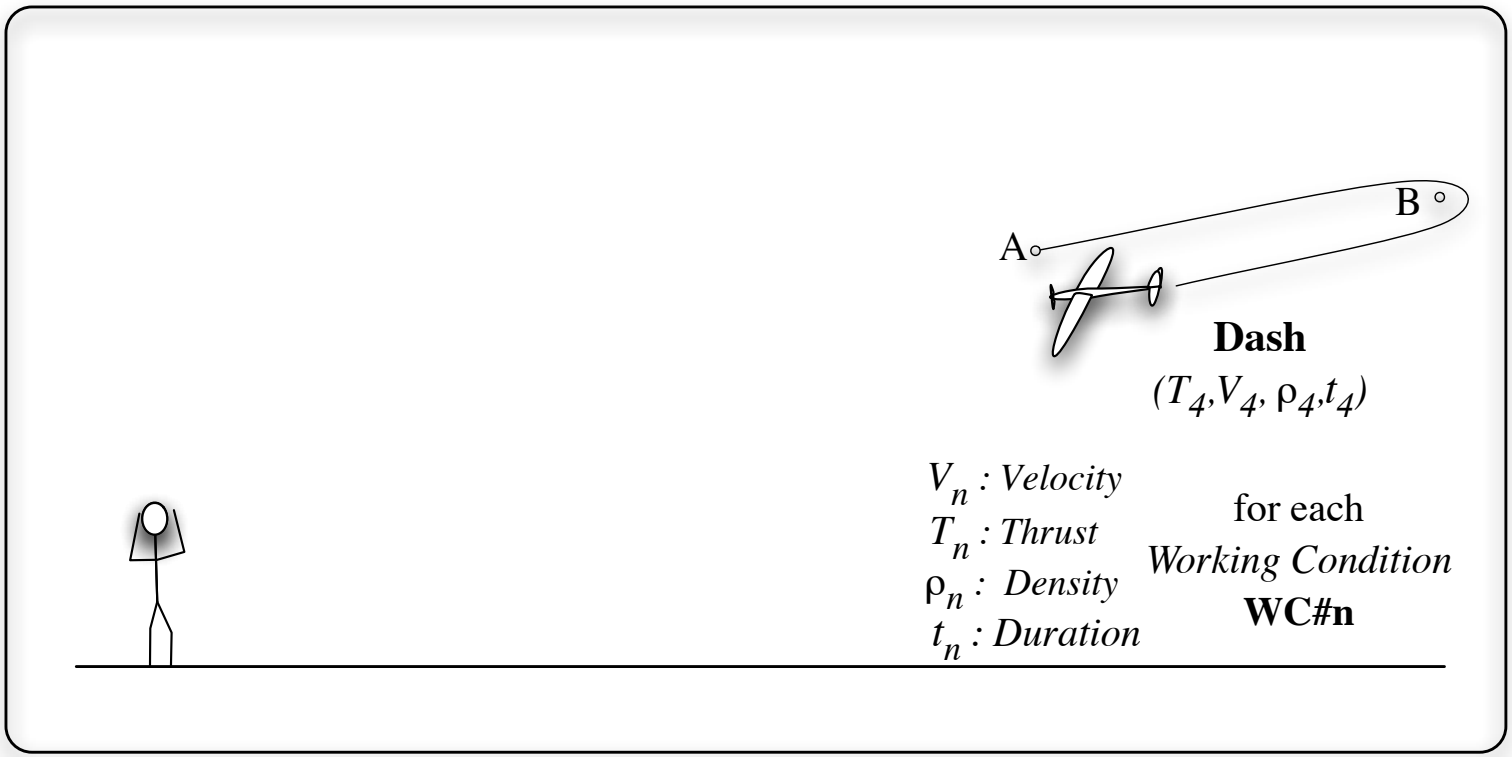

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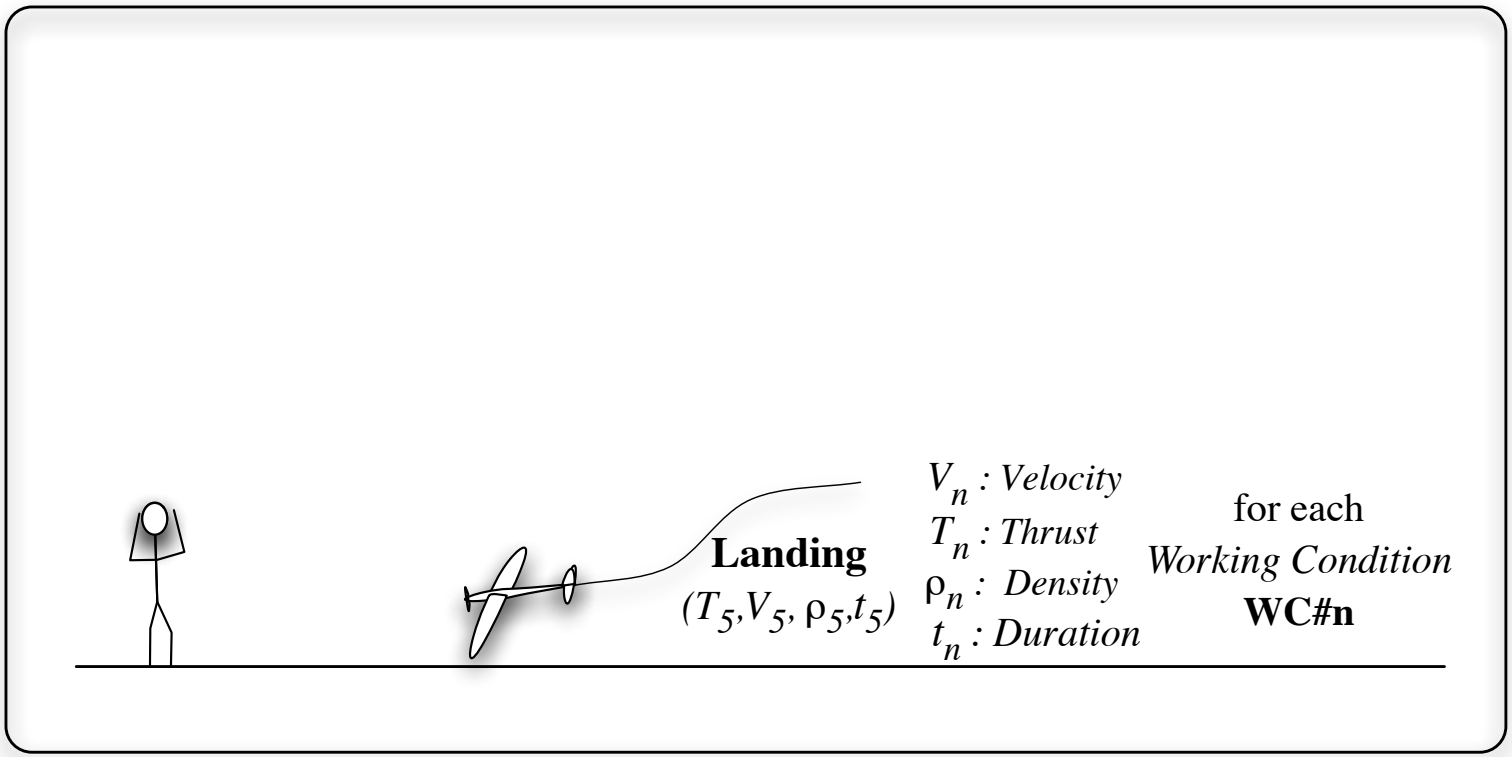

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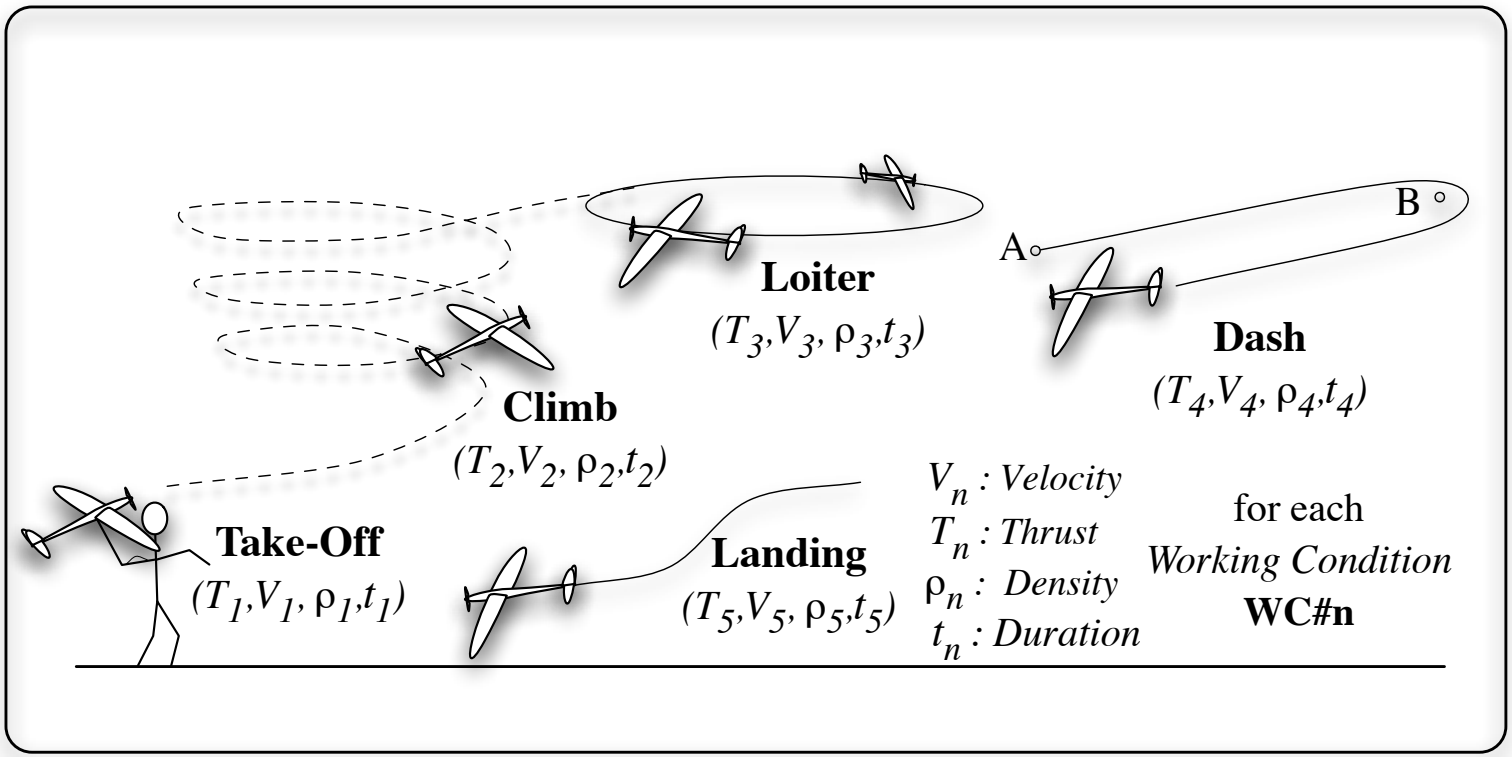
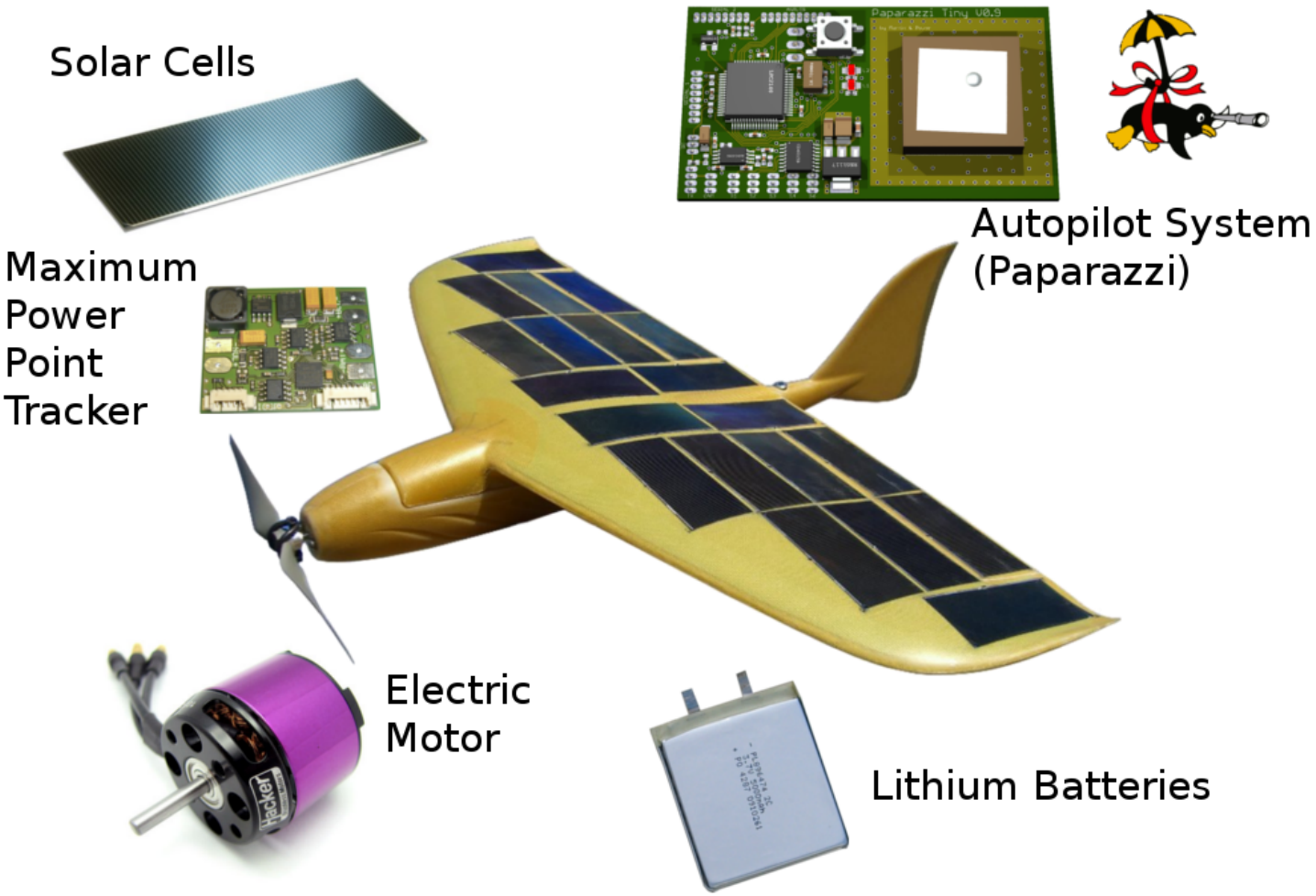


MULTIDISCIPLINARY DESIGN PROBLEM



CONCEPTUAL DESIGN PROGRAM (CDSGN)

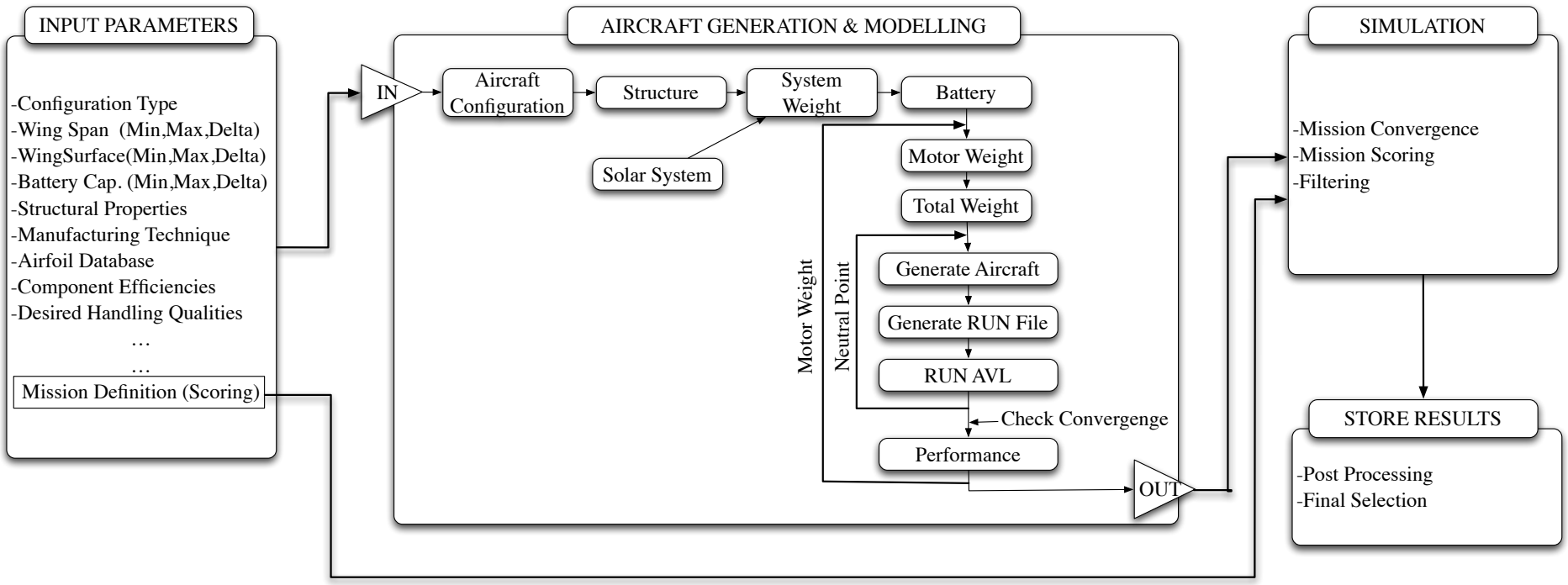
Cdsgn

Main objective of **Cdsgn** program is to calculate the aerodynamic characteristics of a configuration in an accurate and fast way to compare with different configurations.

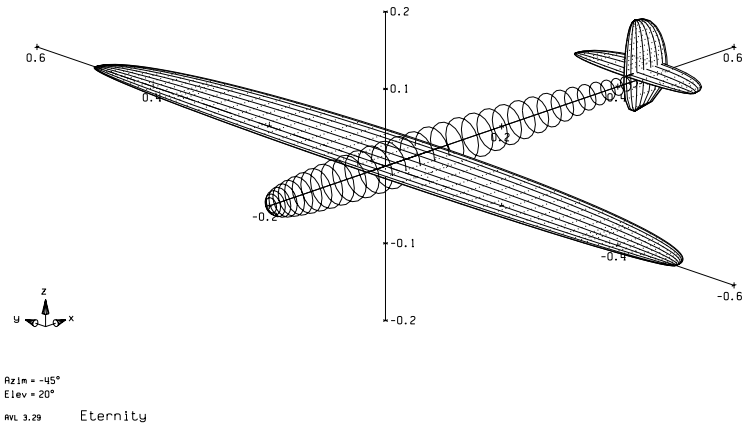
Creates GENERIC aircraft configurations by :

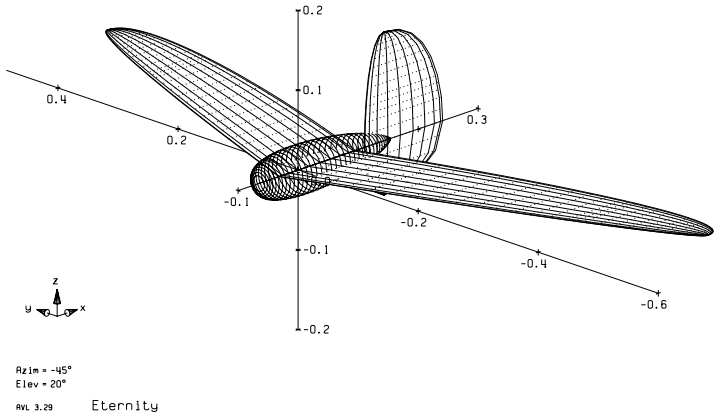
- Wing span dimension
- Reference surface area
- Reference coefficients and constants

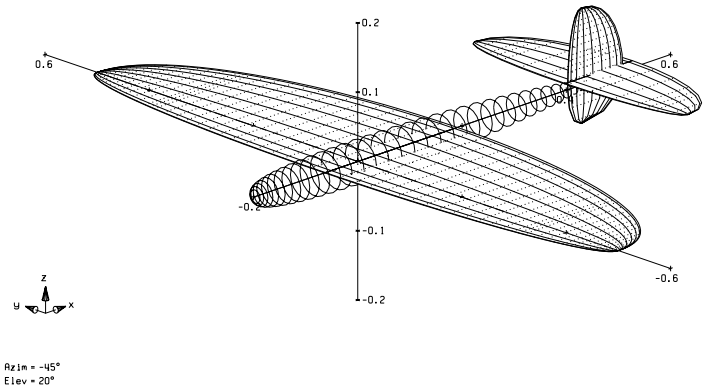
CDSGN FLOW CHART

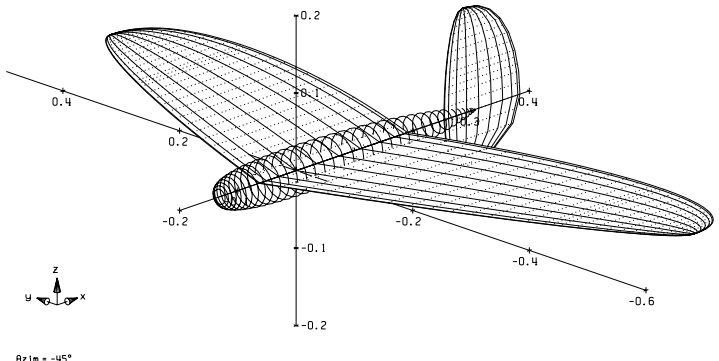


AUTO-GENERATED AIRCRAFT EXAMPLES









PARTICULARITIES OF CDSGN

- Two aircraft configurations
- Structure model calibrated for MAVs
- Computationally fast aero-analyses with Reynolds number effects taken into account
- Trim analysis
- Stall detection (Airfoil $C_{l_{max}}$)
- Same longitudinal stability (via Static margin)

EXTERNAL PROGRAMS

XFOIL[1] is a design and analysis program for subsonic isolated airfoils.

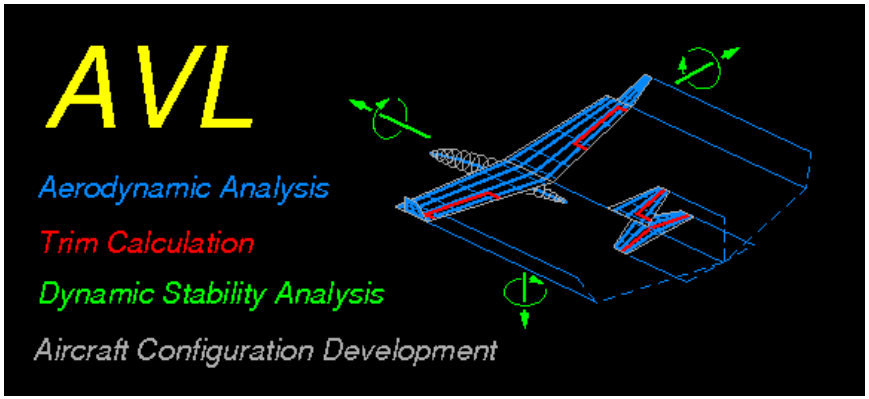
- Linear-vorticity stream-function panel method for the inviscid formulation
- The boundary layers and the wake are described with a two-equation lagged dissipation integral boundary layer formulation

[1] Mark Drela. An analysis and design system for low reynolds number airfoils. In University of Notre Dame, editor, *Conference on Low Reynolds Number Airfoil Aerodynamics*, June 1989.

EXTERNAL PROGRAMS

AVL[1] is an open source program for the aerodynamic and flight-dynamic analysis of rigid aircraft.

- Aerodynamic Analyses, with Vortex-Lattice Method
- Trim Calculations
- Predicts flight stability characteristics



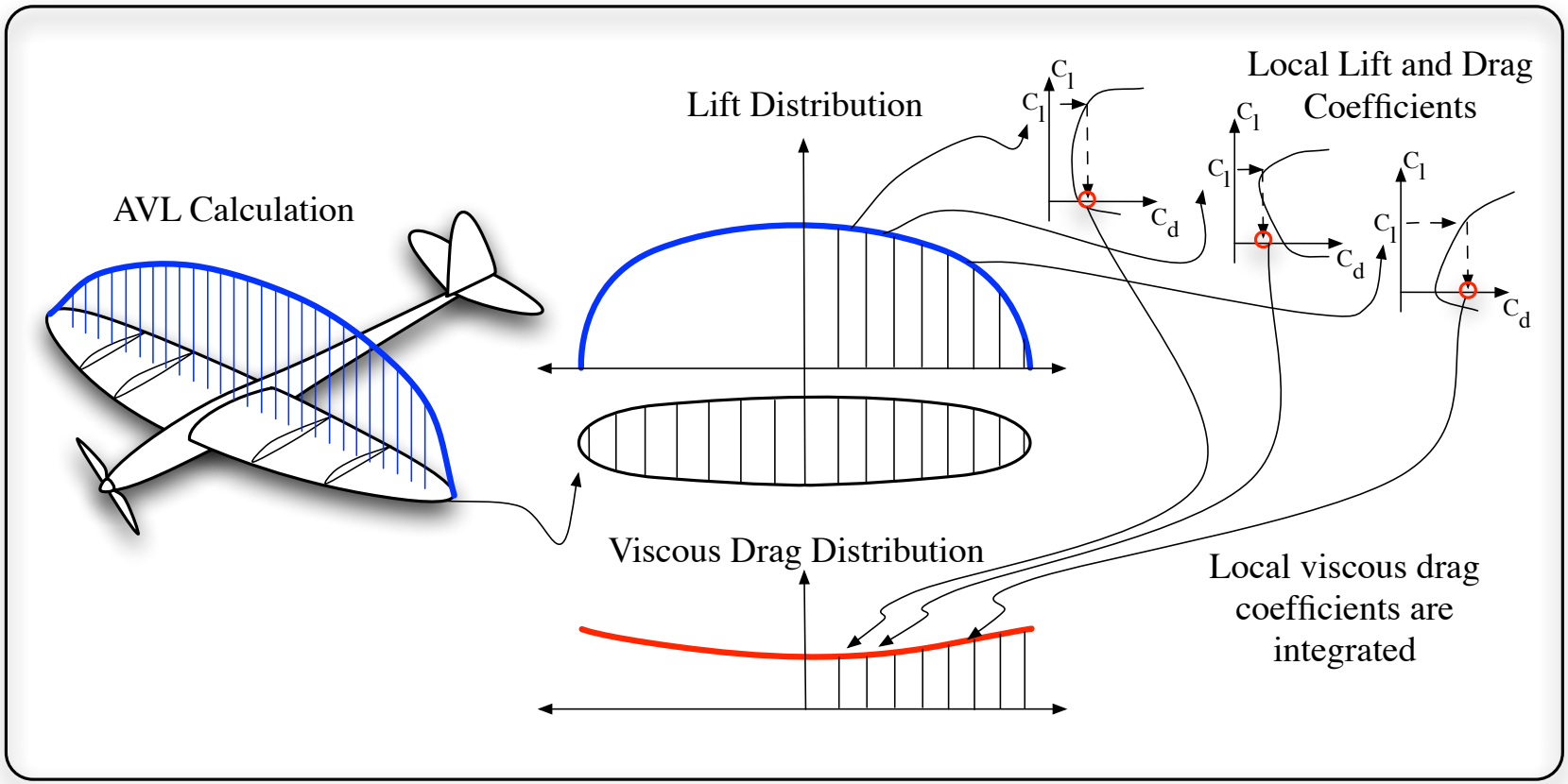
[1] *http : //web.mit.edu/drela/Public/web/avl*

REQUIRED MODIFICATIONS TO AVL

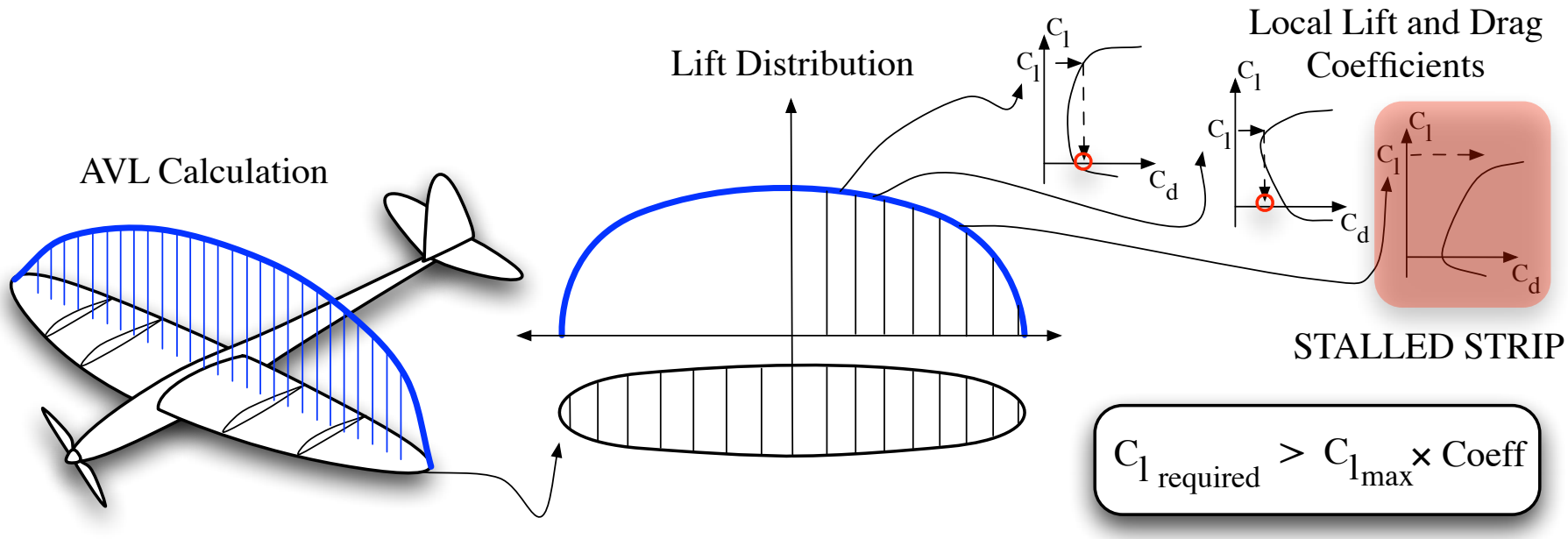
- Viscous drag addition for the lifting surfaces (via Xfoil)
- Stall information
- Fuselage viscous drag
- Verification and calibration of the modifications

VISCOUS DRAG IMPLEMENTATION

- Lift distribution obtained from AVL
- Corresponding local drag coefficients from polars
- Airfoil polar database generated by Xfoil for each Reynolds

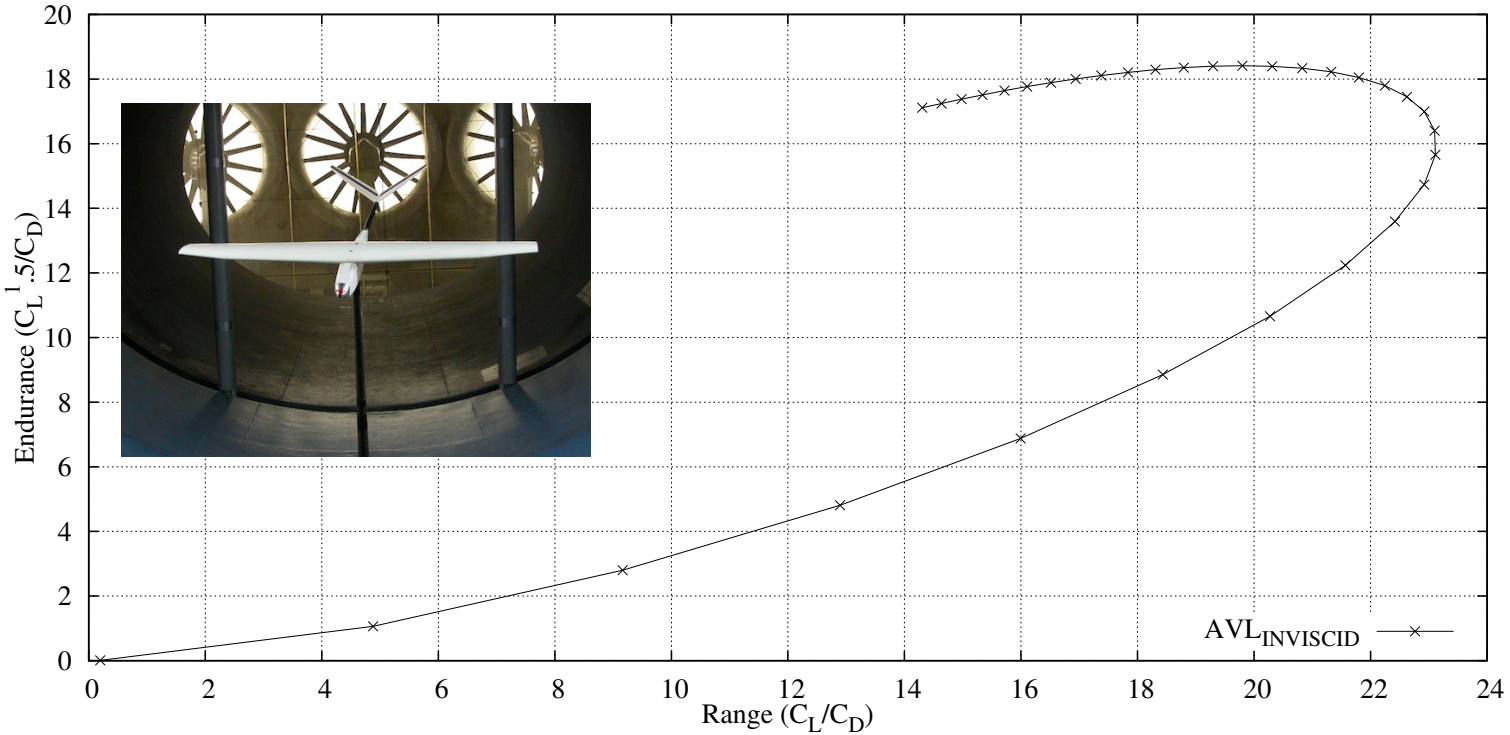


STALL DETECTION



REPRESENTATION OF VISCOUS EFFECTS

Comparison of wind tunnel measurements with modified and original AVL program



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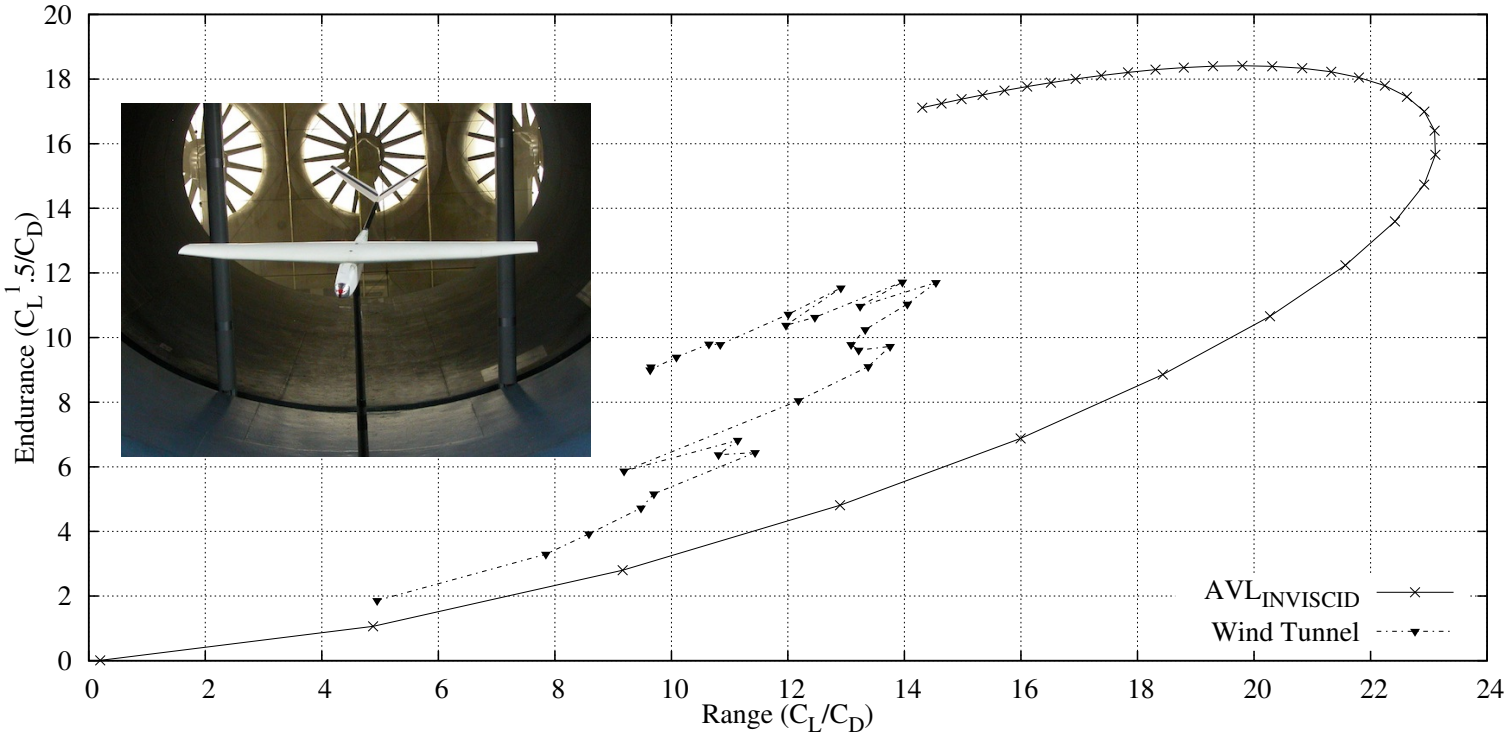

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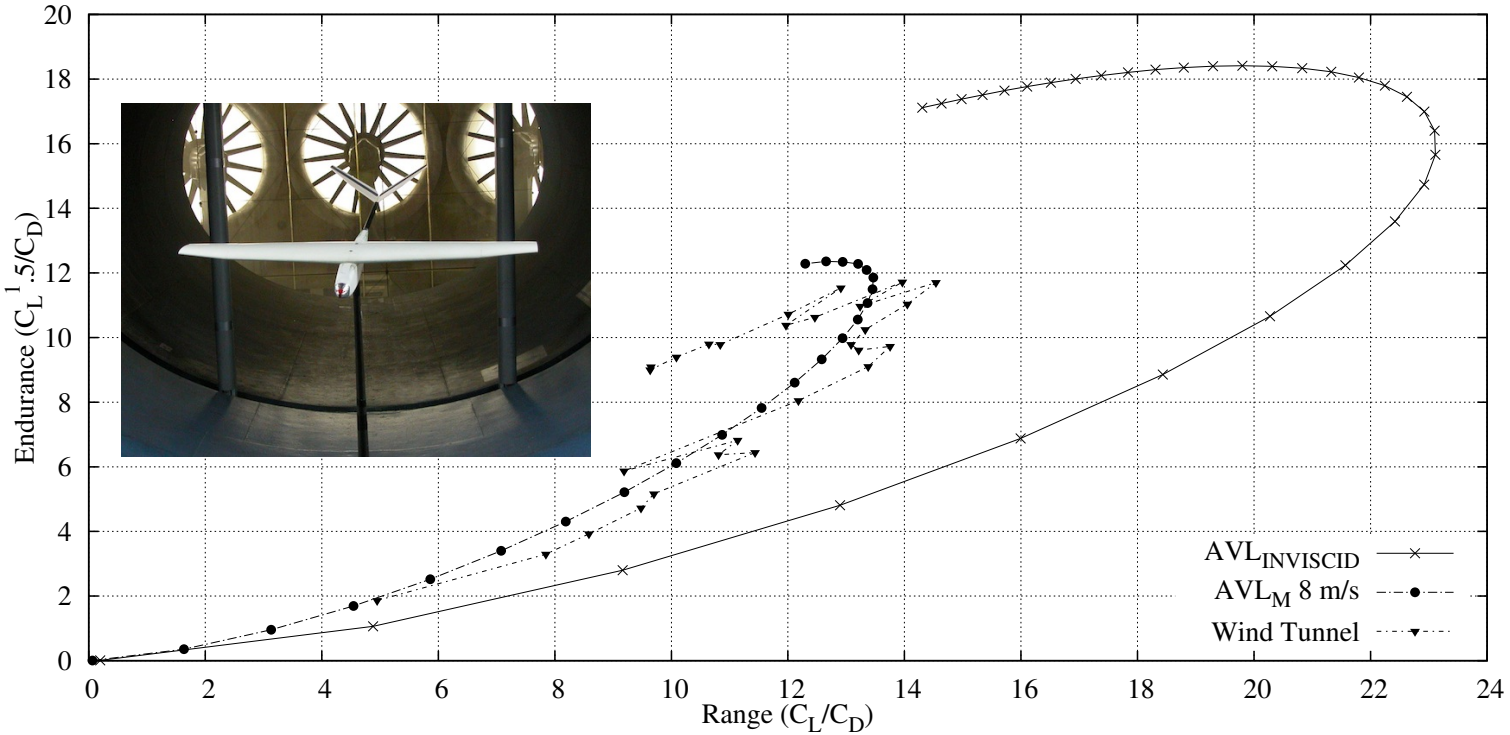

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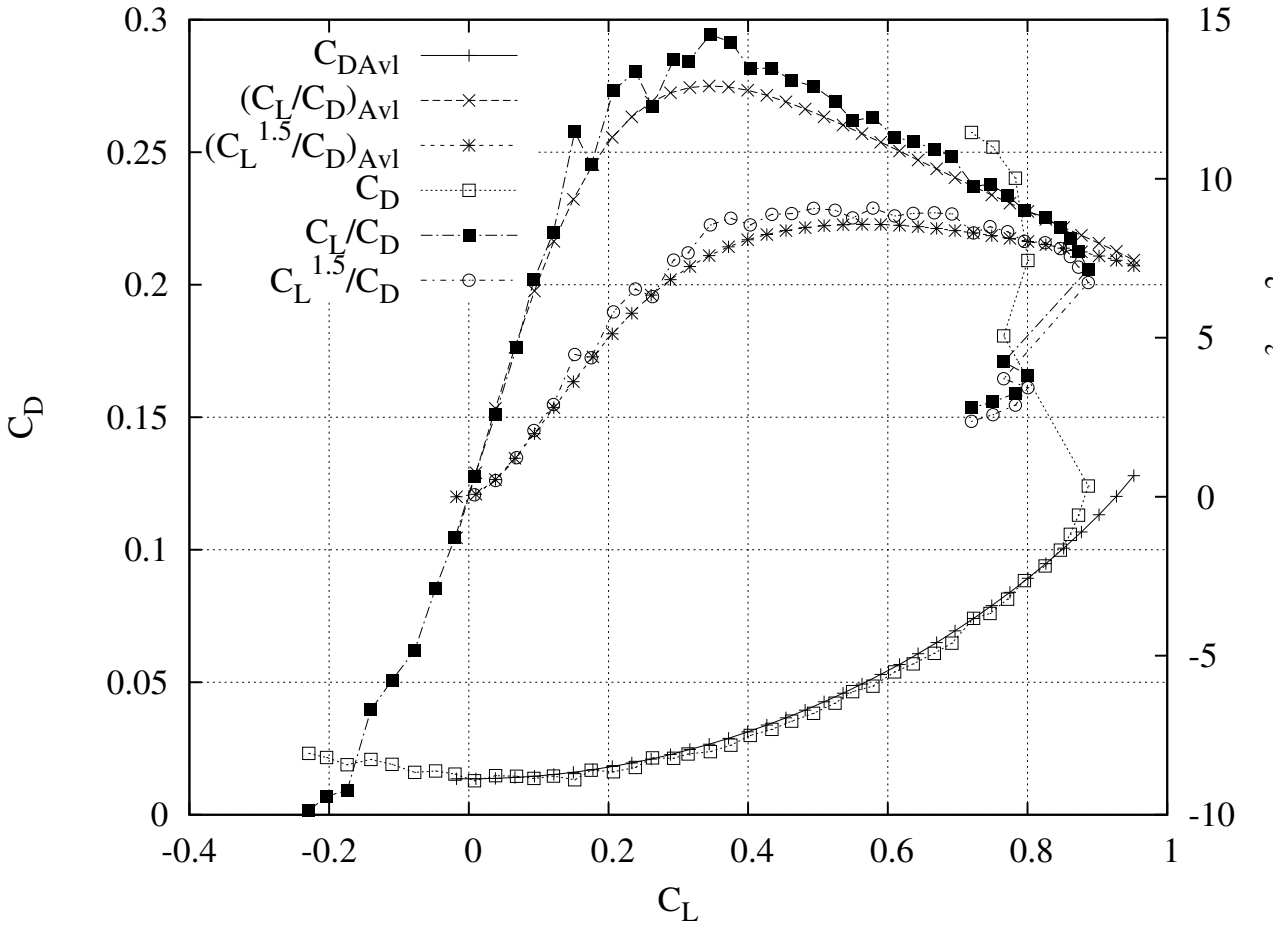
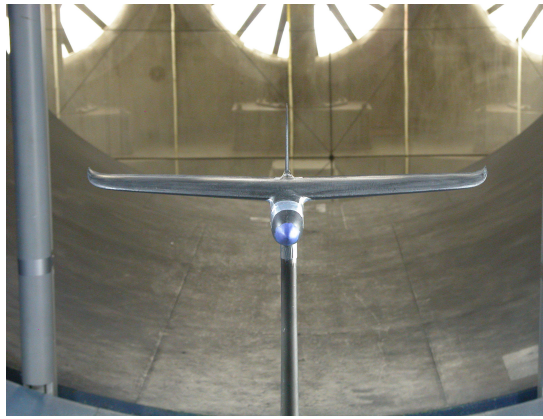
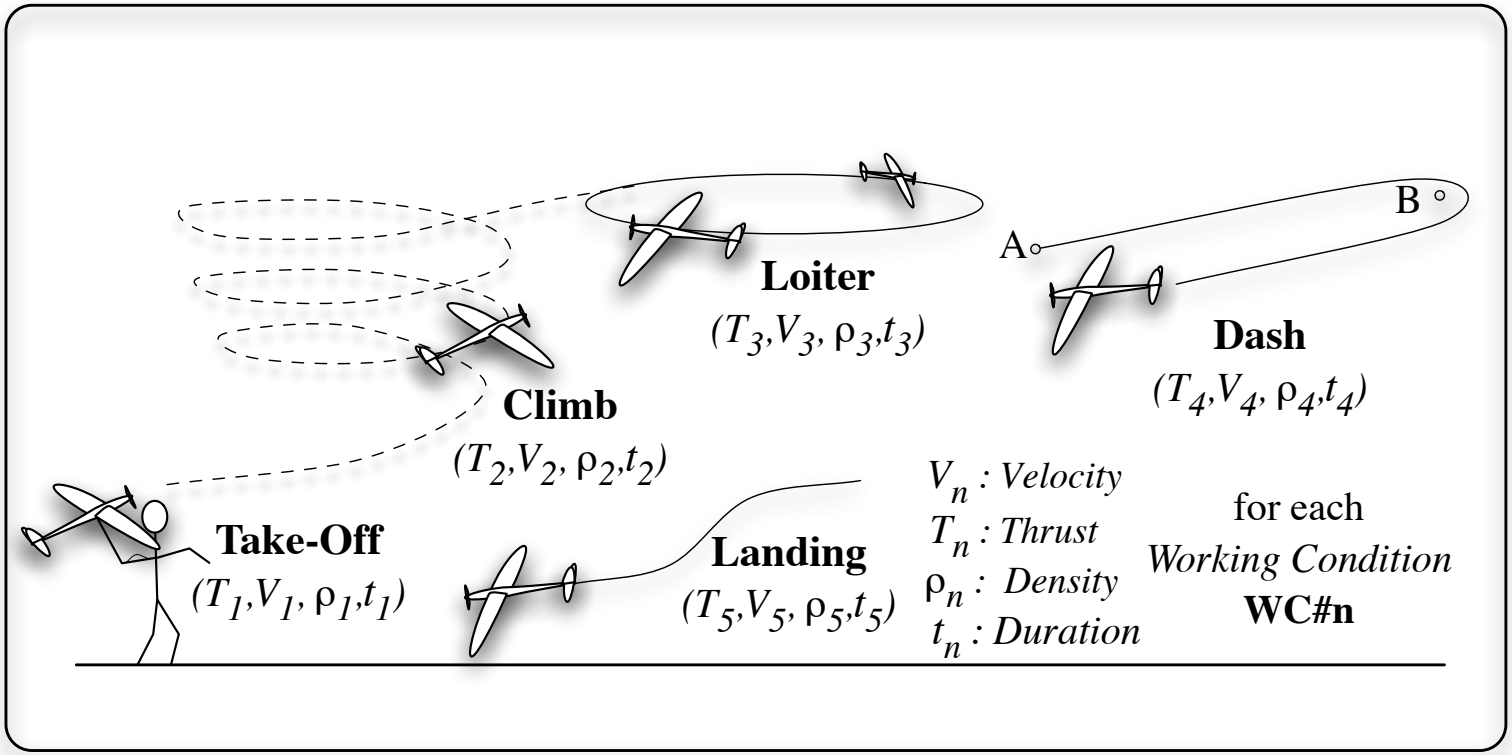


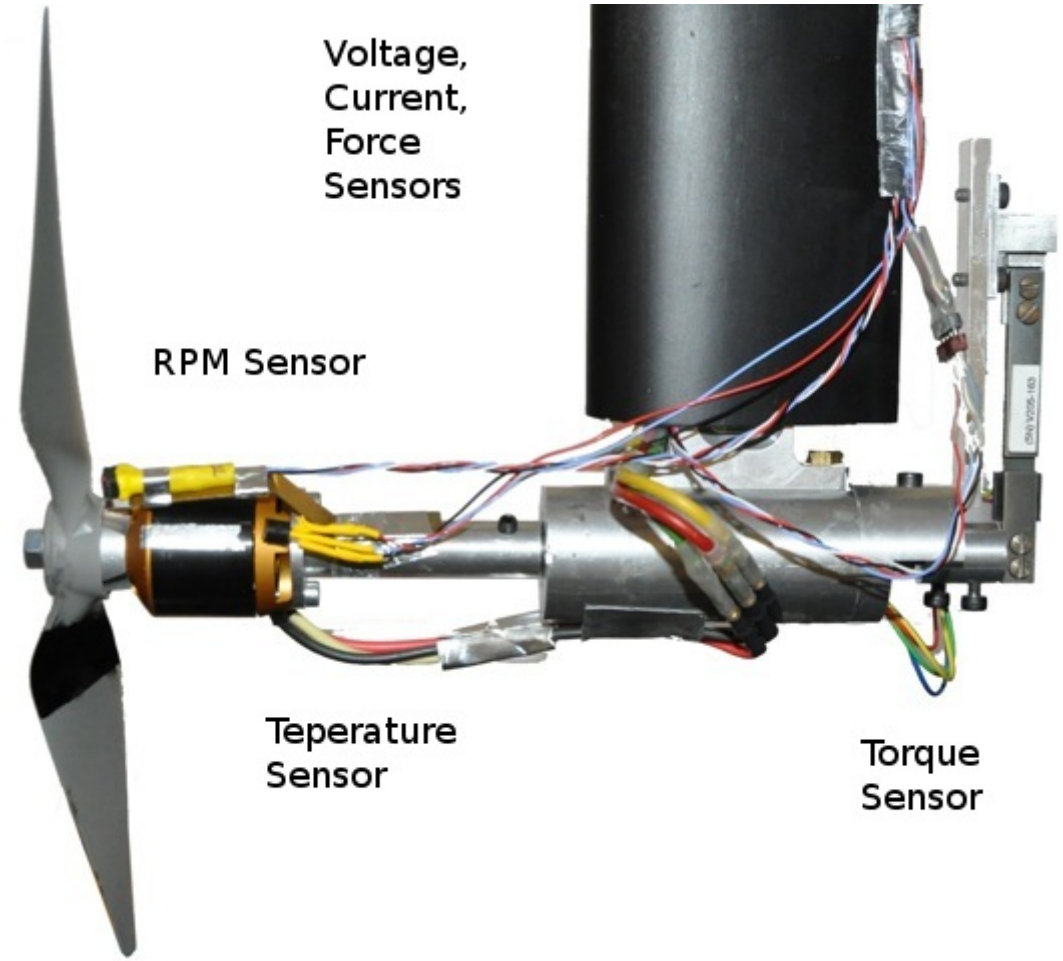


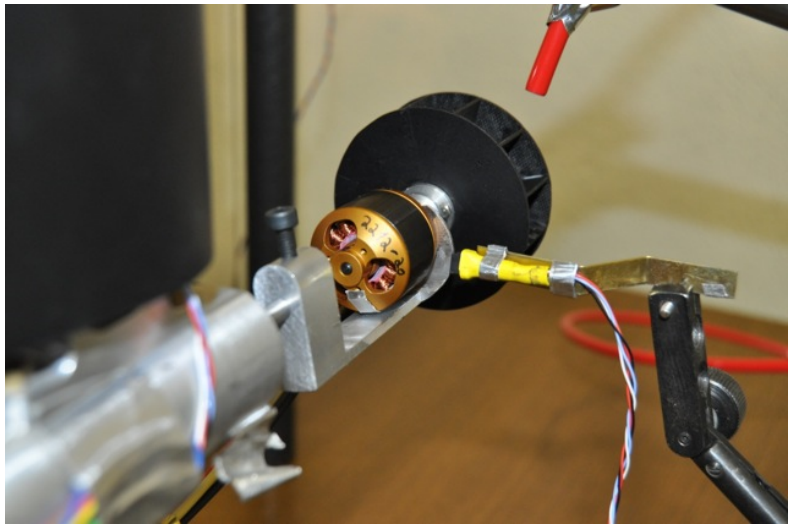
PROPULSION SYSTEM OPTIMIZATION

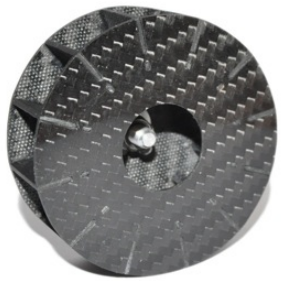
Starts with the *MISSION DEFINITION*



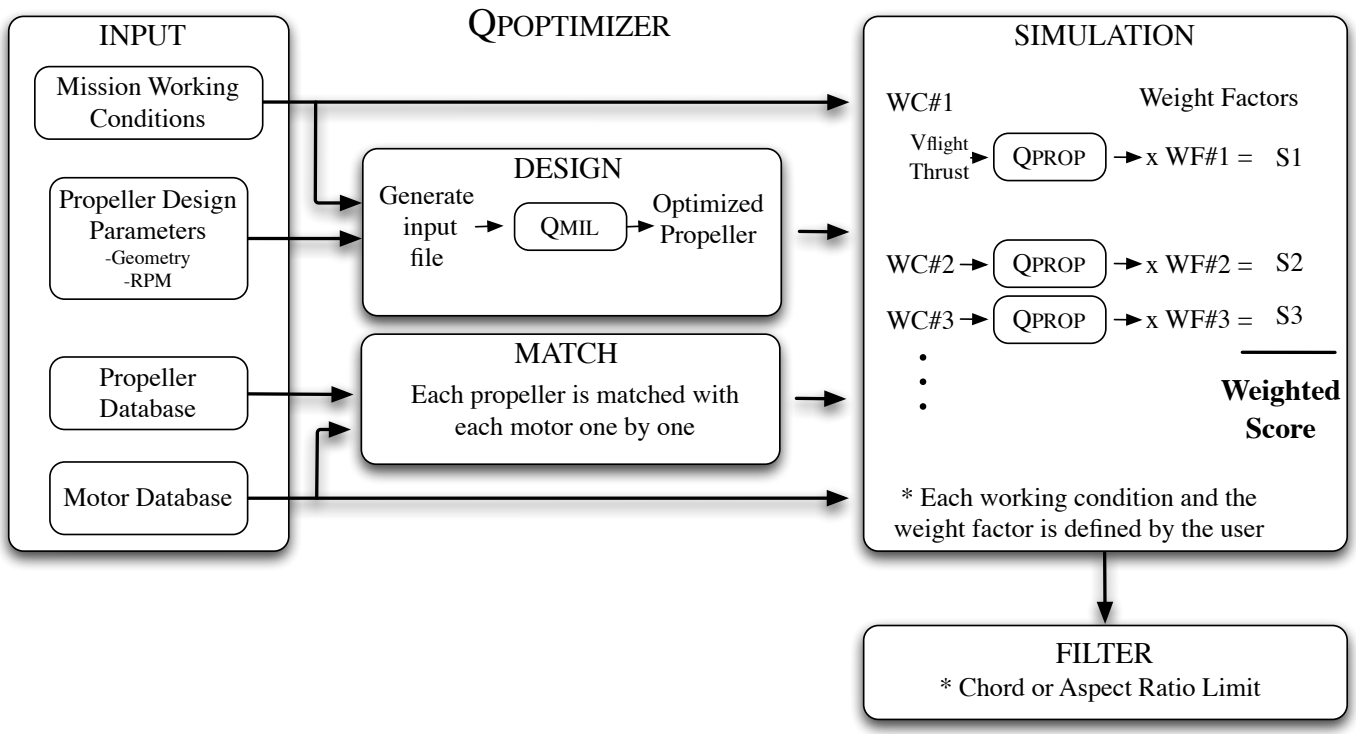
EXPERIMENTAL MOTOR AND PROPELLER DATABASE

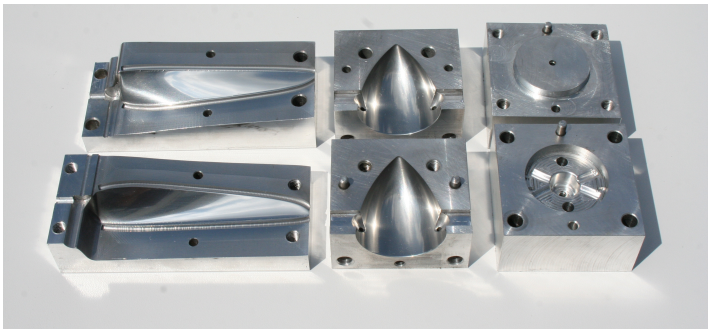






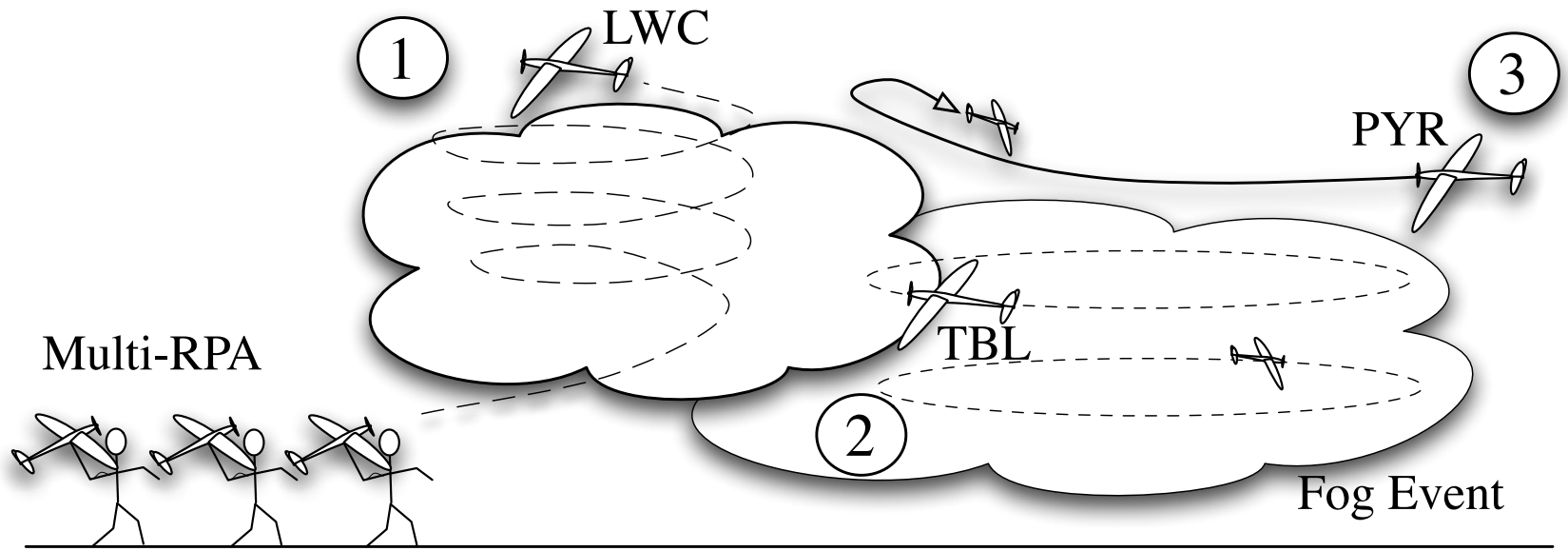
OPTIMIZATION TOOL QPOPTIMIZER





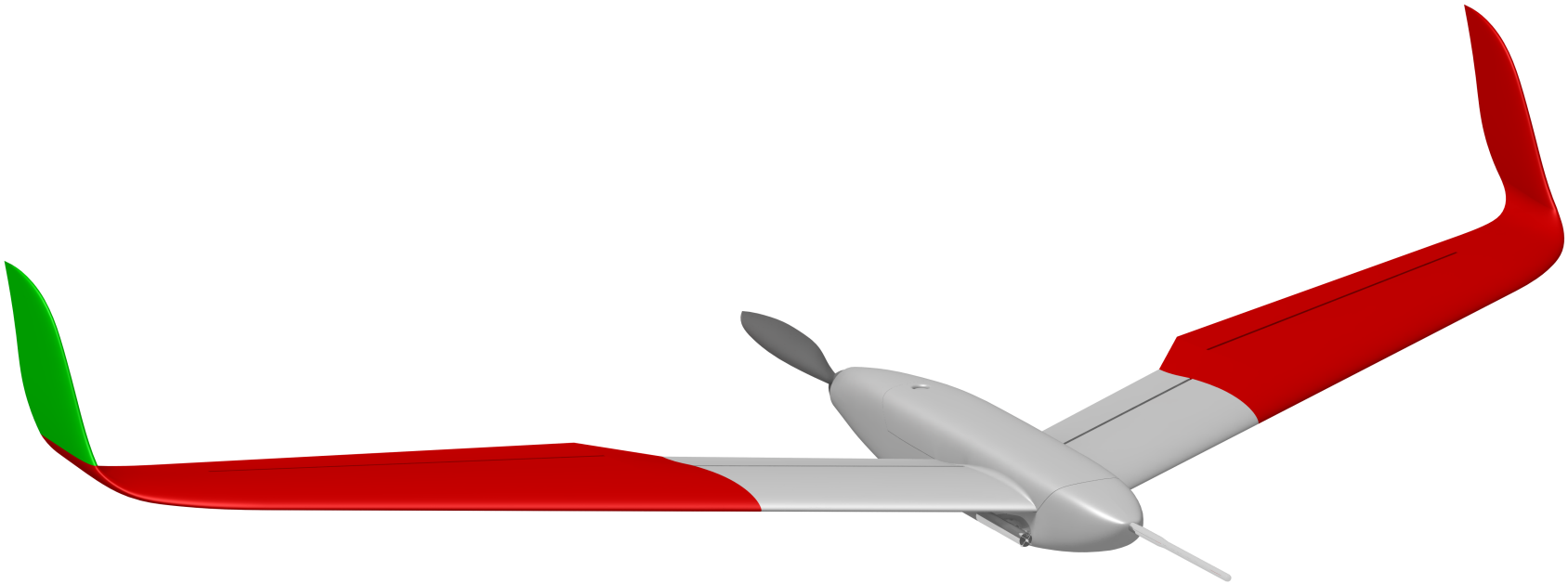
VOLTIGE PROJECT

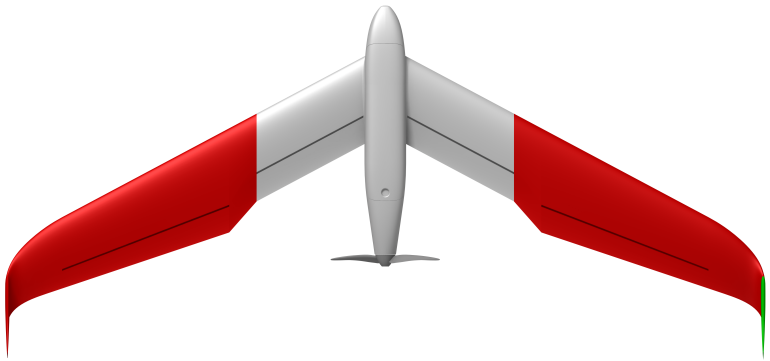
VOLTIGE Project between ENAC and Meteo-France on simultaneous observations of the planetary boundary layer, surface radiation and cloud micro-physical properties.

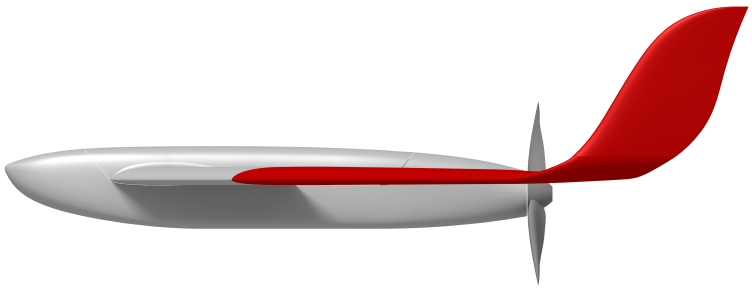


Good opportunity to use aero-mechanical skills to design a new plane dedicated to the specific requirements of the project

FINAL SHAPE "FENIX"







PROTOTYPES BUILD

FINAL MOLDED VERSION

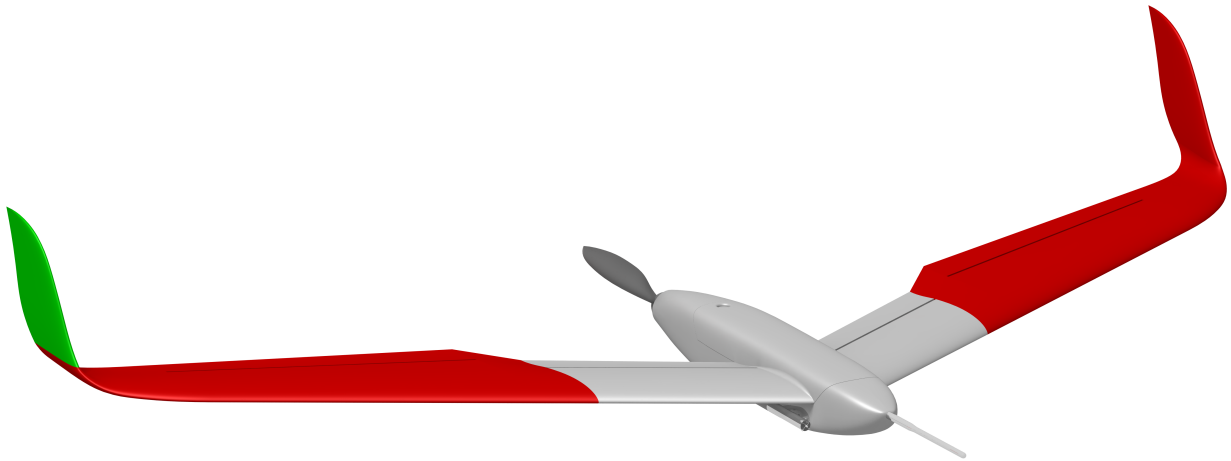
CONCLUSION

The "*magic*" is in the selection of the design parameters in a synergistic way so as to reach a greater final effect then the sum of each individual part.

Mainly;

- For a new design, wing span, wing surface area, airfoil and the battery capacity can be selected optimally
- For an existing aircraft, the flight speed and the battery capacity can be selected optimally

in order to reach the highest performance.



Thank you very much for your attention

Contact and Links

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