Aircraft Design Project
Urban Air Mobility (UAM)

Week 4

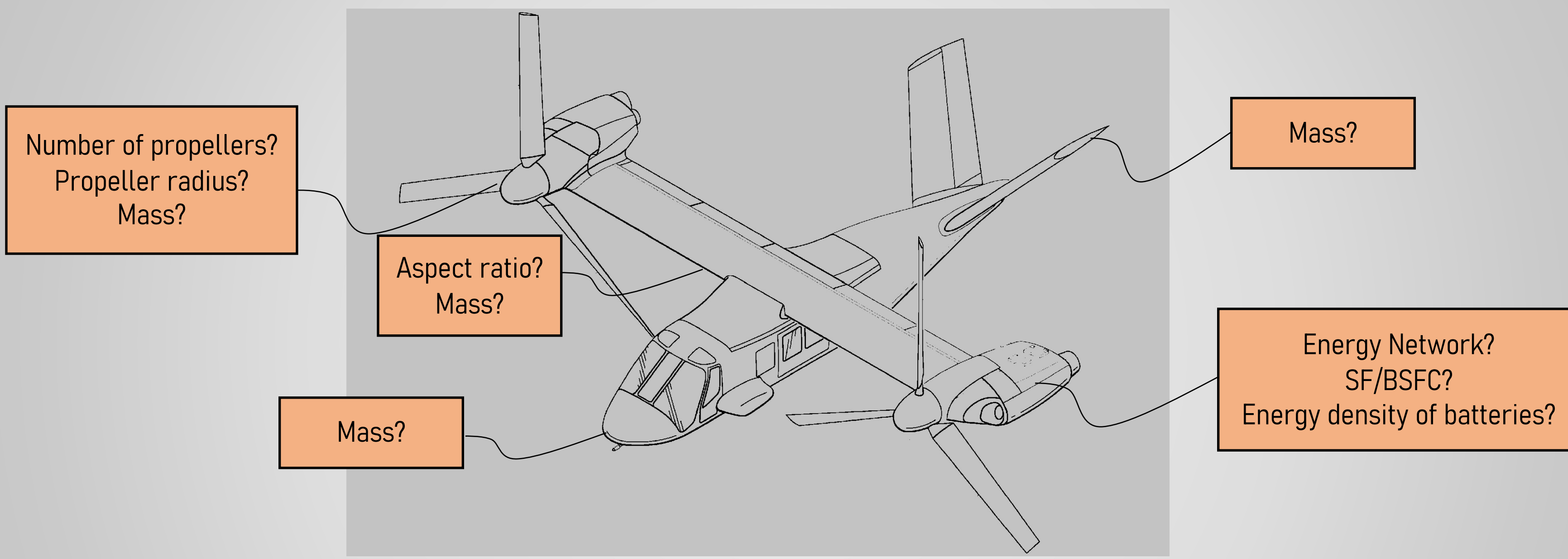
08/11 – 12/11

TÉCNICO
LISBOA

Instituto Superior Técnico
Universidade de Lisboa

Design Point
Introduction

- At this point, you have partly adapted the JSON file to your specific design and computed your first MTOW estimate.



?

Is your current design feasible?

Design Point
Introduction

- Based on your MTOW, geometric parameters and powerplant(s), you can estimate the following variables:

Disk loading	Wing loading	Power loading
$\frac{W}{A}$	$\frac{W}{S}$	$\frac{W}{P}$

<u>Meaning</u>: *How much weight can the aircraft carry per [unit] of* $\left\{ \begin{array}{l} \textit{rotor area?} \\ \textit{wing area?} \\ \textit{power installed?} \end{array} \right.$

<u>Goals:</u>

- Guarantee design points lie within feasible regions limited by performance constraints
- Maximize loading ratios.

Design Point
MATLAB implementation steps

1. Make modifications to variables in the JSON file that you didn't consider for the MTOW estimation stage:

Engine types

```json
{
    "name": "Electric Motor",
    "type": "engine.electric",
    "number": 3,
    "efficiency": 0.97,
    "mass": 50,
    "max_power": 300000
}
```

You don't need to have an exact idea of the maximum power installed in your aircraft! This will be only used to give you an upper limit of feasibility.

Fuselage types

```json
{
    "name": "Fuselage",
    "type": "fuselage",
    "interf_factor": 1.0,
    "diameter": 1.0,
    "length": 4.0,
    "mass": 800
},
```

Important to estimate an initial value for the base drag coefficient!

Wing types

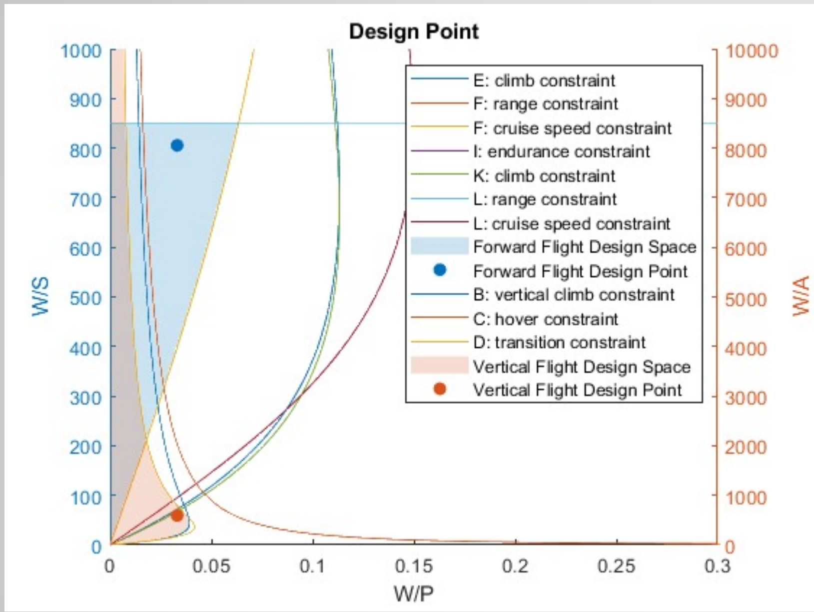
```json
{
    "name": "Main Wing",
    "type": "wing.main",
    "interf_factor": 1.0,
    "aspect_ratio": 7.0,
    "mean_chord": 2.3,
    "oswald_efficiency": 0.85,
    "airfoil": {
        "type": "naca0012",
        "tc_max": 0.15,
        "xc_max": 0.3,
        "lift_slope_coefficient": 6.2,
        "cl_max": 2.0
    },
    "sweep_le": 10.0,
    "sweep_c4": 15.0,
    "sweep_tc_max": 20.0,
    "mass": 200
},
```

```json
{
    "name": "Horizontal Tail",
    "type": "wing.htail",
    "interf_factor": 1.0,
    "aspect_ratio": 5.0,
    "mean_chord": 0.5,
    "oswald_efficiency": 0.85,
    "airfoil": {
        "type": "naca0012",
        "tc_max": 0.15,
        "xc_max": 0.3,
        "lift_slope_coefficient": 6.2,
        "cl_max": 2.0
    },
    "sweep_le": 10.0,
    "sweep_c4": 15.0,
    "sweep_tc_max": 20.0,
    "mass": 50
},
```

Using aspect ratio and mean chord values, span will be automatically calculated.

Design Point
MATLAB implementation steps

2. Confirm if design points lie within feasible region, and make modifications to your input file if needed!



The plotted constraints are automatically selected based on your mission profile.

You'll have to make important decisions for the loading ratio optimization:

- Should you <u>minimize wing area</u> at the possible expense of <u>increasing power installed</u> for forward flight ?
- Should you <u>minimize power installed</u> for vertical flight at the expense of <u>increasing rotor/propeller area</u>?

<u>You will be running the functions:</u>

```
data.vehicle = aero_analysis(data.mission, data.vehicle);
data.vehicle = design_space_analysis(data.mission, data.vehicle, data.energy);
```

Design Point
Objectives/deliverables

This week's objectives are:

Plot your design points for forward and vertical flight conditions

- Loading fractions, total wing and rotor areas, and total power required

For next week's meeting:

Prepare Powerpoint presentation

Max: 5-10 min