1 Summary

1.1 ”The Seven Intellectual Pivot Points for Conceptual Design”

- **Requirements** This is where you establish the set of requirements the aircraft must meet.
- **Weight of the Airplane - First Estimate** Getting an initial estimate of the airplane’s weight is important for determining the performance parameters.
- **Critical Performance Parameters** This is where the airfoil will be chosen to determine some initial aerodynamic characteristics.
- **Configuration Layout** Here we will determine more specifics about the design of our aircraft.
- **Better Weight Estimate** Based on the configuration and initial prototype, a better weight estimate can be determined.
- **Performance Analysis** Are we meeting or exceeding our requirements? If not, iterate steps until we converge on a solution.
- **Optimization** Is this the best design?

1.2 Requirements

- Easily re-configurable to accommodate different sensor suites and adequate internal cooling fans
- Long battery life to enable distance missions where autonomy is required
- Small size that enables flight testing at a variety of locations
- Easily decomposable for easy transportation
- 3D printable parts for quick prototyping

1.3 Trade Studies

- Previously Successful Small UAS
  - The Pointer, Raven, Puma, Dragon Eye, Desert Hawk, Orbiter, Razor
- High wing vs low wing configuration
- Tractor motor vs pusher motor configuration

1.4 Weight of the Airplane - First Estimate

- MATLAB/Python code
  - Determines initial guess of take-off weight, given a certain payload
  - Produces graphs of some initial performance parameters
  - Defines constraint space for this aircraft using the following equations:

1.4.1 Constraint Equations

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Max Load/Turn:

$$\frac{HP}{W} = \frac{1}{550\eta_p}[\frac{1}{2}\rho V^3 C_{D_O}(\frac{S}{W}) + 2K\frac{n^2}{\rho V}(\frac{W}{S})] \tag{1}$$

Endurance:

$$\frac{HP}{W} = \frac{4}{550\eta_p} C_{D_O}^{1/4}(\frac{K}{3})^{3/4}(\frac{2}{\rho}\frac{W}{S})^{1/2} \tag{2}$$

Cruise:

$$\frac{HP}{W} = \frac{2}{550\eta_p} C_{D_O}^{1/4} K^{3/4}(\frac{2}{\rho}\frac{W}{S})^{1/2} \tag{3}$$

Takeoff Distance:

$$\frac{HP}{W} = \frac{2.44}{550\eta_p}\frac{1}{gd_{to}}(\frac{1}{\rho_{SL}C_{L_{max}}}\frac{W}{S})^{3/2} \tag{4}$$

Stall Condition

$$\frac{W}{S} = \frac{\rho}{2} C_{Lmax} V_{SO}^2 \tag{5}$$