

1. **Research Title:** Tools for Conceptual Design and Engineering Analysis of Micro Air Vehicles
2. **Individual Sponsor:**
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3. **Academic Area/Field and Education Level:** Aeronautical engineering (MS or Ph.D. level)
4. **Objectives:** The objective is to (1) integrate a statistical database of Micro Air Vehicle designs into a sizing/look-up table for conceptual design trades and (2) establish and demonstrate low-level numerical models for MAV aerodynamics and flight dynamics.
5. **Description:** Conceptual design of aircraft, outlining of engineering requirements in aircraft design, and systems-level analysis for engineering trades all depend on reliable low-level analysis/computation. The need for rapid search of large parameter space renders impossible the use of high-fidelity physical models. For manned aircraft and large UAVs, aerospace engineering practice benefits from physics-based and non-physics-based tools: the latter includes extensive statistical databases for table-look references, and the former includes for example lifting-line theory and stability derivatives for airframe performance and flight dynamics analysis. Together these enable quick trade studies and go/no-go evaluations of proposed airplane design concepts. But for Micro Air Vehicles (MAVs – that is, UAVs with linear dimension < 15cm, and either fixed-wing, rotary-wing or flapping-wing configuration) there is a lack of statistical information, and considerable doubt on the validity of traditional aerodynamics models. Even for nominally fixed-wing (“rigid” or flexible-wing) configurations which loosely resemble larger UAVs, the combination of low Reynolds numbers, low aspect ratio wings and impact of wing-propeller interactions together places traditional models into question. For flapping-wing MAVs the challenge is even more complex. The proposed research is a combination of survey of state of the art, and original model/code development, to assemble a conceptual design tool for practical MAVs. Depending on student interest, the topic could be weighted towards airplane system-level analysis, or specialized to aerodynamics/stability and control.
6. **Research Classification/Restrictions:** public-domain.
7. **Interest in Summer USAFA Cadet (Avg Cost for USAF Cadet for 33 days was \$4000):**

The work may be suitable for a cadet, provided that the cadet is partnered with a Ph.D. student for mutual interaction.

Eligible Research Institutions:

- Universities (DAGSI) ■ AFIT (only) ■ USAFA

