

Design of a Easy-to-fly Hovering Fixed-wing Aircraft (HFA) **AAE451, Aircraft Design, Fall 2008**

Background: Remotely piloted unmanned aerial vehicles are today finding an increasing number of useful military, commercial and consumer roles. The Predator and the Global Hawk are two fixed-wing examples. Vehicles that hover are useful for reconnaissance and target acquisition. The Voyeur rotary-wing aircraft designed and developed by Lite Machines of West Lafayette is an example. The model aircraft industry has picked up this trend and is producing small aircraft that mimic those roles. However, for a model aircraft to be successful it must also be easy to fly by a teenager.

Design Mission: The HFA must be designed for the following mission. Within the confines of the Purdue Armory, the vehicle must safely takeoff horizontally, climb, loiter for 3 minutes, hover vertically over a fixed spot for 2 minutes, and land horizontally. It must be an inexpensive, fun to fly, visually attractive, safe, and robust fixed wing aircraft capable of hovering while being flown by a typical teenager.

Design Constraints: Flight of this remotely piloted vehicle must be safely demonstrated in the Purdue Armory. The aircraft in level flight must have typical aircraft modes of motion that have damping ratios that satisfy the military requirements for flying qualities of manned aircraft. The vehicle must be stable under all flight conditions. In order to simplify flying skills, stability in the hovering condition must be augmented using a feedback controller to minimize deviation in the roll angle from the intended roll orientation.

The vehicle must be robust to crashes, easy to fly (i.e., have exceptional flying qualities). In all aspects of design and construction cost must be minimized. The cost to build the fixed-wing aircraft must not exceed \$150 (excluding radio-control transmitter and receiver, and speed controller). The powerplant must be electric (battery powered). The aircraft will be marketed to existing companies who sell and manufacture model aircraft to teenagers.

The aircraft should be as small and light as practical and possess the following performance abilities.

- Horizontal take-off distance ≤ 10 ft of ground roll,
- Climbing right-angle turn following take-off with minimum climb angle 45 degrees ($\gamma_{\text{climb}} \geq 45$ degrees),
- $V_{\text{Stall}} \leq 15$ ft/sec, where V_{Stall} is the level flight speed at $C_{L\text{max}}$,
- Maintain roll angle within ± 20 degrees while hovering vertically,
- Demonstrate the mission safely in the Purdue Armory.

Any deviation from the design constraints must be formally requested in writing to the customer (Professor Andrisani) and justified using sound engineering and business logic.