

## Design of a Long-Endurance Stealthy Aircraft (LESA) AAE-451, Aircraft Design, Fall 2009

**Background:** Hard to detect (stealthy) remotely piloted unmanned aerial vehicles are today finding an increasing number of useful military roles. The Predator C is good example of an armed reconnaissance aircraft with 20 hours of endurance. The model aircraft industry has picked up this trend and is producing small stealthy-looking 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 LESA must be designed for the following mission. Within the confines of the Purdue Armory, the vehicle must safely takeoff horizontally, climb, loiter for 2-hours, and land while carrying a 1-pound payload. It must be an inexpensive, fun to fly, stealthy or stealthy looking, safe, and robust fixed wing aircraft capable of being flown by a typical teenager. Stealth considerations include small size, low radar cross-section, low infrared emission and low noise emission.

**Design Constraints:** Flight of this stealthy remotely piloted vehicle must be safely demonstrated in the Purdue Armory. Less than 2-hours of endurance can be demonstrated if ballast is carried sufficient to simulate a battery that would provide the required 2-hour endurance. 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. In order to make the aircraft easier to fly it must incorporate yaw rate feedback to the rudder to help damp the Dutch roll mode of motion.

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 \$200 (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 and stability properties:

- Horizontal take-off distance  $\leq 30$  ft of ground roll,
- Climbing right-angle turn following take-off with minimum climb angle 30 degrees ( $\gamma_{\text{climb}} \geq 30$  degrees),
- $V_{\text{Stall}} \leq 15$  ft/sec, where  $V_{\text{Stall}}$  is the level flight speed at  $C_{L_{\text{max}}}$ ,
- Have a mission endurance of 2 hours while carrying a 1-pound payload,
- Damping ratio of the Dutch roll mode greater than 0.8,
- 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.