13th Wernher von Braun Memorial Symposium
October 26 – 28, 2020

An Approach to the Development of a High Endurance Solar Electric Motorglider

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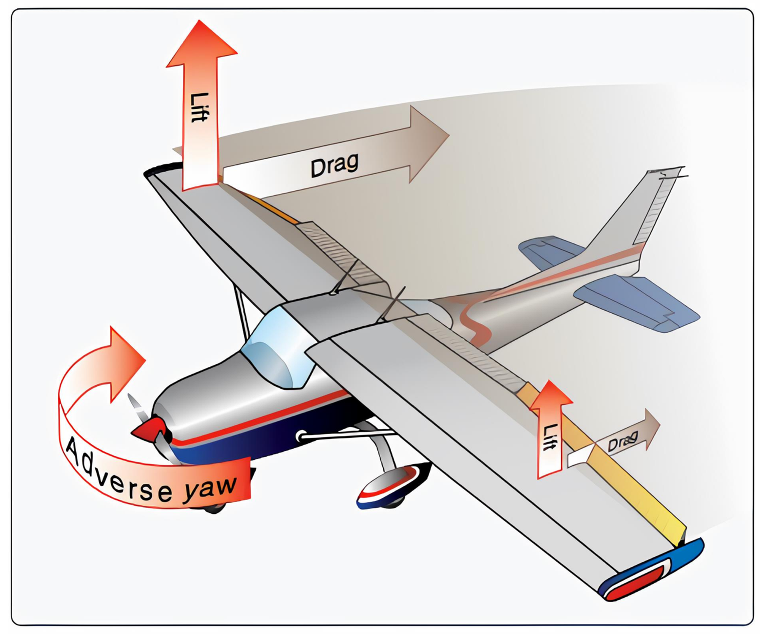
Overview

Solar electric aircraft are limited through a wide number of factors. These include obstacles such as relatively low energy storage density, lack of constant energy influx, lackluster solar panel efficiencies, and airframe drag. In order to maximize flight time, all these factors must be hyper-optimized.

Adverse Yaw



Forces Involved in Adverse Yaw
Image Credit: studyflying.com

Adverse yaw is a rotational force exerted during rolling maneuvers

- Can lead to rapid instability
- Loss of Aircraft

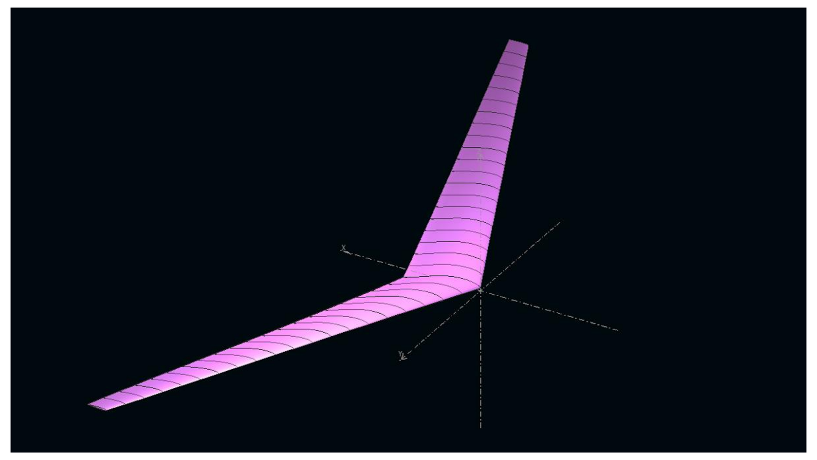
Several measures are employed to counteract adverse yaw:

- Yaw Stability
- Rudder Movements
- Differential Aileron Deflection

Increased Drag, Decreased Efficiency

Prandtl Wing

- The Prandtl Wing is our solution to adverse yaw.
- The base airframe was taken from the Prandtl-D program at NASA Dryden.
- **Key Benefits:** low induced drag, high lift to drag ratio, and long duration gliding capability.

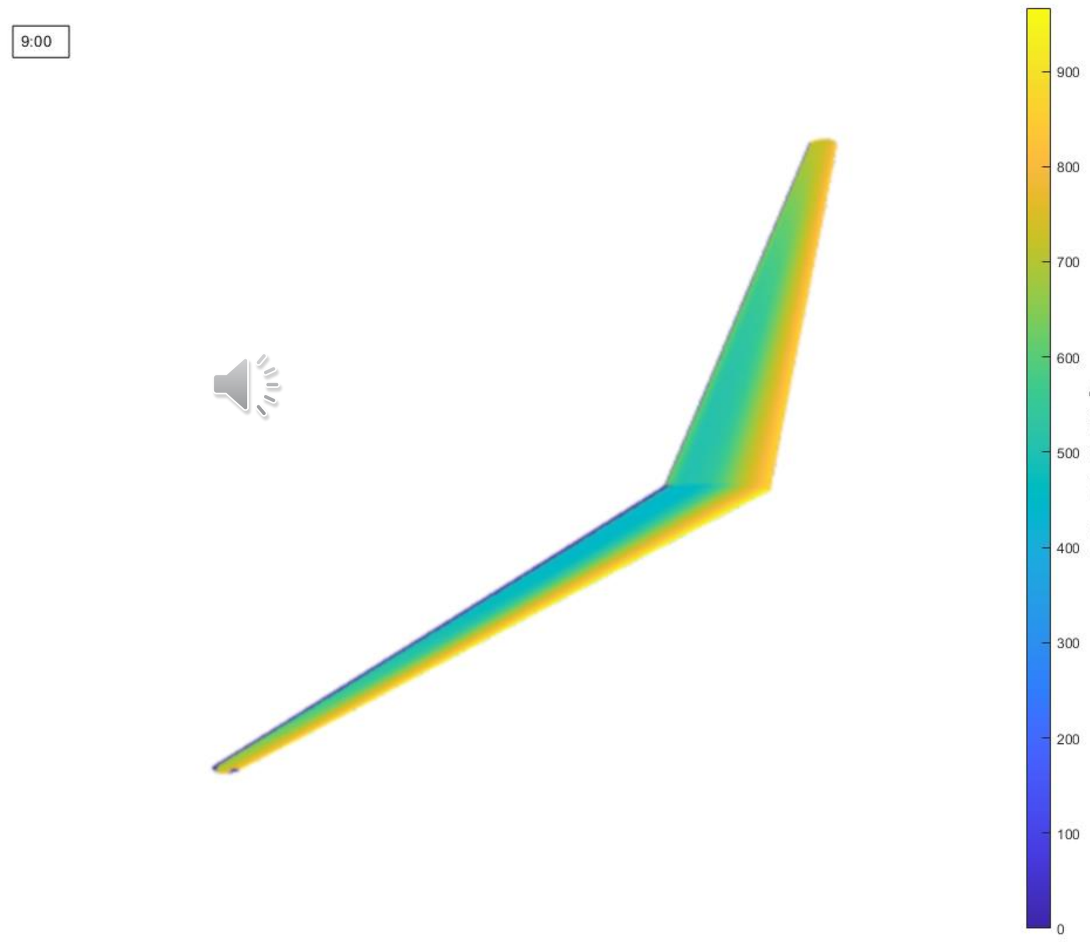

3D Model of the Airframe Being Analyzed in Xflr5

- Furthermore, the nonlinear wing twist produces proverse yaw at the tips, counteracting the adverse yaw without additional drag.

Solar Optimization

In addition to maximizing airframe efficiency, our vehicle needs to utilize as much solar flux as possible throughout the day in order to sustain long duration missions.

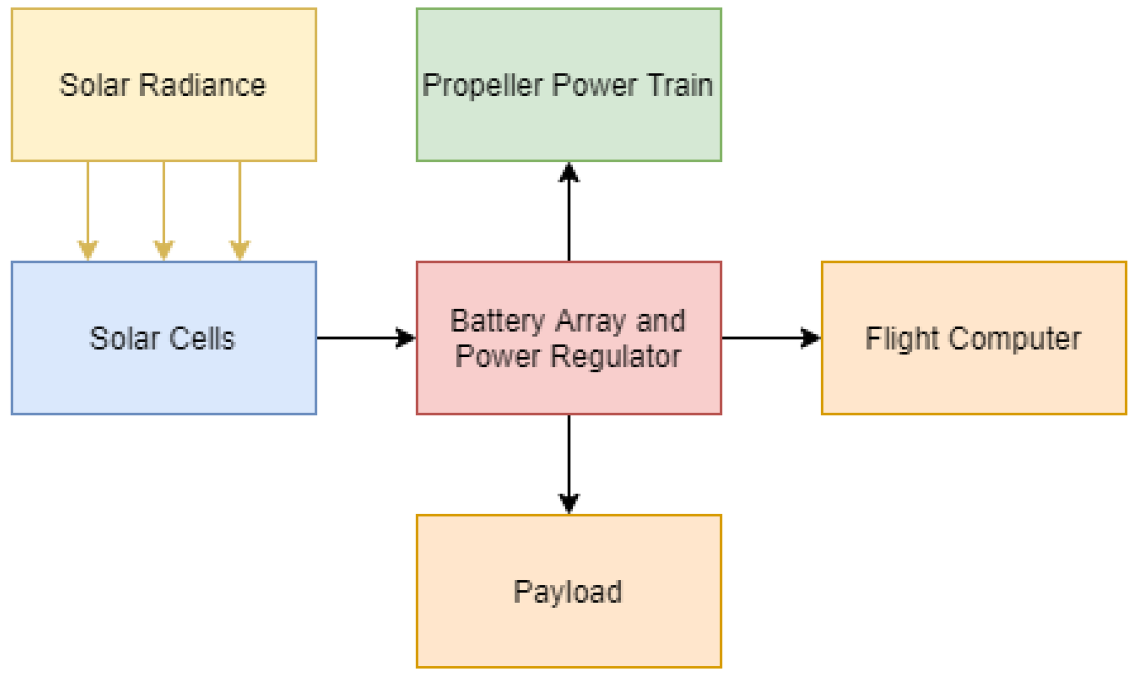
To optimize solar cell placement and time of launch, we developed a Solar Flux Analysis simulation based on a model of an aircraft, solar incidence angle, and solar cell efficiency.


Graphical Output of the Solar Flux Analysis Simulation

Total energy influx received by the aircraft can be determined in order to specify energy budgets and battery requirements.

- Portions of the aircraft with the highest flux can be prioritized for solar cell placement
- Time of launch can be chosen to maximize flight duration
- Energy inflow versus outflow calculations can help inform battery mass requirements

Power Distribution



- A power control system with charging circuit design is needed to meet the unique power demands of our vehicle
- Key parameters to be identified include
  - Solar panel discharging cycles
  - Propeller motor power profile
  - Battery array charging cycles

Eye in the Sky

- Prototypes will be developed based on the results from the optimization of flight dynamics and power consumption calculations.
- Proposed futures tasks include
  - Higher sampling rates than satellite-based observation
  - Greater stability than weather balloon payloads

Acknowledgements

The authors would like to thank the Alabama Space Grant Consortium and Space Hardware Club for supporting this project. Additional thanks are sent out to Drs. Tantaris and Wang for their input and guidance as faculty advisors.

Bowers A, Murillo O. On Wings of the Minimum Induced Drag: Spanload Implications for Aircraft and Birds. NASA/TP—2016–219072, NASA, 2016

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