Group AF: All-Electric Air Tractor
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Introduction
Problem Statement: The goal is to provide a conversion plan for transforming a popular gas-powered agricultural airplane, the Air Tractor 502B, to full-electric using our industry sponsor’s electric motor, the Magni-500.

Motivation/Background
Aviation accounts for almost 11% of transportation CO2 emissions in the U.S. Aviation CO2 emissions are also the fastest growing and hardest to eliminate due to the low specific energy of batteries.

Customer Specification: A successful conversion would involve a total conversion cost lower than the overhaul cost of the current PT6 engine, and the aircraft maintaining its current maneuverability, pilot interface, and outside structure. However, the resulting mission profile may deviate from the typical profile of the current model.

Testbed Plane
Maximum Takeoff Weight
Empty Weight
Hopper Capacity
Wing Span
Typical Use
Range
9400 lbs.
4946 lbs.
500 gal
3850 lbs.
52 feet
Agricultural Spraying
620 miles

Engine Comparison
Parameter
PT6A-15AG
Magni500
Weight
315 lbs
282 lbs
Power
680 shp
750 shp
Length
-61 in
-21 in
Diameter
~17.1 in (based on Quincy measurements)
~21.5 in
Operating Speed
2200 RPM
1900-3000 RPM

Power Supply
EvoTracion Battery
48 VDC/300 Ah/15 kWh
Specific Power
203 Wh/kg
Max Current
900 A
Protection Class
IP67
Additional Features
Imbedded BMS, 2 CAN ports

Total of 24 batteries: 12 in wings, 4 in aft, 8 in front

Regulations
Batteries/Electrification
● AC 20-184 Engine Mount
● FAA FAR Part 23.303: Factor of Safety
● FAA FAR Part 23.361: Engine Torque
● FAA FAR Part 23.371: Gyroscopic Loads
● FAA FAR Part 23.561: Ultimate Inertial Forces

Roadmap for Certification
● Commercial use requires a 30 minute reserve
● Experimental certification until battery technology improves
● Commercial use 5-10 years out

Engine Mounting
Custom Engine Mount
● Analyzed against gyroscopic loading, engine torque, and ultimate inertial forces
● Yield factor of safety ~ 1.63 to 8.19
● Constructed out of 6061-T6 Aluminum and 4130 Alloy Chromoly Steel

Future Performance
● Aircraft will charge completely in 10 to 15 minutes
● Reserve calculated using 60% throttle
● Flights assume battery technology advances as predicted by Roland Berger
● Flight time and hopper capacity are trade offs (customer to specify based on their needs)
● Models include efficiency of motor, inverters, and batteries as well as energy consumed by avionics and lights

Conversion Finances
Assumptions
● Less overhauls save $265,000 every 4 years
● Fuel savings amount to $285,000/year
● Pilot flies 85 hrs/month for 6 months

Future
● Limited commercial use in 5-7 years, widespread use in 10-15 years

Aircraft Performance and Future Outlook
Power Consumption Model
Flight profile developed with the help of agricultural pilot

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Schedule and Budget

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References