Evaluating the Performance and Acoustic Footprint of Aircraft for Regional and Urban Air Mobility

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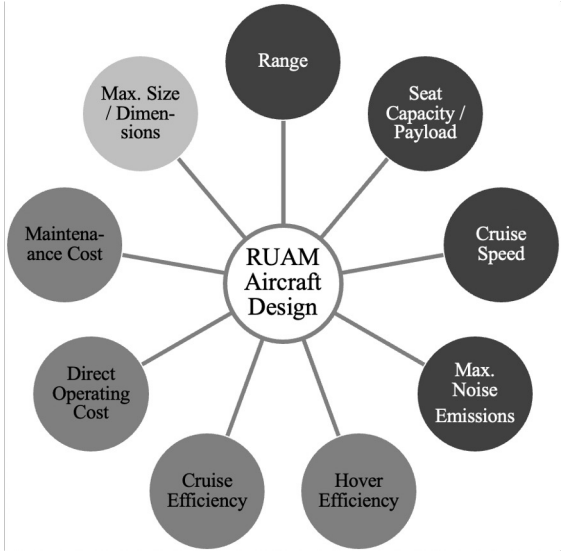
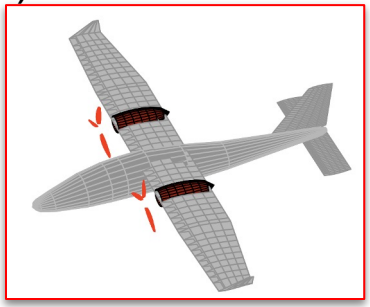
Stanford University
AIAA AVIATION Forum, 2-6 August 2021

RUAM Aircraft Design

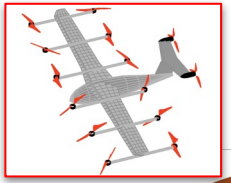
Design Considerations for RUAM aircraft

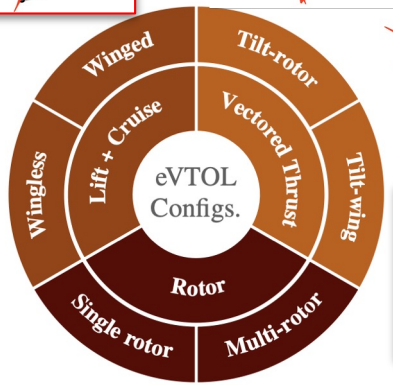


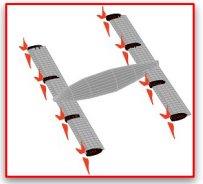
Conventional Tube-and-Wing i.e. Electric General Aviation (eGA)



Electric Vertical Takeoff and Landing (eVTOL)



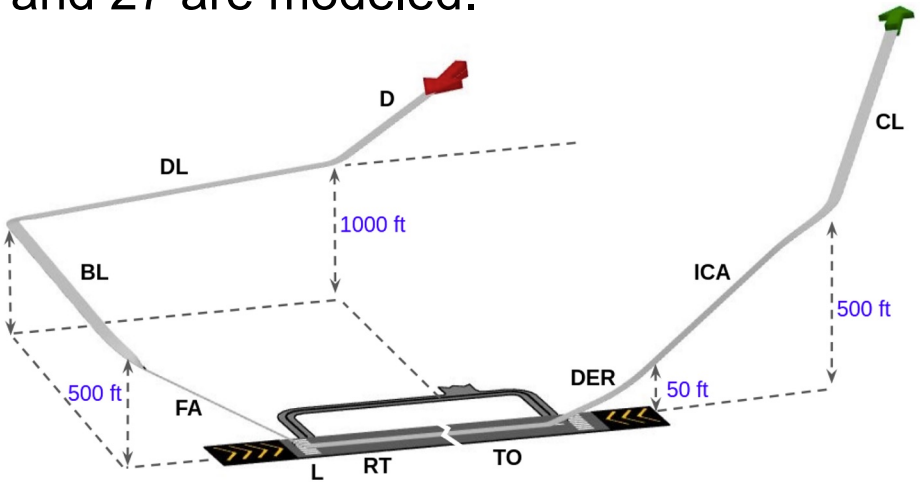




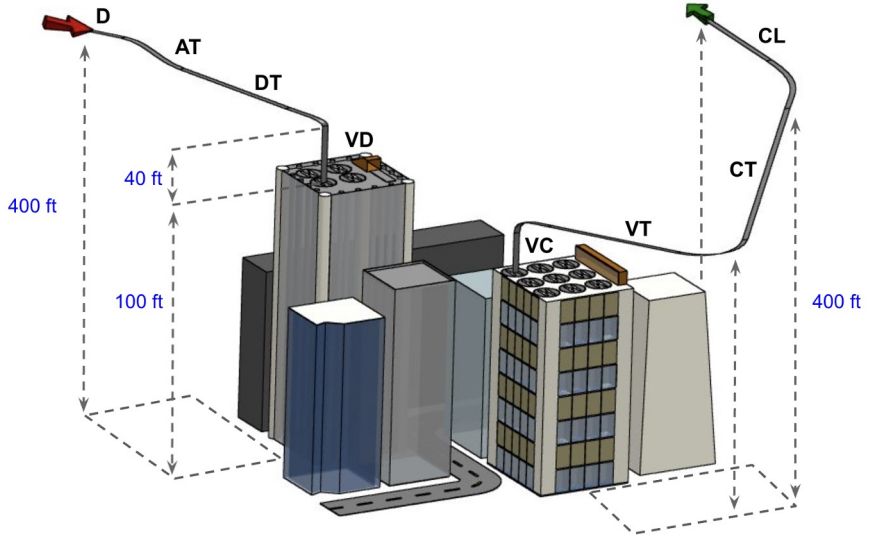
Adapted from Straubinger (2020)

Flight Profiles

Realistic flight profiles that conform operating limits, service ceilings, maximum speeds and allowable climb rate documented in 14 CFR § 23 and 27 are modeled.



Flight Profile for eGA

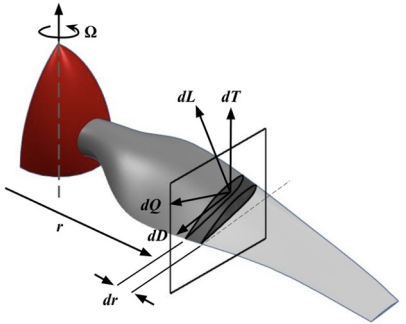


Flight Profile of eVTOL

Computational Methods for Discipline Analyses

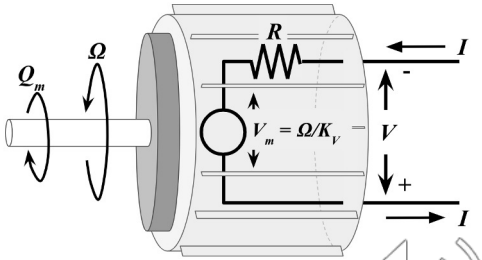
Propeller/Rotor Model

- Blade Element Momentum Theory (BEMT) Model.
- Each blade is characterized by two-dimensional radial stations where twist angle, chord and sweep (mid-chord alignment) is defined.



Electric Motor Model

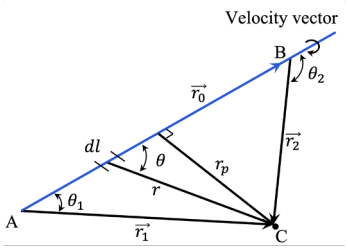
- Brushed AC motor that assumes no loss in latency from switching polarity.
- Matches power coefficient obtained from propeller model in mission solver.

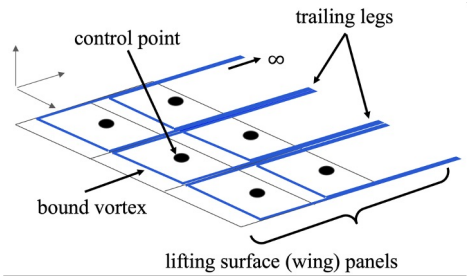


Computational Methods for Discipline Analyses

Aerodynamics

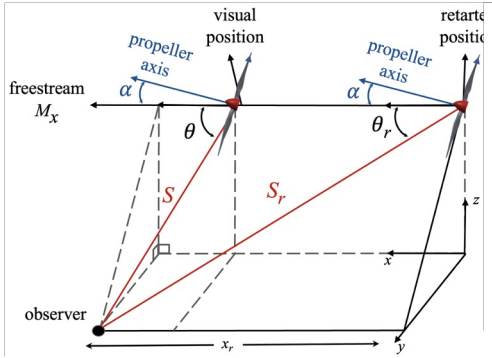
- Vortex Lattice Method - fast with reasonable accuracy compared to CFD.

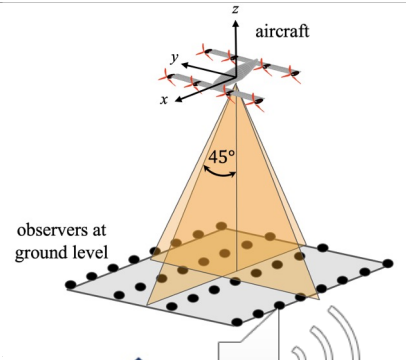




Aeroacoustics

- Frequency-domain method by Hanson
- Only dominating harmonic sources are modeled (broadband noise is ignored).
- Noise is measured from microphone/observer locations at ground level.

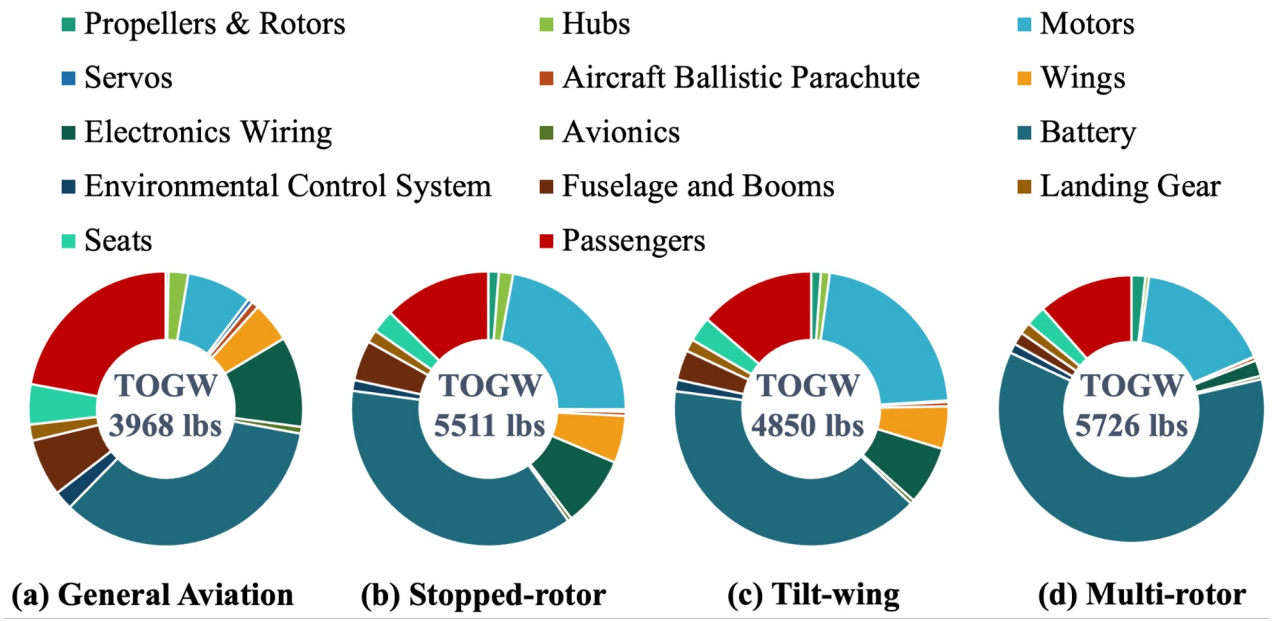




SHAPING THE FUTURE OF AEROSPACE

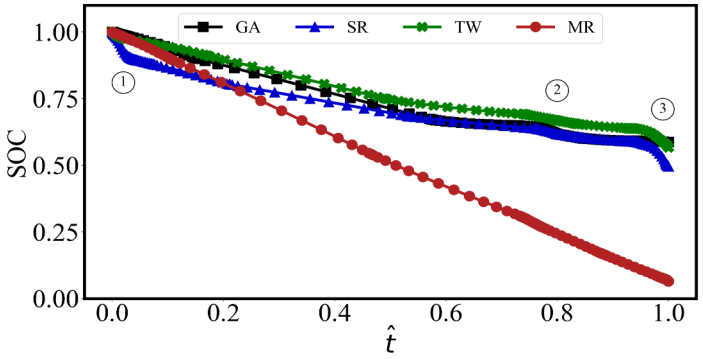
Physics-based Weight Build-up

Using commercially available lithium-ion (NMC) 18650 battery cells, the total battery pack weight can be as much as 60% to TOGW

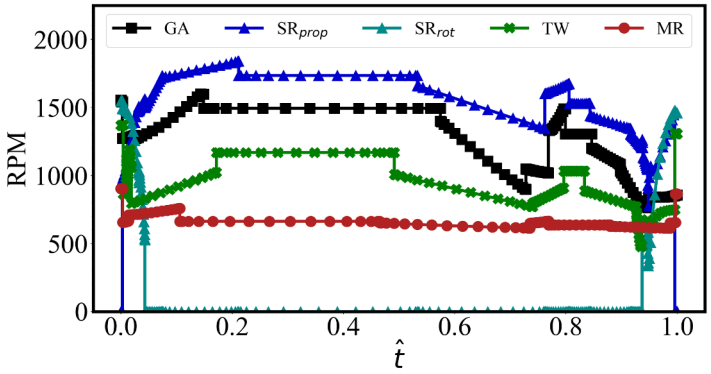


Powertrain Characteristics

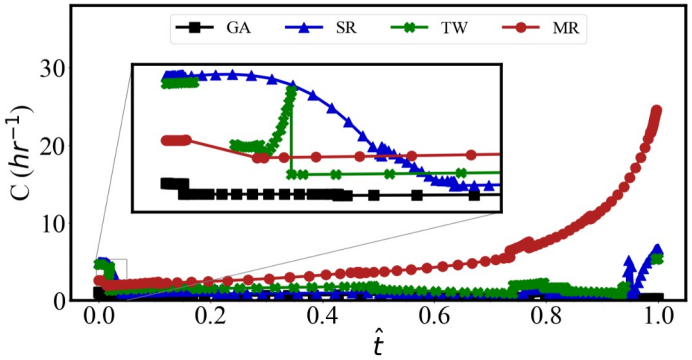
Battery State of Charge



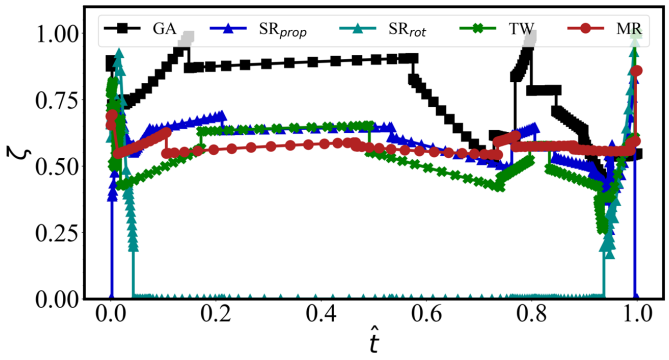
Propeller/Rotor RPM



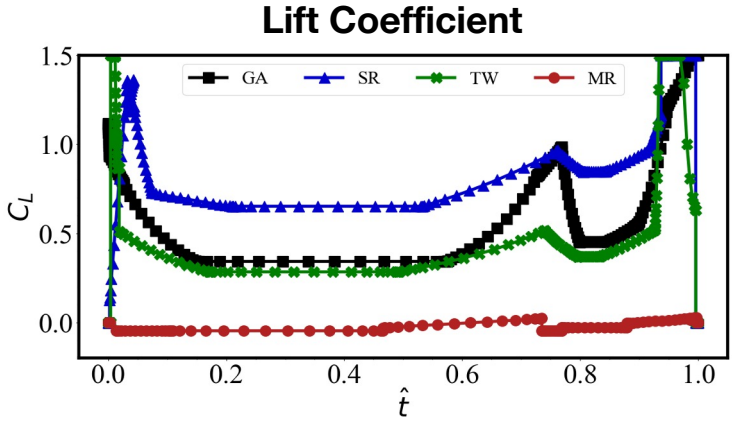
Battery C-rate

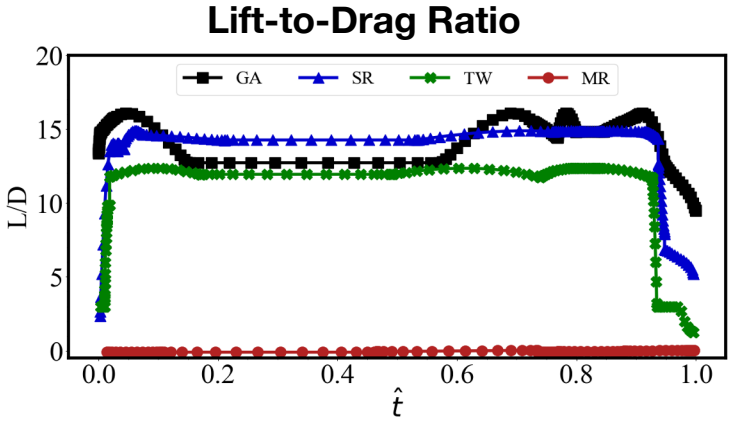


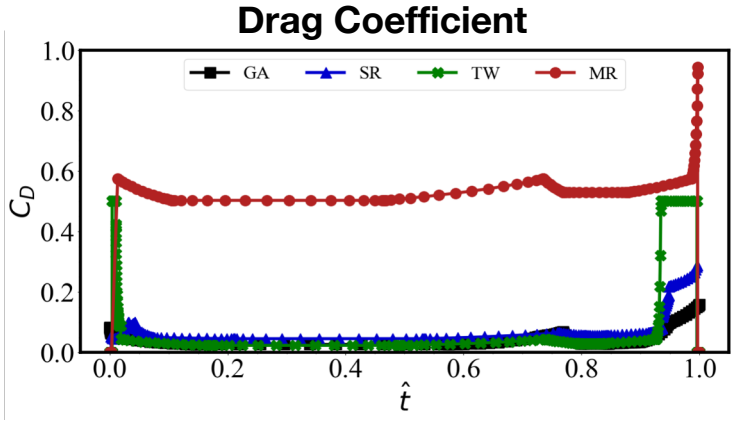
Throttle

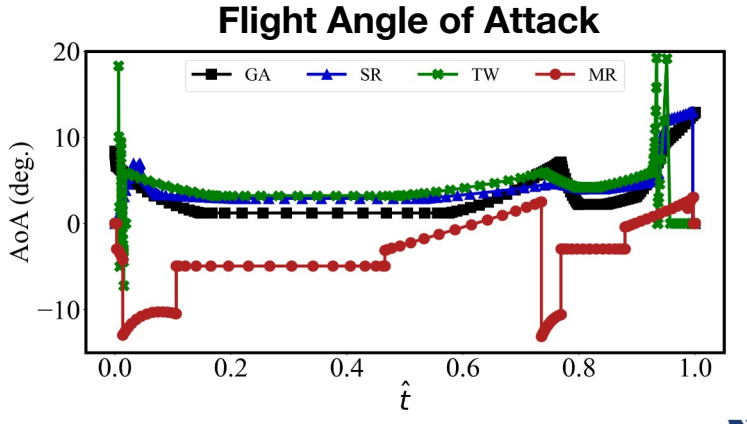


Aircraft Flight Dynamics

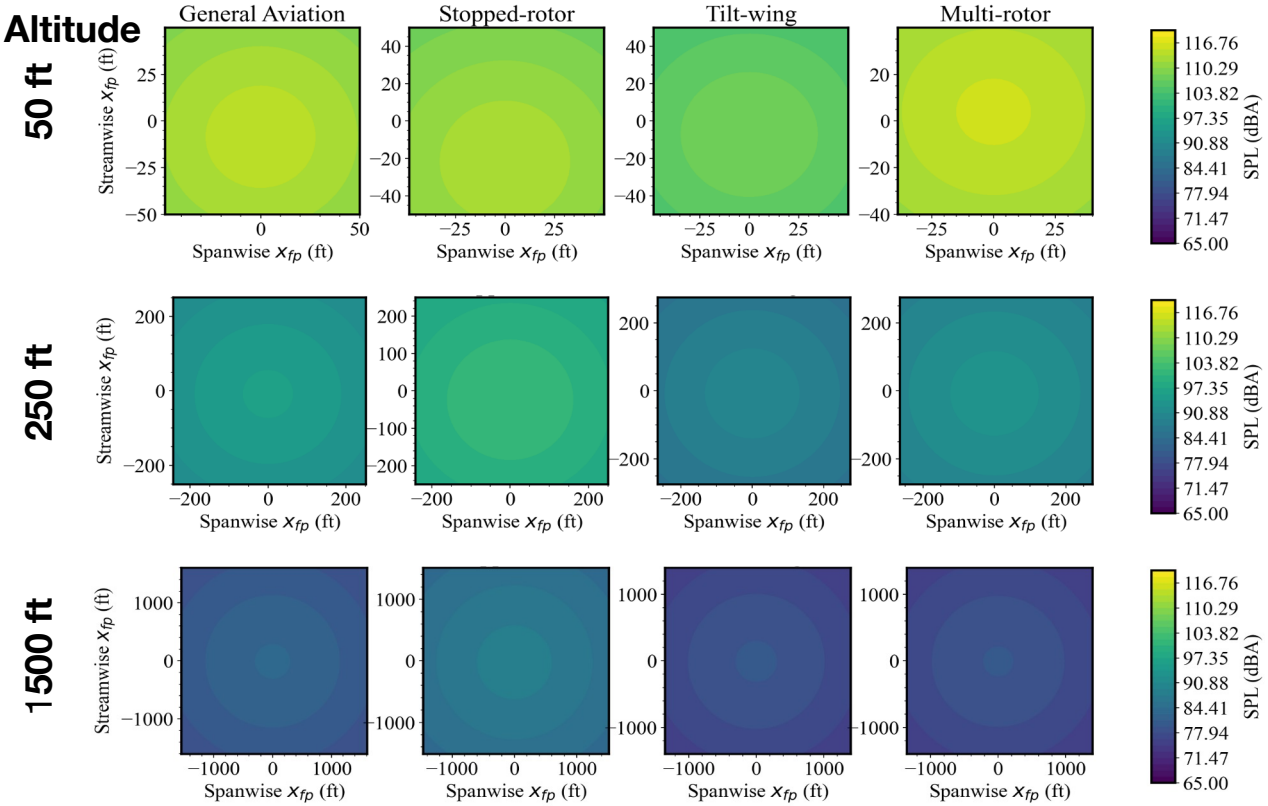


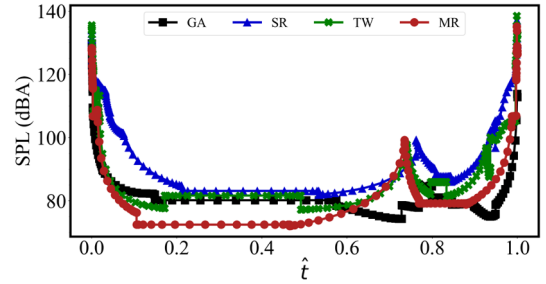


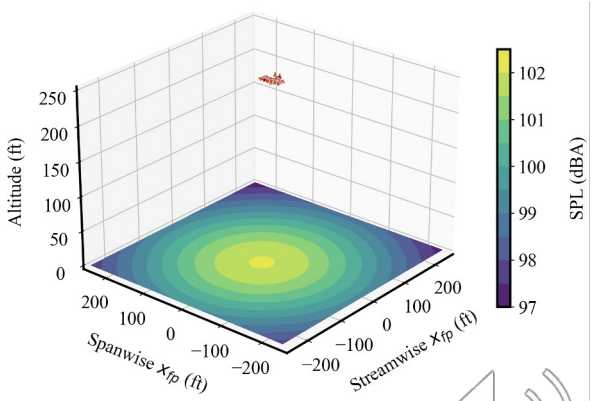




Flight Profile Noise and Acoustic Footprint







Thank you

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