Transformative Modeling and Physics of Free and Tethered Bluff and Blunt Bodies

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Opportunities and Challenges

Opportunities:

- Reduce flight test costs for certification of sling and towed loads, as well as design of new stabilization approaches
- Develop understanding of bluff and blunt body separation/reattachment behavior on canonical and complex shapes

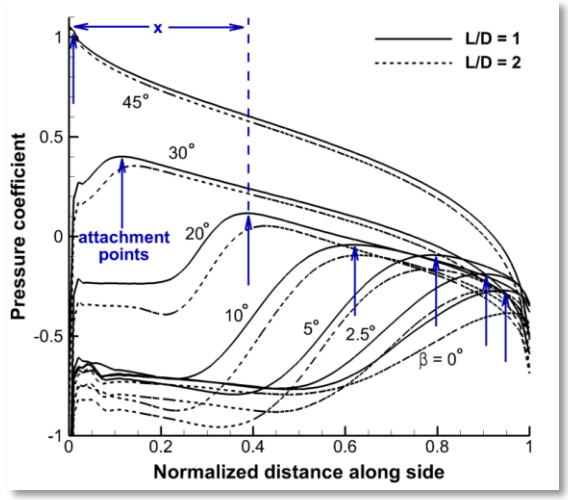
Challenges:

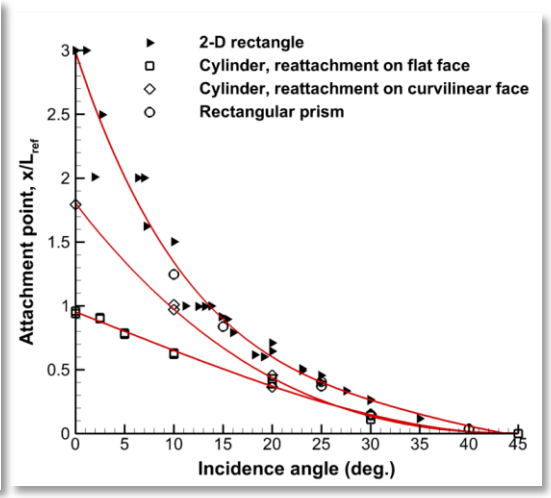
- **Aerodynamics**: complex wakes, vortex shedding, 3D flow, separation/reattachment
- **Dynamics:** coupled helicopter/load motion, tether dynamics, unknown variable values

Innovation in Physical Understanding

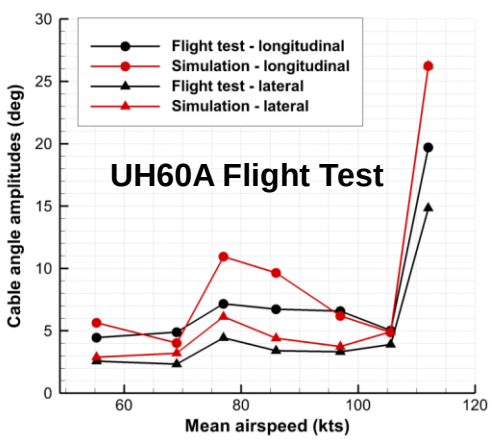
- ***Identify and characterize*** the important aerodynamic phenomena in finite bluff and blunt bodies
- ***Significant breakthrough*** in quantifying relationship of flow behavior and integrated coefficients
- ***Transformative algorithms*** capture behavior of complex dynamic geometries

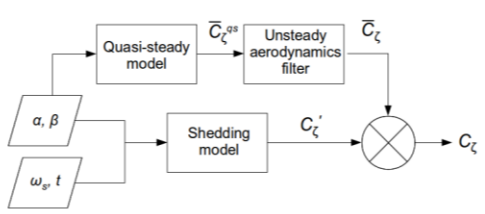
Finite Cylinders:





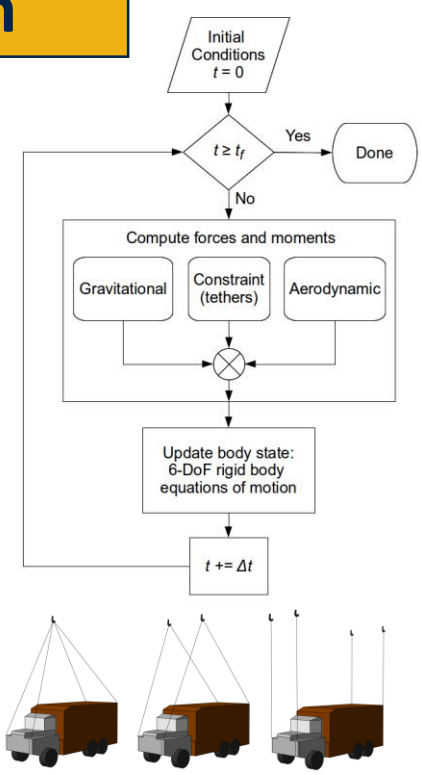
Transformative M&S Algorithm





Innovative Physics-Based Reduced-Order Model

- **Extension** to **new configurations** and operating conditions
- **Adopted by** AMRDEC sling loads support team
- **V&V** with experiments, theory, UAV and full-scale flight test, wind tunnel tests, and Large Eddy Simulations (LES)
- Correctly **predicts load instability and tether angles**
- Uncertainty quantification underway for **certification** – identification and ranking of important variables
- **Near-real time simulation** for HQ, PIO, and design
- **Open source code available** with aerodynamic, 6 dof, and tether models



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