A General Approach to Lifting-Line Theory, Applied to Wings with Sweep

Jackson T. Reid

USU Student Research Symposium 2020

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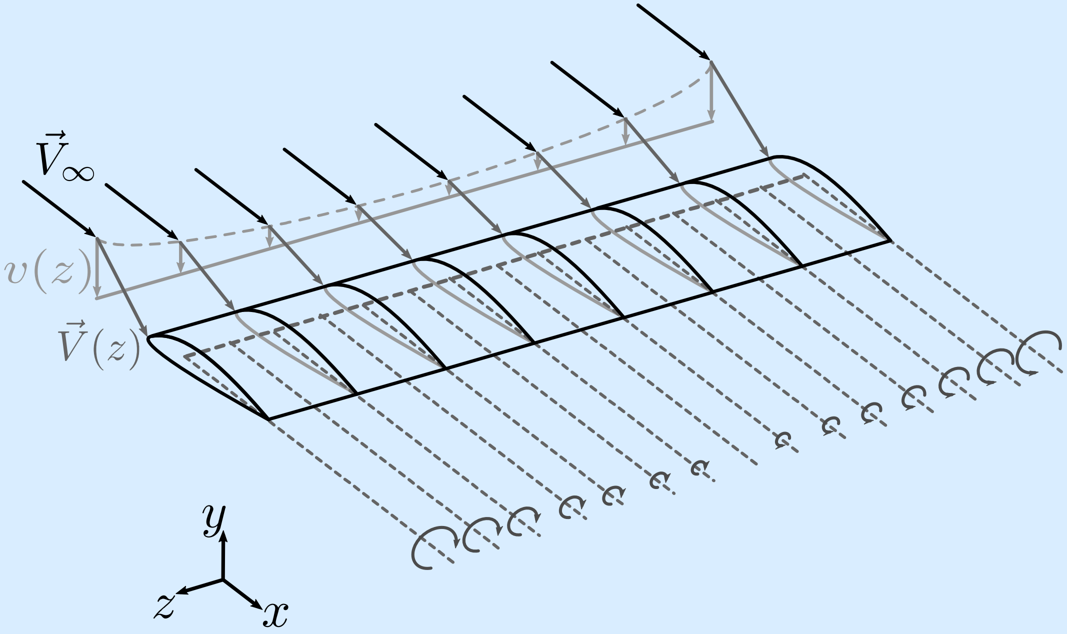
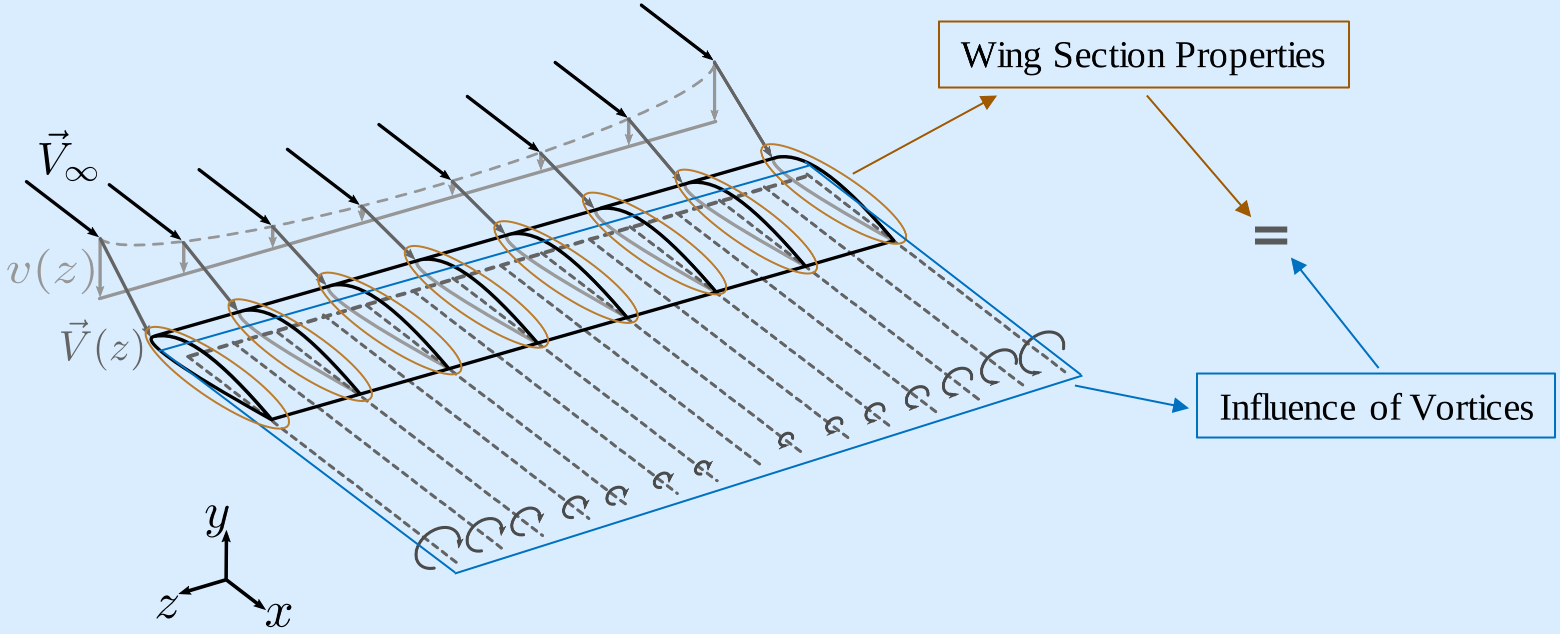
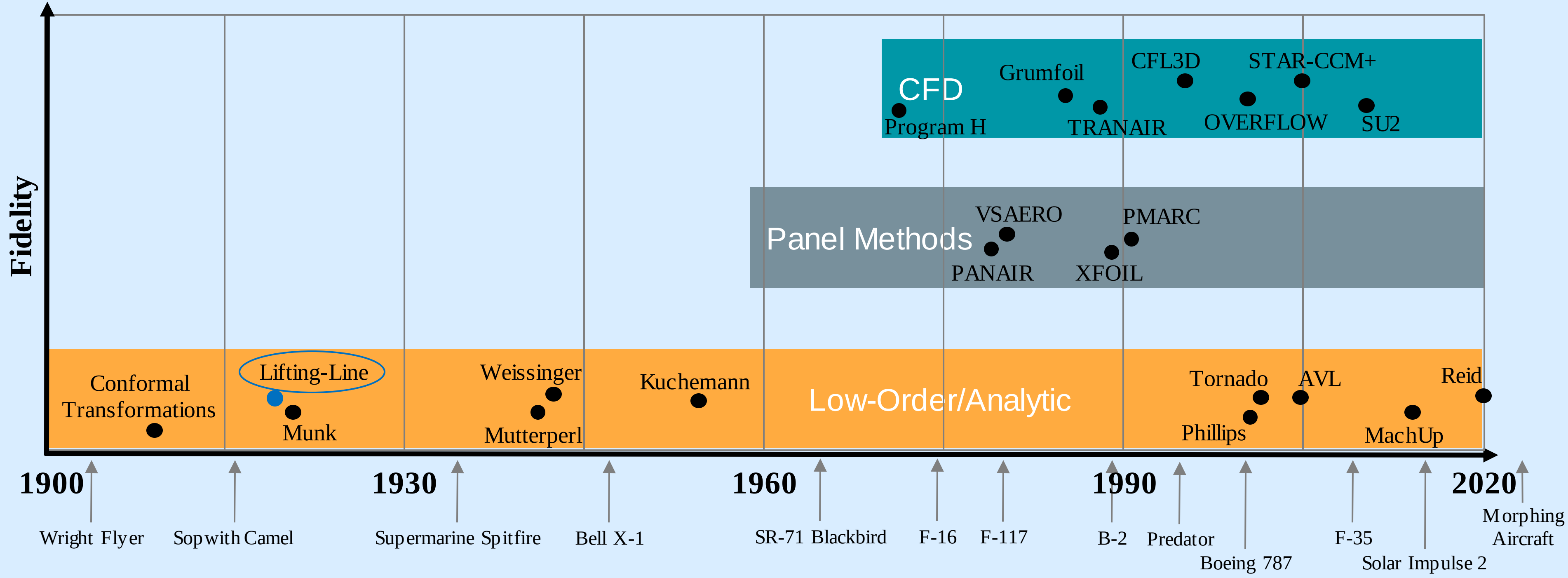
Lifting-Line Theory



Lifting-Line Theory



Aerodynamic Tools



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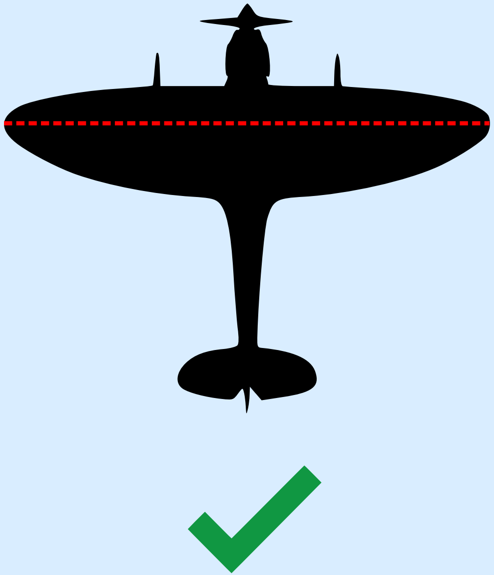
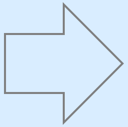
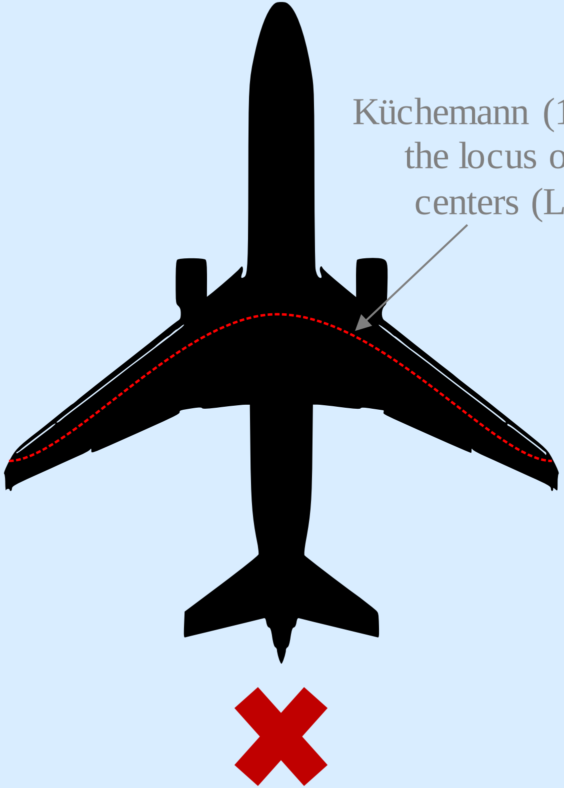
Usefulness of Prandtl's Implementation

Prandtl's classical implementation was instrumental in the design of aircraft during WWII.

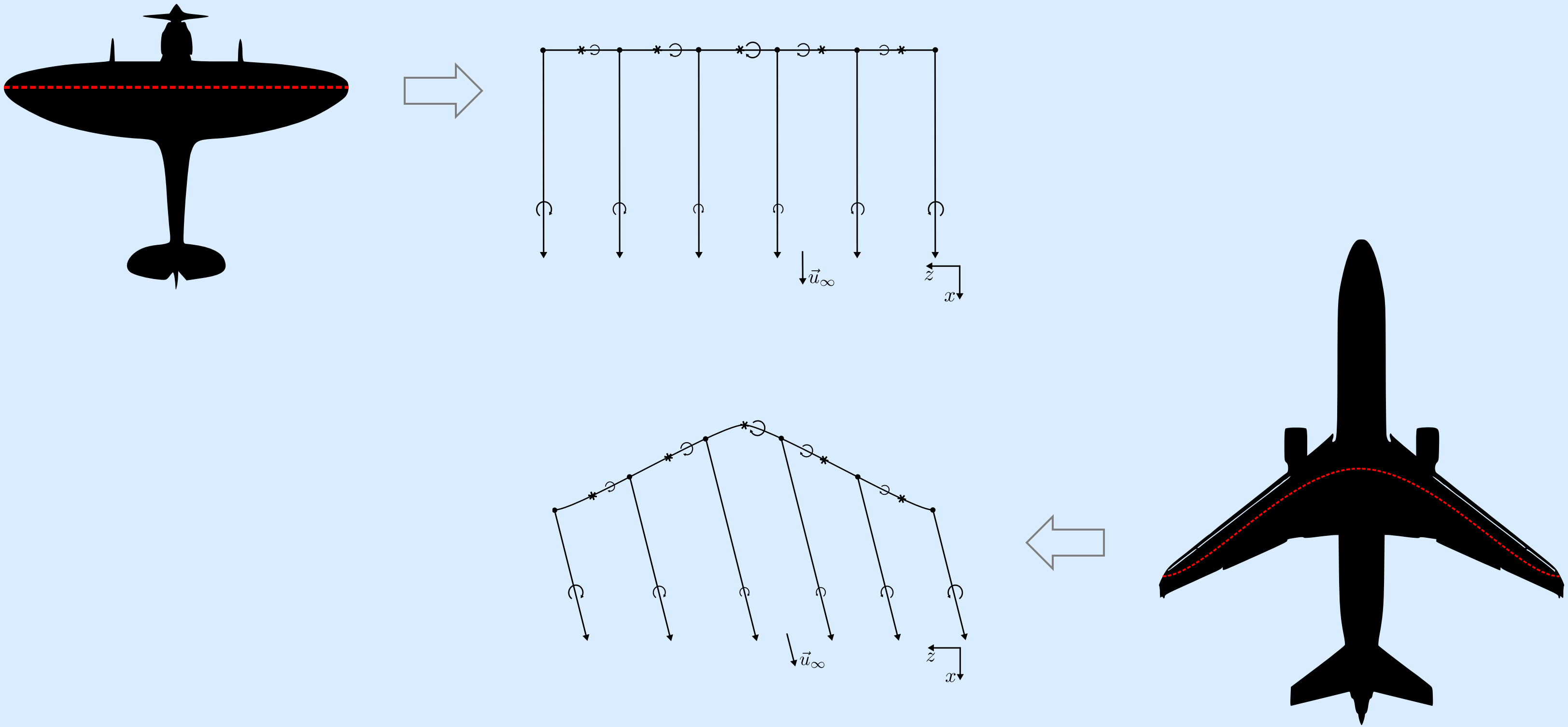




Küchemann (1956) modeled the locus of aerodynamic centers (LAC) for swept wings



Influence of Vortices



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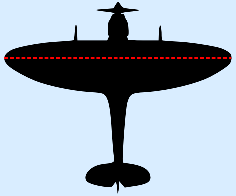
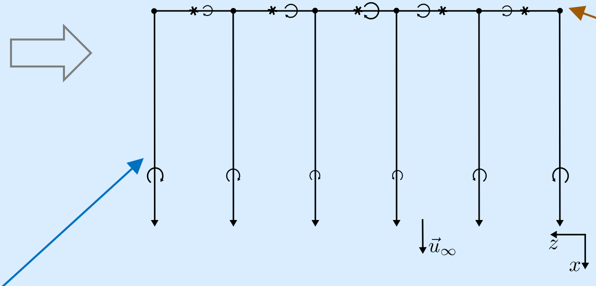
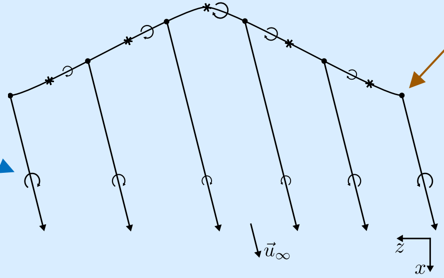
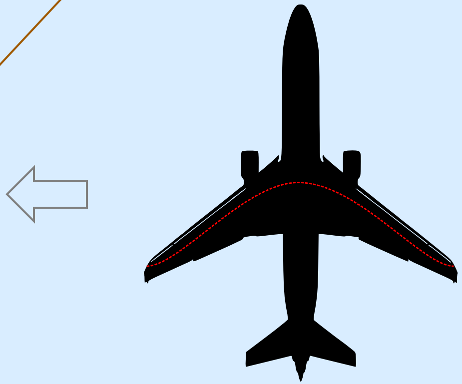




Influence is finite only if the bound vortex has **no curvature**

Influence is finite only if the trailing vortices are **perpendicular** to locus of aerodynamic centers





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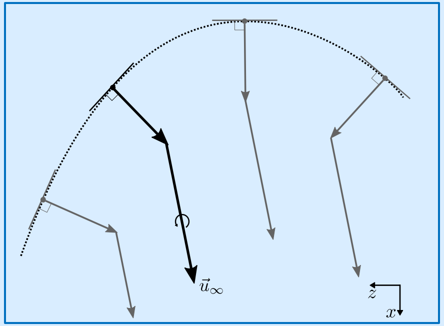
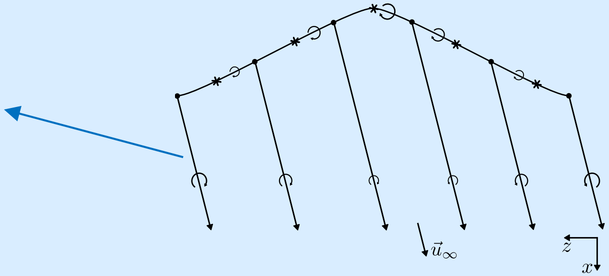
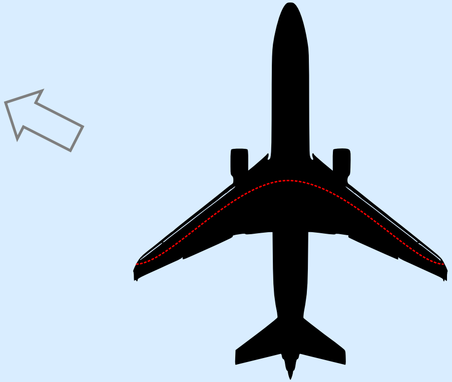


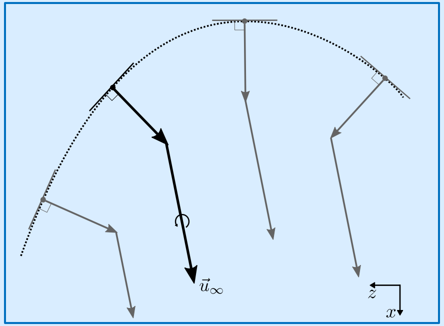


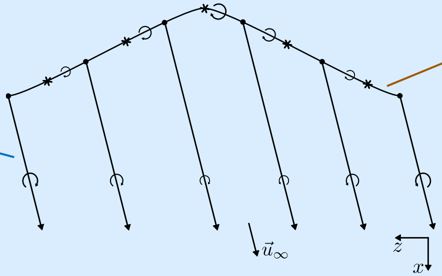


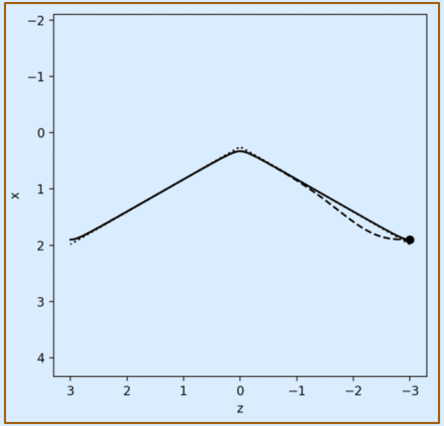
Jointed Trailing Vortices:

- Finite vortex segment perpendicular to LAC
- Semi-infinite vortex aligned with freestream

Influence of Vortices







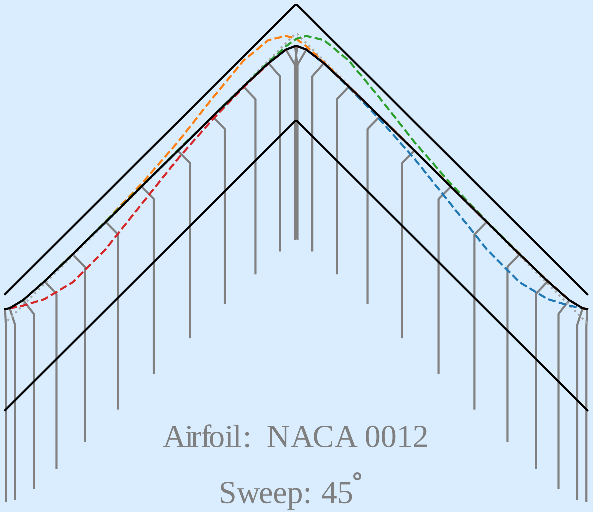
Jointed Trailing Vortices:

- Finite vortex segment perpendicular to LAC
- Semi-infinite vortex aligned with freestream

Effective Loci of Aerodynamic Centers:

- No concavity at control point
- Blend between tangent line and original LAC

General Implementation Accuracy



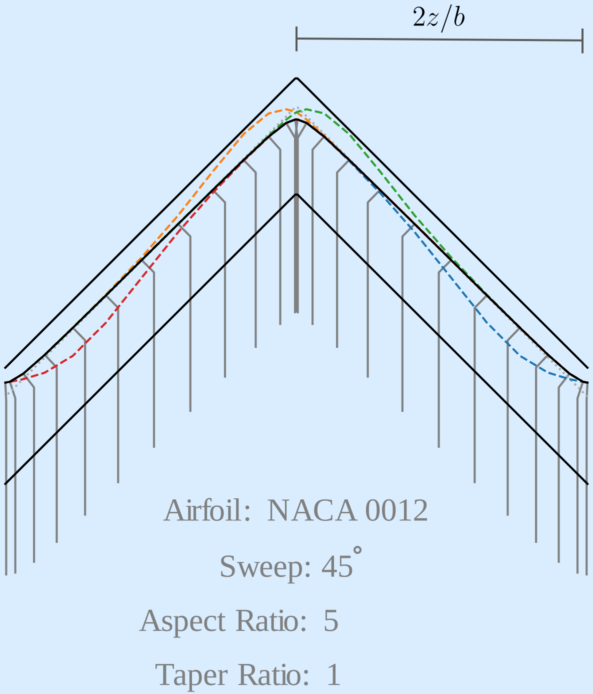
Airfoil: NACA 0012

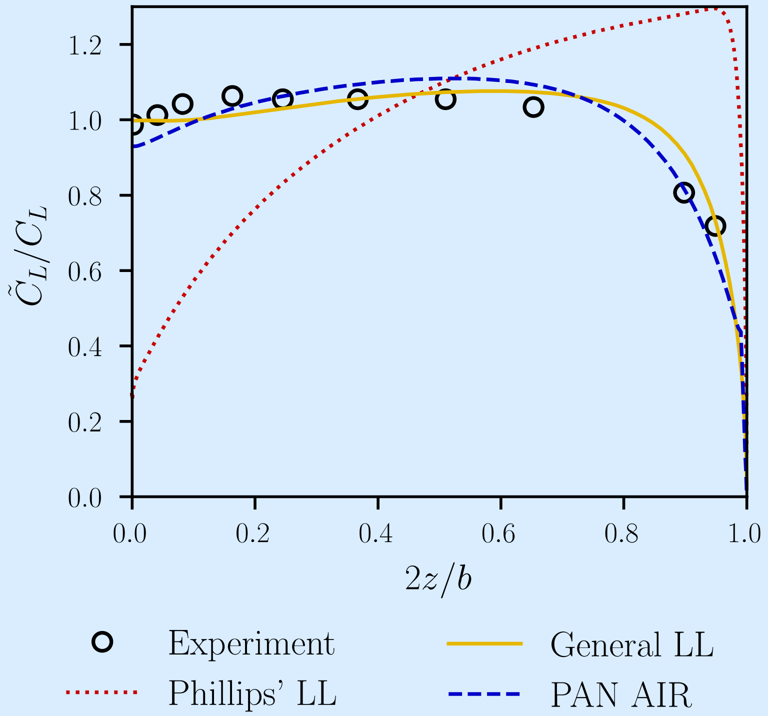
Sweep: 45°

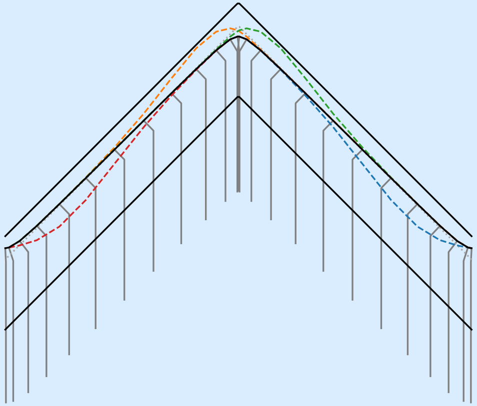
Aspect Ratio: 5

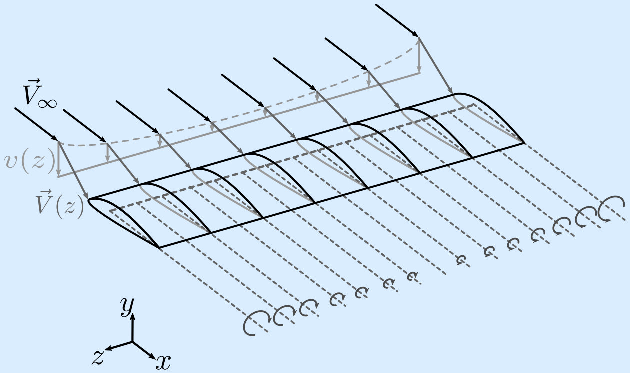
Taper Ratio: 1

General Implementation Accuracy









Thank You

For More Information:

Reid, Jackson T. and Hunsaker, Douglas F., *"A General Approach to Lifting-Line Theory, Applied to Wings with Sweep"*, AIAA SciTech Forum and Exposition, January 2020, https://doi.org/10.2514/6.2020-1287

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