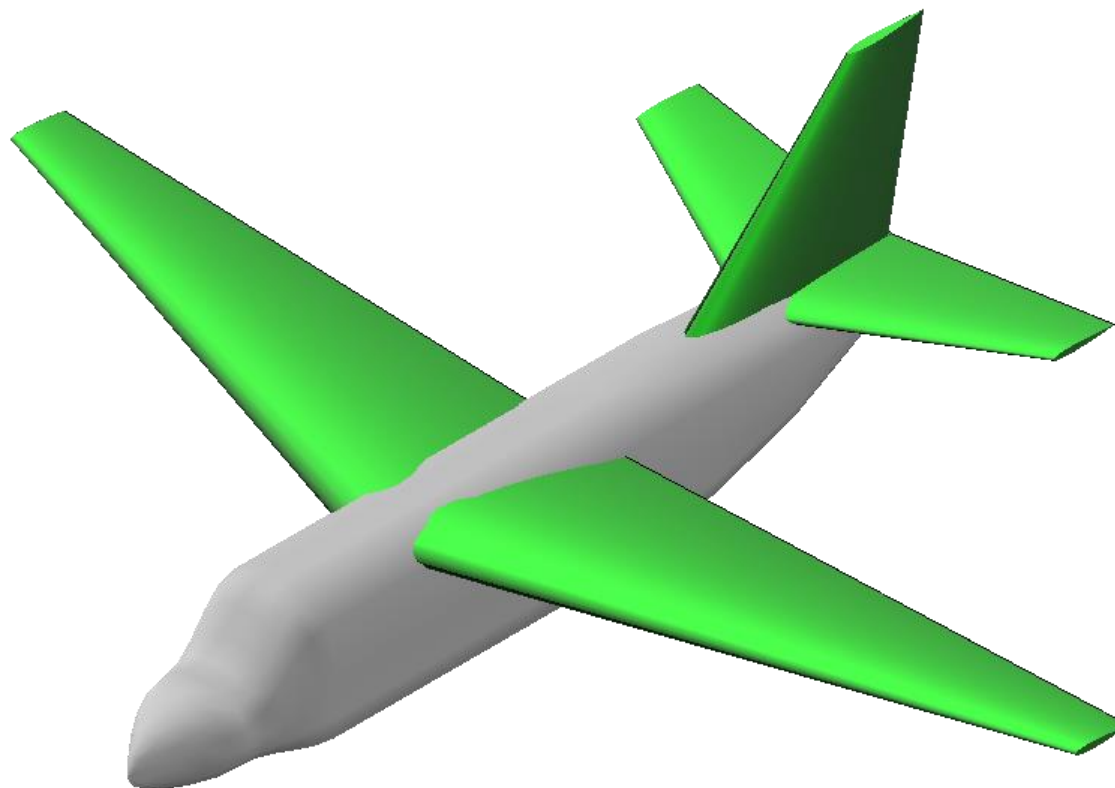


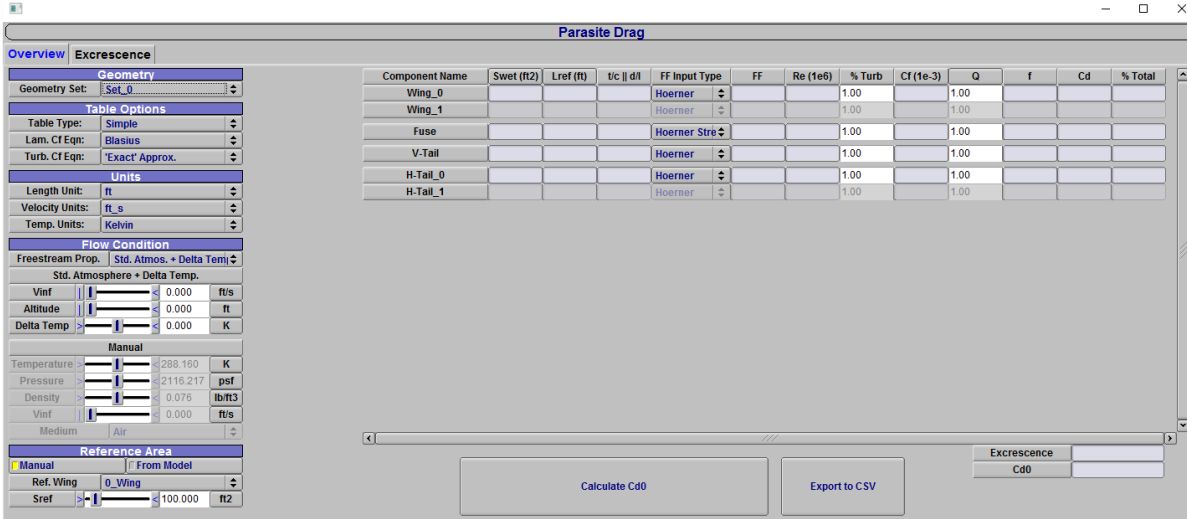
VSP Workshop 2016

OpenVSP – Parasite Drag Build Up



Presented by:
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- Uses existing geometry, equations for friction coefficient, form factor equations, and flow conditions to create a full parasitic drag build up of the selected components
- Research done to give user plenty of options for calculated friction coefficient and calculated form factor
 - However, manual input is also available
- User can freestream flow parameters manual or use a standard atmosphere model
- Exports table data to organized CSV file



The screenshot displays the 'Parasite Drag' software interface. On the left, there are several configuration panels: 'Geometry' (Set_0), 'Table Options' (Simple, Blasius, Exact Approx.), 'Units' (ft, ft/s, Kelvin), 'Flow Condition' (Std. Atmosphere + Delta Temp), and 'Reference Area' (Manual, 0_Wing, 100,000 ft²). The main area features a table with the following data:

Component Name	Swet (ft ²)	Lref (ft)	t/c dl	FF Input Type	FF	Re (1e6)	% Turb	Cf (1e-3)	Q	f	Cd	% Total
Wing_0				Hoerner			1.00		1.00			
Wing_1				Hoerner			1.00		1.00			
Fuse				Hoerner Stre			1.00		1.00			
V-Tail				Hoerner			1.00		1.00			
H-Tail_0				Hoerner			1.00		1.00			
H-Tail_1				Hoerner			1.00		1.00			

At the bottom, there are buttons for 'Calculate Cd0' and 'Export to CSV', along with a display for 'Excessance Cd0'.

Friction Coefficient Equations Used

- Laminar:
 - Blasius
- Turbulent:
 - “Fluid-Dynamic Drag” by S. F. Hoerner
 - Prandtl-Karman
 - Approximate Schoenherr
 - Intrinsic Schoenherr
 - Schultz-Grunow 1
 - “A Simple New Analysis of Compressible Turbulent Two-Dimensional Skin Friction Under Arbitrary Conditions” by F. M. White and G. H. Christoph
 - Schultz-Grunow 2
 - Blasius Power Law
 - Intrinsic Von-Karman
 - Prandtl-Schlichting
 - White-Christoph Best Fit
 - White-Christoph w/ Heat Transfer
 - “Viscous Fluid Flow” by Frank M. White
 - White Power Law
 - Prandtl Power Law
 - ‘Exact’ Solution
 - White w/ Roughness
 - Schlichting w/ Roughness
 - “Thrust and Drag: Its Prediction and Verification” by Eugene E. Covert
 - Intrinsic Karman-Schoenherr

Form Factor Equations Used

- **Wing:**
 - “Zero Lift Drag and Drag Divergence Prediction for Finite Wings in Aircraft Design” – AIAA Paper
 - EDET Conventional
 - EDET Advanced
 - DATCOM
 - Hoerner
 - Williams
 - Kroo
 - Torenbeek
 - “Thrust and Drag: Its Prediction and Verification” by Eugene E. Covert
 - Covert
- **Body:**
 - “Thrust and Drag: Its Prediction and Verification” by Eugene E. Covert
 - Covert Body
 - Covert Nacelle
 - “Fluid Dynamic Drag” by S.F. Hoerner
 - Hoerner Streamlined
 - “Synthesis of Subsonic Airplane Design” by E. Torenbeek
 - Torenbeek
 - Shevell

- Able to pull S_{wet} and L_{ref} directly from individual geometries
- Copies any geoms created through symmetry, copying any user inputs
- Optional inputs for surface roughness and heat transfer ratios
- Can pull S_{ref} directly from model or manually input
- Excrescence drag input for additional factors not captured in VSP geometry
- Export to organized CSV file

Parasite Drag

Overview Excrescence

Geometry Set: Set_0

Table Options

Table Type: Simple
Lam. Cf Eqn: Blasius
Turb. Cf Eqn: 'Exact' Approx.

Units

Length Unit: ft
Velocity Units: ft_s
Temp. Units: Kelvin

Flow Condition

Freestream Prop.: Std. Atmos. + Delta Temp
Std. Atmosphere + Delta Temp.

Vinf: 0.000 ft/s
Altitude: 0.000 ft
Delta Temp: 0.000 K

Manual

Temperature: 288.160 K
Pressure: 2116.217 psf
Density: 0.076 lb/ft3
Vinf: 0.000 ft/s
Medium: Air

Reference Area

Manual From Model
Ref. Wing: 0_Wmg
Sref: 100.000 ft2

Component Name	Swet (ft2)	Lref (ft)	t/c d/l	FF Input Type	FF	Re (1e6)	% Turb	Cf (1e-3)	Q	f	Cd	% Total
Wing_0				Hoerner			1.00		1.00			
Wing_1				Hoerner			1.00		1.00			
Fuse				Hoerner Stré			1.00		1.00			
V-Tail				Hoerner			1.00		1.00			
H-Tail_0				Hoerner			1.00		1.00			
H-Tail_1				Hoerner			1.00		1.00			

Excrescence Cd0

Calculate Cd0 Export to CSV

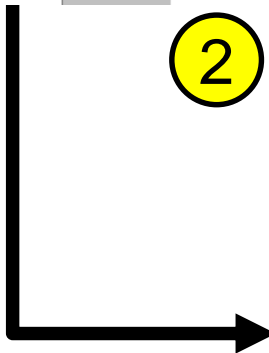
Order of Operations

Add and Edit Geoms

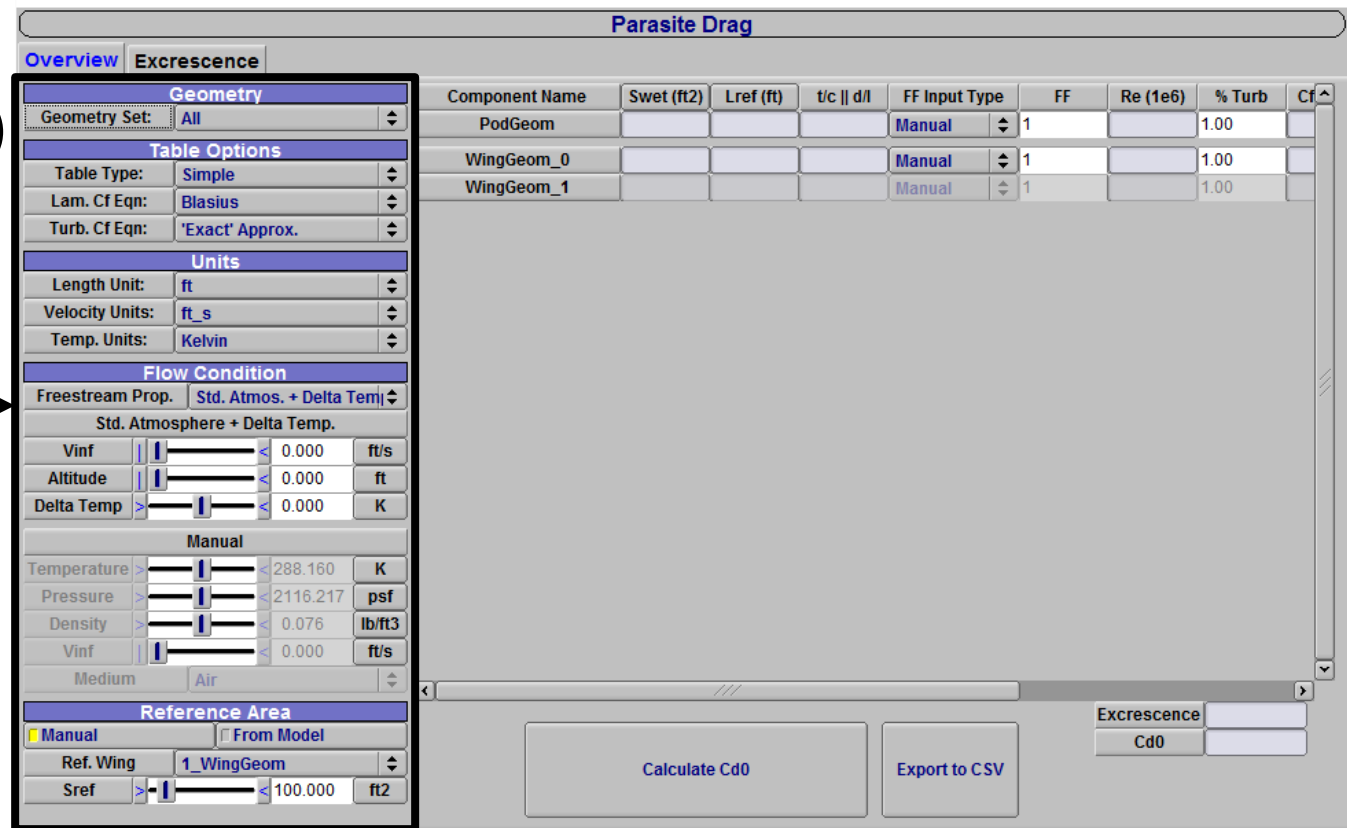
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Edit Options as Desired



Component Name	Swet (ft2)	Lref (ft)	t/c d/l	FF Input Type	FF	Re (1e6)	% Turb	Cf
PodGeom				Manual	1		1.00	
WingGeom_0				Manual	1		1.00	
WingGeom_1				Manual	1		1.00	

Geometry

Geometry Set: All

Table Options

Table Type: Simple

Lam. Cf Eqn: Blasius

Turb. Cf Eqn: 'Exact' Approx.

Units

Length Unit: ft

Velocity Units: ft_s

Temp. Units: Kelvin

Flow Condition

Freestream Prop. Std. Atmos. + Delta Temp

Std. Atmosphere + Delta Temp.

Vinf: 0.000 ft/s

Altitude: 0.000 ft

Delta Temp: 0.000 K

Manual

Temperature: 288.160 K

Pressure: 2116.217 psf

Density: 0.076 lb/ft3

Vinf: 0.000 ft/s

Medium: Air

Reference Area

Manual (checked) From Model

Ref. Wing: 1_WingGeom

Sref: 100.000 ft2

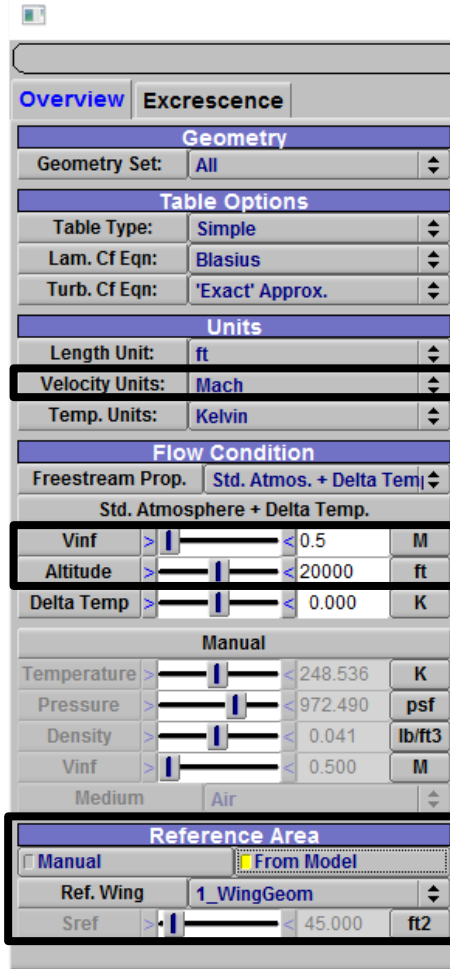
Buttons: Calculate Cd0, Export to CSV

Output: Excrescence Cd0

Order of Operations – Cont.

Options as Desired

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Geometry

Geometry Set: All

Table Options

Table Type: Simple

Lam. Cf Eqn: Blasius

Turb. Cf Eqn: 'Exact' Approx.

Units

Length Unit: ft

Velocity Units: Mach

Temp. Units: Kelvin

Flow Condition

Freestream Prop. Std. Atmos. + Delta Temp

Std. Atmosphere + Delta Temp.

Vinf: 0.5 M

Altitude: 20000 ft

Delta Temp: 0.000 K

Manual

Temperature: 248.536 K

Pressure: 972.490 psf

Density: 0.041 lb/ft3

Vinf: 0.500 M

Medium: Air

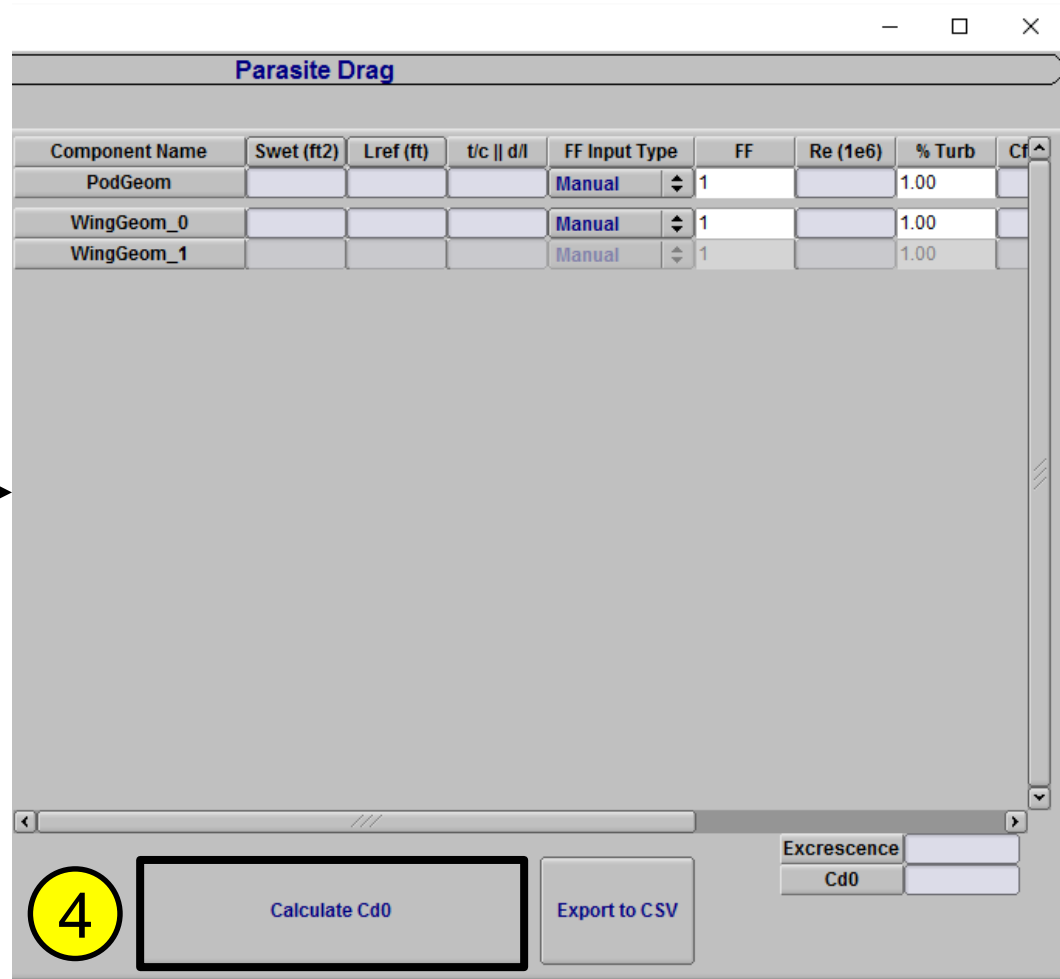
Reference Area

Manual From Model

Ref. Wing: 1_WingGeom

Sref: 45.000 ft2

Calculate Cd0



Parasite Drag

Component Name	Swet (ft2)	Lref (ft)	t/c d/l	FF Input Type	FF	Re (1e6)	% Turb	Cf
PodGeom				Manual	1		1.00	
WingGeom_0				Manual	1		1.00	
WingGeom_1				Manual	1		1.00	

Calculate Cd0 Export to CSV

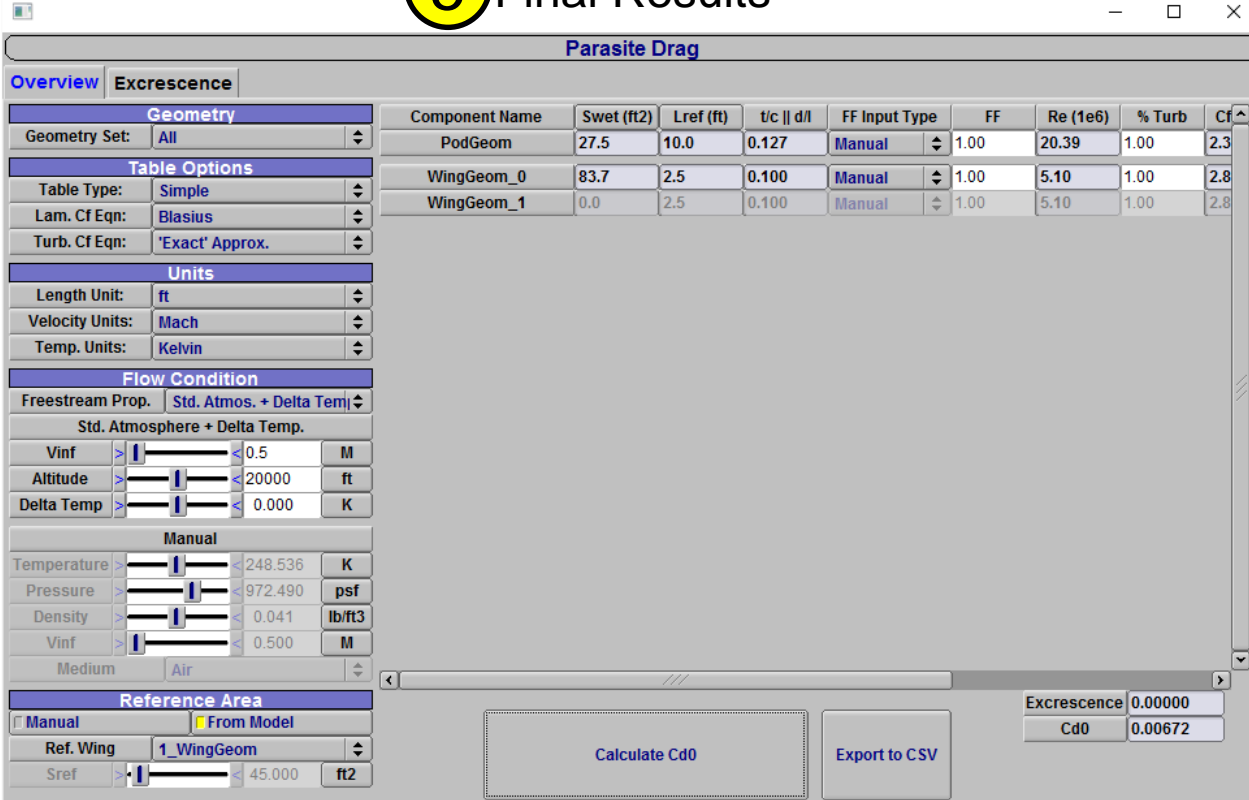
Excescence Cd0

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Order of Operations – Cont.

- Use scrollbar or expand window to see rest of data
- Press “Export to CSV” to output the data into an organized CSV file
- Changes to Freestream properties can be changed from here to witness changes to C_{d0}
- If Geoms are added, everything is cleared and must calculate again

5 Final Results



The screenshot shows the 'Parasite Drag' software interface. The 'Excrescence' tab is active, displaying a table of component drag data. The table has columns for Component Name, Swet (ft2), Lref (ft), t/c || d/l, FF Input Type, FF, Re (1e6), % Turb, and Cf. The data rows are PodGeom, WingGeom_0, and WingGeom_1.

Component Name	Swet (ft2)	Lref (ft)	t/c d/l	FF Input Type	FF	Re (1e6)	% Turb	Cf
PodGeom	27.5	10.0	0.127	Manual	1.00	20.39	1.00	2.3
WingGeom_0	83.7	2.5	0.100	Manual	1.00	5.10	1.00	2.8
WingGeom_1	0.0	2.5	0.100	Manual	1.00	5.10	1.00	2.8

Below the table, the 'Flow Condition' section shows freestream properties: Vinf (0.5 M), Altitude (20000 ft), and Delta Temp (0.000 K). The 'Reference Area' section shows Ref. Wing (1_WingGeom) and Sref (45.000 ft2). At the bottom right, the 'Excrescence' value is 0.00000 and the 'Cd0' value is 0.00672. There are buttons for 'Calculate Cd0' and 'Export to CSV'.

DEMO

Questions?

Contact Information

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