Dragon Eye

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AOE 4124 Configuration
Aerodynamics

Outline

- Purpose/Mission
- Air Vehicle Configuration
- Airfoil Data
- Planform Data
- Aerodynamic Characteristics
- Assessment

Purpose / Mission:

- Real-Time Imagery Data
- Single Company / Platoon Deployment
- Complete light-weight ready-to-use as delivered system
- Point reconnaissance.
- Area reconnaissance (less than point).
- Confirmation of other intelligence sources.
- Investigation of the situation in a city before entry.
- Reconnaissance of bridges and routes with patrols, and from towns.
- Identification of forces that were firing on them.
- Battle damage assessment.
- During a convoy movement.

Dragon Eye:

Naval Research Laboratory: Washington, D.C.

http://www.mcwl.quantico.usmc.mil/events/index.asp

AOE 4124 Configuration
Aerodynamics

Air Vehicle:

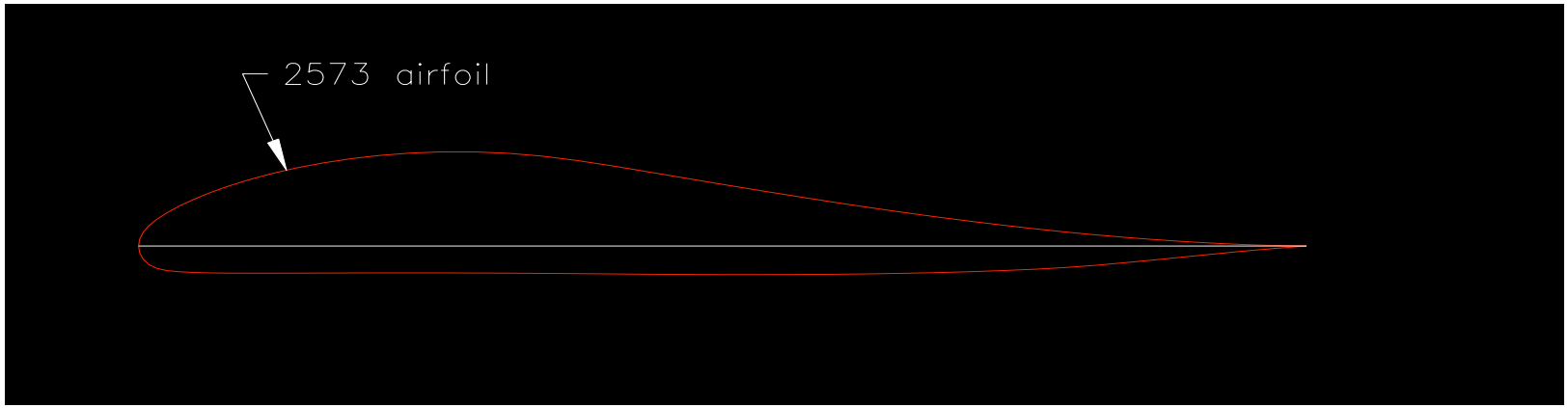
- Airframe
  - Comprised of Kevlar based composite systems.
  - Comprised of 5 pieces that can be assembled in under 5 minutes.
- Propulsion
  - Two small electric motors (props)
- Autonomous flight capability
- Payloads
  - Day time color, low-light level, and infrared cameras

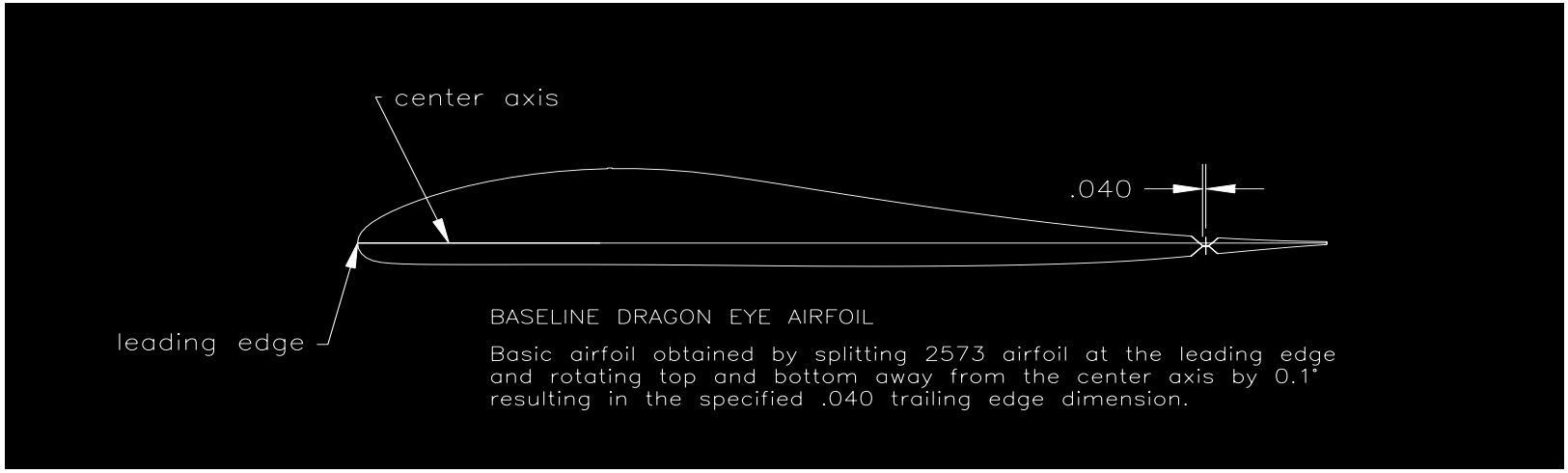
http://www.livingroom.org.au/uavblog/archives/dragon_eye_uav.php

Specifications:

- Wingspan – 45 in
- Chord – 12 in
- Operational Weight – 5 lbs
- Operational Radius – 3.1 mile
- Combat Radius – 6.2 miles
- Altitude – 300 to 500 ft
- Operational Speed – 35 kts

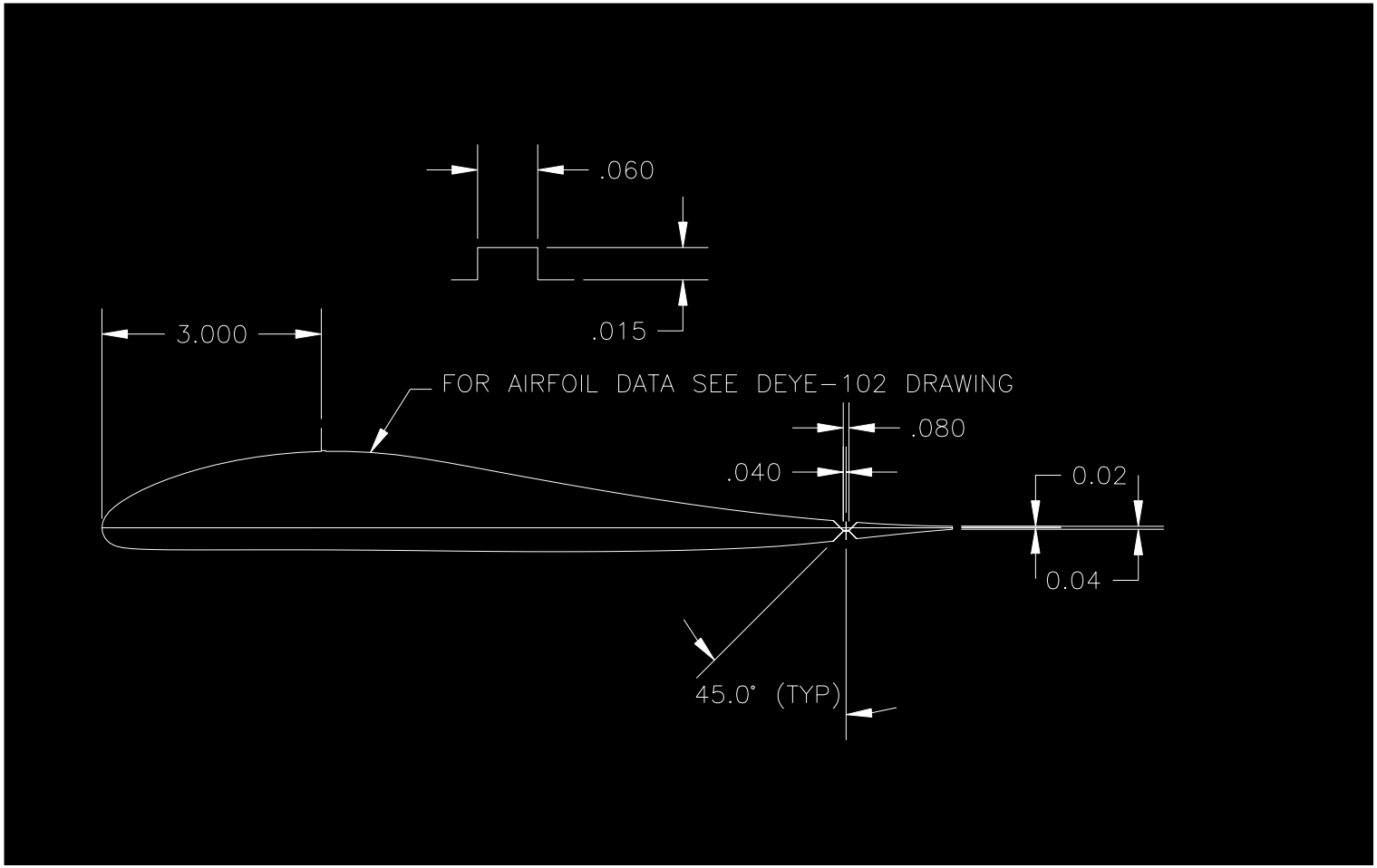
Airfoil Data:





CADD from N.R.L

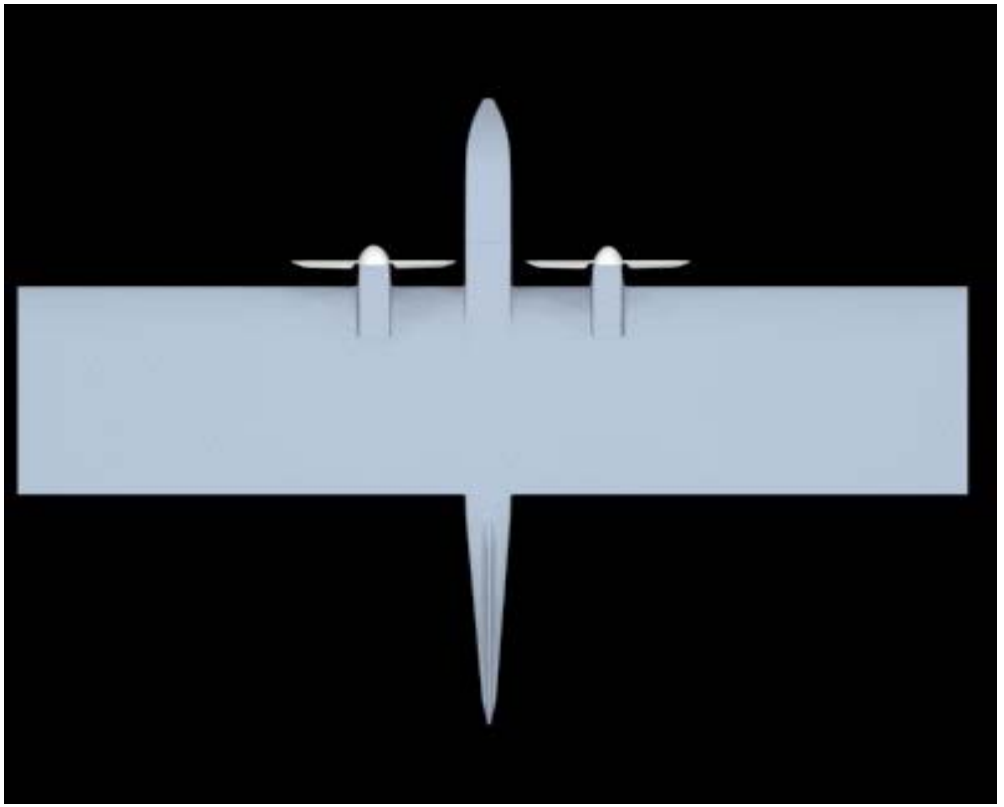
Airfoil Data (cont.):



CADD from N.R.L

Planform Characteristics:

- Rectangular Wing
- No Twist
- Simplicity is the Key!



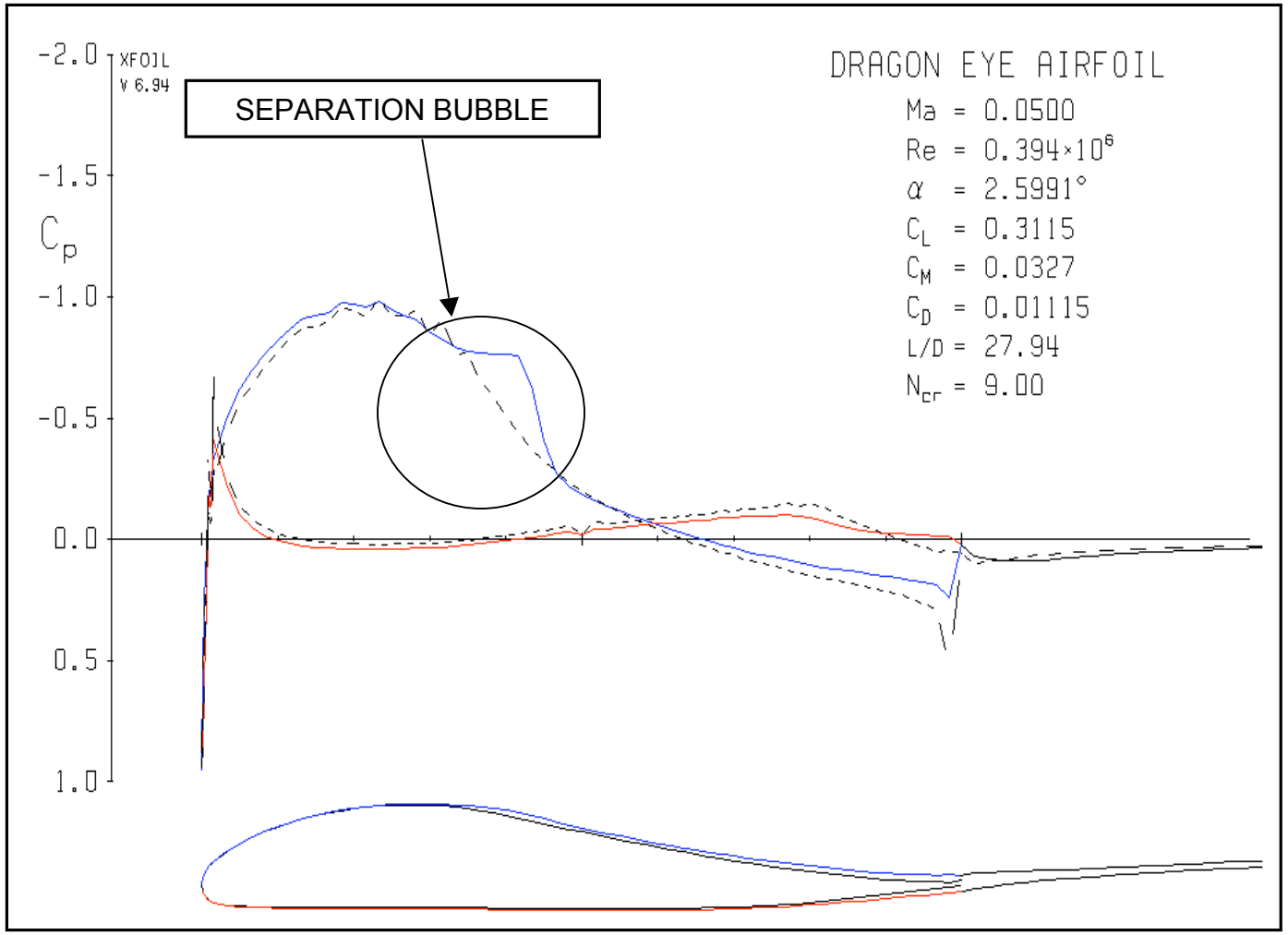
http://www.turbosquid.com/HTMLClient/FullPreview/FullPreview.cfm/ID/199104/Action/FullPreview

Aerodynamic Parameters:

- $C_{Lcruise\ 2D} = 0.31$
- $C_{Lcruise\ 3D} = 0.2804$
- $C_{Lmax\ 2D} = 1.2719$
- $C_{Lmax\ 3D} = 1.1447$
- $M_{cruise} = 0.05$
- Span e = 0.98 (from LIDrag)

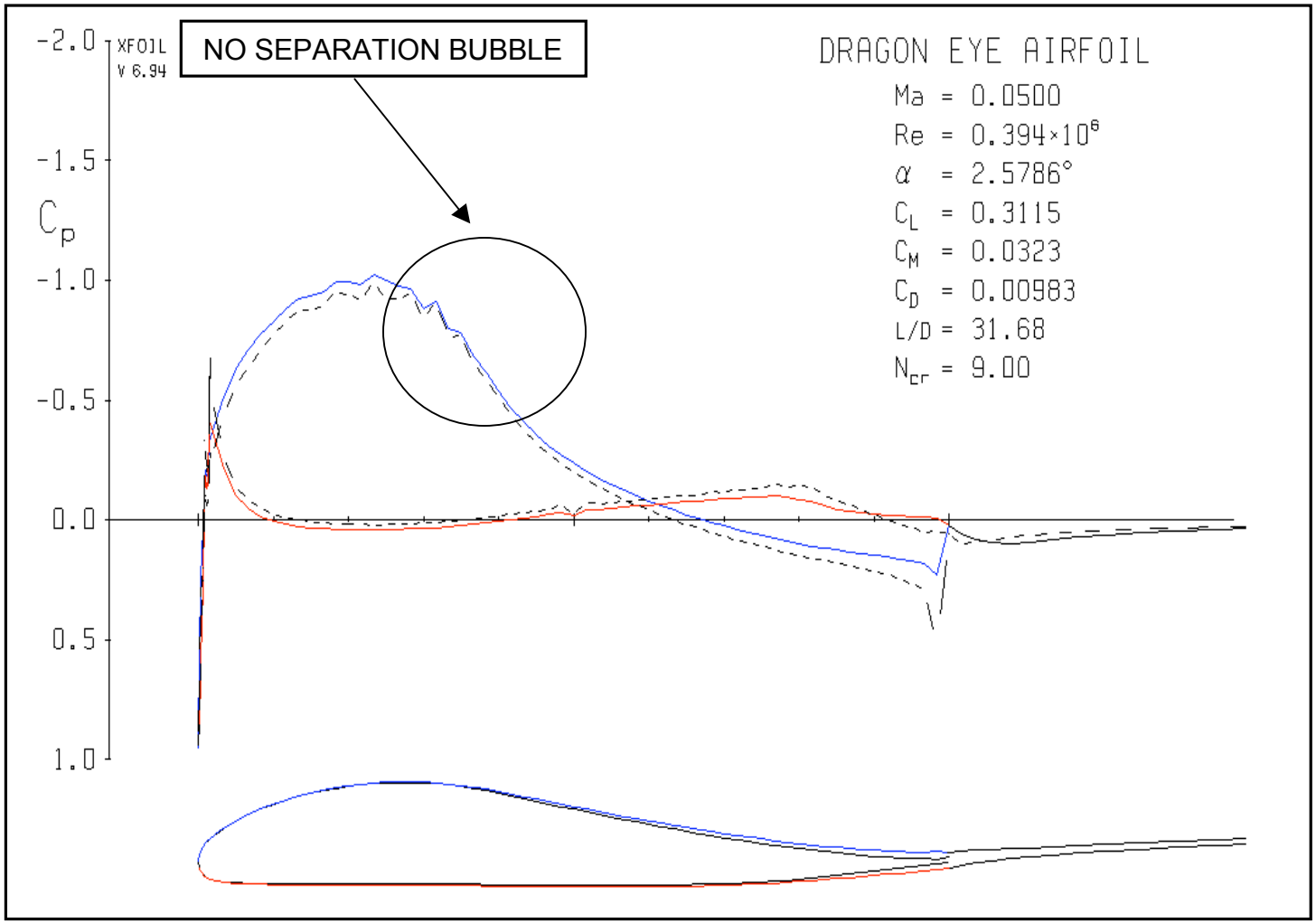
C_l Cruise

w/o Boundary Layer Trip



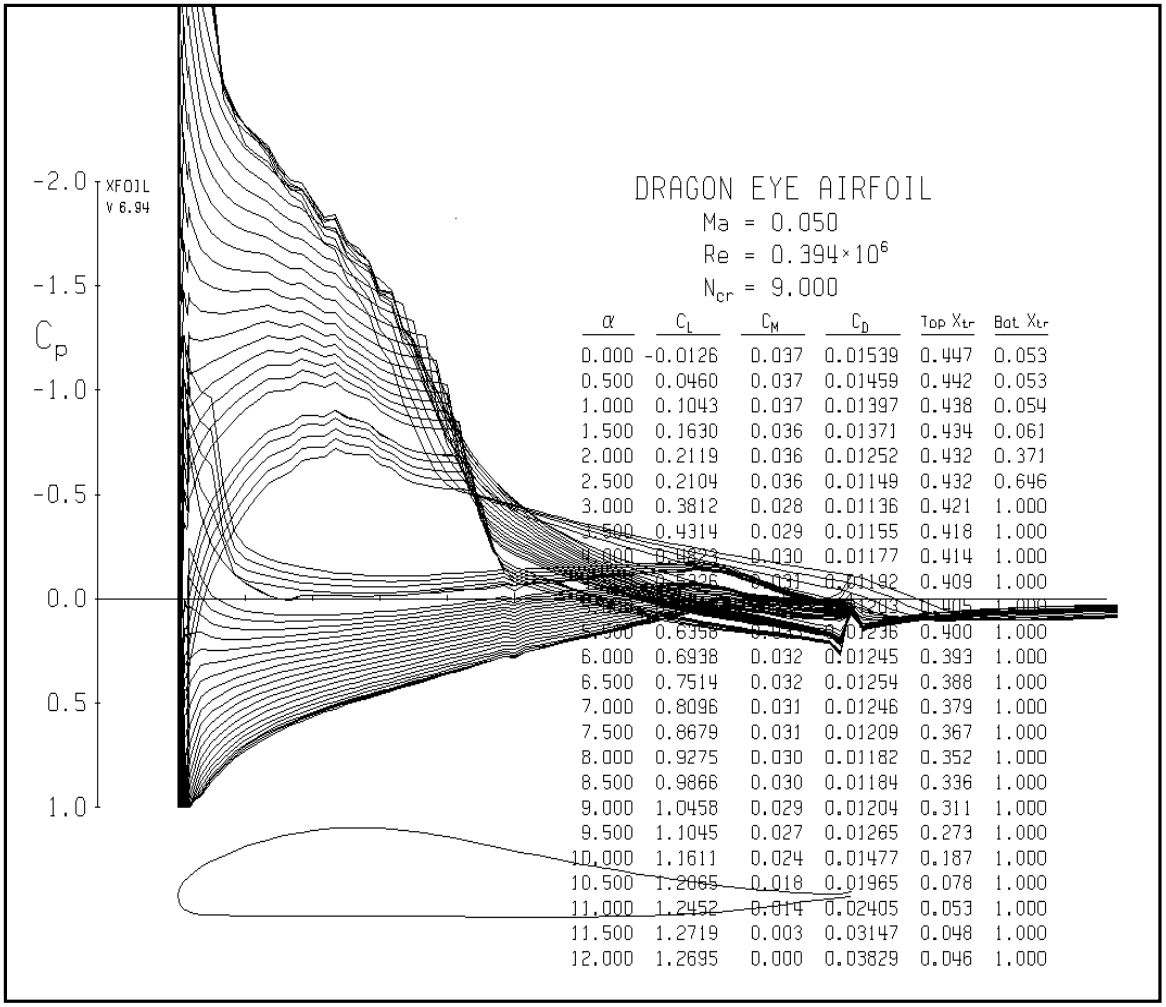
C_l Cruise

Boundary Layer Trip at 25% c



Alpha Sweep

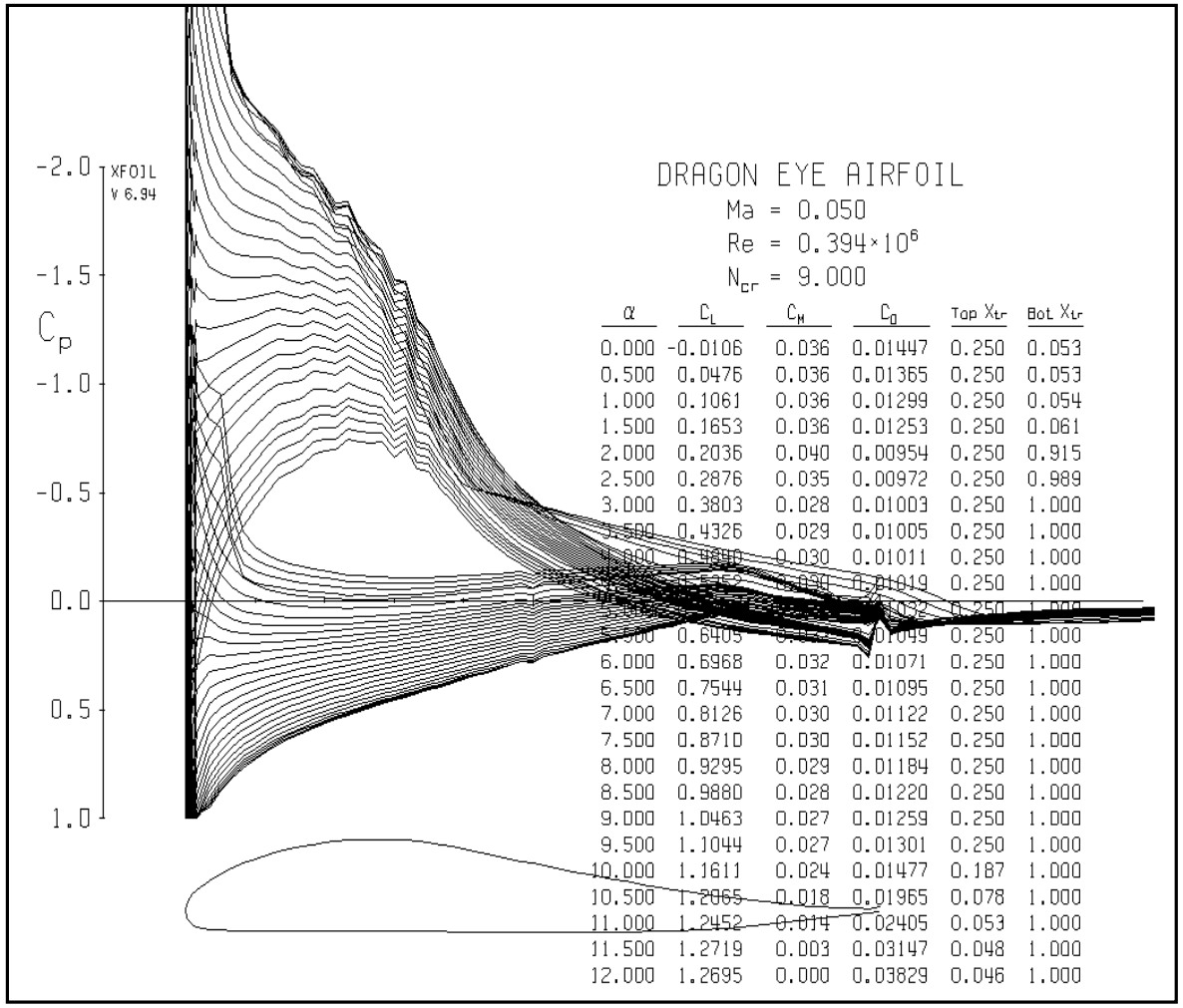
w/o trip



α	C_L	C_M	C_D	Top X_{tr}	Bot X_{tr}
0.000	-0.0126	0.037	0.01539	0.447	0.053
0.500	0.0460	0.037	0.01459	0.442	0.053
1.000	0.1043	0.037	0.01397	0.438	0.054
1.500	0.1630	0.036	0.01371	0.434	0.061
2.000	0.2119	0.036	0.01252	0.432	0.371
2.500	0.2104	0.036	0.01149	0.432	0.646
3.000	0.3812	0.028	0.01136	0.421	1.000
3.500	0.4314	0.029	0.01155	0.418	1.000
4.000	0.4823	0.030	0.01177	0.414	1.000
4.500	0.5325	0.031	0.01192	0.409	1.000
5.000	0.5825	0.031	0.01213	0.405	1.000
5.500	0.6350	0.031	0.01236	0.400	1.000
6.000	0.6938	0.032	0.01245	0.393	1.000
6.500	0.7514	0.032	0.01254	0.388	1.000
7.000	0.8096	0.031	0.01246	0.379	1.000
7.500	0.8679	0.031	0.01209	0.367	1.000
8.000	0.9275	0.030	0.01182	0.352	1.000
8.500	0.9866	0.030	0.01184	0.336	1.000
9.000	1.0458	0.029	0.01204	0.311	1.000
9.500	1.1045	0.027	0.01265	0.273	1.000
10.000	1.1611	0.024	0.01477	0.187	1.000
10.500	1.2065	0.018	0.01965	0.078	1.000
11.000	1.2452	0.014	0.02405	0.053	1.000
11.500	1.2719	0.003	0.03147	0.048	1.000
12.000	1.2695	0.000	0.03829	0.046	1.000

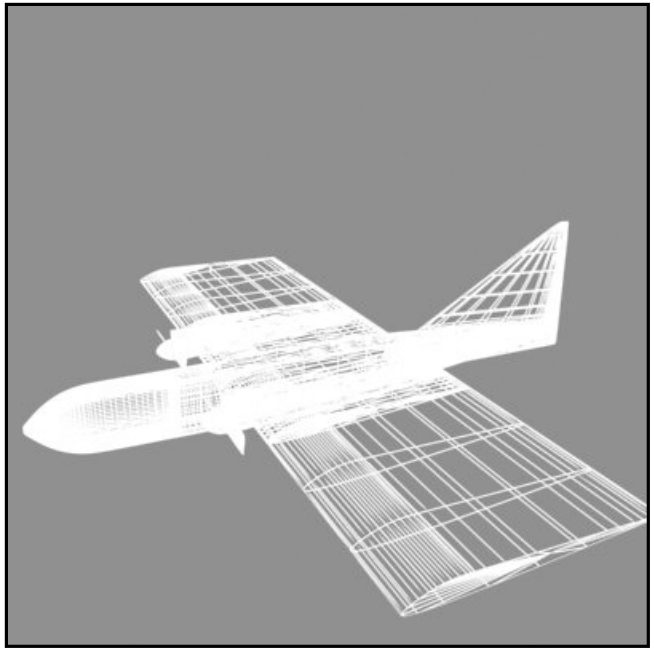
Alpha Sweep

trip at 25% c



α	C_L	C_M	C_D	Top X_{tr}	Bot X_{tr}
0.000	-0.0106	0.036	0.01447	0.250	0.053
0.500	0.0476	0.036	0.01365	0.250	0.053
1.000	0.1061	0.036	0.01299	0.250	0.054
1.500	0.1653	0.036	0.01253	0.250	0.061
2.000	0.2036	0.040	0.00954	0.250	0.915
2.500	0.2876	0.035	0.00972	0.250	0.989
3.000	0.3803	0.028	0.01003	0.250	1.000
3.500	0.4326	0.029	0.01005	0.250	1.000
4.000	0.4890	0.030	0.01011	0.250	1.000
4.500	0.5452	0.030	0.01019	0.250	1.000
5.000	0.5917	0.031	0.01032	0.250	1.000
5.500	0.6405	0.032	0.01049	0.250	1.000
6.000	0.6968	0.032	0.01071	0.250	1.000
6.500	0.7544	0.031	0.01095	0.250	1.000
7.000	0.8126	0.030	0.01122	0.250	1.000
7.500	0.8710	0.030	0.01152	0.250	1.000
8.000	0.9295	0.029	0.01184	0.250	1.000
8.500	0.9880	0.028	0.01220	0.250	1.000
9.000	1.0463	0.027	0.01259	0.250	1.000
9.500	1.1044	0.027	0.01301	0.250	1.000
10.000	1.1611	0.024	0.01477	0.187	1.000
10.500	1.2065	0.018	0.01965	0.078	1.000
11.000	1.2452	0.014	0.02405	0.053	1.000
11.500	1.2719	0.003	0.03147	0.048	1.000
12.000	1.2695	0.000	0.03829	0.046	1.000

Planform Analysis



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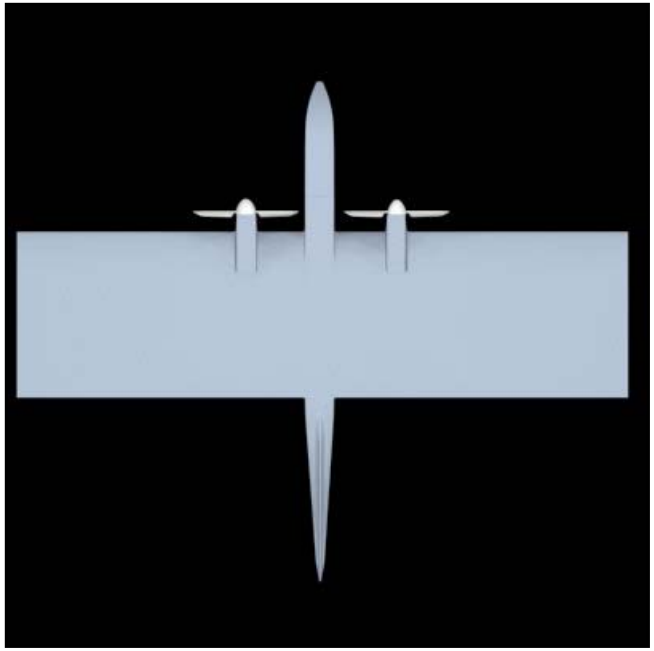

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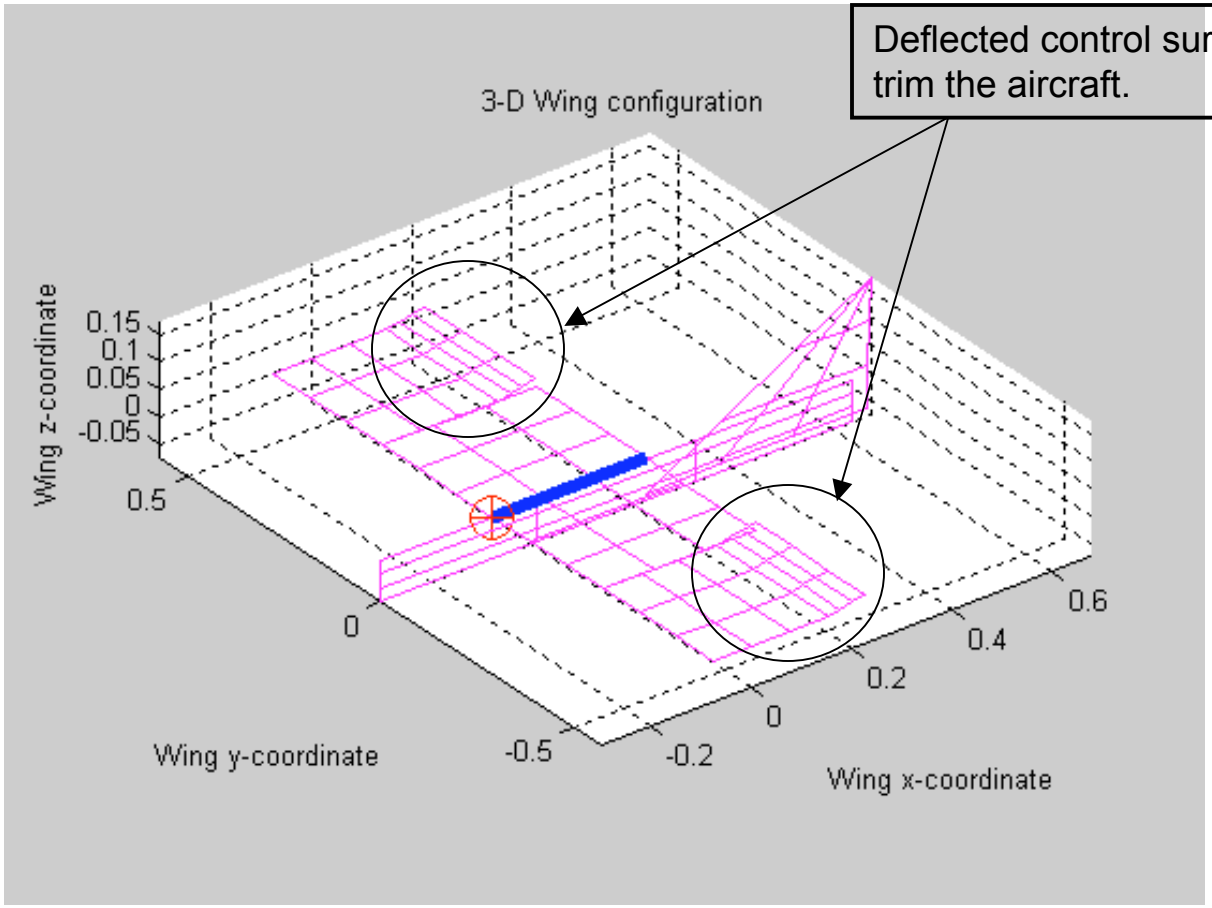
Tornado Analysis Model



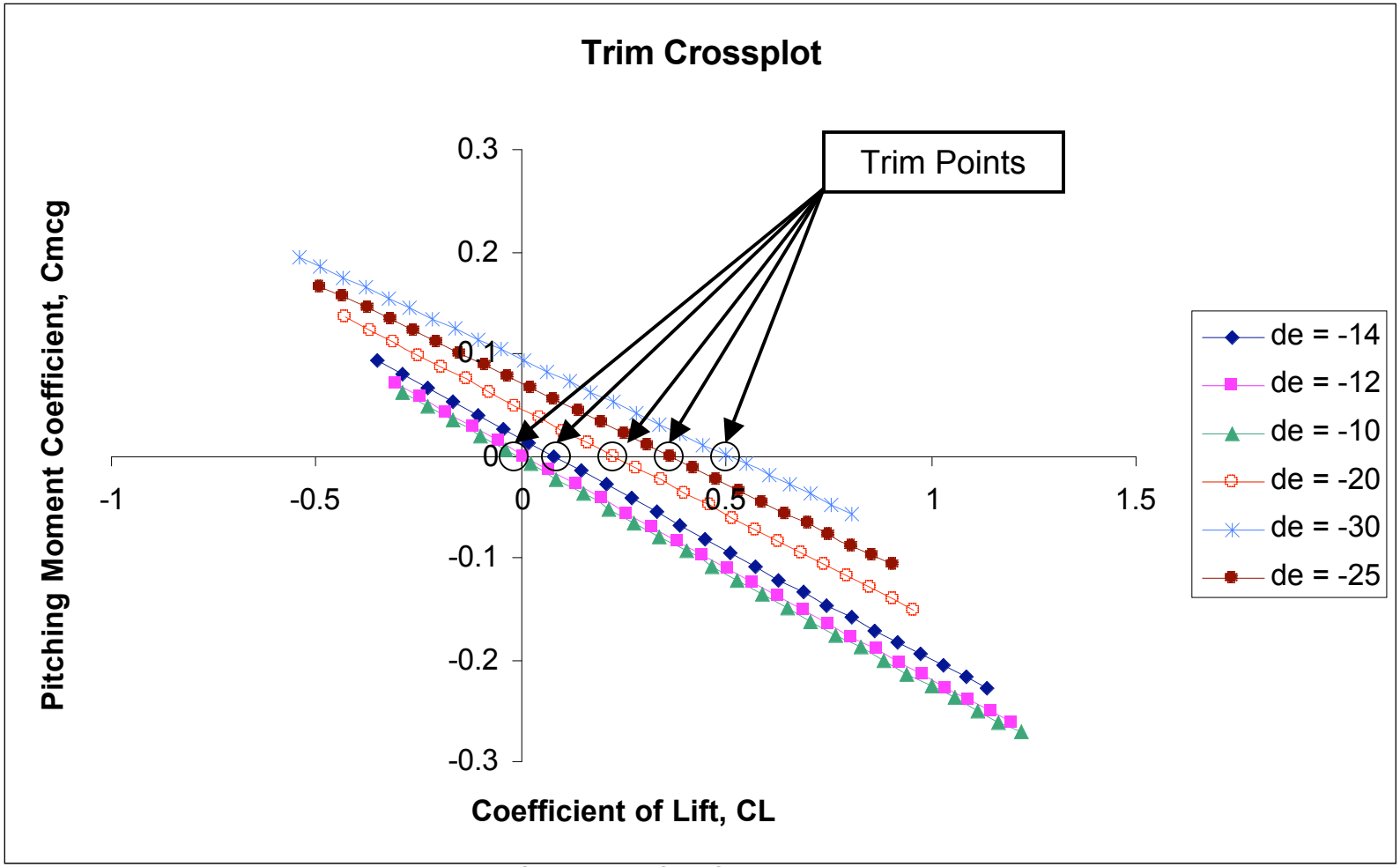
Longitudinal Stability

Software	C_{mo}	$\delta Cm/\delta C_L$	$\delta C_m/\delta\alpha$
Tornado	0.07	-0.1969	-0.301
VLMpc	0.00398	-1.0359	-0.0111

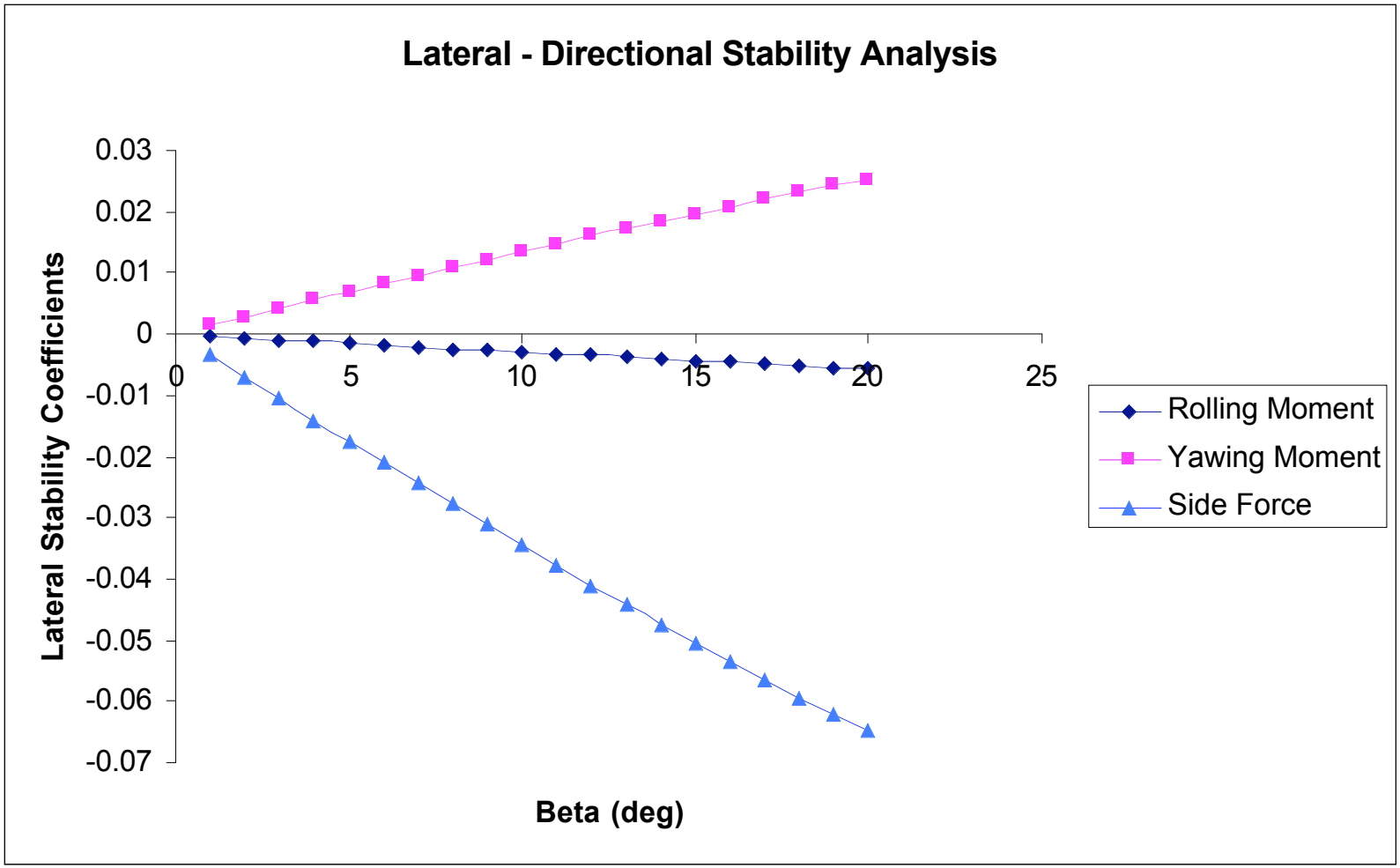
The reason for the discrepancy in the results obtained from Tornado and VLM4998 result from the fact that the model of Dragon Eye created in tornado was able to estimate the reflex of the airfoil sections by deflection of the trailing-edge flaps. In order to obtain more accurate results the reflex that the Dragon Eye UAV has must be correctly modeled.

Tornado showed that the control surfaces must be deflected to -25 degrees in order to obtain the required $C_{Lcruise}$ of 0.3115 at trim. This deflection also serves as a rough estimate of the reflex and the required control surface deflection for trim.

Lift Coefficient vs. Moment Coefficient



Lateral-Directional Stability



Drag Analysis:

$$C_{DO} = C_{DF} + C_{DForm}$$

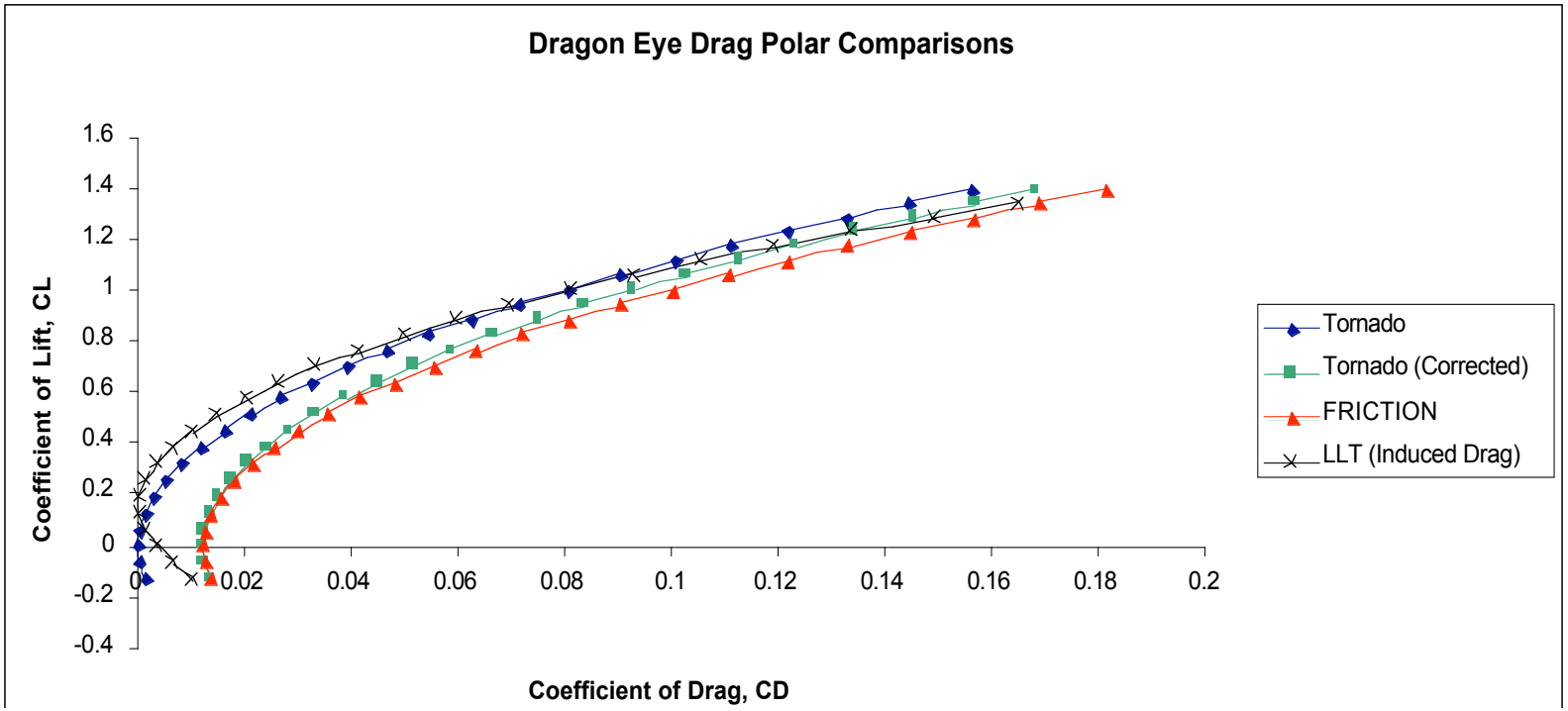
$$C_D = C_{Do} + \frac{C_L^{\,2}}{\pi A \,\mathrm{Re}}$$

$$C_D = 0.01233 + 0.086614935 * C_L^{\,2}$$

The drag analysis was completed with the use of *Tornado, FRICTION and Lifting Line Theory.*

C_{DF}	0.01005
C_{DForm}	0.00228
C_{Do}	0.01233

Drag Polar Comparison



Assessment

- "The true value of it is that it's right there in the hand of the guy who needs the info and needs the intel," said Col. Jim Howcroft, who served as the intelligence officer for the 1st Marine Division in Iraq. "It was literally in his hip pocket … and gives him info on what he wants to find and gets it back, no kidding, as it's flying."
- "It's somewhat fragile … and its range isn't huge"

  By Sandra Jontz, Stars and Stripes
  European edition, Friday, January 23, 2004
- Increased range and endurance would be considered desirable—provided there is no increase to weight of air vehicle

  Department of the Navy (OIF feedback)

Department of the Navy

References

- Carruthers, Steven. Naval Research Laboratory.
- Bryant, John. Naval Research Laboratory.
- http://www.composites.sparta.com/uav.htm
- http://www.mcwl.quantico.usmc.mil/events/index.asp (mission)
- http://www.mcwl.quantico.usmc.mil/divisions/expplans/dragon_eye_employment.pdf
- http://www.turbosquid.com/FullPreview/Index.cfm/ID/199104/Action/FullPreview
- “Stars and Stripes” European edition, Friday, January 23, 2004