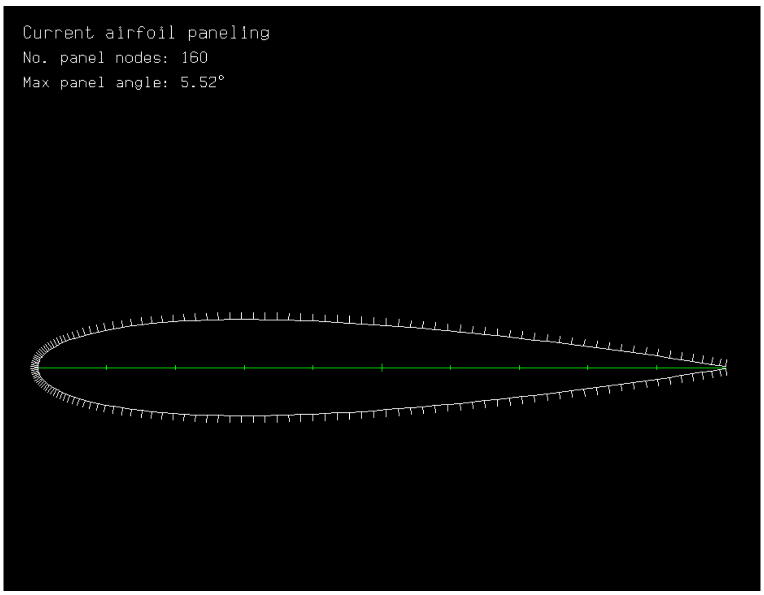
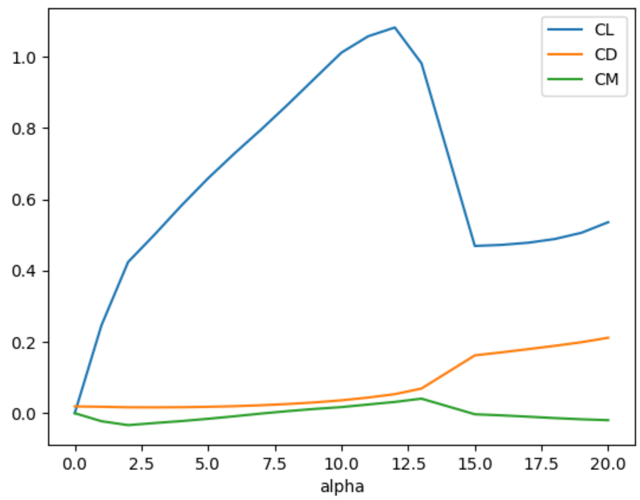
Aerodynamics Activity

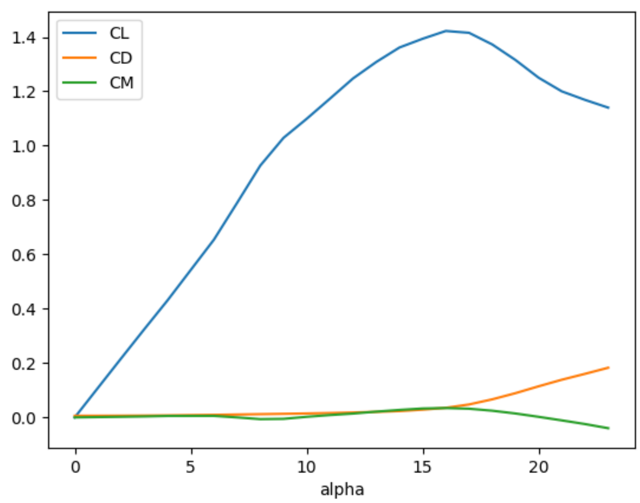
Micaiah Smith-Pierce, Yohannes Kasseya

18-Feb-2017

- 

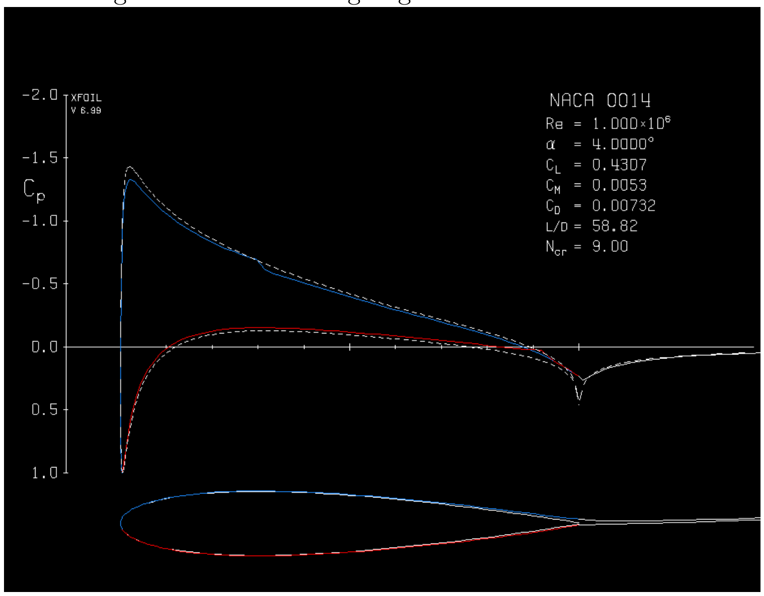
- The program clearly predicts stall. At approximately $\alpha = 12$ for $Re = 10^5$ and $\alpha = 15$ for $Re = 10^6$ C_L drops sharply, and shortly after that, C_D rises dramatically. C_M is also affected.



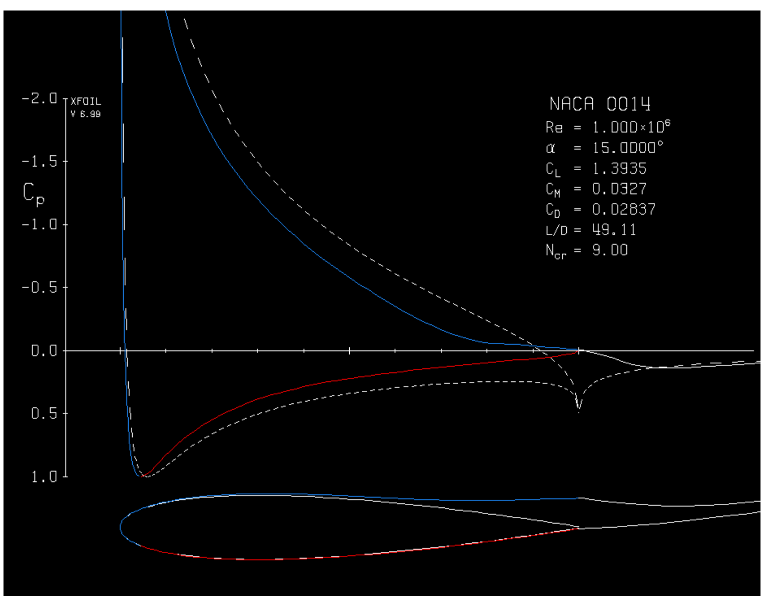


- The data set was restricted to the linear regime and a linear fit calculated using the `polyfit` function from Python's `numpy` library. In order to calculate the $C_{L\alpha}$ quoted here slope of said best fit line was converted from degrees to radians.
  - $Re = 10^5 : C_{L\alpha} = 4.70$
  - $Re = 10^6 : C_{L\alpha} = 5.40$
- For one thing, at every point along the chord, the pressure coefficient on the upper surface is less than on the lower surface. In addition, the

difference is largest near the leading edge and smallest near the trailing edge.



- The distribution is considerably different. The C_P near the trailing edge is approximately zero instead of being positive. In general, the fact that the C_P deviates heavily from the inviscid prediction (dashed line) indicates stall. However, the airfoil does not appear to be completely stalled, since the C_P is close to the inviscid prediction near the leading edge, and the C_L is still near C_{Lmax}.



- In order to complete the rest of the assignment, it is necessary to know some properties of the airplane. The assignment contained no information as to what airplane to use besides a single reference to "this airplane". It is assumed that the assignment is referring to the SST that our class has been designing, and the SST's values were used in the assignment. I hope that we correctly inferred the intent of the problem. In addition, the air density at 2500m was taken from the atmosphere assignment. Below is a summary of the values which were imported from our previous assignments:

ρ	$0.9095 kg/m^3$
W	$1.62 * 10^6 N$
S	$324.20 m^2$
AR	4.94

- Let the speed for minimum drag be denoted V_{min}. The equation below was used to calculate it:

$$\left(\frac{W^2}{S^2 \rho^2 C_{D0} \pi A R e}\right)^{\frac{1}{4}}$$

- The following equations were also used:

$$C_L = \frac{2W}{\rho {V_{min}}^2 S}$$

$$C_{Di} = \frac{{C_L}^2}{\pi A R e}$$

$$D = (C_{D0} + C_{Di}) \frac{1}{2} \rho {V_{min}}^2 S$$

- We obtained the following values:

Re	V_{min}	C_L	D
10^5	$142.35 m/s$	0.55	$1.13 * 10^3 N$
10^6	$189.47 m/s$	0.31	$6.4 * 10^4 N$

- Using the equation explained in part (7) and the answeres from part 4, the lift curve slope is 0.0815 (in degrees) for $Re = 10^5$ and 0.104 for $Re = 10^6$. Using this, the respective α values are 6.74°and 2.97°