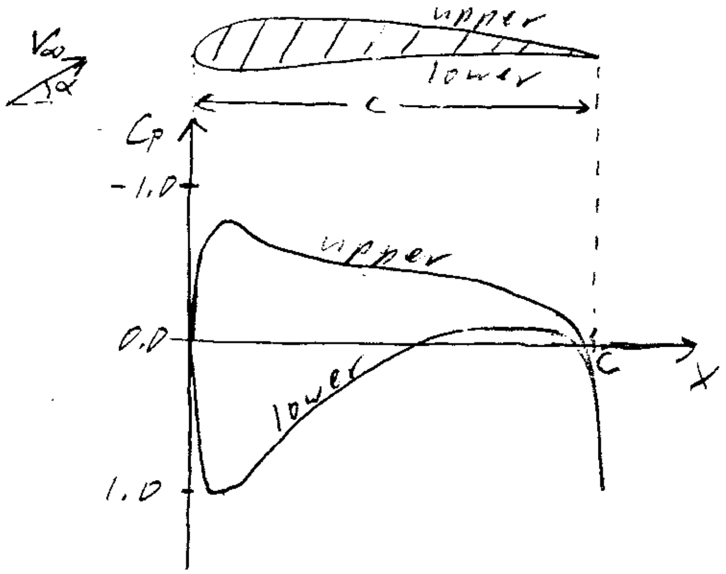
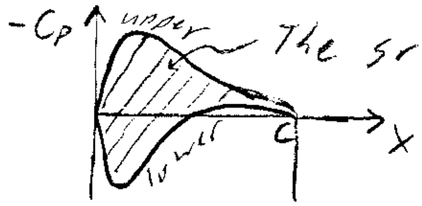
Incompressible C_p Distributions

• Consider a typical pressure coefficient around an airfoil in incompressible flow



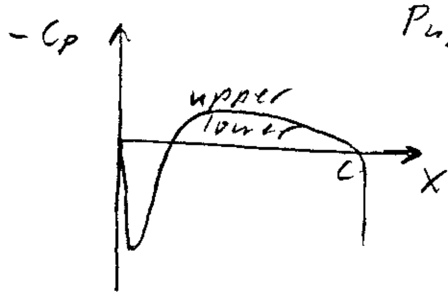
* Note the following about Cp Distributions

- The vertical axis is reversed so that $C_p < 0$ values are shown at the top. (i.e. $-C_p$ vs x)
  - This way, the upper surface (which has lower pressures than lower surface for lifting cases) is normally depicted by the upper curve.
- The area between the upper & lower curves is proportional to F_z' and is thus related to lift.



The greater this area, the greater the lift.

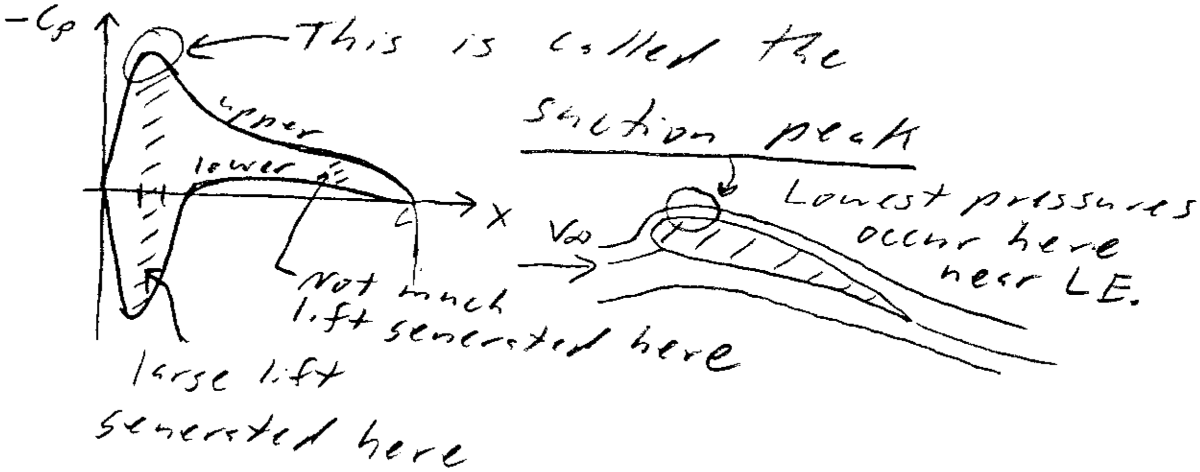
  - For a symmetric airfoil at zero angle of attack:



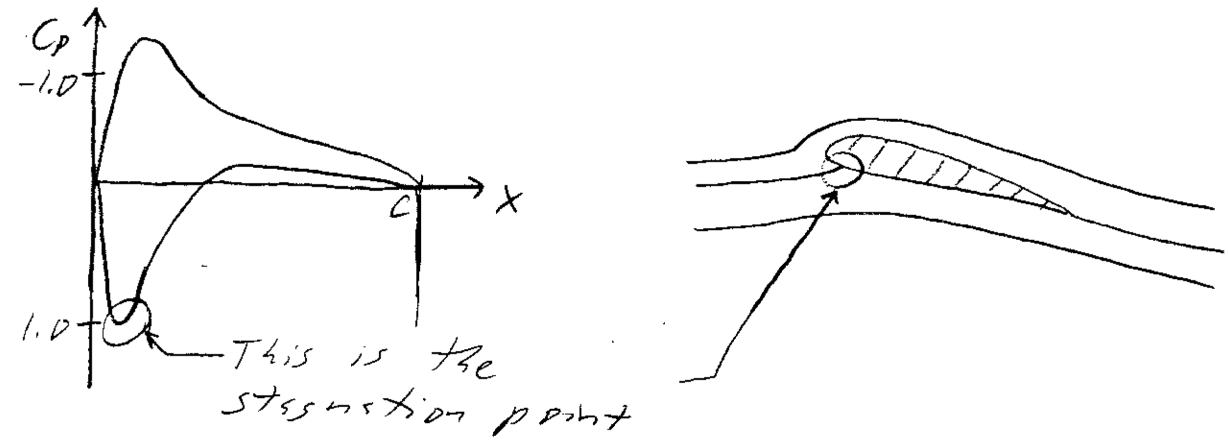
For this case:
$P_{upper} = P_{lower}$

$Area = 0 = F_z' = L'$

- Much of the lift is generated near the leading edge where a peak in $-C_p$ occurs on the upper surface.



- Now, consider the peak on the lower surface.



<u>If</u> the flow is <u>incompressible</u>, we can use Bernoulli equation to find C_p at that location: $P_\infty + \frac{1}{2}\rho_\infty V_\infty^2 = P + \frac{1}{2}\rho_\infty \cancel{V^2}\to 0$ at stag point

$$P = \underbrace{P_\infty + \frac{1}{2}\rho_\infty V_\infty^2}$$

$$C_p \equiv \frac{P - P_\infty}{\frac{1}{2}\rho_\infty V_\infty^2} = \frac{\left(P_\infty + \frac{1}{2}\rho_\infty V_\infty^2\right) - P_\infty}{\frac{1}{2}\rho_\infty V_\infty^2} \Rightarrow \underline{C_p = 1.0 \text{ at stagnation point}}$$

for incompressible flow