

LIFT

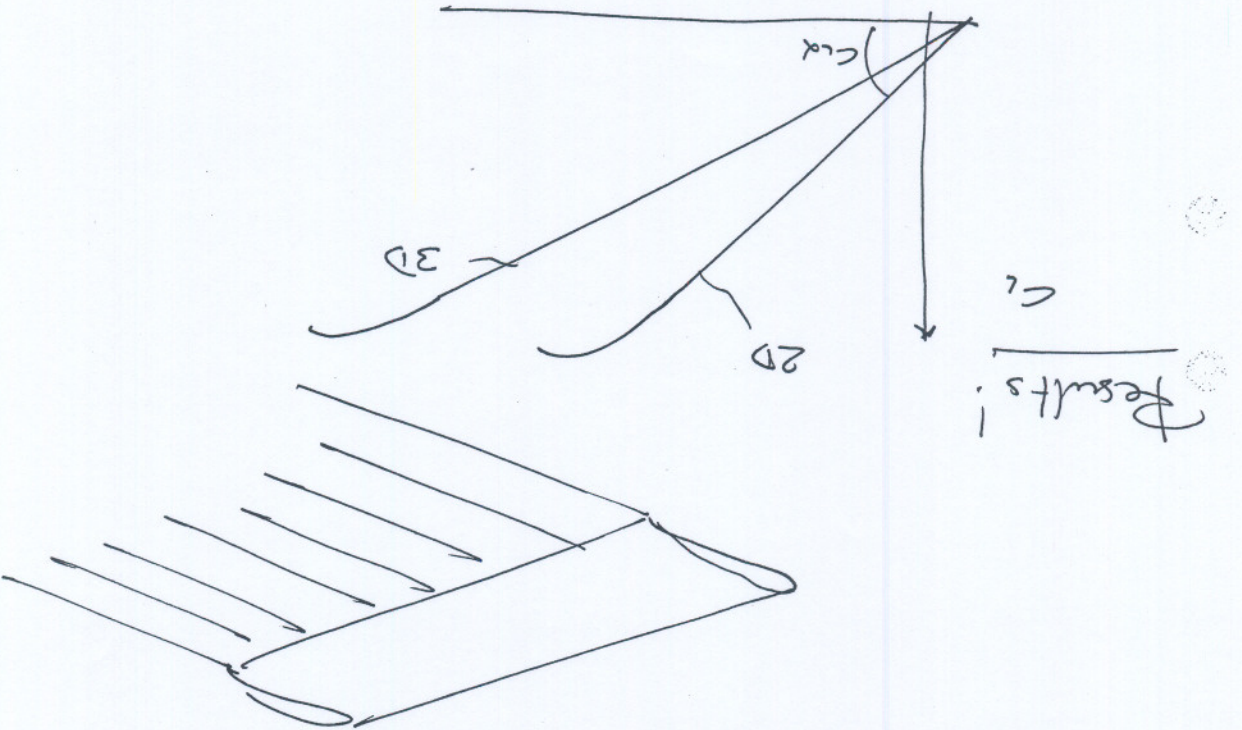
Aerodynamic bodies

Important parameters $AR = \frac{b^2}{S}$, $\lambda = \frac{c}{c}$, λ

It we take wings:

hyp: each section behaves like a wing profile
but with a modified flow.

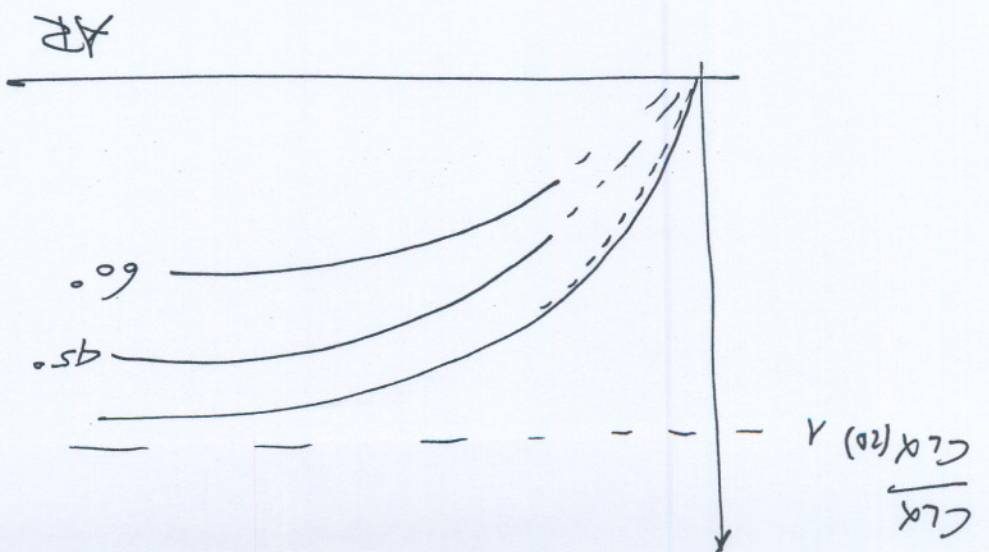
Presence of streamwise vorticity

This vorticity does not cancel out when the water
is squeezed.We have to increase α . Maximum value of c_l
doesn't change too much.

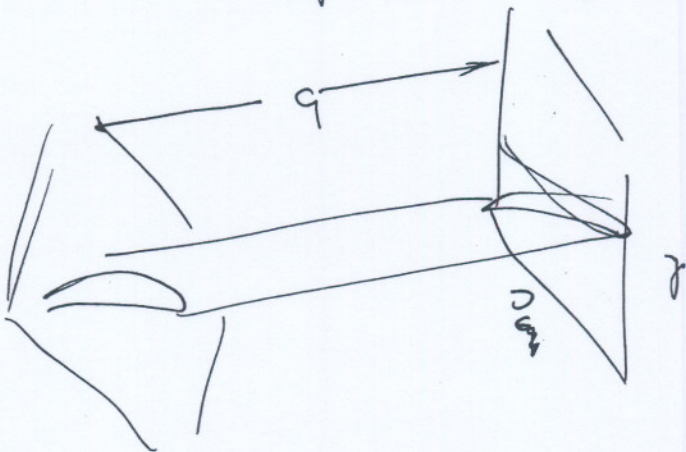
$$C_{L\alpha} = \frac{AR}{AR + 2} C_{L\alpha(2D)}$$

Valid only for elliptic distribution of lift

effects of sweep angle.



if we put PLATES at the end:

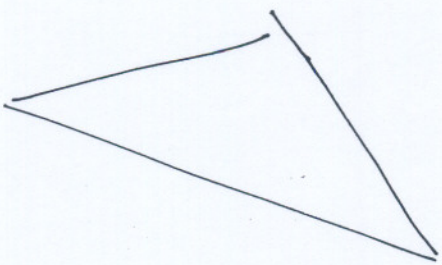


$$AR = AR \left(1 + 1.9 \frac{b}{l} \right)$$

SLENDER WINGS

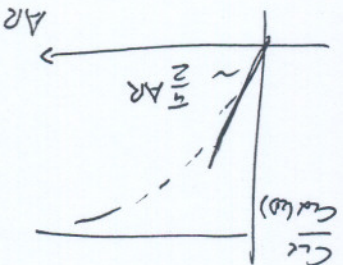
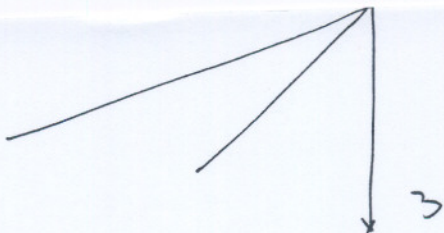
at low angle of attack

$$C_L = \left(\frac{\pi}{4} \right) AR \sin \alpha$$

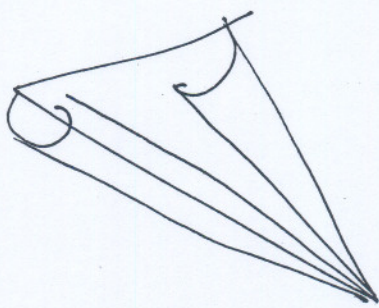


at small angle of attack very low C_L .

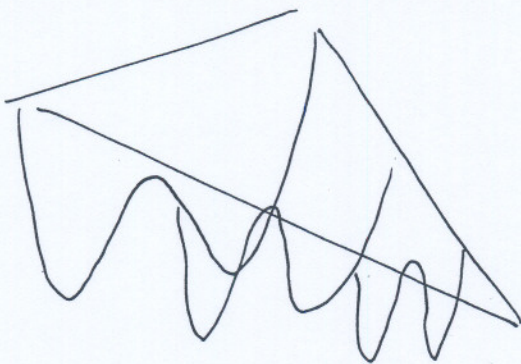
Studied for high speed. $U_\infty \uparrow$



At high angle of attack

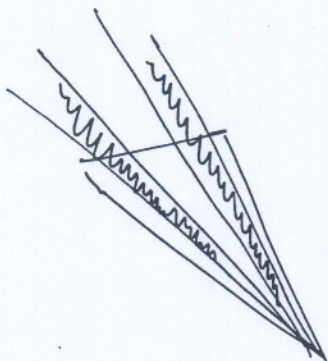


formation of streamwise vortices



pressure distribution

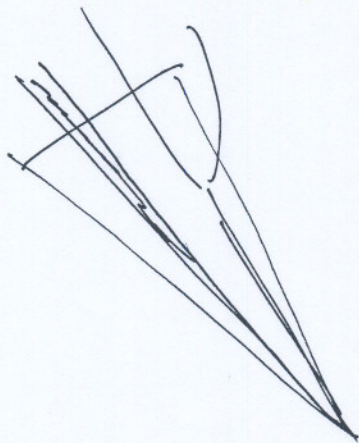
strong vortices → high energy in the wake.



break down.
~40%

can be asymmetric

bad for airplanes.



Drag in 3D aerodynamic bodies.

Even squeezing the wake there is still

energy.

$$G = \left(\frac{1}{\frac{1}{2} \rho A V^2} \right) C_L^2$$



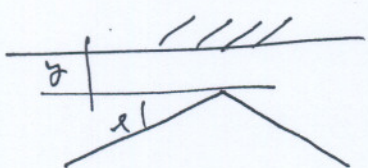
INDUCED DRAG

Be careful!!

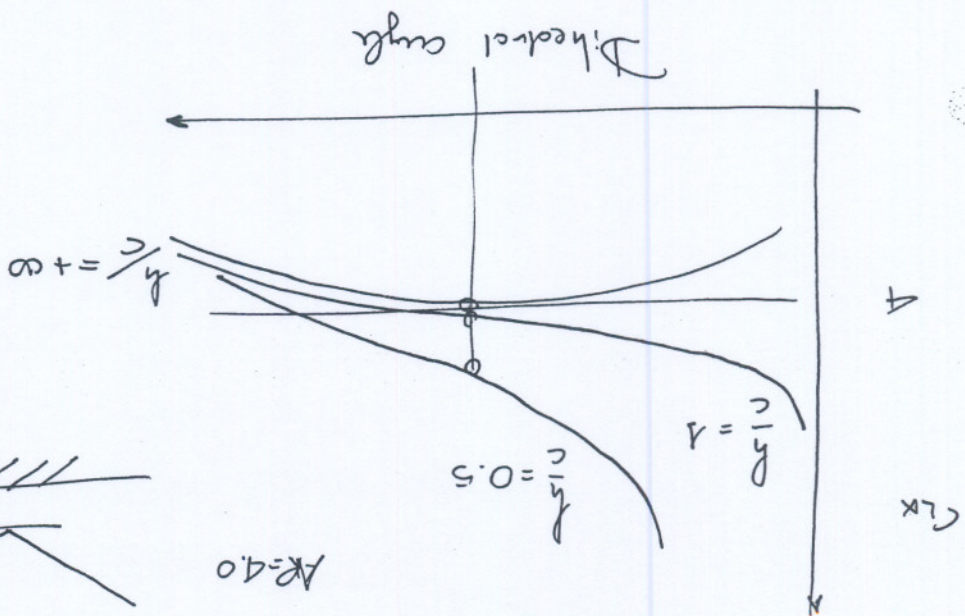
To get no induced drag the lift must be zero everywhere!!

Other wise you have a wake and a $C_D \neq 0$ in the formula $C \rightarrow \infty$

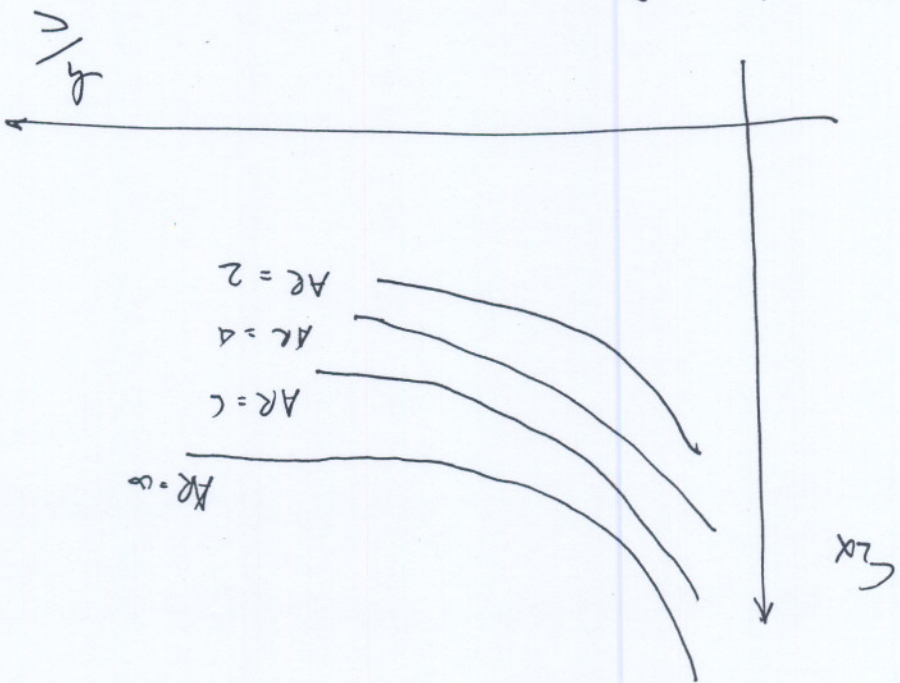
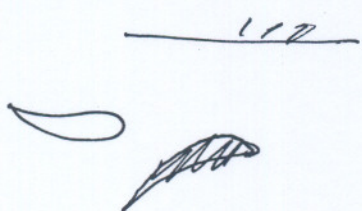
Wing in Ground Effect



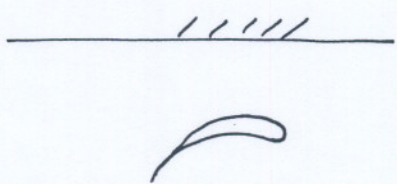
$AR=4.0$



→ negative dihedral is better!



In the following case we can have a minimum



Iterative procedure for 3D ^{lots} blip

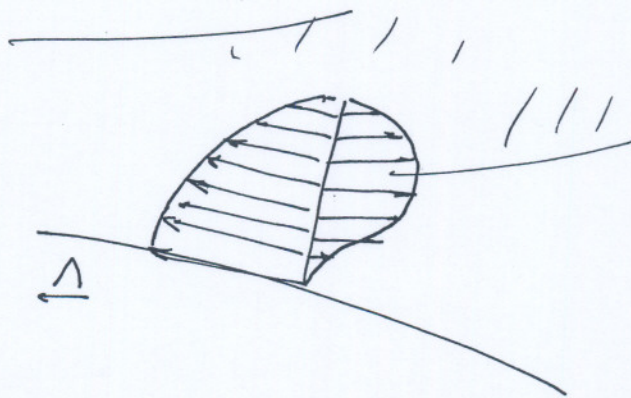
bodies.

See transparencies!

Not much different from 2D situation

Boundary layer are very complicated!

Follow streamlines but that can bring mistakes



Take the right S_u (wet surface)

Form drag.

REAR Aerodynamics.

form drag.

Generally we have the same rules as the

2D.

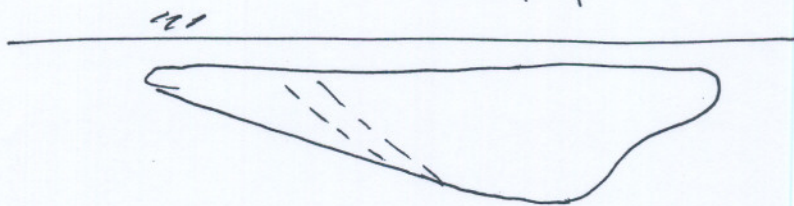
But be careful with curvature. We still

can get some differences.

ex Audi 6

(see Lucido Bovesi)

Problem of the rear induction



Good but difficult to park.

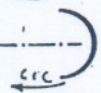
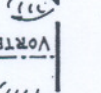
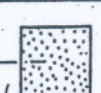
→ change induction of the back.

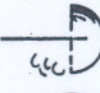
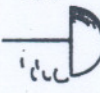
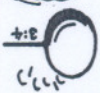
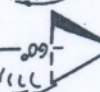
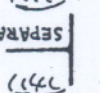
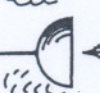
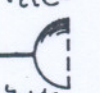
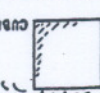
C_D ~ from 0.35 → 0.55.

The problem was investigated by Morel

Control of streamwise vortices

You cannot change intensity and distance
maybe distance with BOAT TAILING

SHAPE	REF.	C _D
	(a)	1.17 ₄
	(a)	1.20
	(g)	1.16
	(d)	1.60 ₄
	(e)	1.55
	(d)	1.55
	(a)	1.98
	(a)	2.00
	(a)	2.30
	(b)	2.20
	(a)	2.05 ₄

SHAPE	REF.	C _D
	STING SUPPORT	0.47 ₄
	(c)	0.38
	(c)	0.42
	(e)	0.59 ₄
	(f)	0.80 ₄
	(d)	0.50
	SEPARATION	1.17
	(c)	1.17
	(b)	1.42
	(a)	1.38
	(f)	1.05 ₄

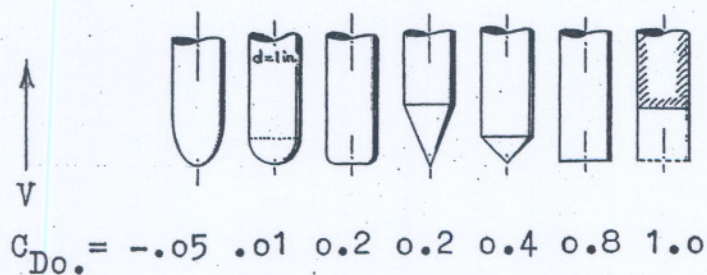


Figure 20. Coefficients indicating the forebody-pressure drag of a series of cylindrical bodies, evaluated from pressure distribution (25,e).

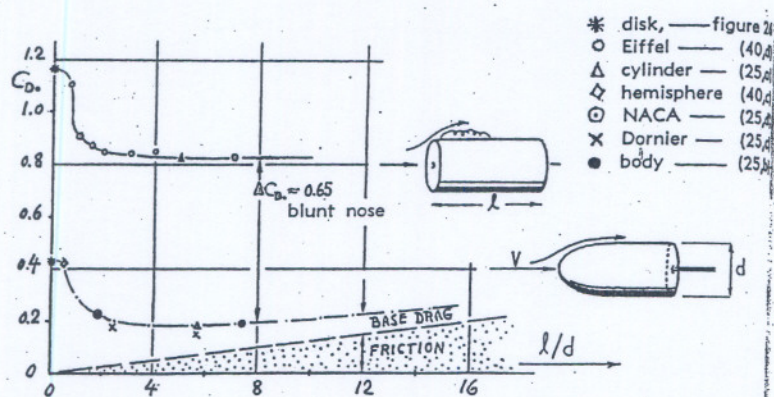


Figure 21. Drag coefficients of cylindrical bodies in axial flow, with blunt shape (in the upper part) and with rounded or streamlined head forms (lower part)—as a function of the fineness ratio l/d .

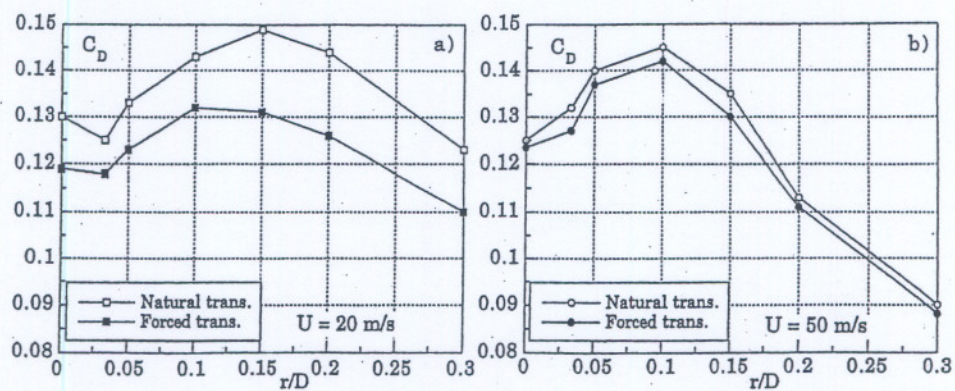
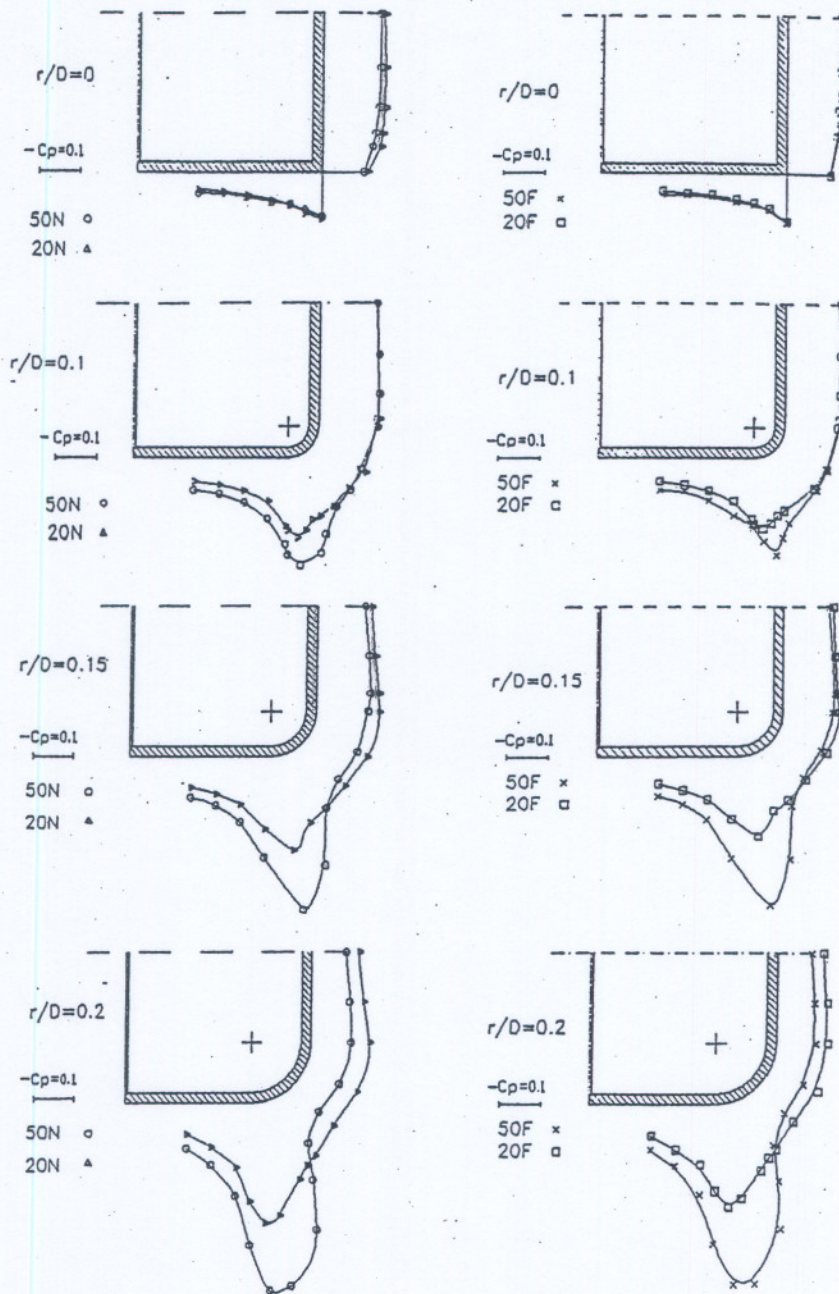


Fig. 5-30. Schematics of the aerodynamic interaction during overtaking.

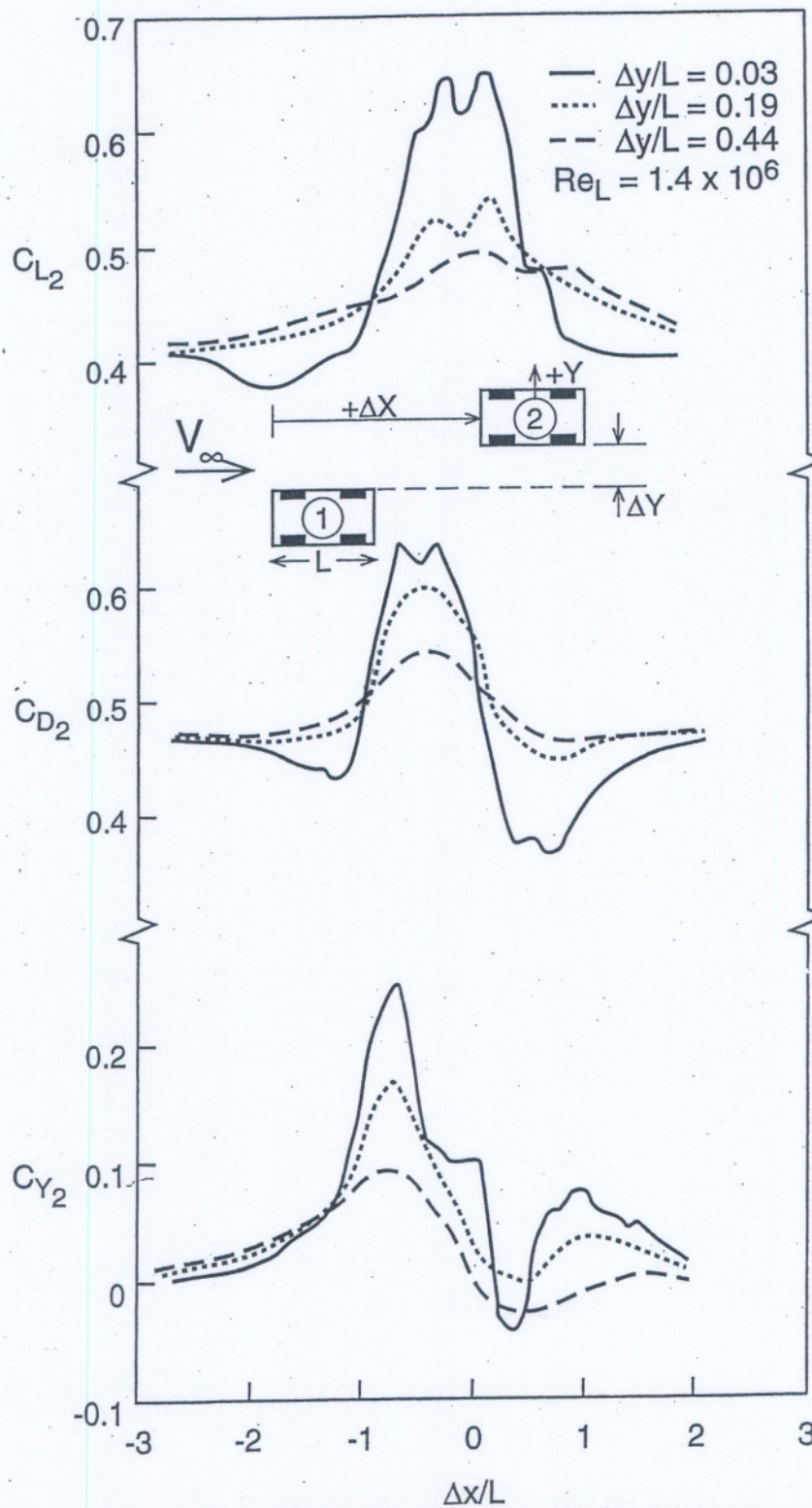
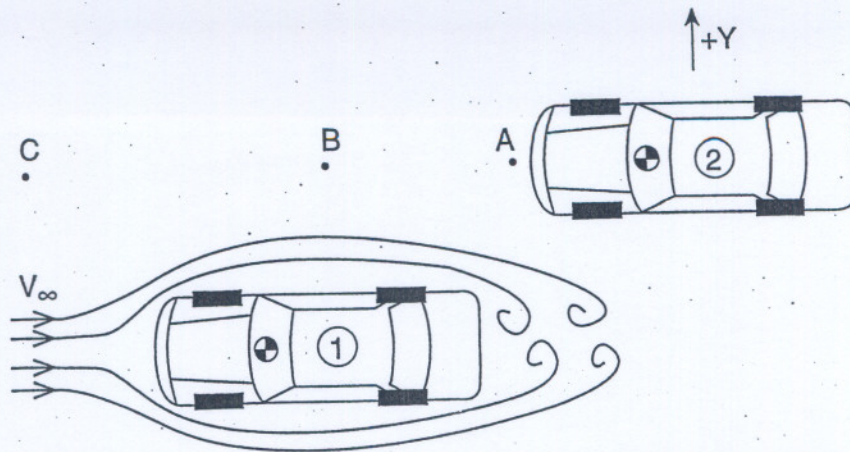


Fig. 5-34. Visualization of a smoke particle line above two Jackson NASCARs at the Lockheed wind tunnel. There is some indication that the free-stream flow does not impinge on the front grill of the following car, thus reducing its aerodynamic drag. Courtesy of Automotive Aerodynamics, Inc.

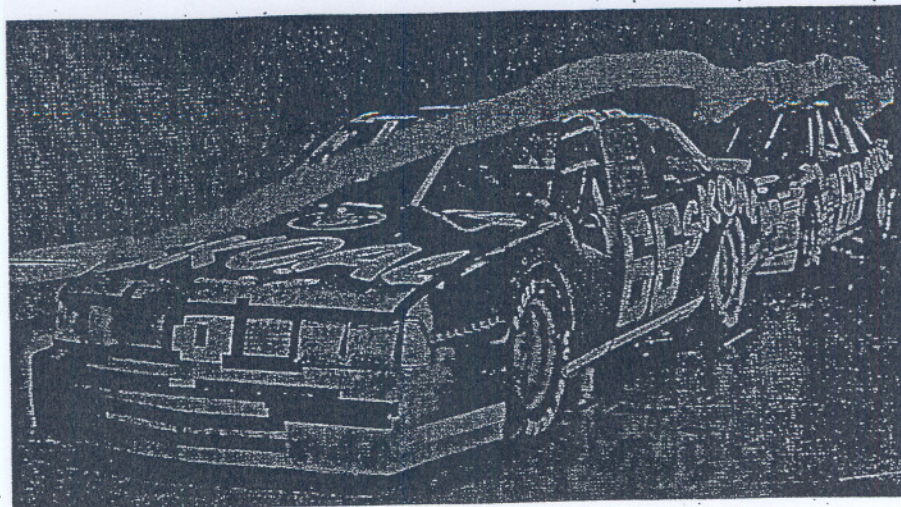


Fig. 5-32. Schematic description of the aerodynamic interaction during drafting.

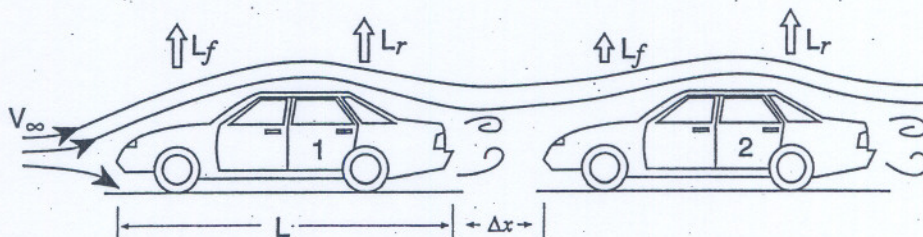


Fig. 5-33. Lift and drag variation for the two cars during drafting. Reprinted with permission from SAE Paper 710213, Copyright ©1971 SAE, Inc.

