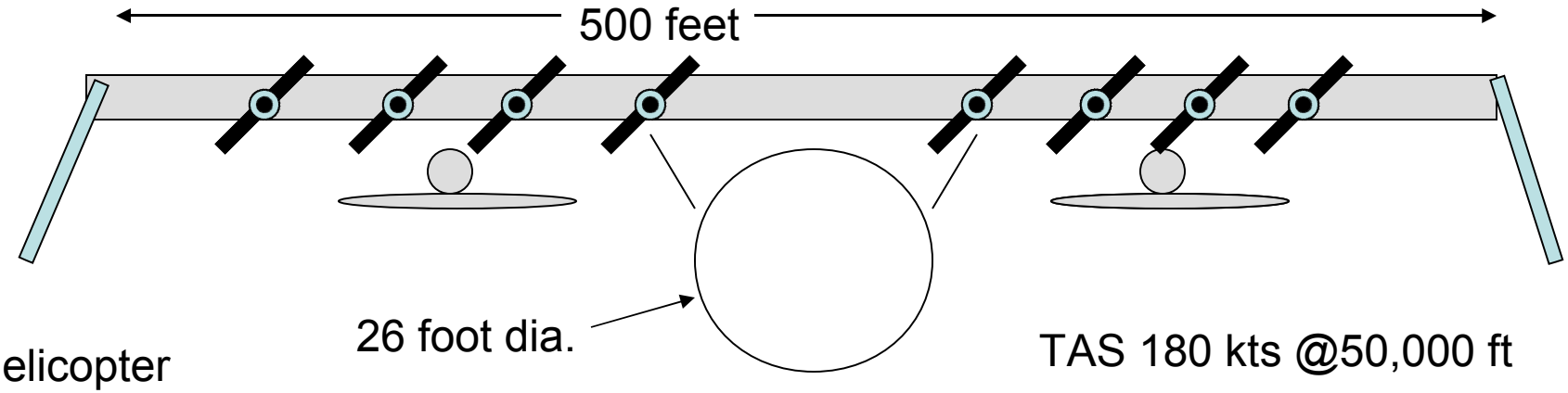
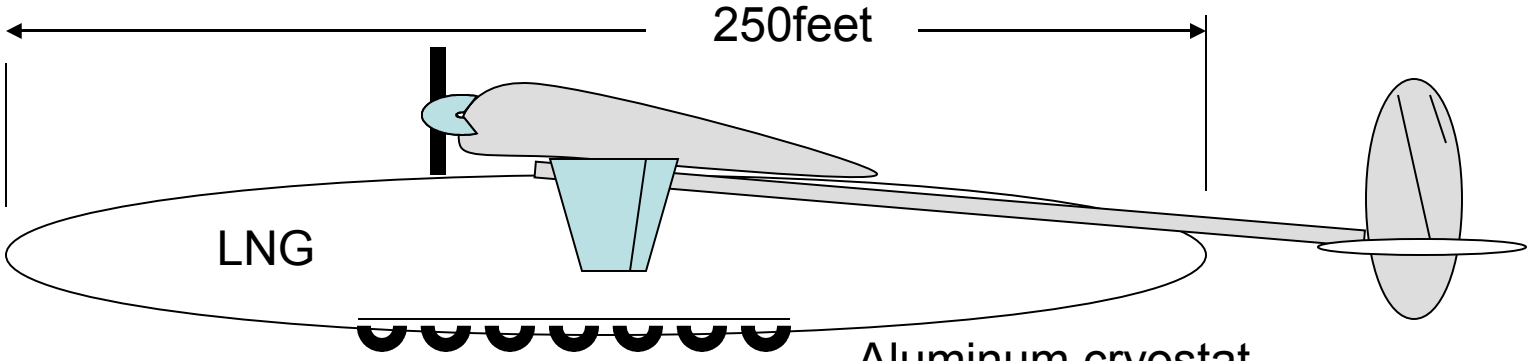
# Airborne Gas Transport

## The Alternative to a Pipeline

By Mike Fallwell

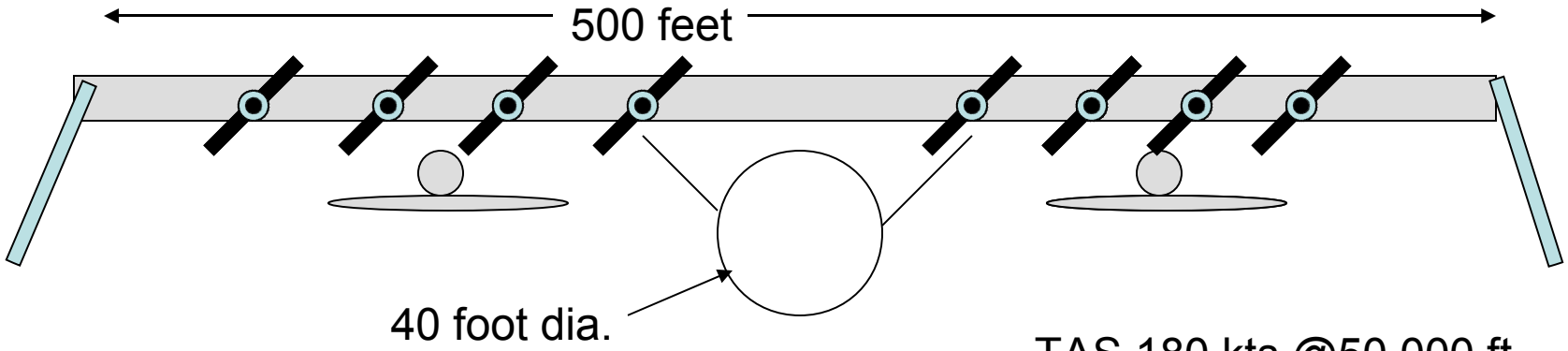
# 1000 Ton LNG Tanker



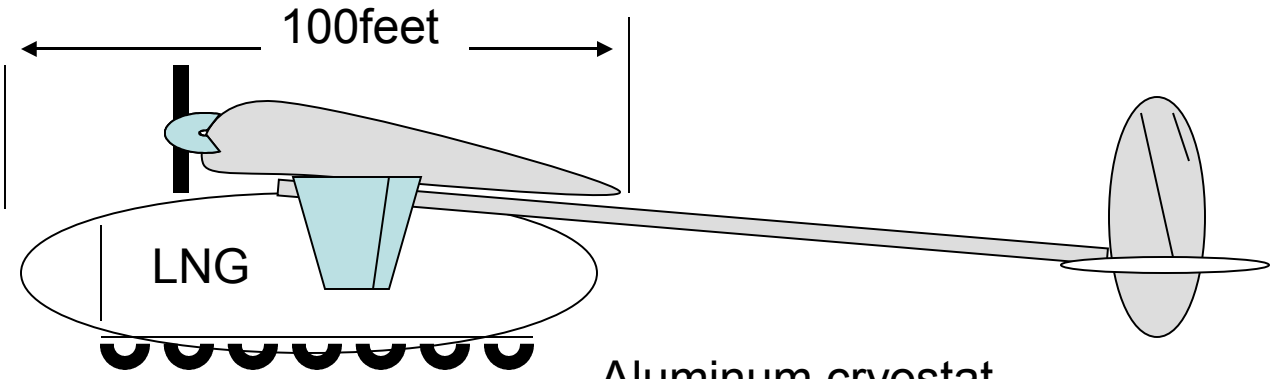

High altitude low speed aircraft

# 1000 Ton LNG Tanker




Helicopter engines

TAS 180 kts @50,000 ft
Aluminum skin / stir welded




Aluminum cryostat

# The best alternative

- Bring stranded fuel to market
- Green fuel will displace coal
- Low environmental impact
- Access to global markets
- Short lead time
- Manageable risk
- Fast return on investment
- Carry freight on the back haul

# Power systems

- 30,000shp @ 50,000ft – Lissaman airfoil?
- 200,000 lb thrust at sea level
- 40lb/shp – 60lb/ft wing loading
- Convert 6-8 helicopter power packs /rotors

- Use low bypass ratio turbofan to normalize engine and cool transmissions (0.7 bar)

# Possible Airfoils

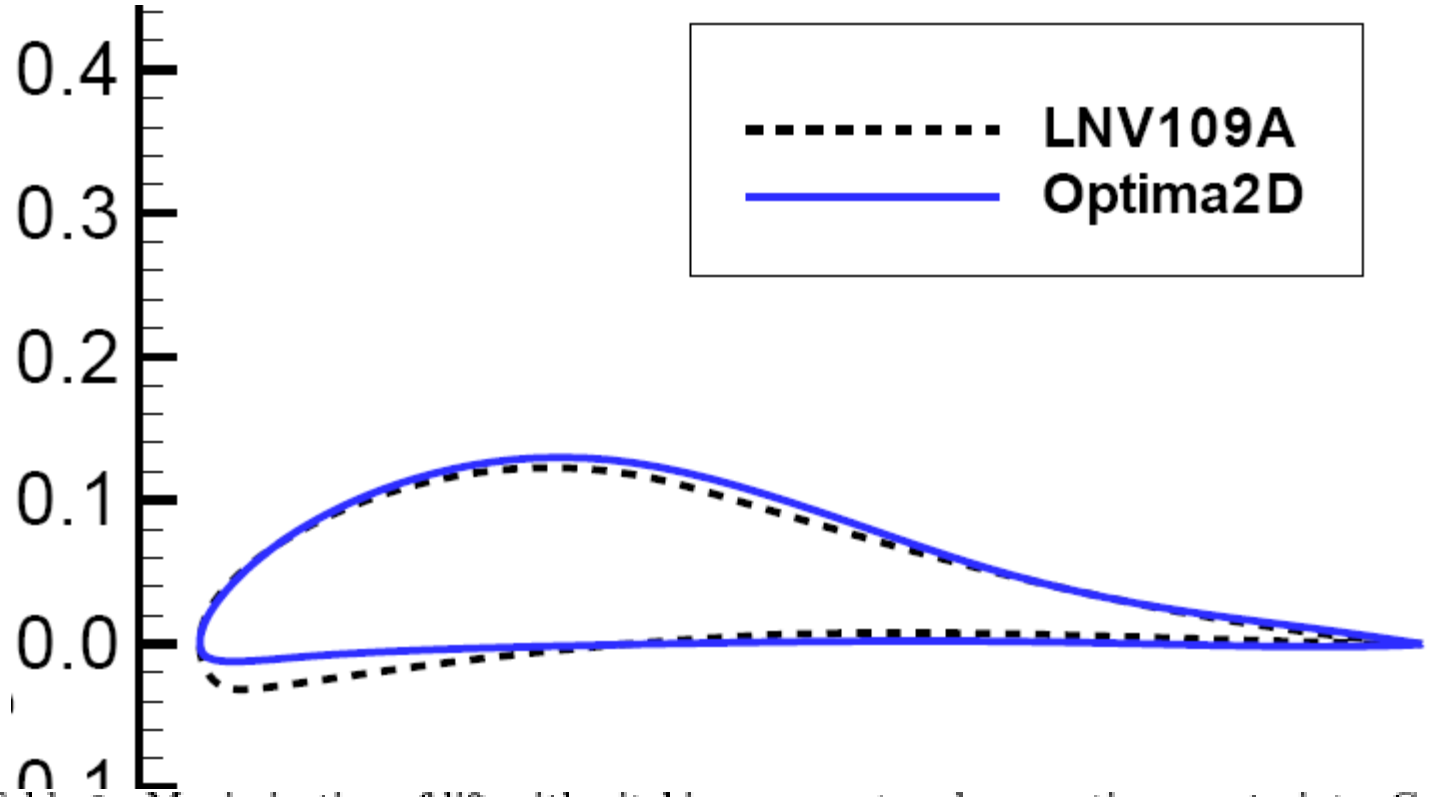
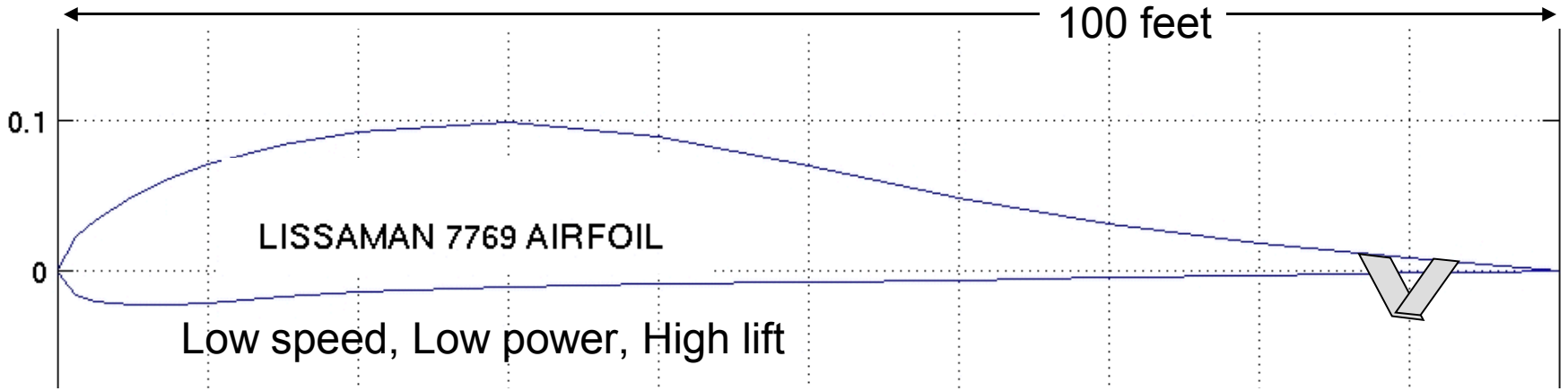



Table 9. Maximization of lift with pitching moment and separation constraints: Case 7

| Case | $C_L$ | $C_M$ | $T_{up}$ (x/c) | $T_{lo}$ (x/c) | Angle of Attack |
|---|---|---|---|---|---|
| Case $7_{initial}$ | 0.2188 | 0.0028 | 0.37 | 0.75 | 2.00° |
| Case $7_{final}$ | 1.5812 | -0.0324 | 0.33 | 0.95 | 10.06° |

# Loading Tank

- Aircraft will lift loaded tank off moving railcar at 50mph.
- Flying in ground effect aircraft can drop off loaded tank at 25-30 mph.

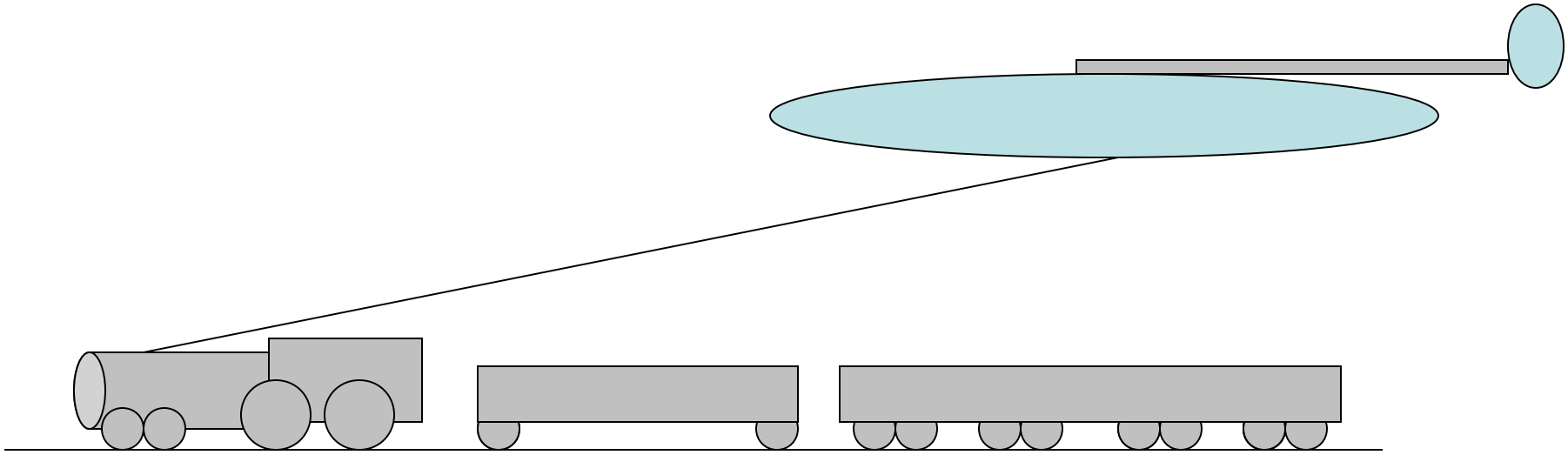


# Hook up and tow to altitude?

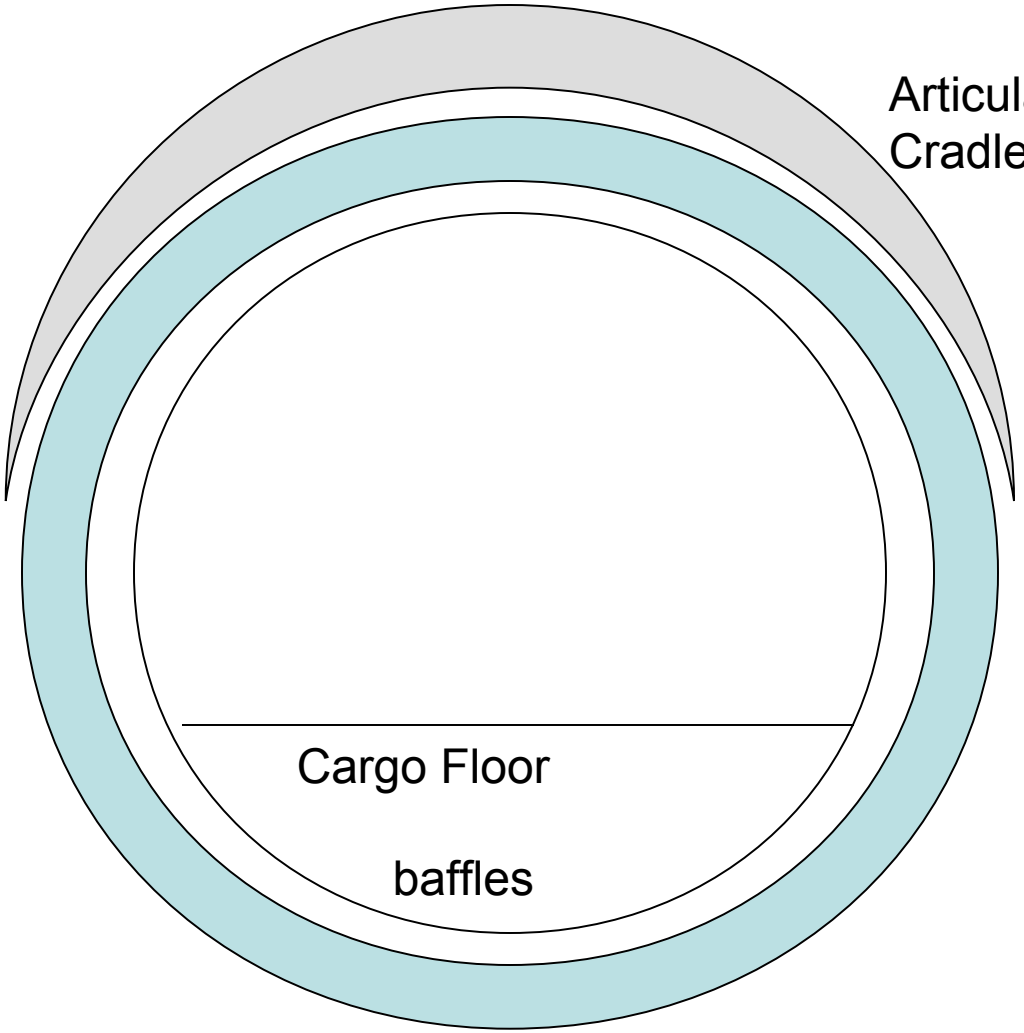
AC will connect to tank at 15-20 mph

Train will accelerate to 50-60 mph

Train will tow AC to 600 ft alt.



# Tank Insulation



# Gear types:

- Wheels
- Skies
- Floats
- Hovercraft
- Skates
- Rails

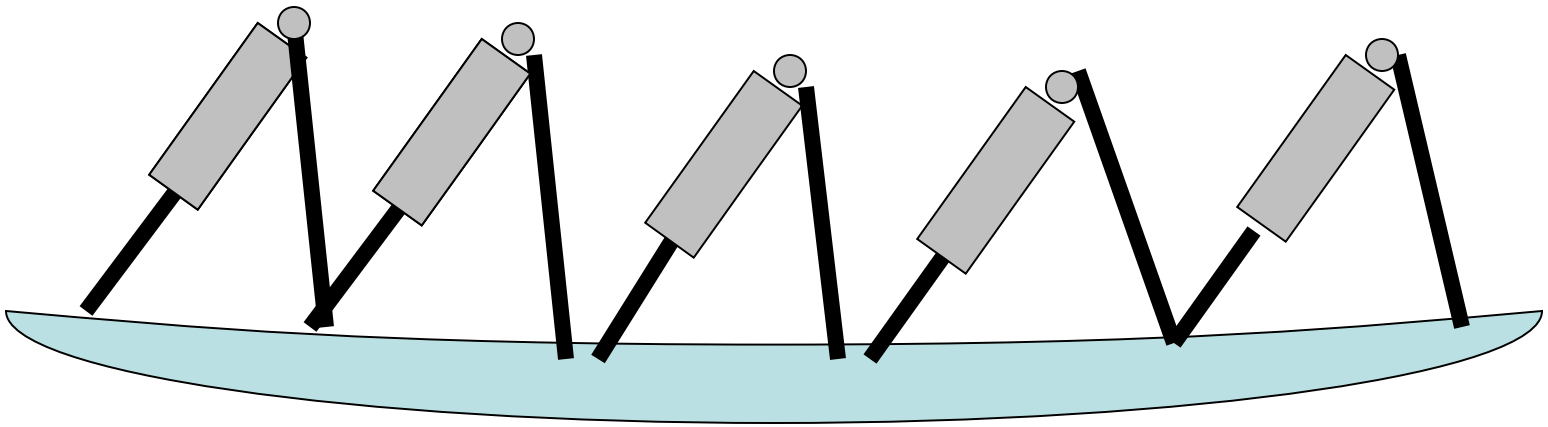
# Shock types:

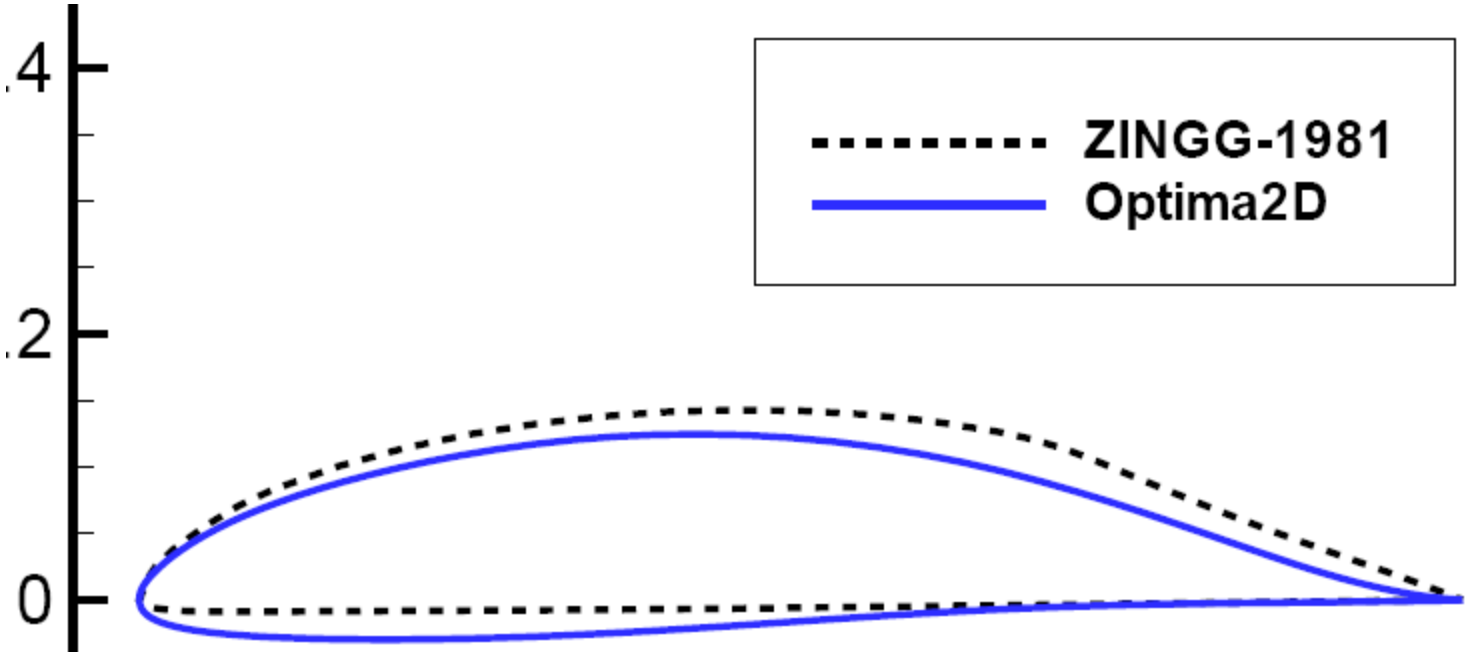
Hydraulic

Air bag

Rubber

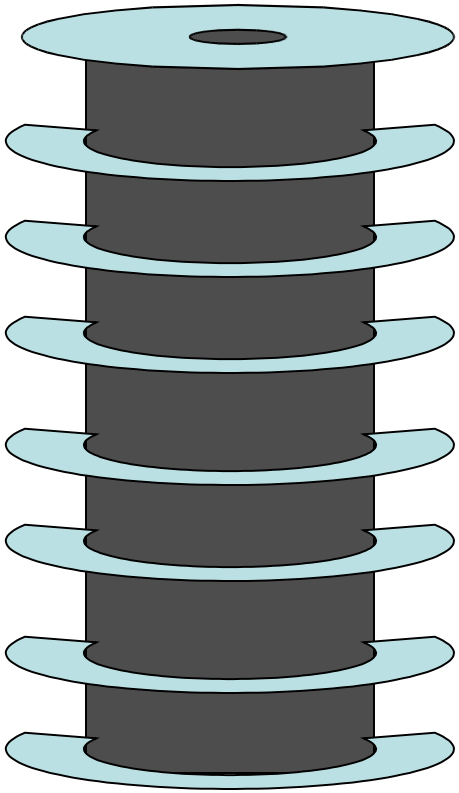
# Skies and hydraulic shocks






The Zingg airfoil has a lift-to-drag ratio of 83 at CL = 0:888, which occurs at an angle of attack of 1:93.
The optimized airfoil has a lift-to-drag ratio of 90 and CL = 0:9974 at an angle of attack of 4:28.
The optimized airfoil has a larger lift-to-drag ratio, but Fig. 14 shows that it has a slightly smaller cross-sectional area.

# Rubber shock with high friction



- Low rebound
- Tunable stiffness and friction
- Low weight
- Low cost
- High wear rate?
- Scale limits?