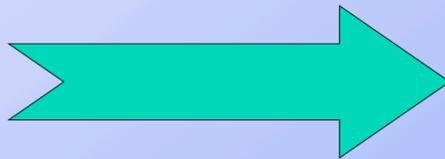


Explorer Post 630 Recovery Vehicle Design and Build

Theory

Design/Implement



Test/Confirm

Review

- Newton Laws $Force = Mass * Acceleration$
- Equilibrium $Lift = Weight$
 $Drag = Thrust$
- Drag Force $C_D * \frac{1}{2} * \rho * V^2 * A$
- Lift Force $C_L * \frac{1}{2} * \rho * V^2 * A$

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Review the forces and how to compute

Conservation

- Energy (Mass, Momentum)

- Potential

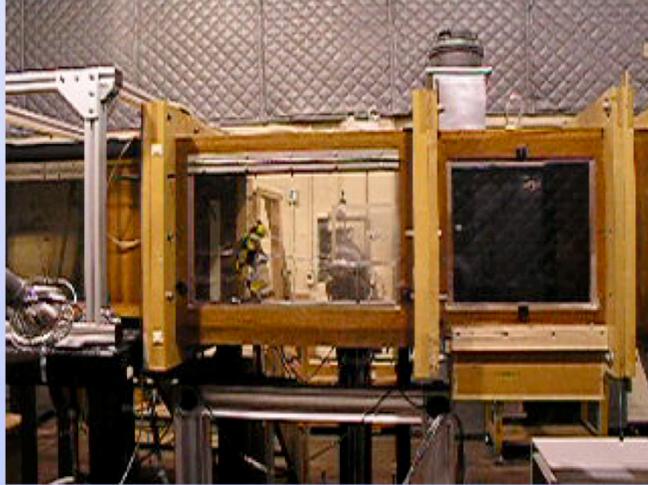
- Kinetic

$$\rho * g * h \Rightarrow m * g * h$$

$$\frac{1}{2} * \rho * V^2 \Rightarrow \frac{1}{2} * m * V^2$$

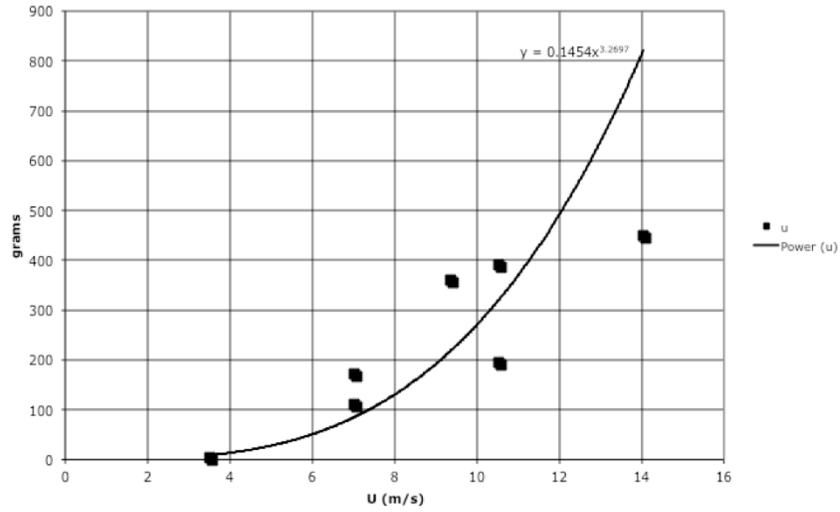
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Check the units

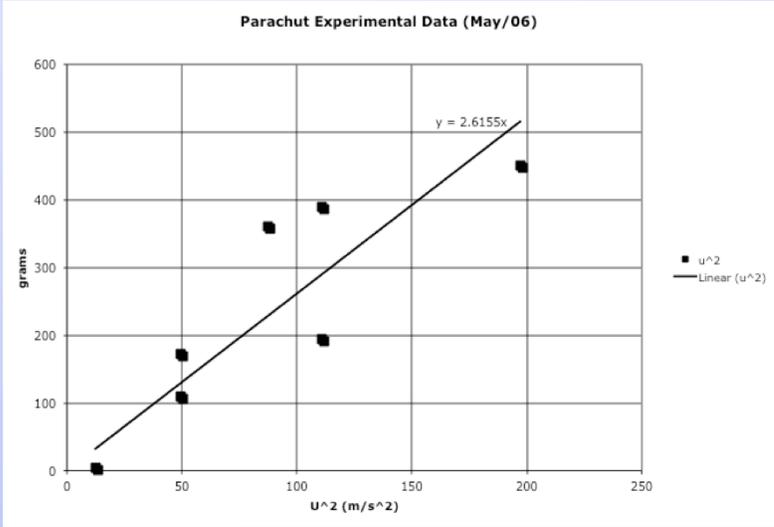


Raw Data

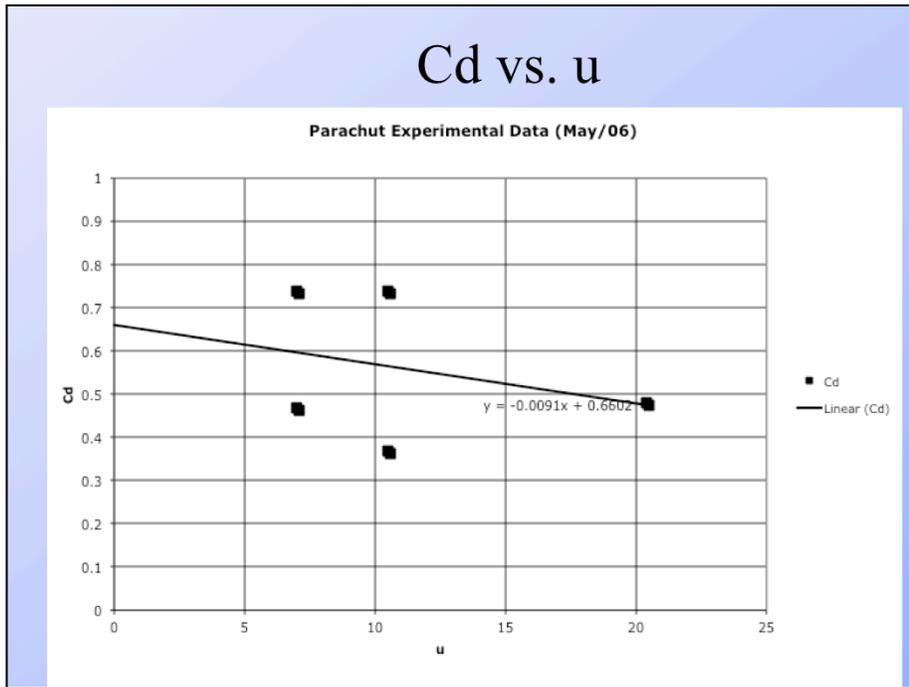
Parachut Experimental Data (May/06)



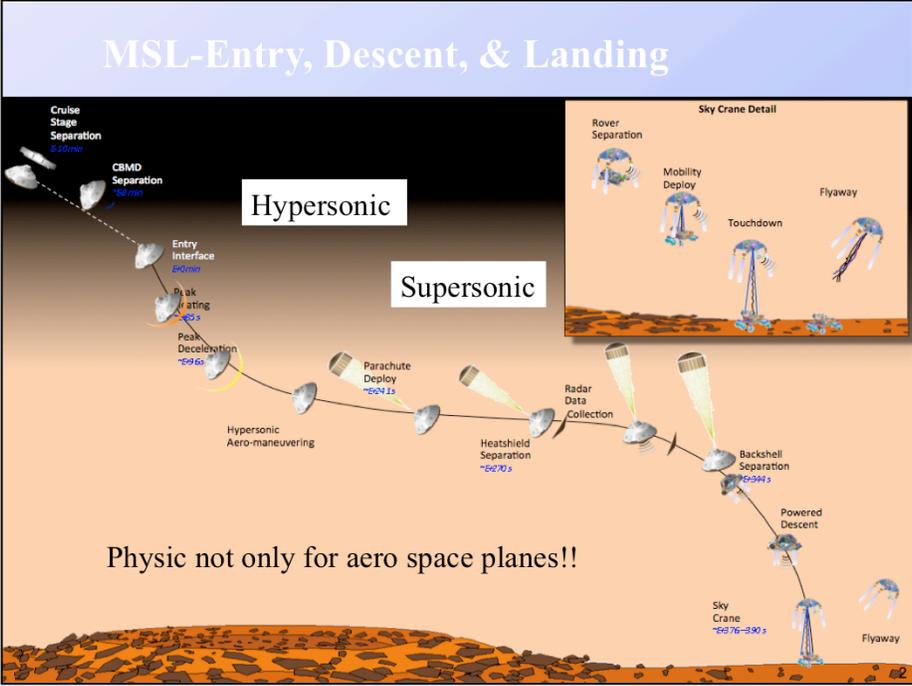
Drag vs. V^2



Cd vs. u



Note the relationship

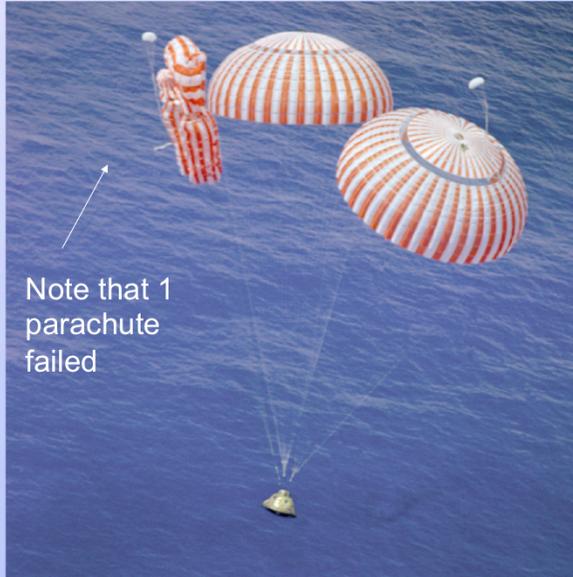


Not just for airplanes

Landing/Takeoff



Apollo 15 Landing after lunar mission



Note that 1
parachute
failed

Parachute into ocean?

Shuttle Orbiter landing



Landing is better?

Build UFOs

Unique Flying Objects for Landing.

Ask What do WE need to do this it is built ?

Note you have experience

Use something **other than parachutes** to get back on the ground

Use Logic to reason it out

Wind Tunnel Test

Research for other Data/Information needed

Eggs(poration)

Explorer Post 630 Egg Drop Experiment(s)



Explorer Post 630 Egg Drop Experiment(s)



Some Results



Some Results



Some Results



Questions ?

What is needed to convince someone (i.e. paying passenger or an astronaut) to ride on your contraption ?

Where do we start on building ?

Did everyone have exact same ideas ?

Where all of the ideas buildable, why or why not ?

How did you communicate on design ?

What would you do differently if you only had one chance and very limited supply ?

Optical Analysis

Sony Camera ~ 30 frames/sec
~ 4 frames
~ 7 frames

Time to drop ~ $4/30 = .13$ sec (.03 sec resolution)
~ $7/30 = .23$ sec

Assume 8 ft and 6 ft drop = 1.8 meters
= 2.4 meters (~ 1/2 ft)

Average speed ~ 13.8 m/s (~ +/- 5 m/s)
~ 10.4 m/s

Frame by frame

First Principal Analysis

Conservation of Energy => Potential = Kinetic
Simple System => $mgh = 1/2 mv^2$

Mass is same

$$V = (2gh)^{0.5}$$

$$\text{@ } 1.8 \text{ m } V = 6 \text{ m/s}$$

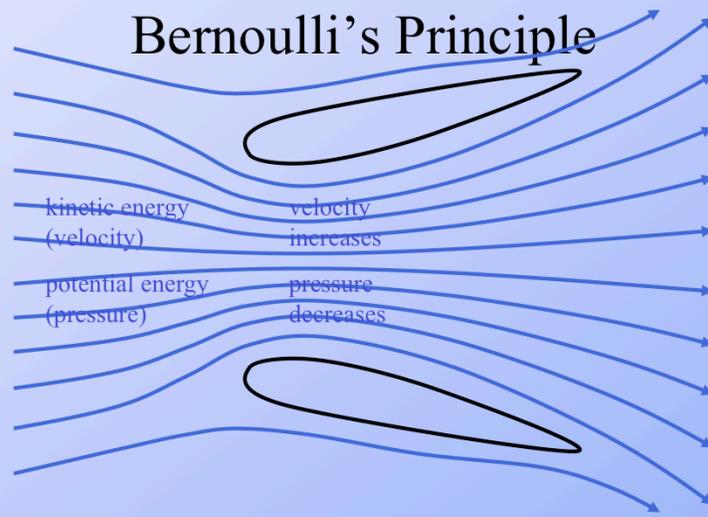
$$\text{@ } 2.4 \text{ m } V = 7 \text{ m/s}$$

Conservation of Momentum => $F = d(MV) / dt = 0$
 $\sim \Delta MV / \Delta t \sim 1.2 \text{ N}$

Egg ~ 60 g (Weight = .6 N)

Where does the Drag Force come in play in this analysis?

The Venturi Tube and Bernoulli's Principle



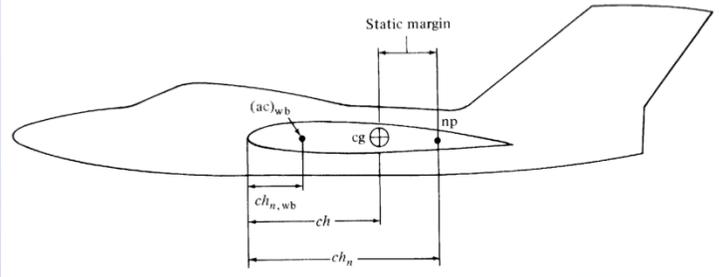
Nomenclature

Center of Mass

Center of Aerodynamics (Aerodynamic Center)

Center of Moment (Neutral Point)

Static Margin

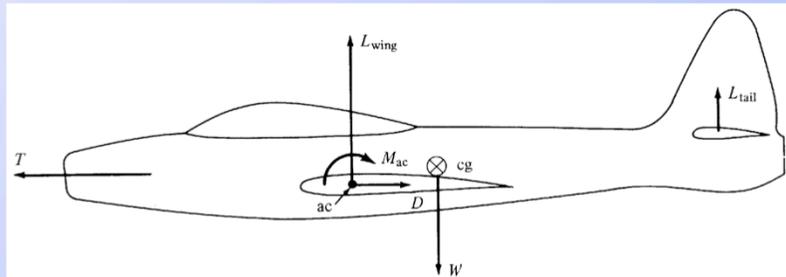


$$\frac{\partial C_{Mcg}}{\partial \alpha} = -a_w(h_n - h_{cg})$$
 For positive static stability, the CG must be located ahead of the neutral point

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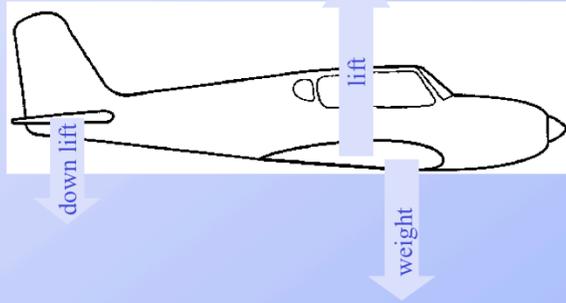
Stick to overall theme with is the balance

Moments on Airplane



- Moment coefficient about CG $C_{Mcg} = \frac{M_{cg}}{q_{\infty} S \bar{c}}$
- At equilibrium, the moment about the CG is zero, the airplane is said to be trimmed
- M_{cg} is created by L_{wing} , D_{wing} , and $M_{ac, wing}$, L_{tail} , T , and forces and moments on other parts of the plane such as the fuselage and engine nacelles.

Longitudinal Stability



- Static stability (tendency to return after control input)
 - up elevator increases downward lift, angle of attack increases;
 - lift increases, drag increases, aircraft slows;
 - less downward lift, angle of attack decreases (nose drops).

Directional Stability

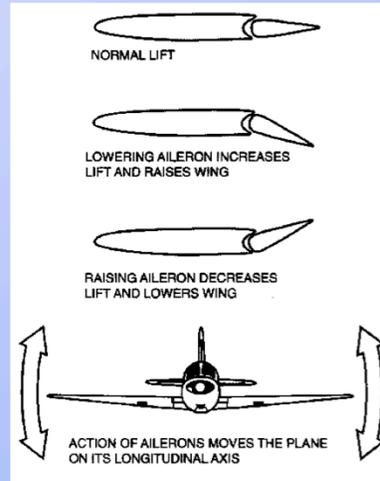
- As the airplane turns to the left (e.g. in turbulence), the vertical stabilizer creates lift toward the left.
 - The airplane turns to the right.



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Turning Flight

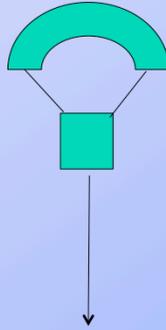
- More lift on one wing than on the other results in roll around the longitudinal axis (bank).
 - Lowering the aileron on one wing results in greater lift and raises that wing.



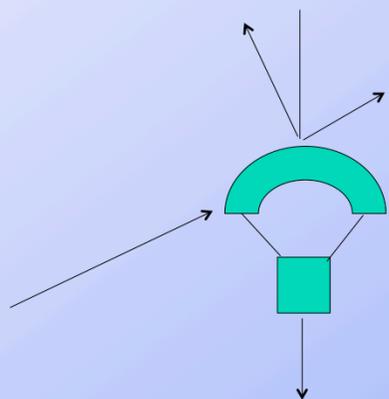
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Problem

- Simple Solution



Problem



The diagram shows a mechanical assembly consisting of a teal semi-circular ring at the top and a teal square block at the bottom. Two thin lines connect the inner ends of the ring to the top corners of the square. Five arrows point towards the assembly: one from the top, one from the top-left, one from the top-right, one from the left side of the ring, and one from the bottom of the square.

- More elegant solution would be FLY it down !

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What force need to be generated and how?

What is your only source of energy for this problem

Build UFOs

Unique Flying Objects for Landing.

Ask What do WE need to do this it is built ?

Note you have experience

Released from a high altitude

Use something **other than parachutes** to get back on the ground

Use Logic to reason it out

We'll let you Wind Tunnel Test

Research for other Data/Information needed

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Scout will need to let us know what your testing for?

Internet/Library

Allow one question by each team – 2 people team?