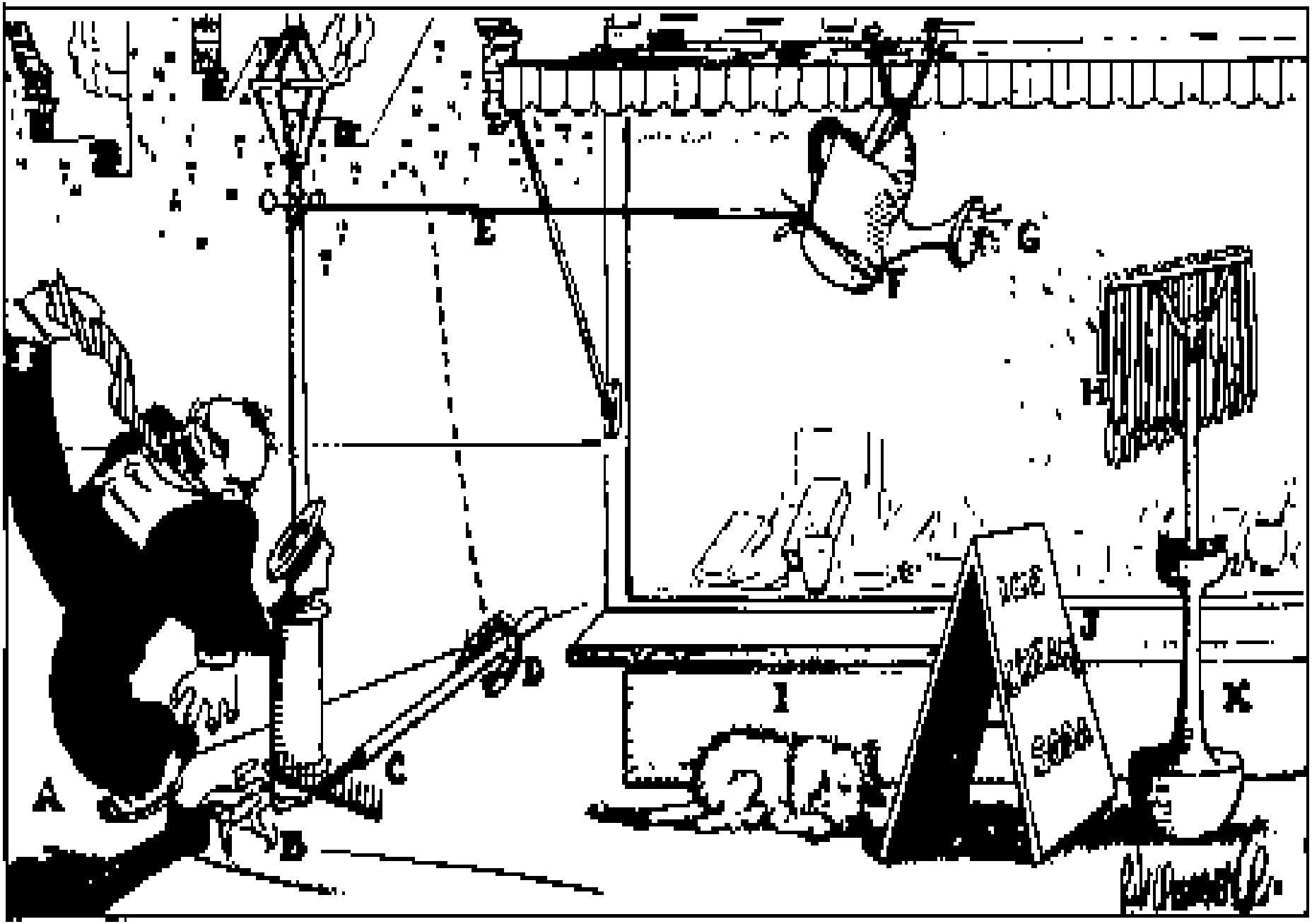
Simple Machines



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A machine* is a device that makes work easier, changes the direction of the work, or changes the speed of the work

A simple machine works with only one movement

- **There are six simple machines**
  - **Lever**
  - **Wedge**
  - **Wheel and axle**
  - **Incline plane**
  - **Pulley**
  - **Screw**

Be able to list the six simple machines*

Actually there is only 2 types of machines and all six of these are types of these two.

Simple Machines

The six simple machines are modifications of two*

- Inclined Plane
  - Wedge
  - Screw
- Lever
  - Pulley
  - Wheel and axle

There are always forces involved in work with machines

- **Effort force* – force applied to the machine by the operator**
- **Resistance force* – force applied by the machine**

Work is force applied over a distance

- **Work = Force x Distance, Joule = Newton x meter**
- **Work input is the force times the distance that is put into the machine**
- **Work output is the force times the distance actually done by the machine**

*What is the work equation?**

*What is the difference between work output and work input?**

Ideal machine

- (a machine without friction) work output is always equal to work input
- Effort force x effort distance is equal to resistance force x resistance distance,
  - $F_e \times D_e = F_r \times D_r$
- Because of friction the work input is always greater than the work output.
  - $F_e \times D_e > F_r \times D_r$

  Why is work input always greater than work output?*

Mechanical advantage*

- **The number of times force is multiplied in a machine.**

Levers

- **a bar that is free to pivot about a fixed point**
  - **A lever has 3 parts**
    - **Effort arm – where effort is applied**
    - **Resistance arm – where resistance to the motion is applied**
    - **Fulcrum – The fixed or pivot point of the lever**

    *What are the parts of a lever?**

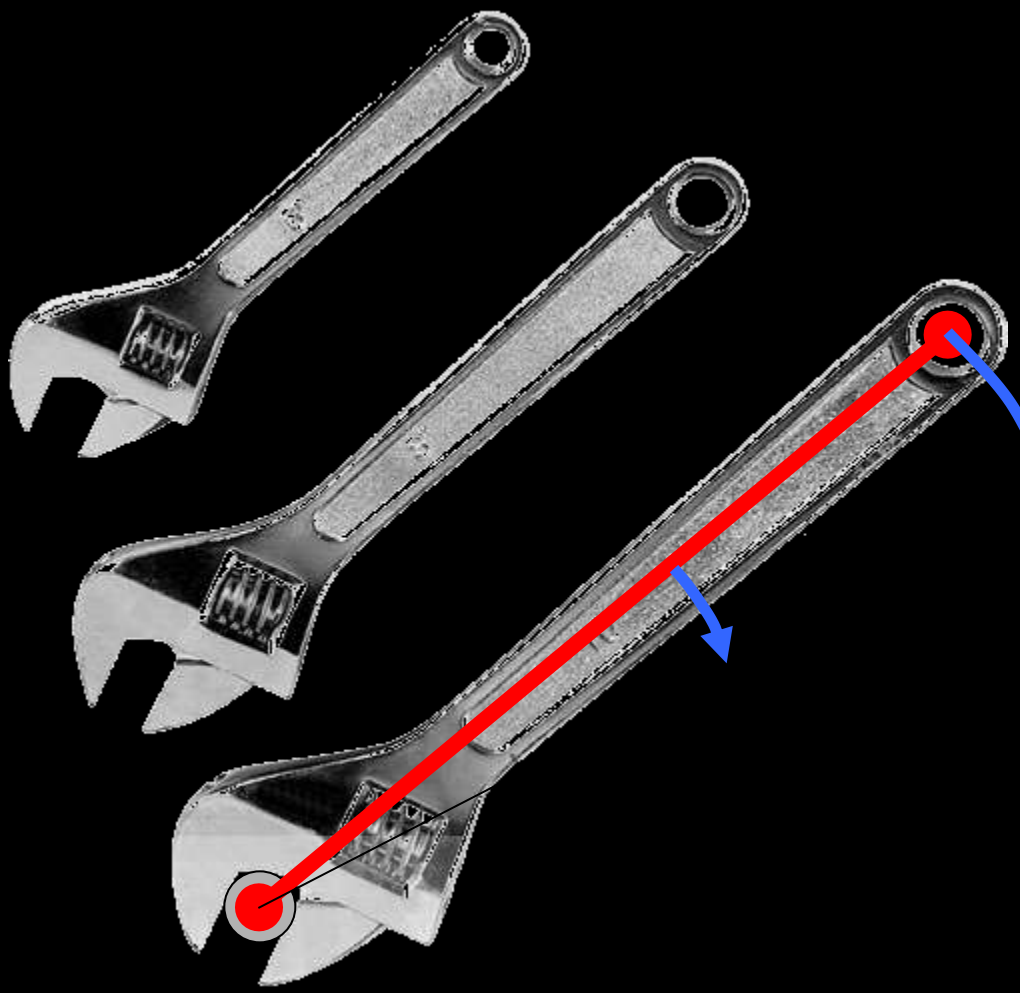
IMA

- **(Ideal Mechanical Advantage) of a lever is calculated: IMA = effort arm length/resistance arm length**

*How do you find the IMA of a lever?**

*You must be able to calculate the IMA of a lever.**

Mechanical Advantage

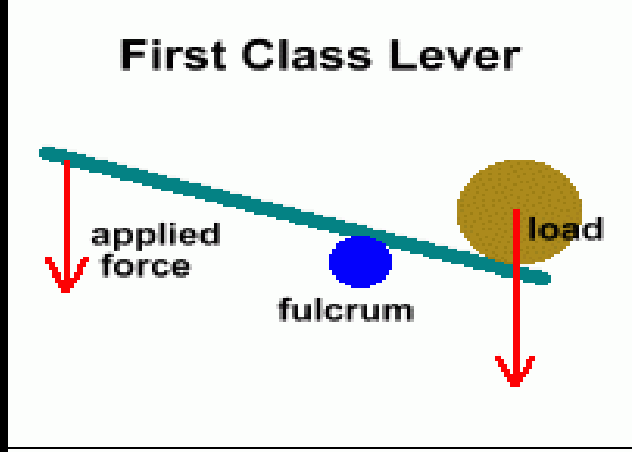


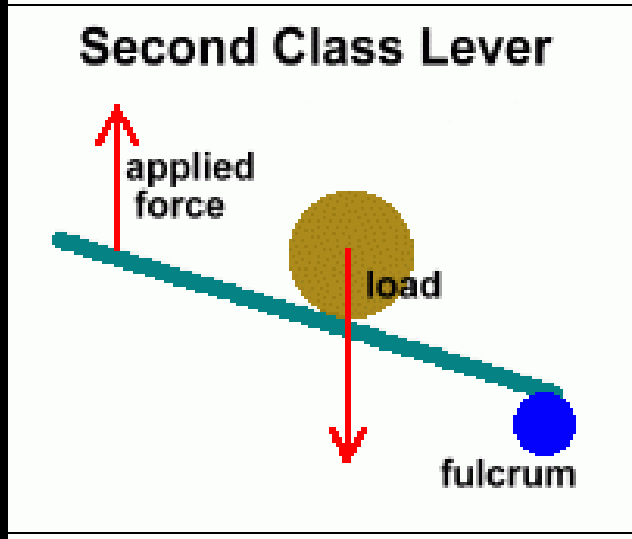
- By increasing the effort arm, I increase the Mechanical Advantage by increasing the distance of change which decreases the amount of effort I need to create the force I need on the resultant side.

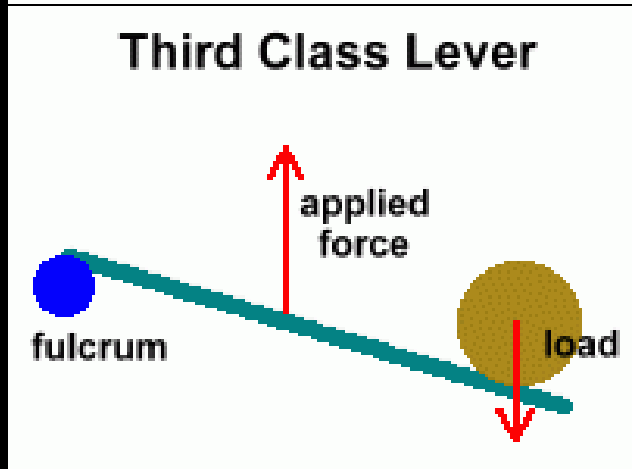
3 types of levers

- First class
- Second class
- Third class

*Be able to draw and classify the three classifications of levers.**







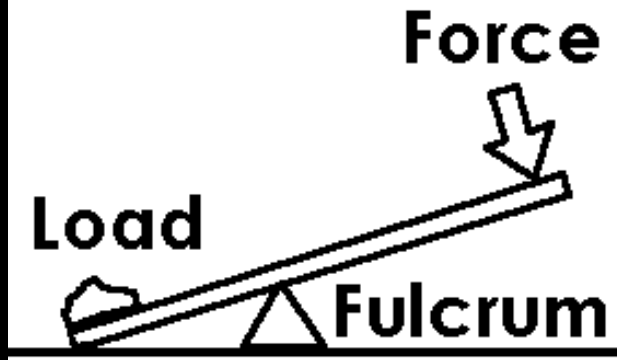
Lever Classification

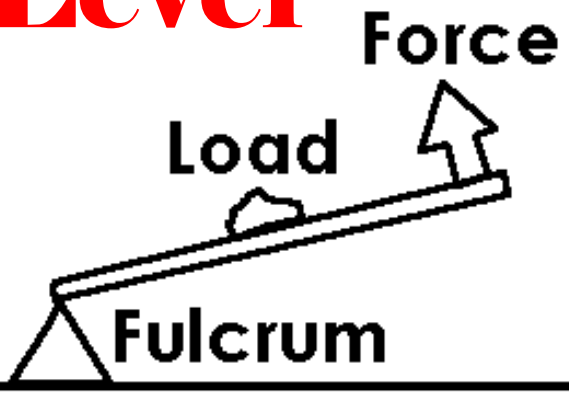
First Class Levers

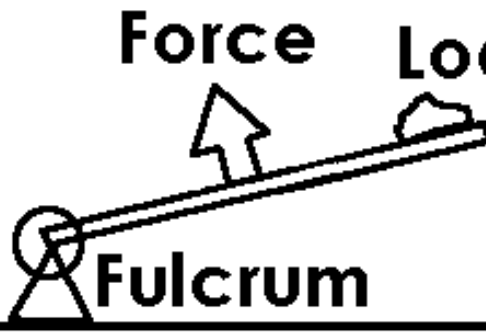
Second Class Levers

Third Class Levers

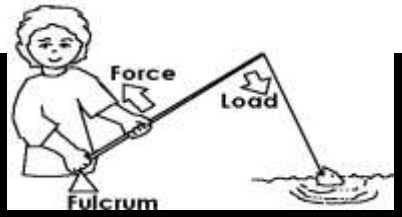
Lever

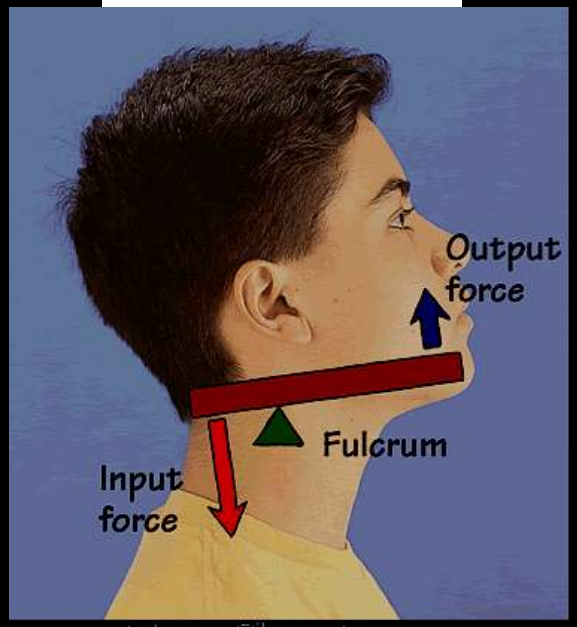




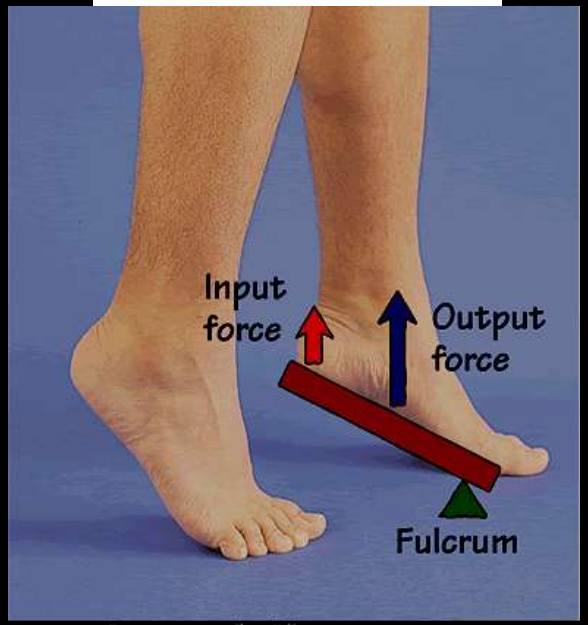


lever attached to fulcrum

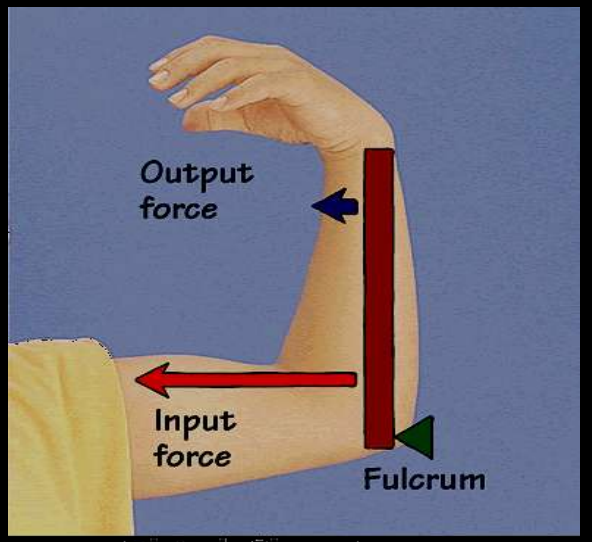




First-Class Lever



Second-Class Lever



Third-Class Lever

Review

- What is a machine?
- Name the six simple machines.
- What is mechanical advantage?
- What is the work equation?
- Draw or explain the three classifications of levers.
- How do you find the ideal mechanical advantage of a lever?
- Why is the work input always greater than the work output?

Quiz
Chapter 7

Name _____

- 1. What is a machine?
- 2. Name the six simple machines.
  - a.
  - b.
  - c.
  - d.
  - e.
- 3. What is mechanical advantage?
- 4. What is the work equation?
- 5. Draw or explain the three classifications of levers.
- 6. How do you find the ideal mechanical advantage of a lever?

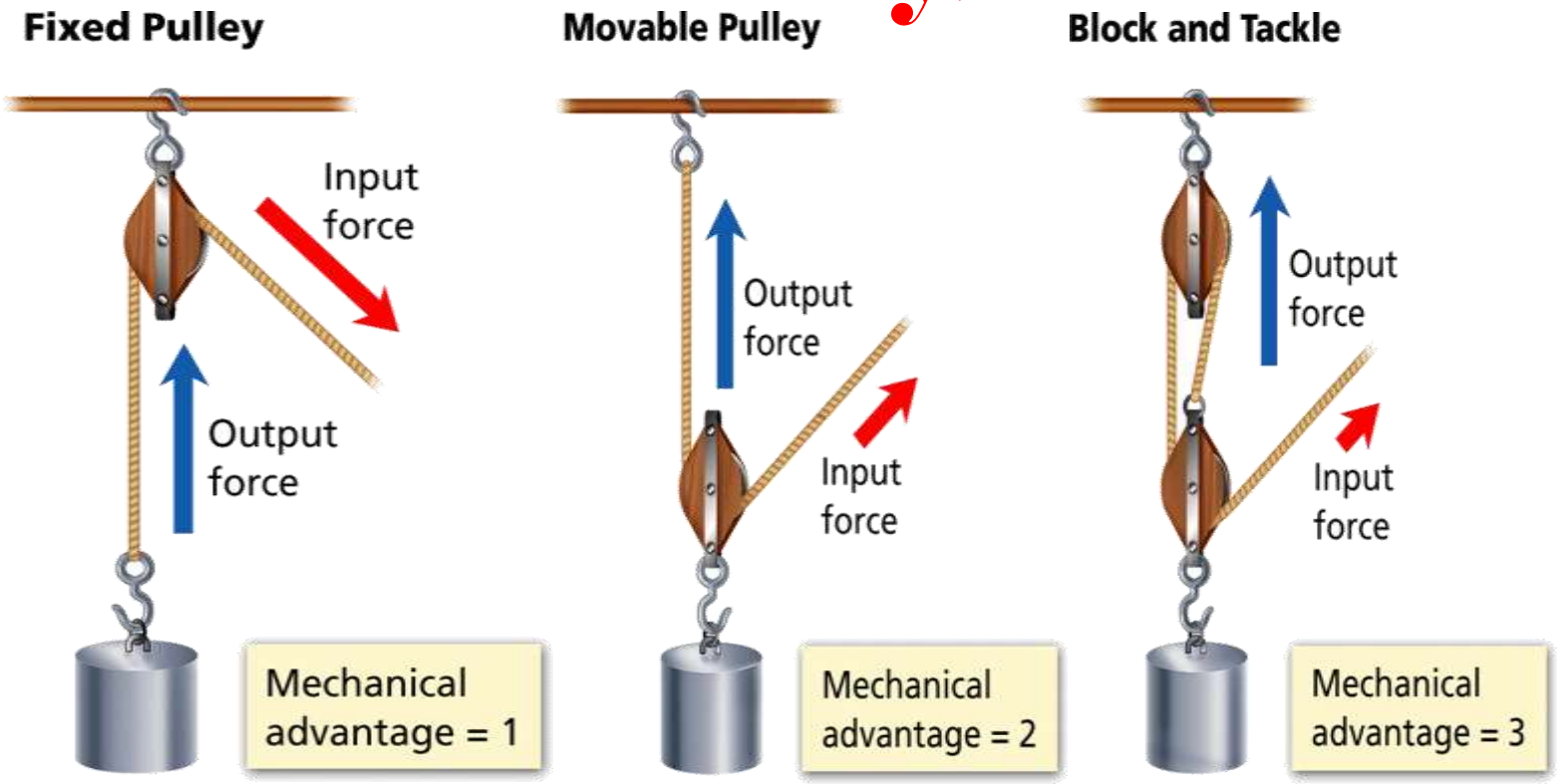
- 7. Why is the work input always greater than the work output?

Pulley

- **Wheel that spins freely on an axle, usually a rope that moves over a grooved wheel**
  - **IMA = # of supporting strands**
  - **IMA can also be calculated dividing the effort resistance by the resistance distance**

How do you find the IMA of a pulley?*

Pulleys



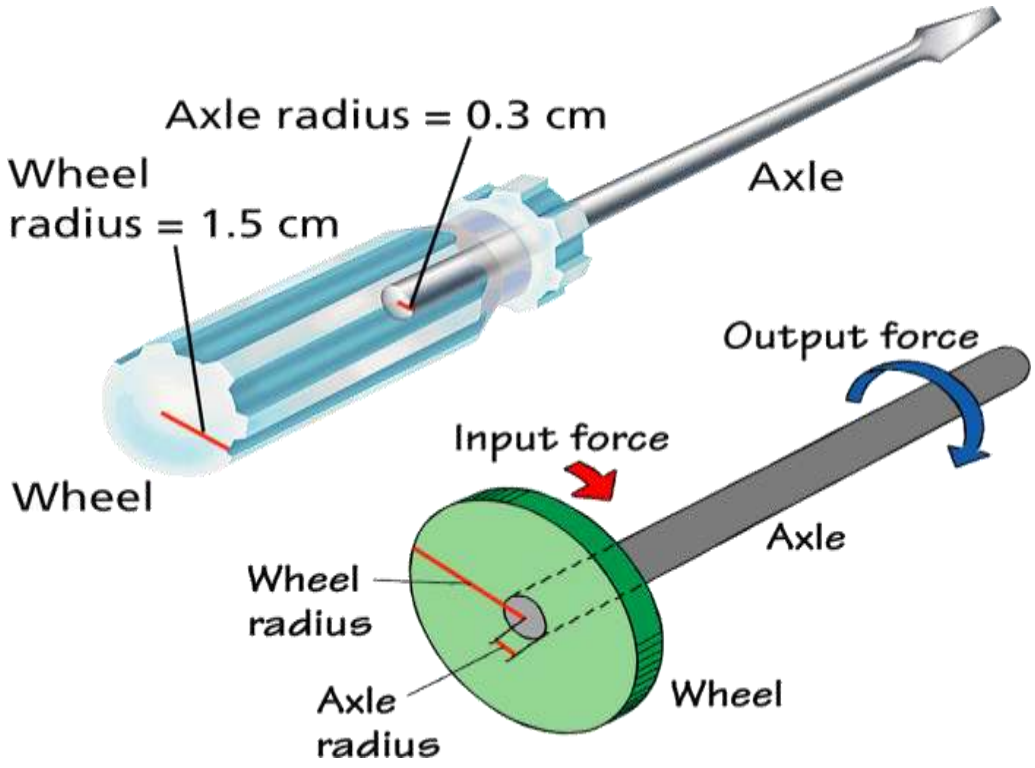
By adding a pulley to the system, I make the distance (rope) to lift the load longer. This spreads out the work which decreases the effort (force) needed to lift the mass (load)

Wheel & Axle

- **consist of a wheel fixed to an axle that rotated about a central point**
  - **IMA = radius of the wheel/radius of the axle**
  - **Wheel and axle is a modified lever**

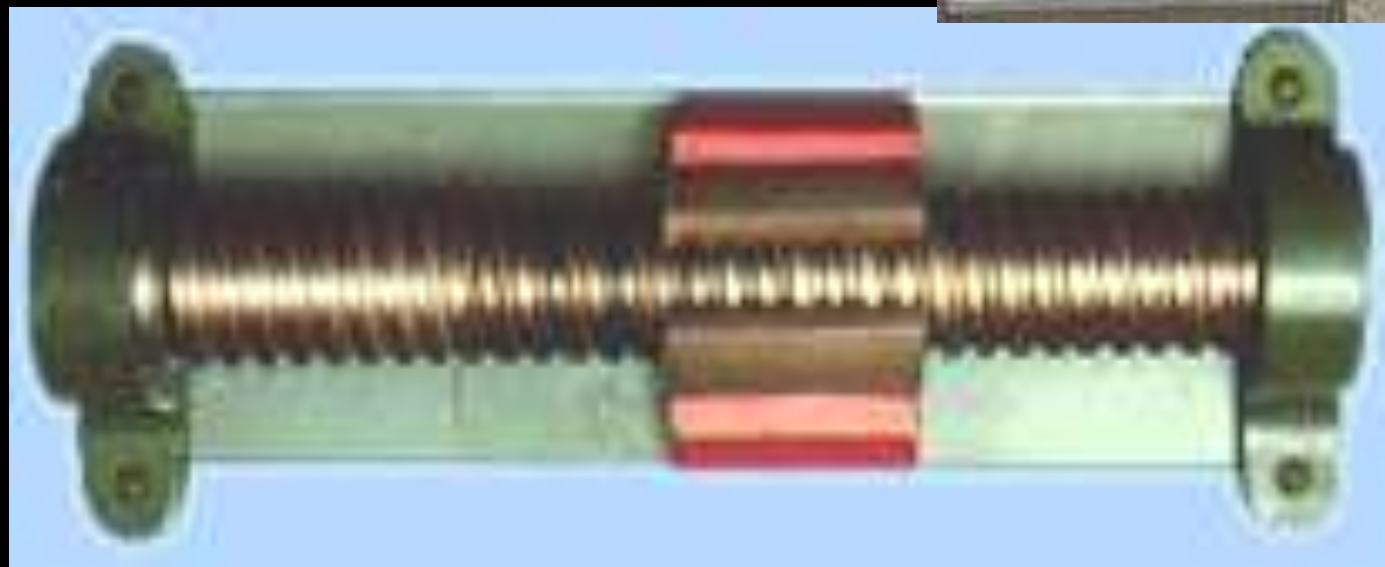
    *How do you find the IMA of a wheel and axle?**

Wheel and Axel

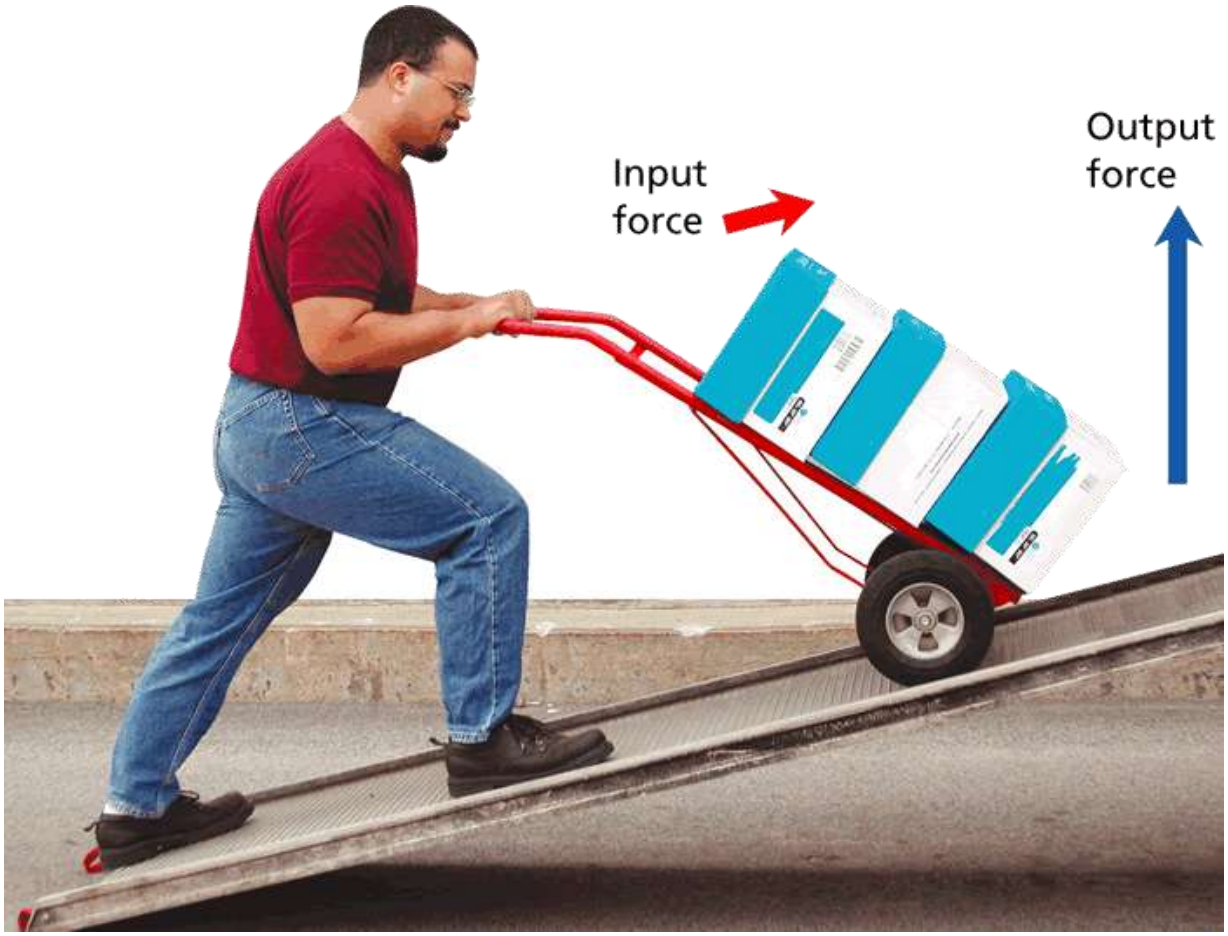


inclined PLANE

- a sloping surface
  - IMA = length of plane/height of plane
- Screw – inclined plane around a cylinder
- Wedge – two inclined planes together
- IMA = Length / width*
  - Ideal Mechanical advantage for all machines is effort distance/resistance distance



Inclined plane:



By increasing the plane, (or making the slope less steep) less input force is required to move the object to the destined height.

Actual Mechanical Advantage

- **resistance force/effort force**
- **Ideal Mechanical advantage for all machines is effort distance/resistance distance**

How do you find actual mechanical advantage AMA.*

Human body as a machine

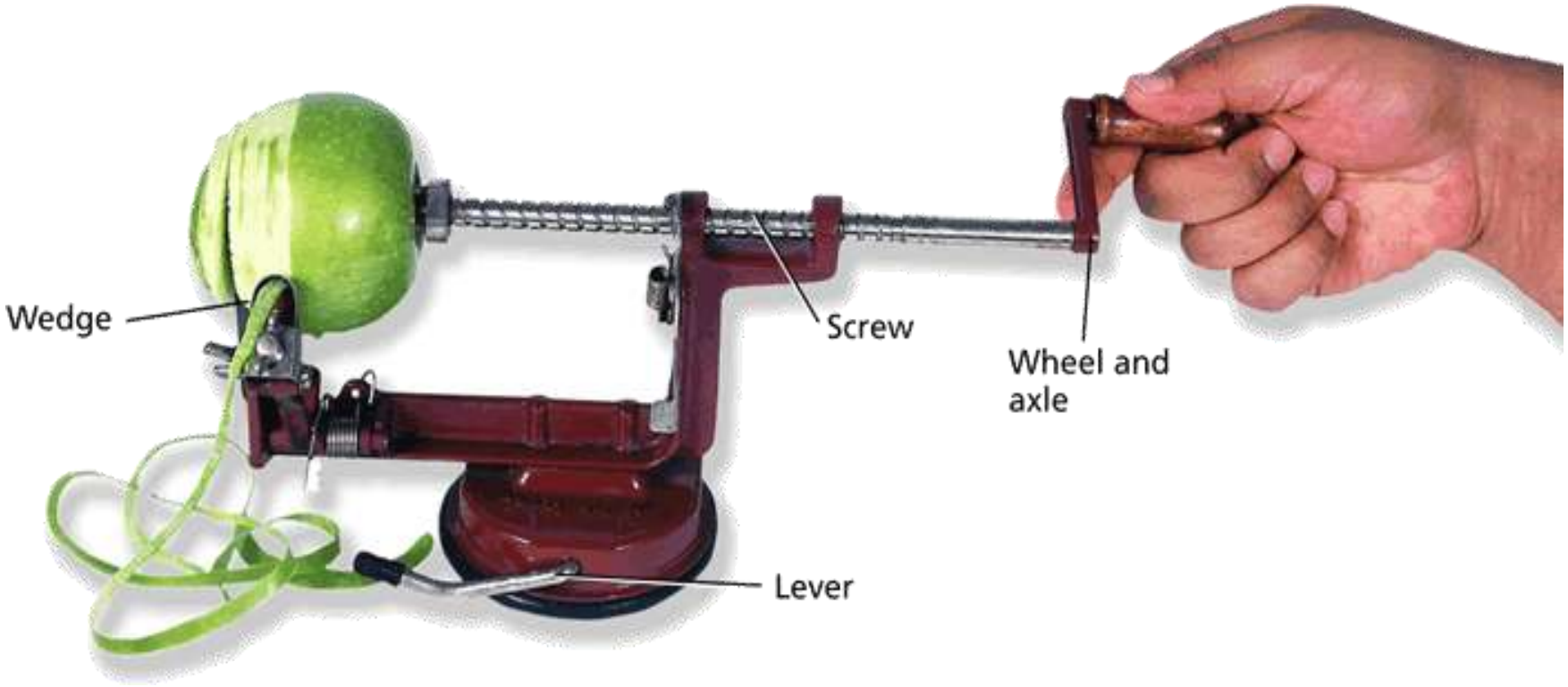
- Composed of muscles and levers
  - Muscle movement is triggered by small electric pulse
- Bionics is the science of designing artificial replacements for human body parts (prostheses)
  - The possibility is to make artificial limbs that can respond much like real ones

Compound machines*

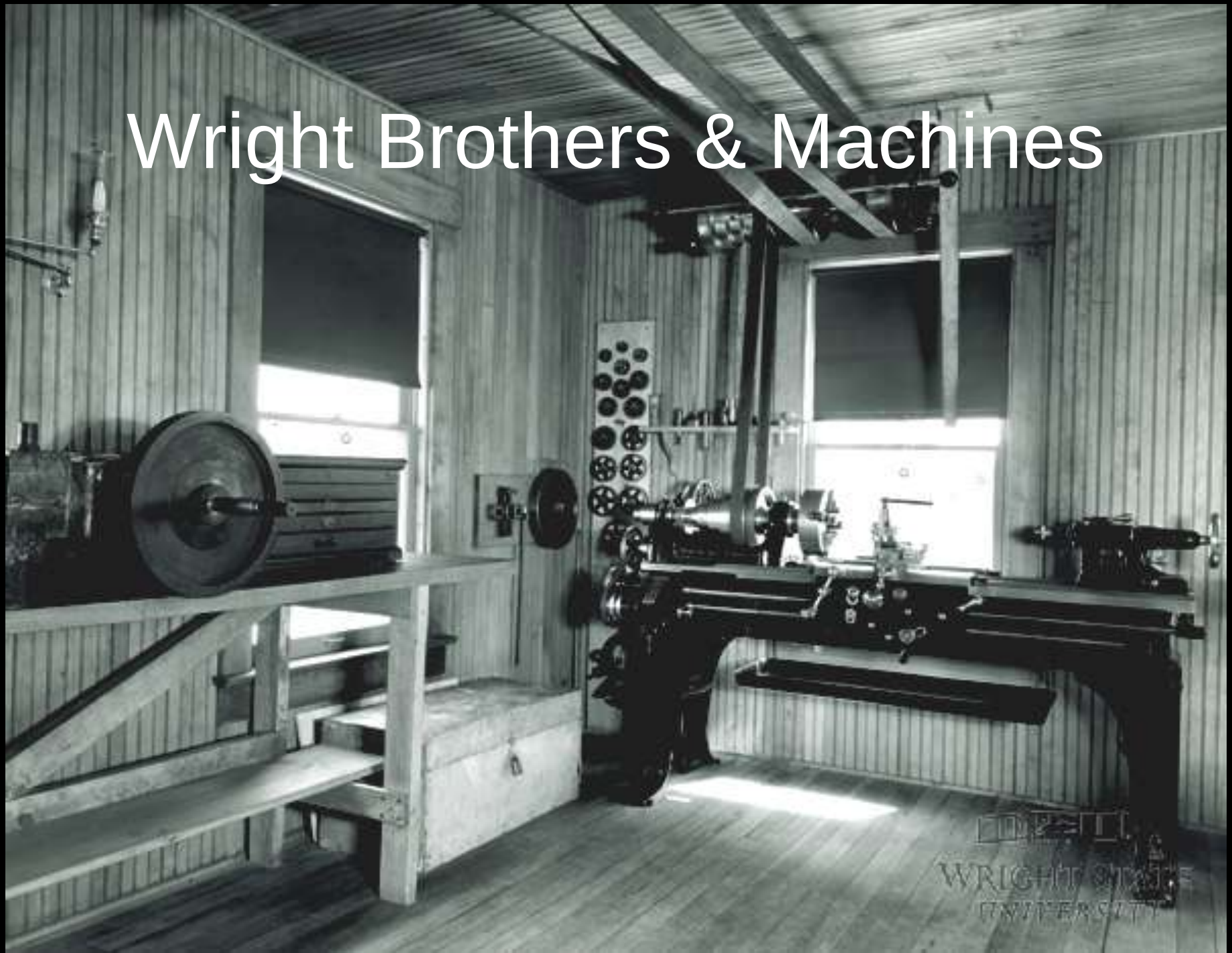
- a combination of two or more simple machines

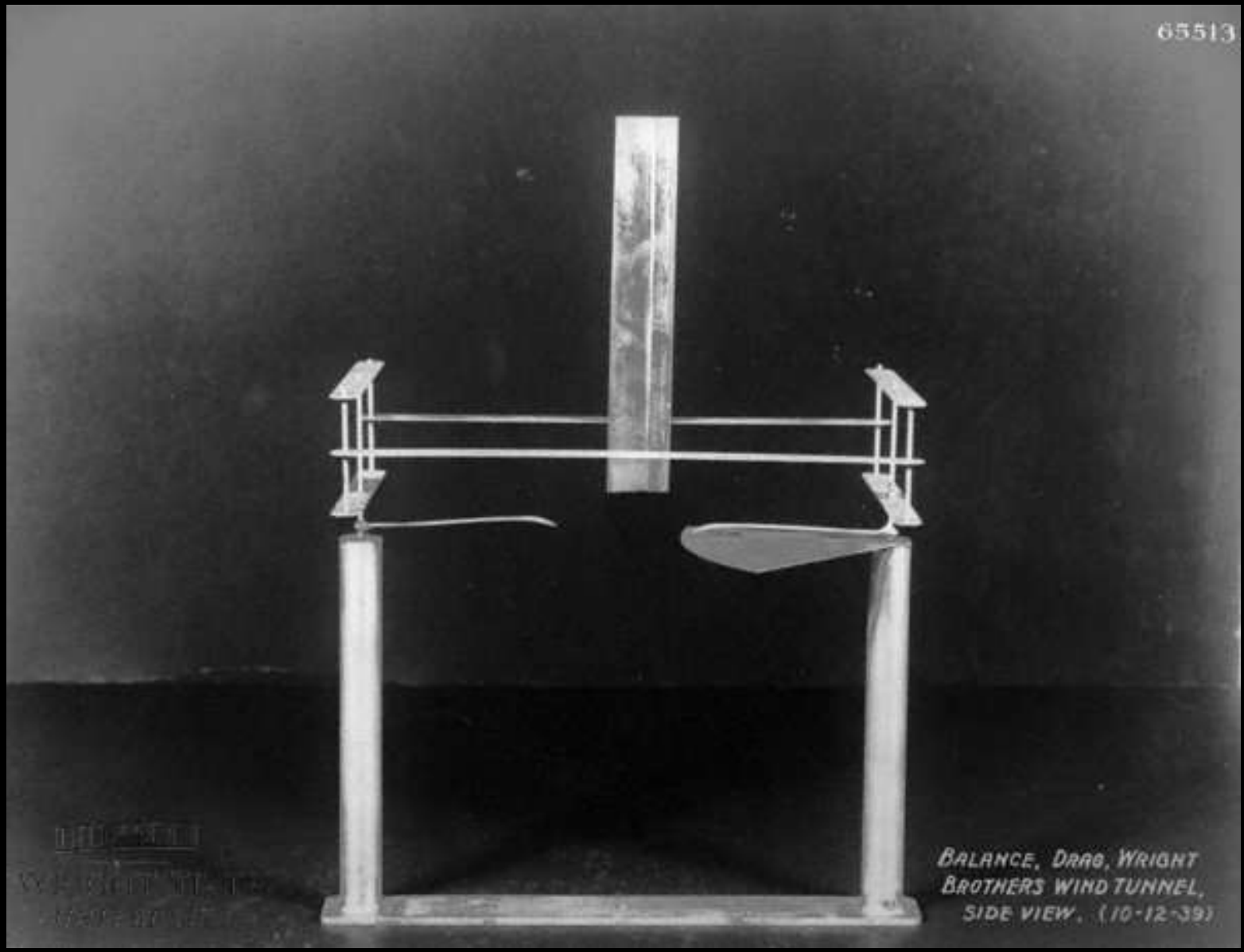
"Compound Machine"

Any combination of several simple machines…



Wright Brothers & Machines

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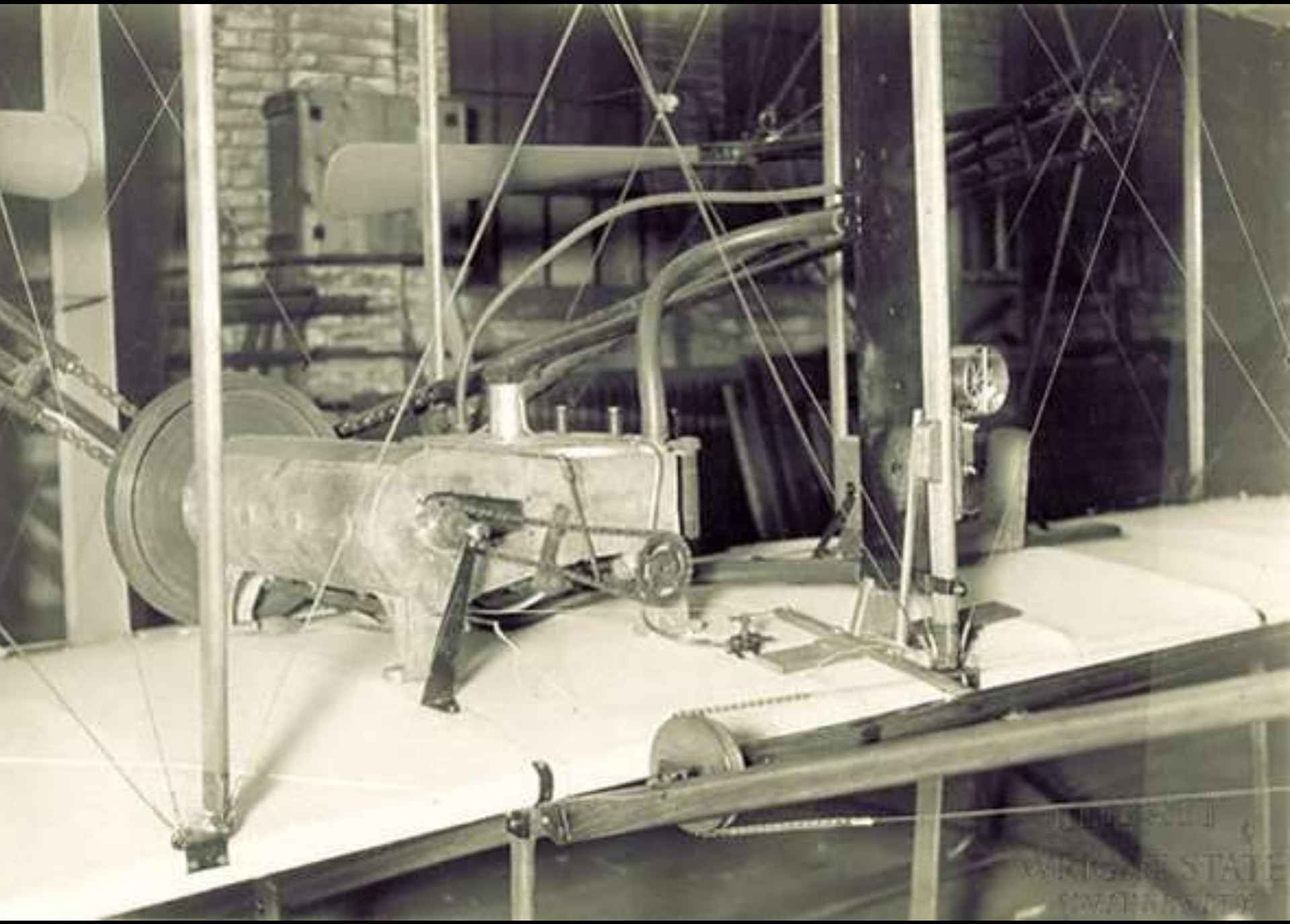
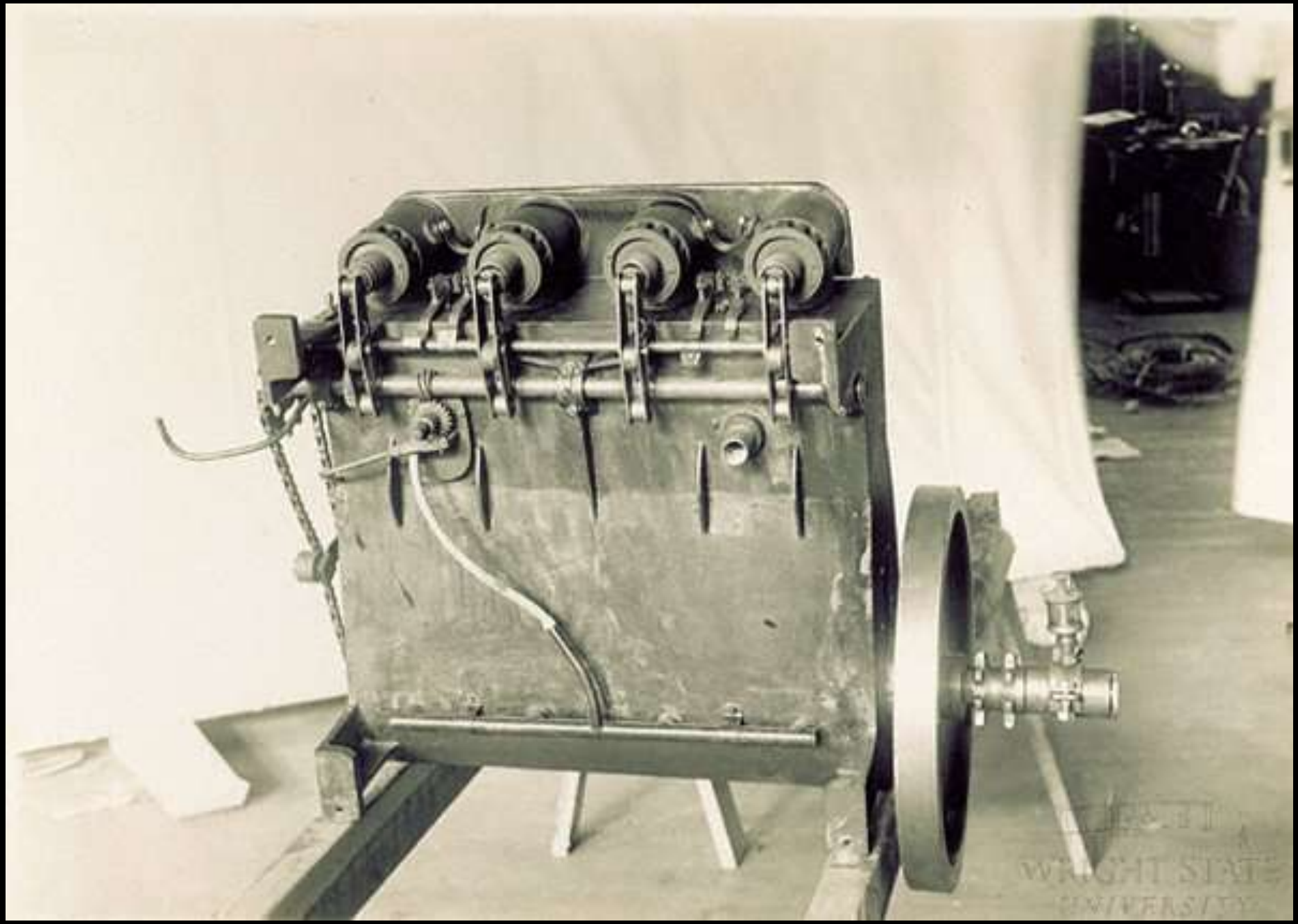
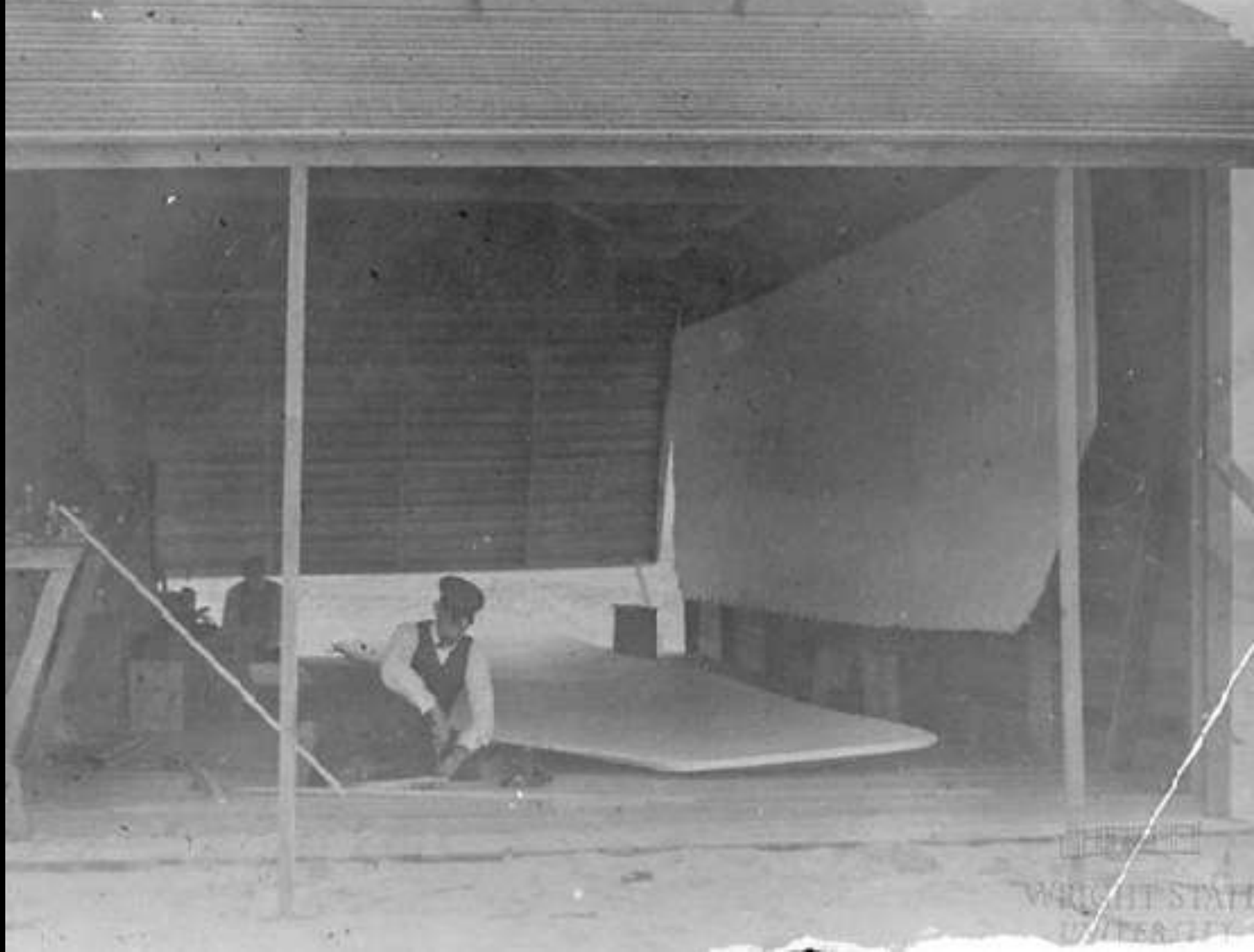
BALANCE, DRAG, WRIGHT
BROTHERS WIND TUNNEL,
SIDE VIEW. (10-12-39)







Efficiency

- **is a measurement of the work put into a machine compared to the work got out of a machine**
- **Percent efficiency = (work output/work input) x 100 , or (F_r x D_r/F_e x D_r) x 100**

How do you find the efficiency of a machine?*

Power

- **The rate at which work is done**
  - **Power = work/time***
  - **The unit of Power is the watt***
  - **1000 watts = 1 Kilowatt or kW**
  - **Do example problem p. 203**
  - **A machine lifts a box weighing 600N 4 meters off the floor in 8 seconds. Find the power of the pulley system.**
    - **F x D = Work, work/time = power**
    - ***Be able to do power calculations.****