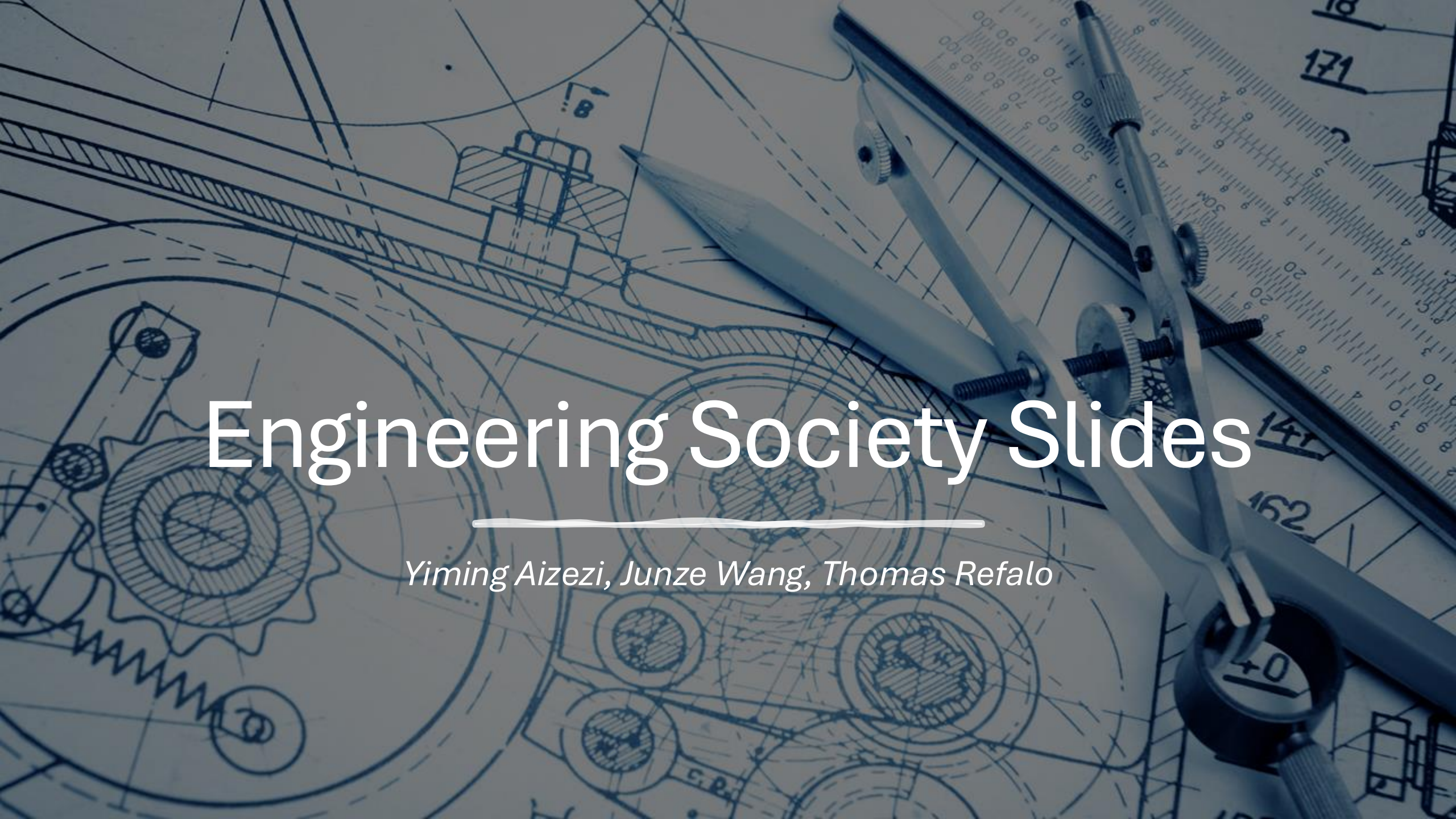


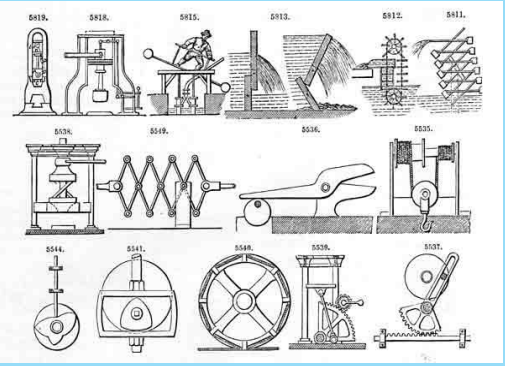
Engineering Society Slides

Yiming Aizezi, Junze Wang, Thomas Refalo

Note:
Sessions 1,2,3 were completed on a separate document

Session 4: Mechanisms

By Yiming for Wednesday 5 February



What is a mechanism?

A mechanism is a system of moving parts designed to perform a function. They usually have moving parts that work together to transfer motion or force in a controlled way

Examples of mechanisms in everyday life:

- Scissors
- Seesaw
- Bicycle
- Music box

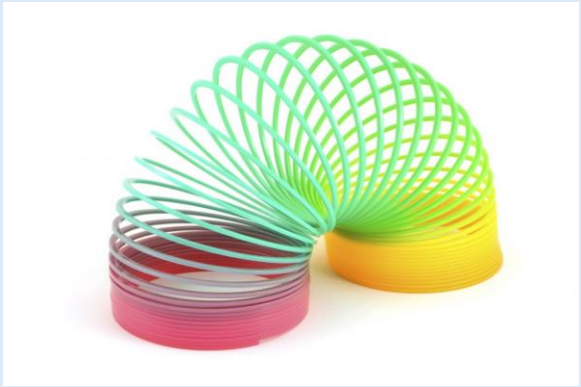
Which of these is not a mechanism?

A) A Spring

B) Zipper

C) Slinky

D) Mechanical pencil



The Answer:

A) A Spring

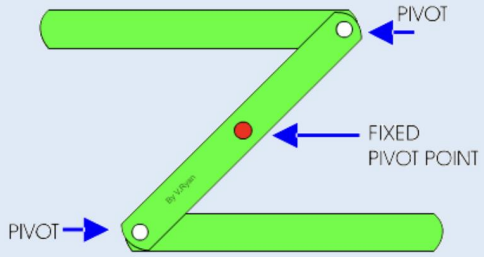
B) Zipper

C) Slinky

D) Mechanical pencil

A single spring may be able to store energy, but it doesn't transfer motion unless combined with other parts

The four basic mechanisms

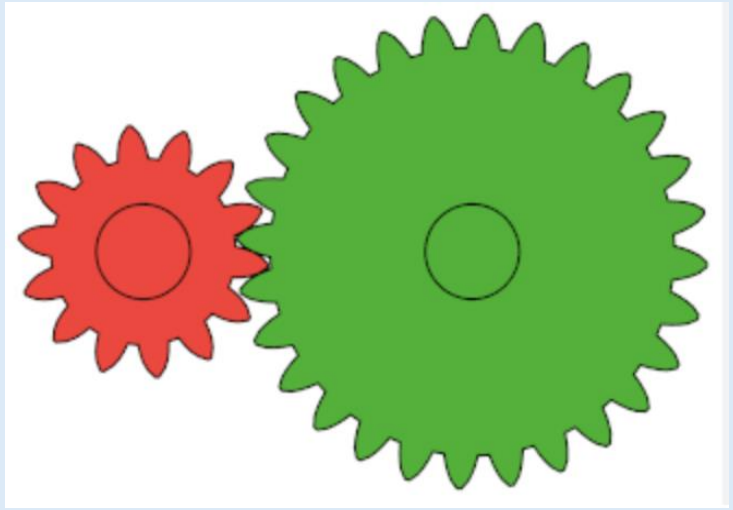


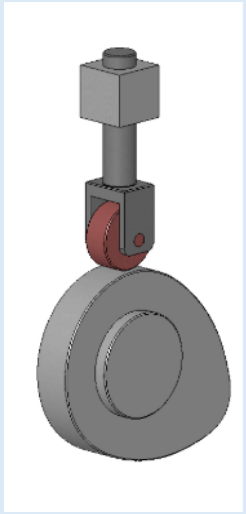
Levers – amplify force (seesaws, crowbar)

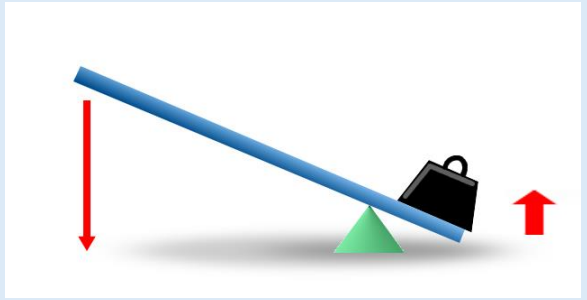
Gears – transfer motion (bicycle, clocks)

Cam & Followers – control movement (car engine)

Linkages – guide motion (scissor lifts)







Focus on linkages

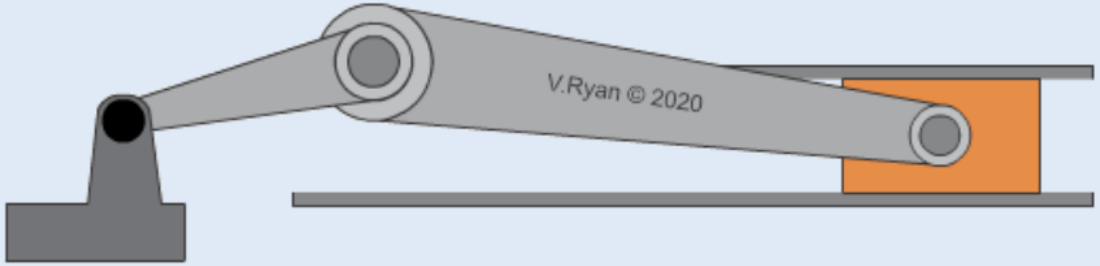
A linkage can:

- Change direction or alter path of motion
- Give a mechanical advantage
- Change speed and/or acceleration
- Create motion that is elegant

Source: https://designwithmovement.aalto.fi/lecture-2-basics-of-movement/

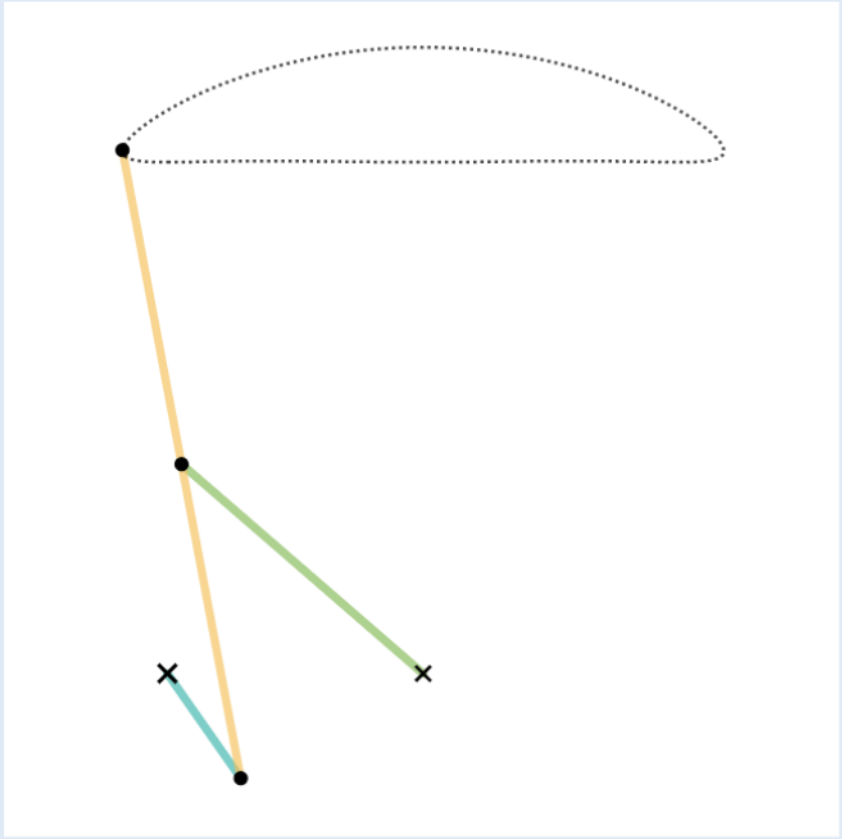
Basic linkage mechanism: from rotational to linear

Crank Slider:



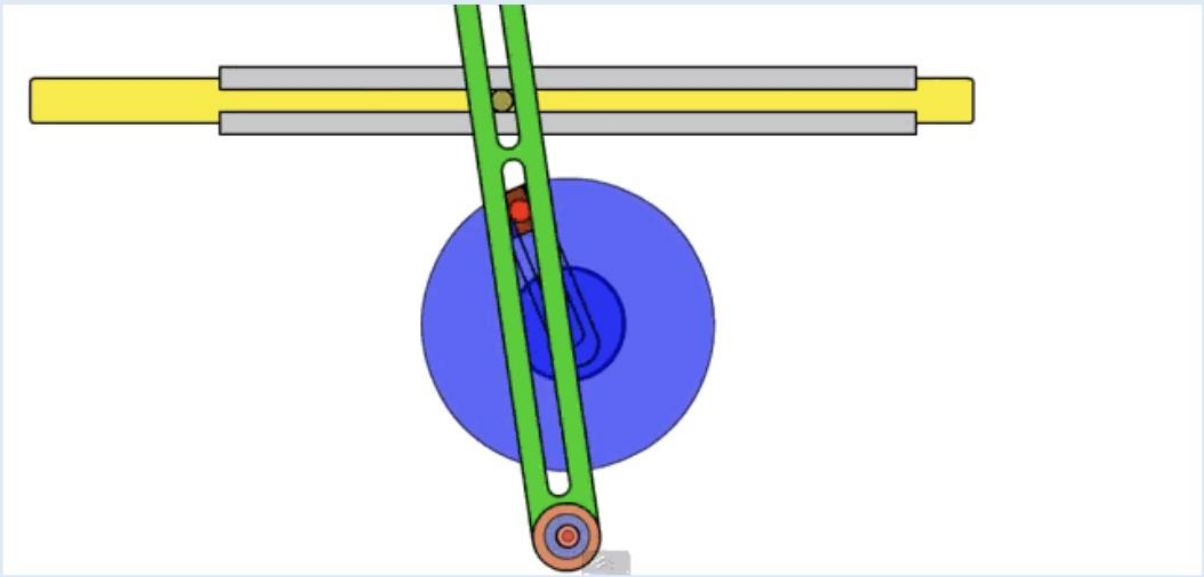
Basic linkage mechanism: from rotational to linear

Chevyshev mechanism:



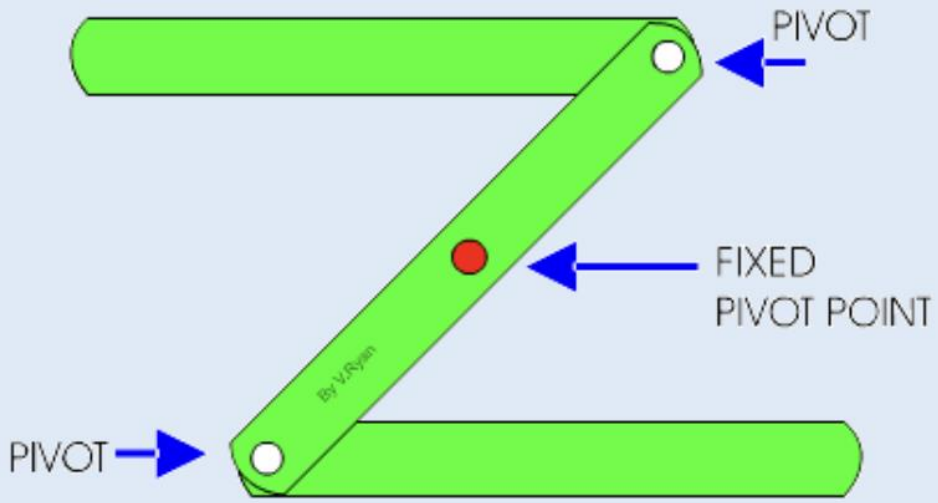
Basic linkage mechanism: from rotational to linear

Quick return



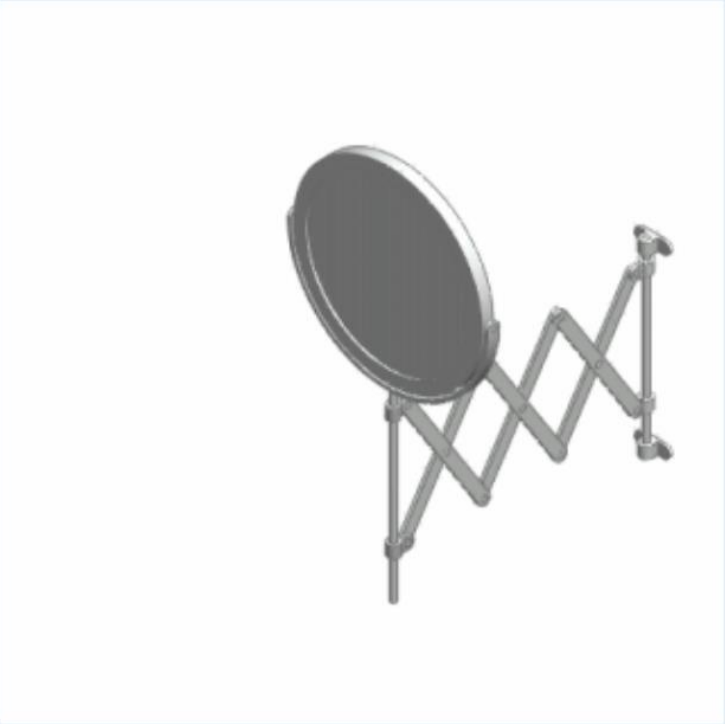
Basic linkage mechanism: changing direction

Lever



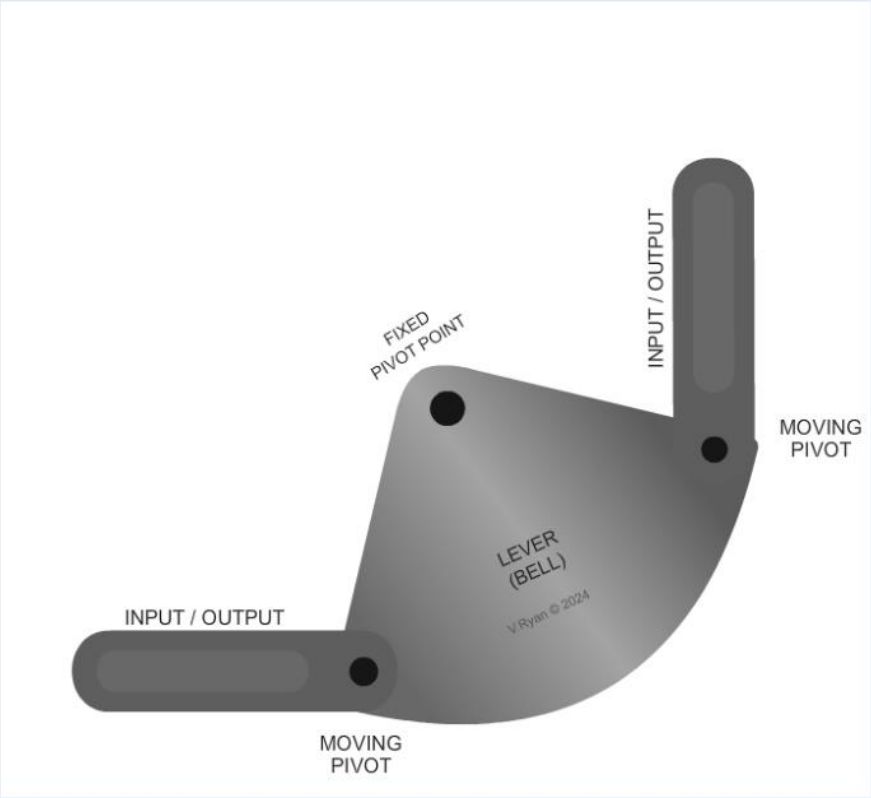
Basic linkage mechanism: changing direction

Scissors



Basic linkage mechanism: changing direction

Bell crank



Task: Design your own linkage mechanism!

1) Choose a motion transfer challenge

Easy: linear to linear motion

Medium: rotary to linear

Hard: motion direction change

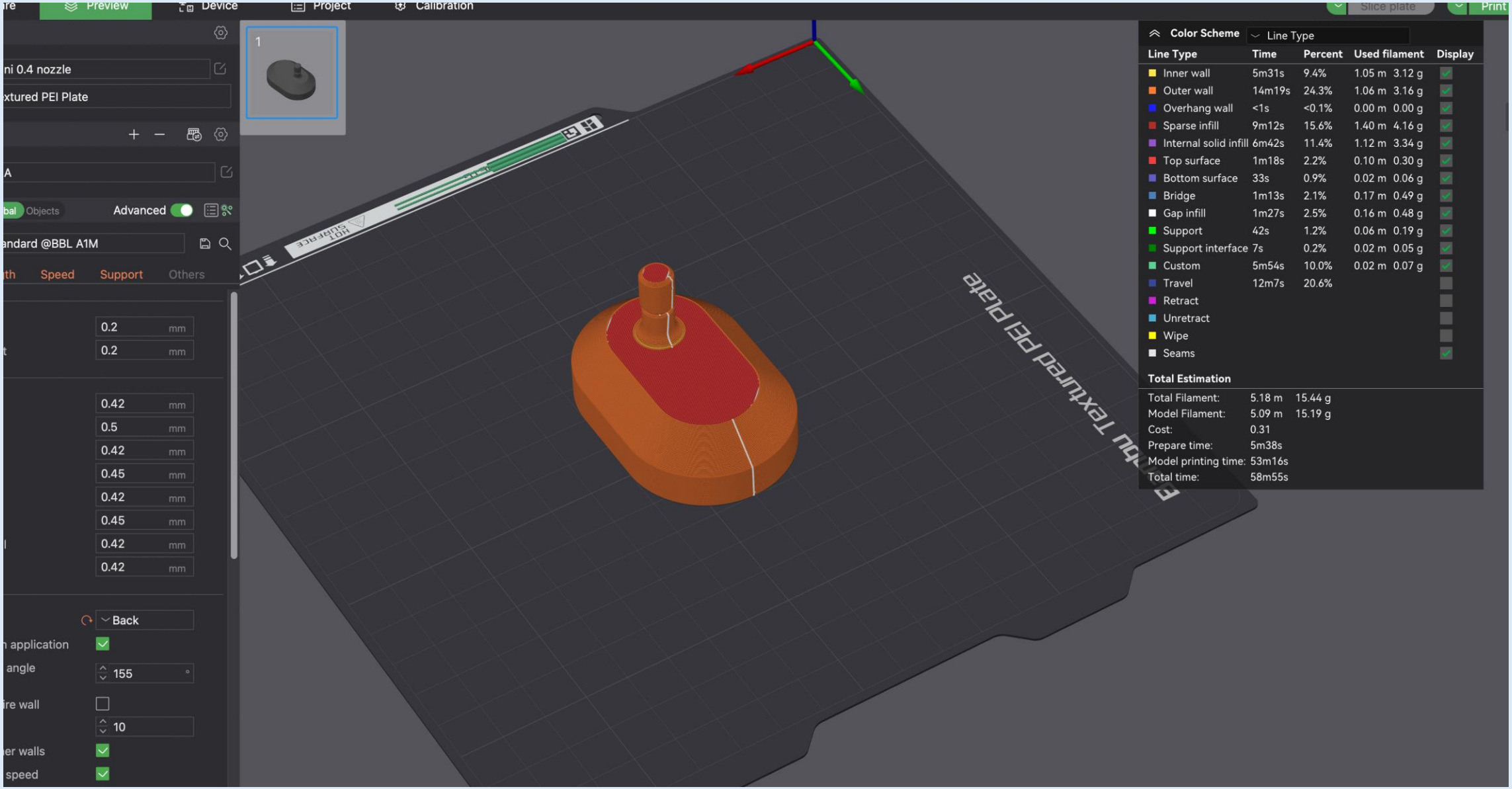
2) Take a piece of paper and start designing your own mechanism to achieve this!

Task: Design your own linkage mechanism!

Info: Don’t use the mechanisms I showed you already, if you can’t produce a design, try searching online!

I also 3D printed an example of continuous rotary motion to intermittent rotary motion

Meaning, it rotates with discrete steps, with pauses in between


Preview
Device
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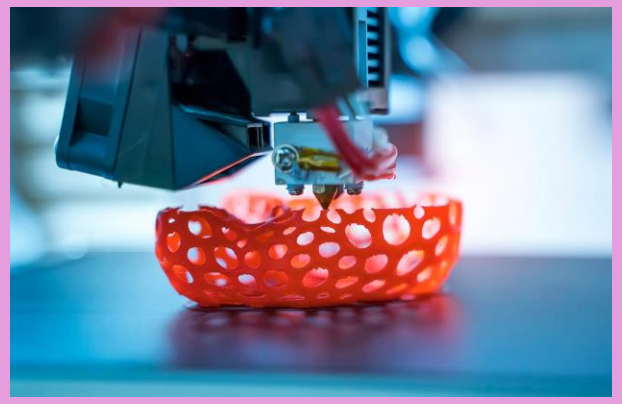
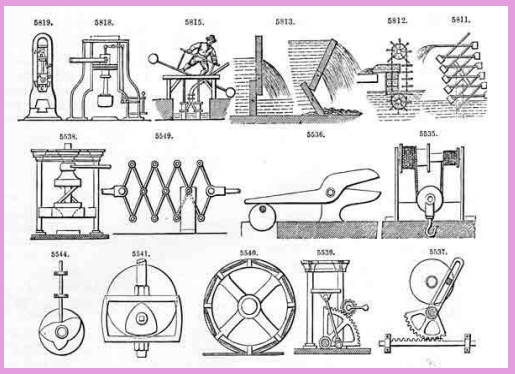
Back
application
angle
155
ire wall
10
er walls
speed
Color Scheme
Line Type
Line Type Time Percent Used filament Display
Inner wall 5m31s 9.4% 1.05 m 3.12 g
Outer wall 14m19s 24.3% 1.06 m 3.16 g
Overhang wall <1s <0.1% 0.00 m 0.00 g
Sparse infill 9m12s 15.6% 1.40 m 4.16 g
Internal solid infill 6m42s 11.4% 1.12 m 3.34 g
Top surface 1m18s 2.2% 0.10 m 0.30 g
Bottom surface 33s 0.9% 0.02 m 0.06 g
Bridge 1m13s 2.1% 0.17 m 0.49 g
Gap infill 1m27s 2.5% 0.16 m 0.48 g
Support 42s 1.2% 0.06 m 0.19 g
Support interface 7s 0.2% 0.02 m 0.05 g
Custom 5m54s 10.0% 0.02 m 0.07 g
Travel 12m7s 20.6%
Retract
Unretract
Wipe
Seams
Total Estimation
Total Filament: 5.18 m 15.44 g
Model Filament: 5.09 m 15.19 g
Cost: 0.31
Prepare time: 5m38s
Model printing time: 53m16s
Total time: 58m55s

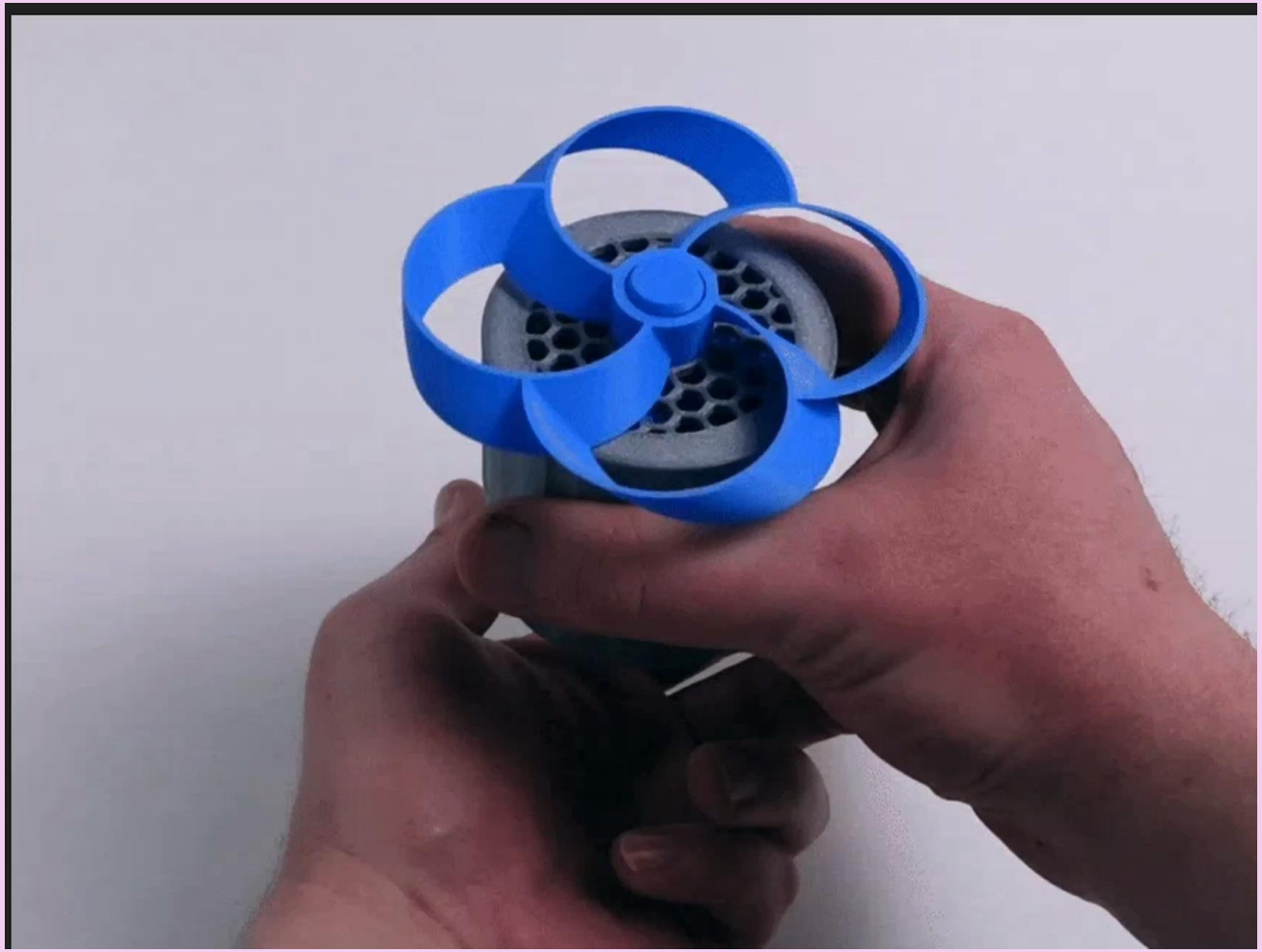
Session 5: (toroidal launcher)

By Thomas





How do you think this works?



Planetary Gears

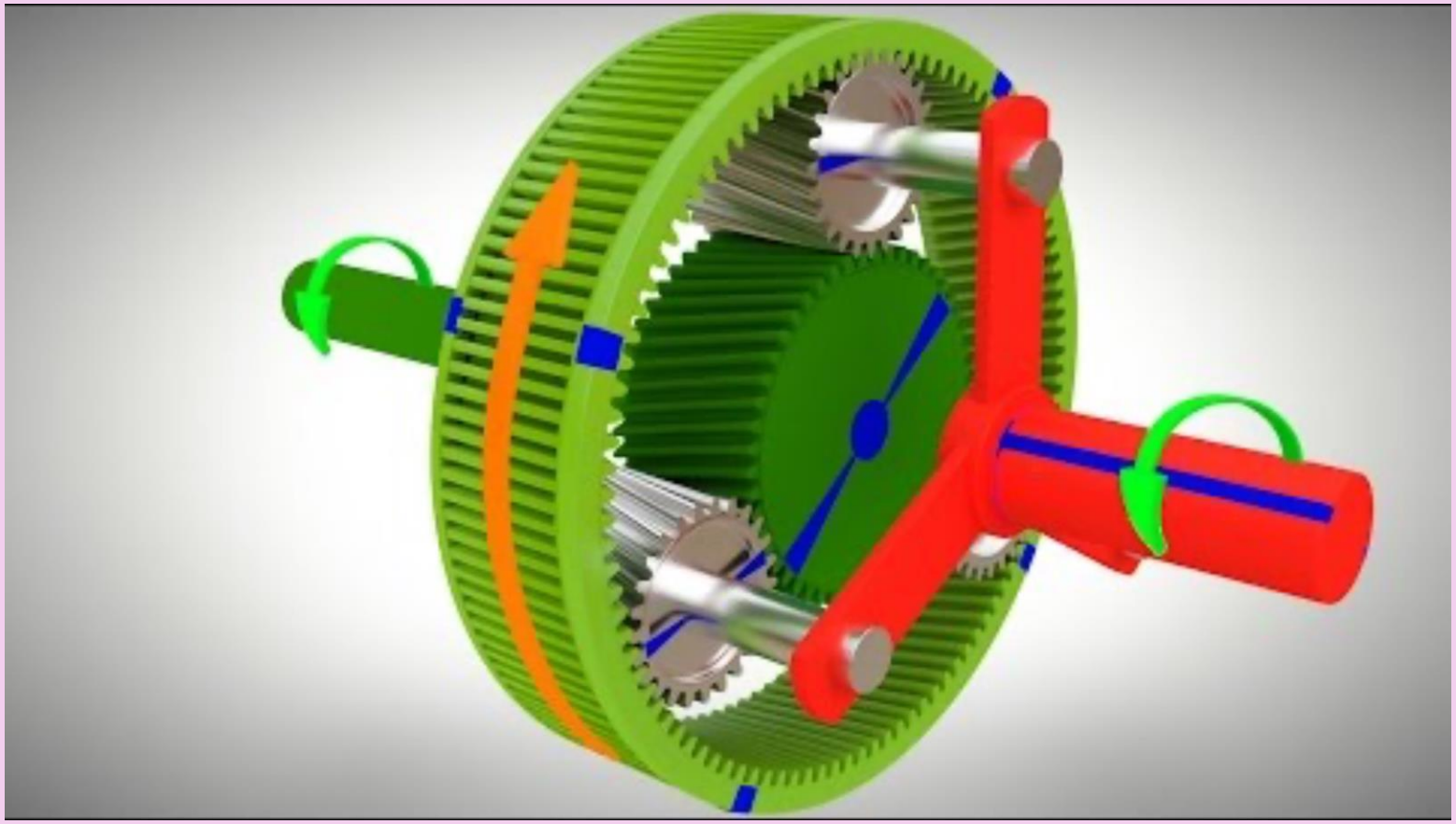
The device utilizes planetary gears as Junze explained two sessions ago

It to high gear ratio 1:48 – allows a higher acceleration by efficiently converting rotational energy into linear motion.

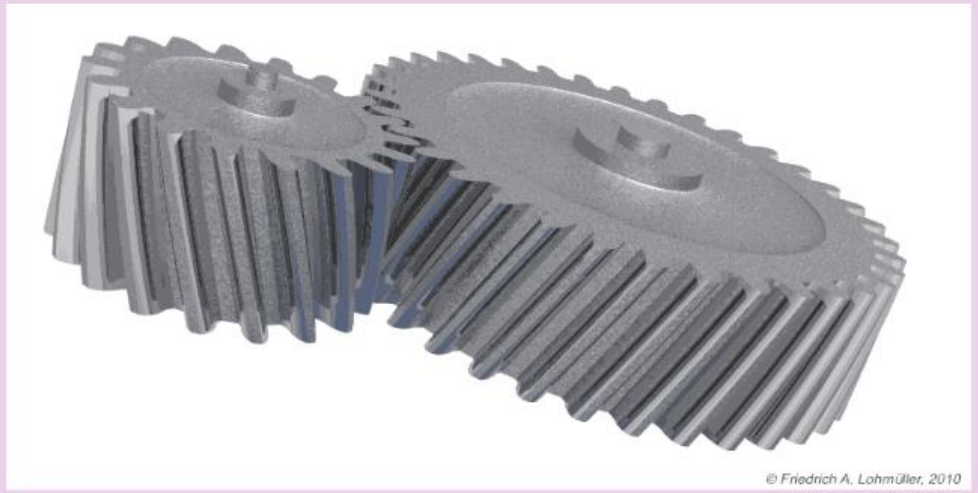
There are two planetary gears inside it, and it is how the propeller accelerates smoothly and swiftly

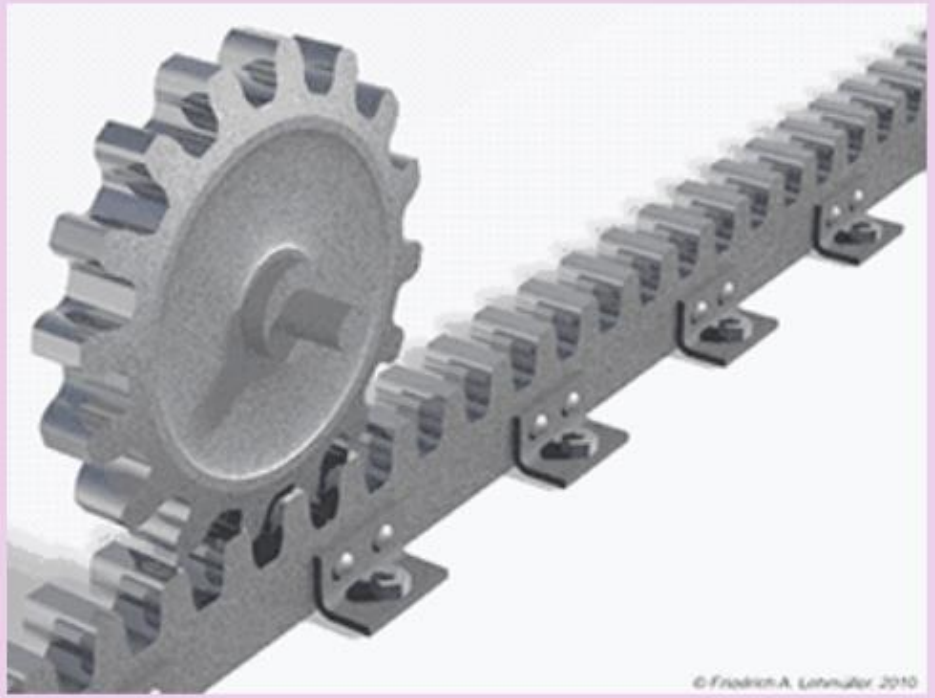
so does anyone remember the benefits of the planetary gears?

Quick recap:

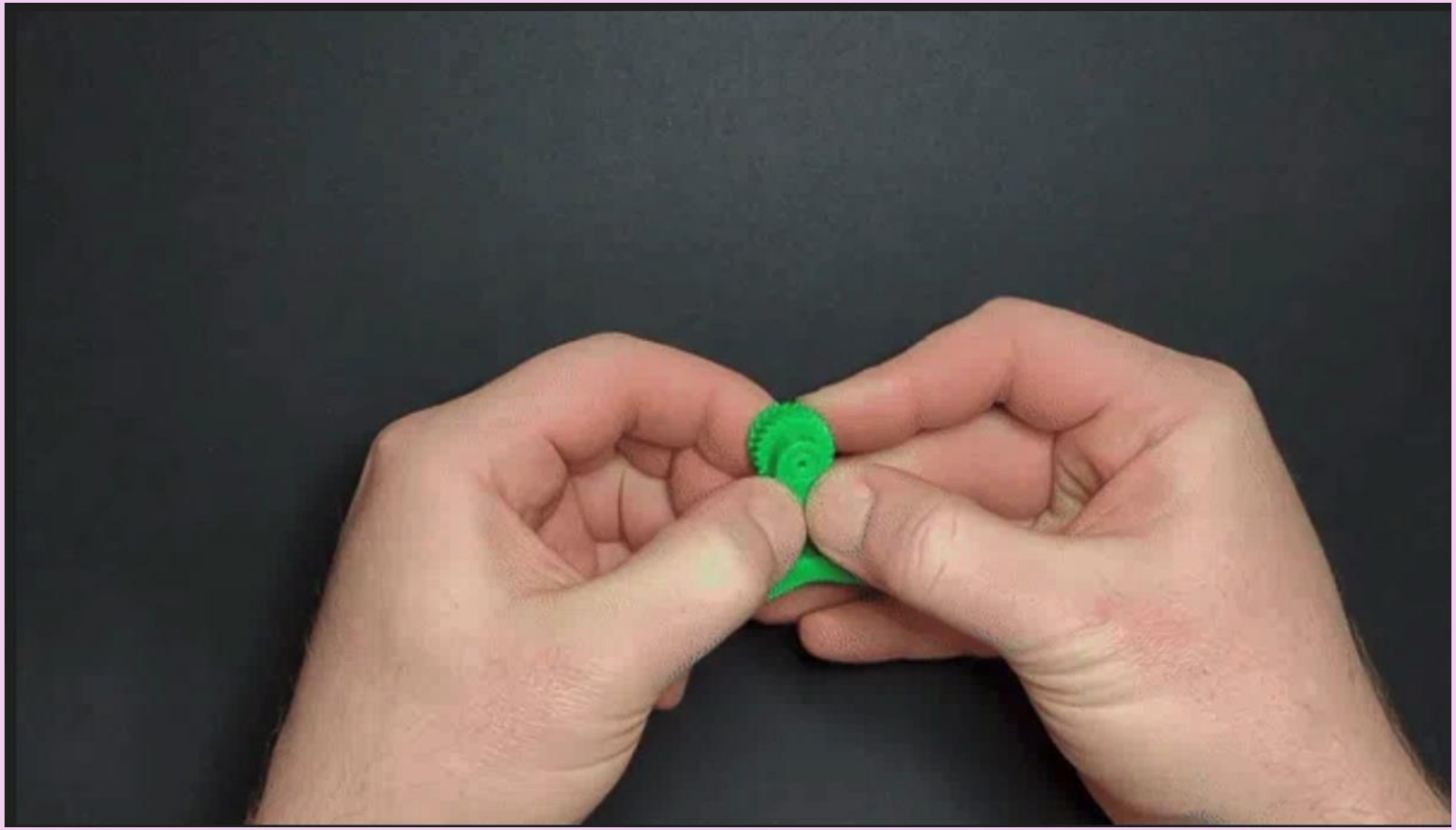


Anyone remember any other gears?

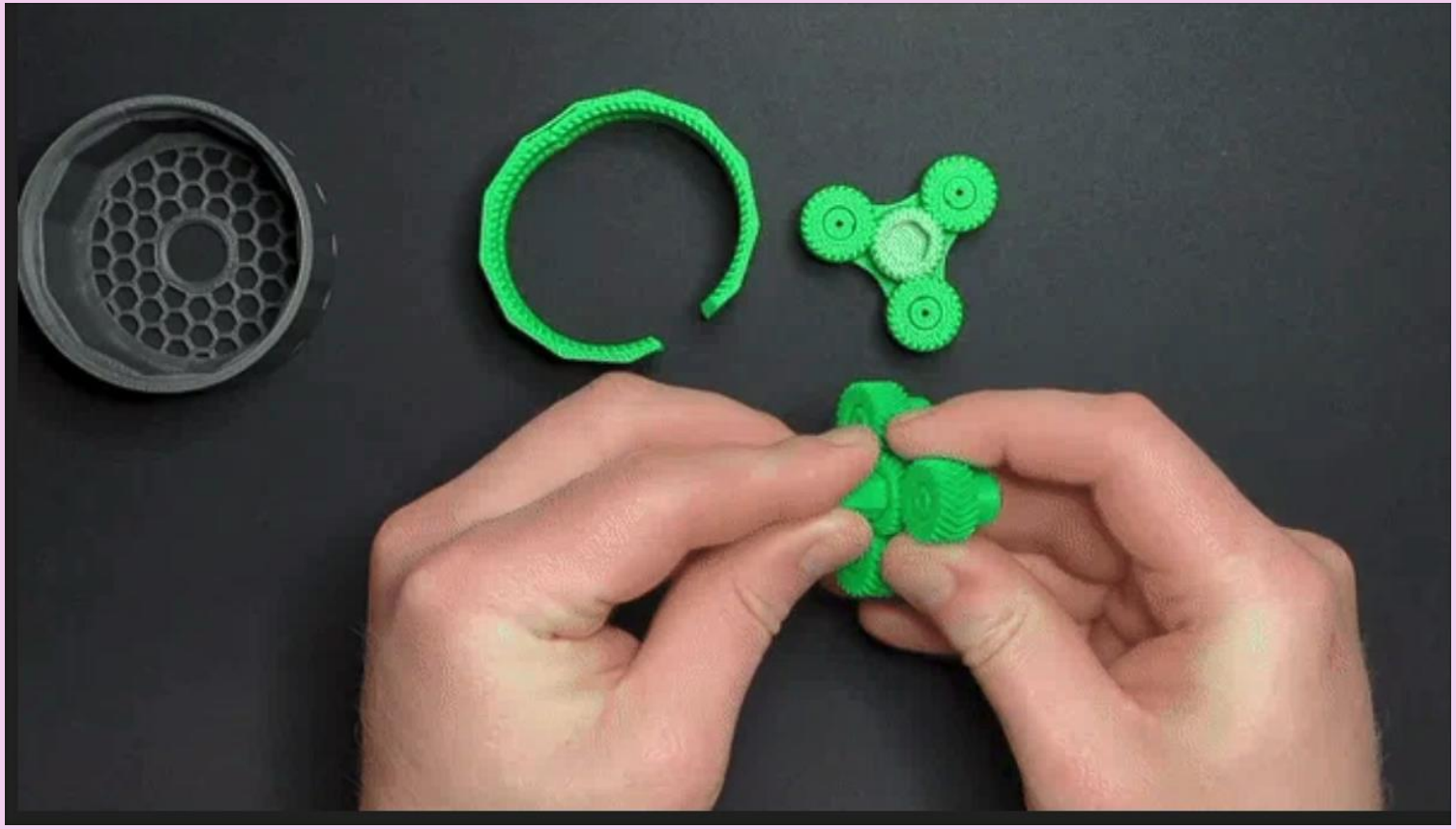




How to construct it? – Making the planetary gears



How to construct it? – connecting the plantary gears



How to construct it? – putting it together

How to construct it? – finishing touches

How it works

- Rotational motion transfer, ratio of 1:48 in terms of gears to build up the rotational torque and speed.
- Once the propeller has enough angular speed, it generates uplift through the Magnus Effect & Thrust.
- In simple terms, the rapid rotational speeds cause invariance of the pressure and that is converted into an upthrust force.

The Upthurst force can be calculated through the formula of:

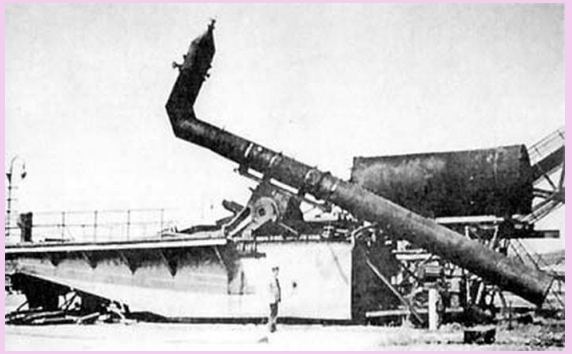
$$F_L = C_L * \frac{1}{2}\rho A v^2$$

CL= Lift coefficient (depends on shape)
P = Air density (1.225 kg/m^3 at sea level)
A = Area swept by the toroidal blades
v = Air velocity generated by rotation

- The curved, looped shape of the toroidal propeller guides airflow into a circular motion.
- toroidal designs distribute air pressure more evenly.
- This controlled air circulation helps sustain a self-reinforcing vortex, reducing turbulence.

Cool slowmo

Which fields are these utilized in?

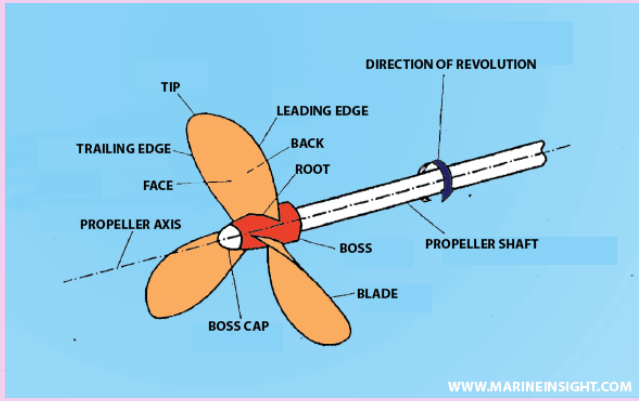


Military

- German WWII Experimental “Vortex Gun”
- Designed to disrupt aircraft flight using high-energy vortex rings.
- Unsuccessful due to inconsistent accuracy.

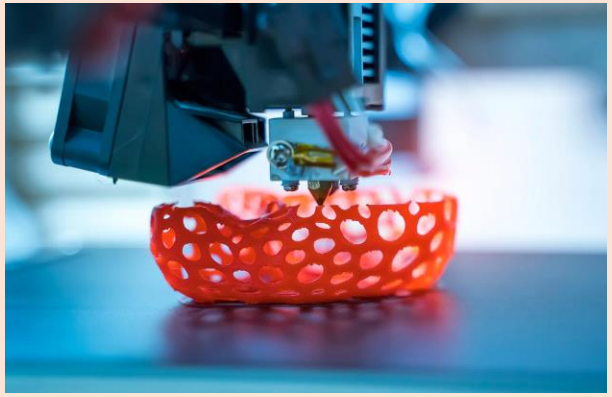
Propositions

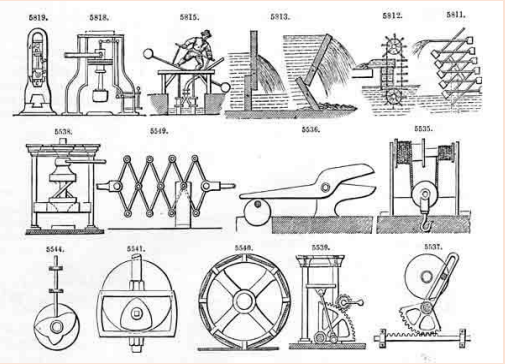
- Resembles it somewhat
- Electric Aircraft & Drones: Silent propulsion with increased efficiency.
- Marine Propellers: Reduces cavitation (bubble formation), improving efficiency.
- Wind Turbines: Increases energy efficiency by optimizing vortex flow.



Session 6: Egg Drop Challenge

By Yiming



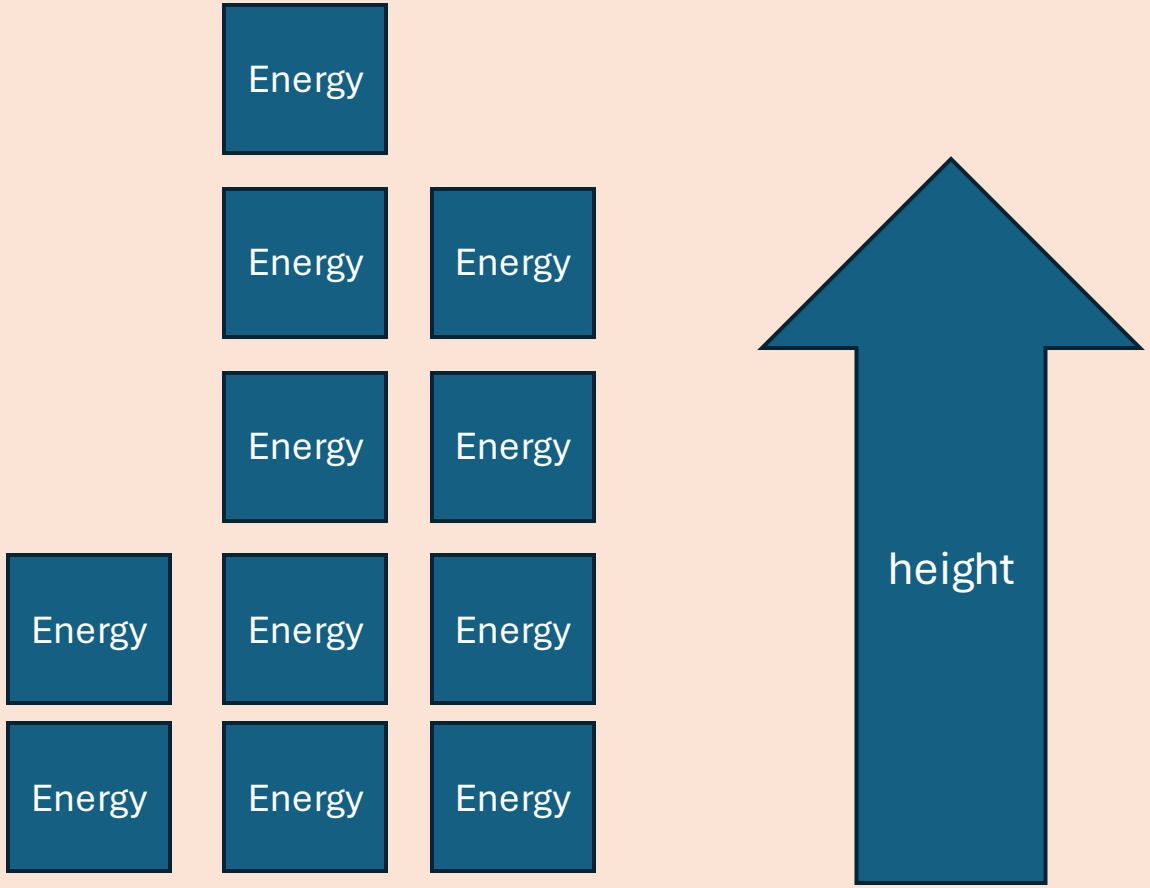


What is the egg drop challenge?

- A fun physics experiment from the 1960 and 1970s for engineering students.
- You must design and create a structure or mechanism that protects an egg from breaking from a high drop.
- Its purpose is to teach engineering and physics principals in a fun and hands-on method.

For those who want know, here are related engineering/physics topics: Newton 2nd law, Impulse and momentum, energy absorption, structural integrity.

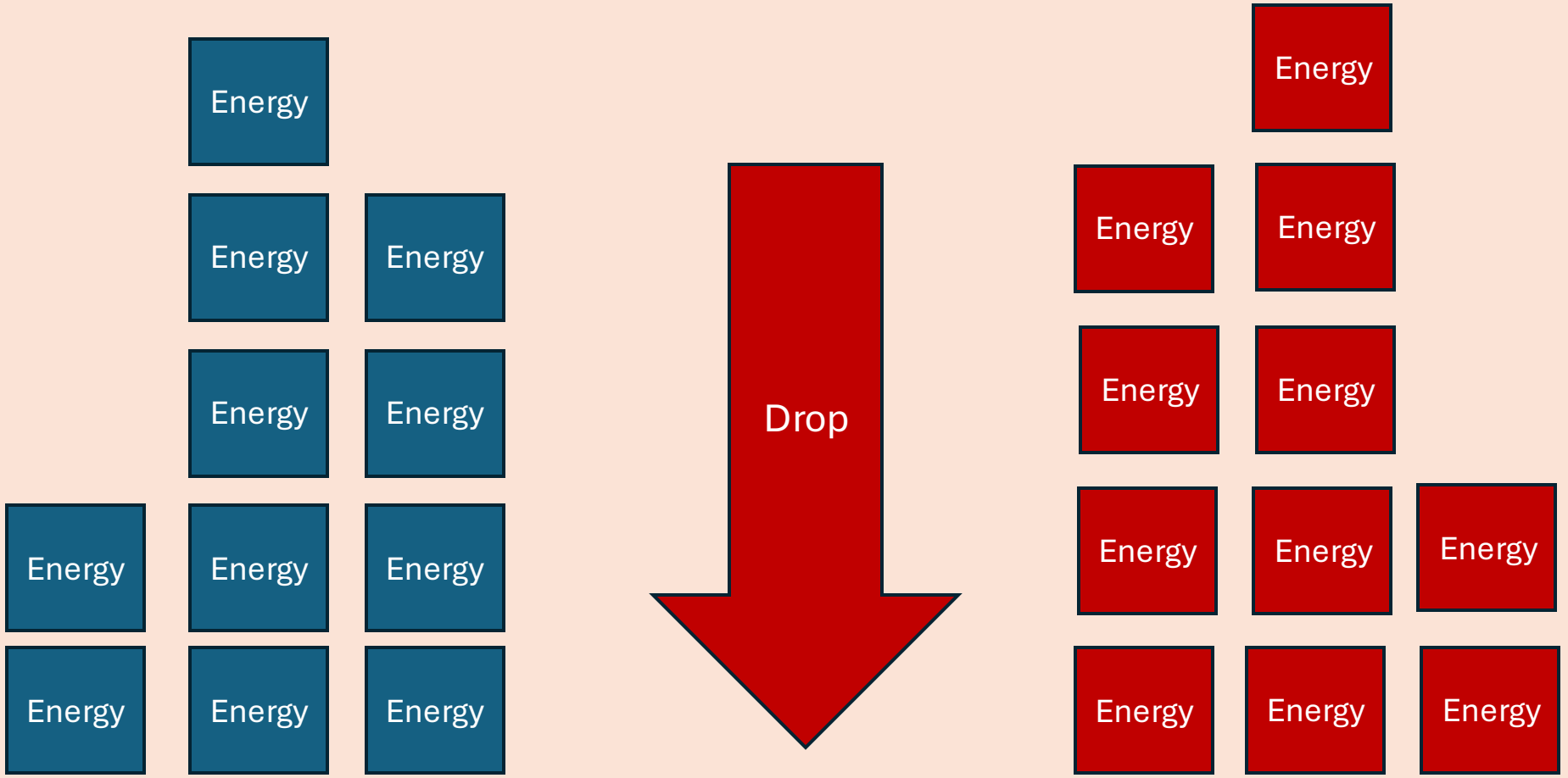
Physics behind how it works! (Fun stuff)



Potential Energy (mgh)

Kinetic energy (1/2mv^2)

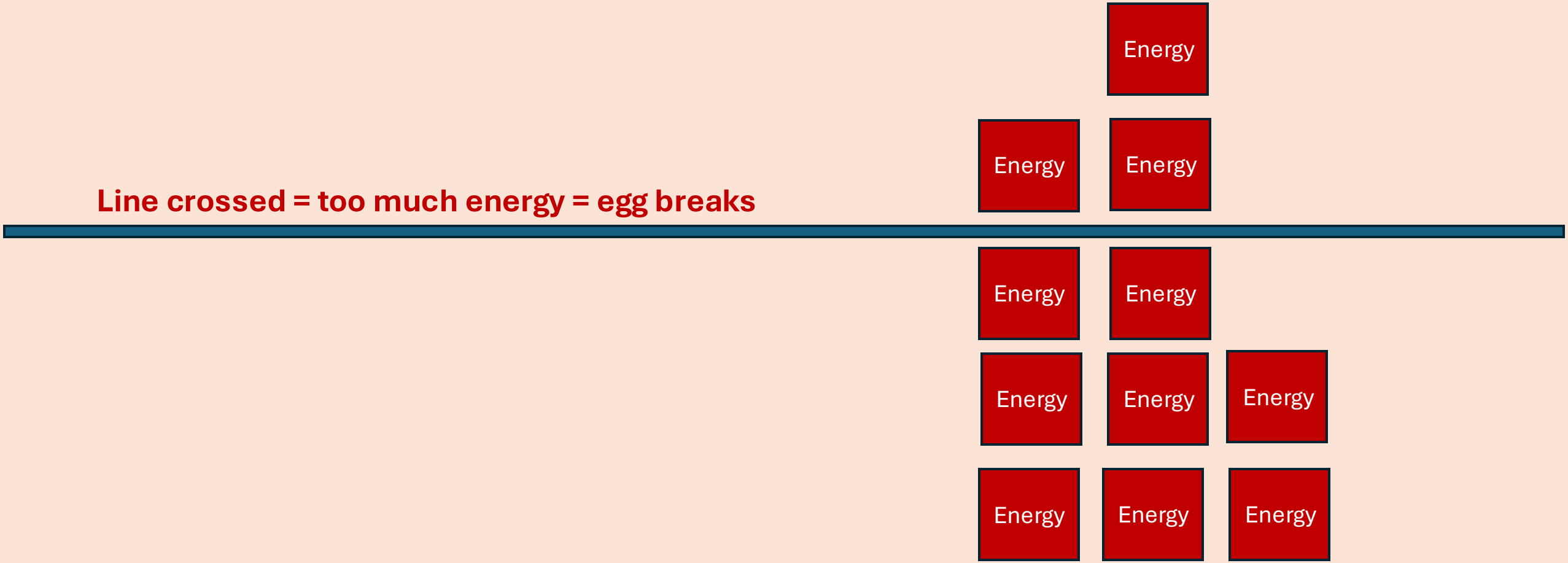
Physics behind how it works! (Fun stuff)



Potential Energy (mgh)

Kinetic energy (1/2mv^2)

Physics behind how it works! (Fun stuff)



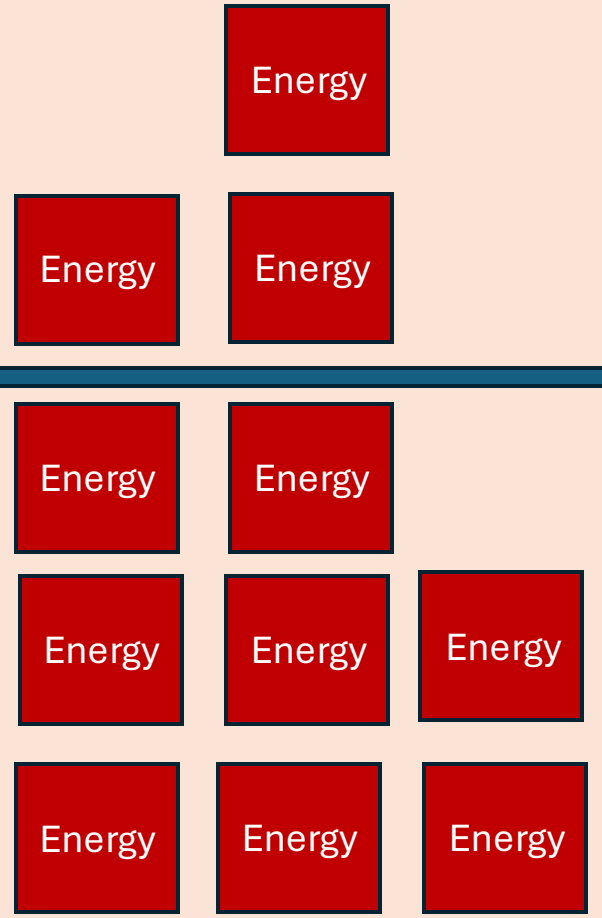
Potential Energy (mgh)

Kinetic energy (1/2mv^2)

Physics behind how it works! (Fun stuff)

Broken egg):

Safe egg):



Potential Energy (mgh)

Kinetic energy (1/2mv^2)

Physics behind how it works! (Fun stuff)

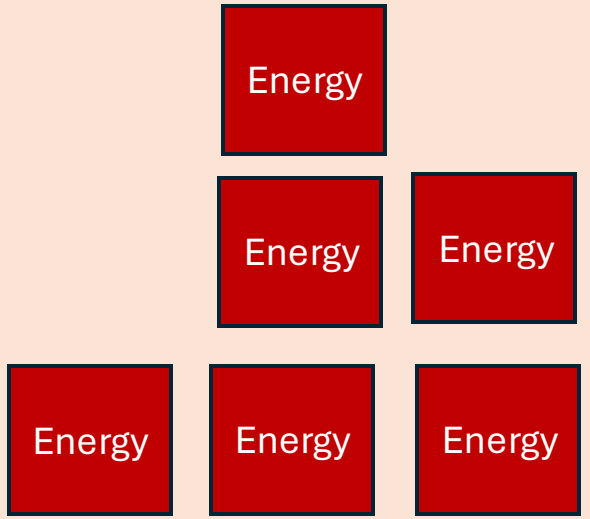
Broken egg):

Safe egg):

Method 1: Less kinetic energy, and make the tower less tall

- Reduced mass
- Reduced speed

(removing energy blocks)



Potential Energy (mgh)

Kinetic energy (1/2mv^2)

Physics behind how it works! (Fun stuff)

Broken egg):

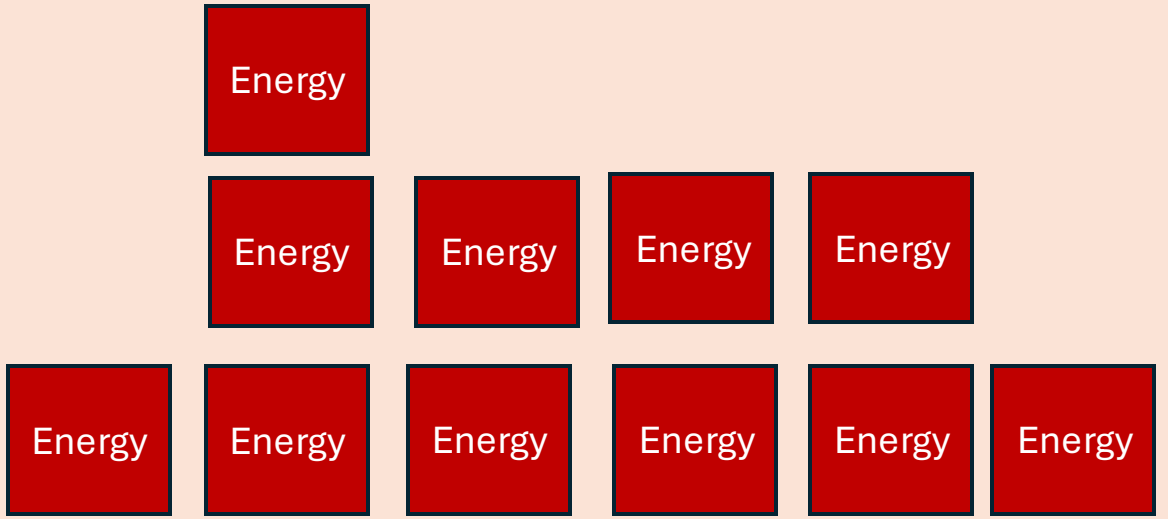
Time axis

Safe egg):

Method 2: Impulse

- Increase the duration at which the force is exerted on the egg

(spreading 'energy' blocks out

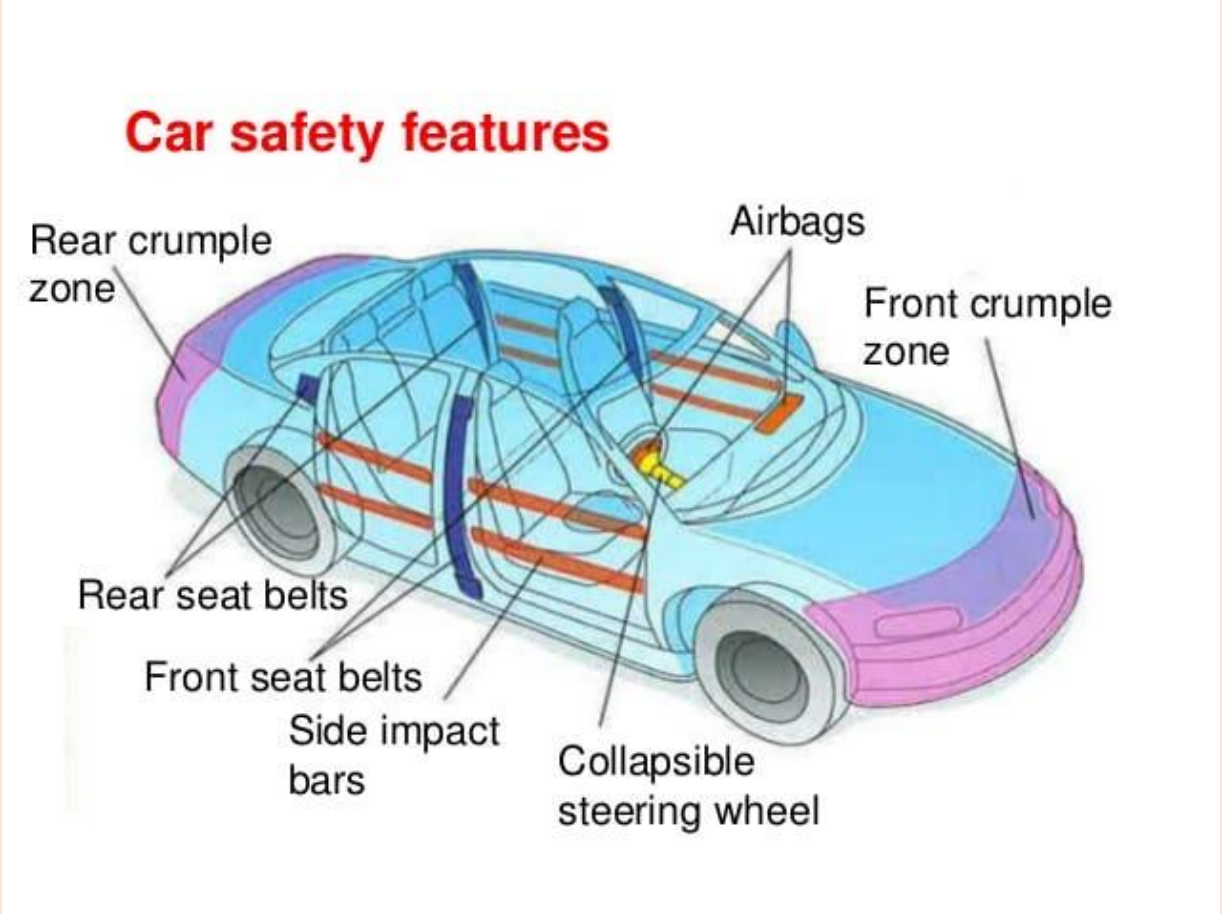


Potential Energy (mgh)

Kinetic energy (1/2mv^2)

Stuff to steal from car safety mechanisms for your egg protection idea

1) Crumple zones, meant for increase duration. Reducing force
2) Seatbelts, so you don't fly away
3) Airbags, meant for increasing duration. Reducing force



Main methods to Protect the Egg

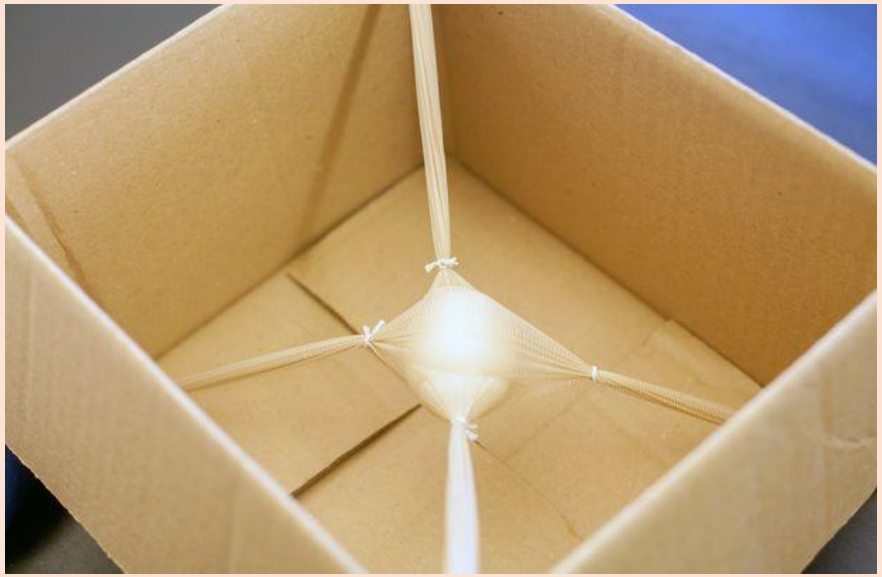
1. Reduce Speed of the egg:
    - Decrease the overall mass
    - More Air resistance

2. Reduce the Contact Time:
    - Use Fluffy materials
    - Use elastic materials

3. Less Pressure:
    - Decrease the overall mass
    - More Air resistance

Example work

- Sponge to increase contact time as well as contact area.
- Parachute to decrease the speed of the egg.
- Plastic straw to increase contact time, no contact with the egg to the ground.



Rules/Info on our competition

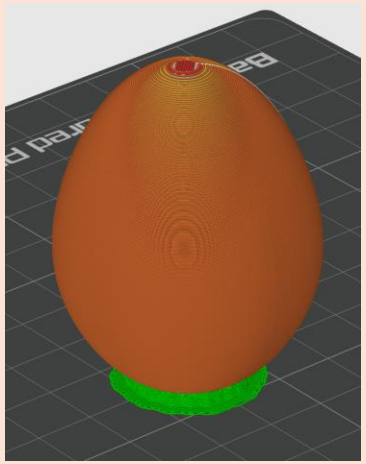
Objective:

- Protect an egg from breaking when dropped from a certain height (we might choose 2-3 floors high)

Material info:

- Egg type - 3D printed 0.4mm wall width PLA egg
- No-premade objects (drones). Instead use materials like straws, cardboard, balloons, foam.
- The egg mustn't be modified (no coating, reinforcing egg)

Determining a winner and prize!



<u>Main criteria:</u>

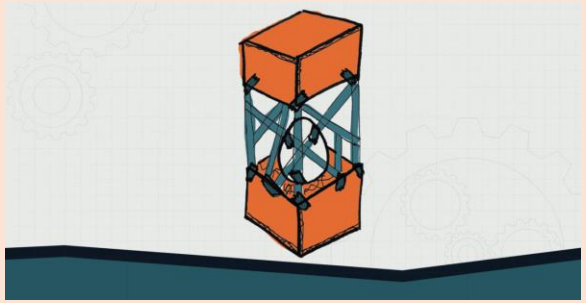
Egg survival

- (0-10 points) *0 is like the egg broken, 10 is like no scratch.*

<u>Other criteria:</u>

Design creativity and originality

- (0-10 points) *0 is like boring parachute or just lots of foam, 10 is like something no one can think of*



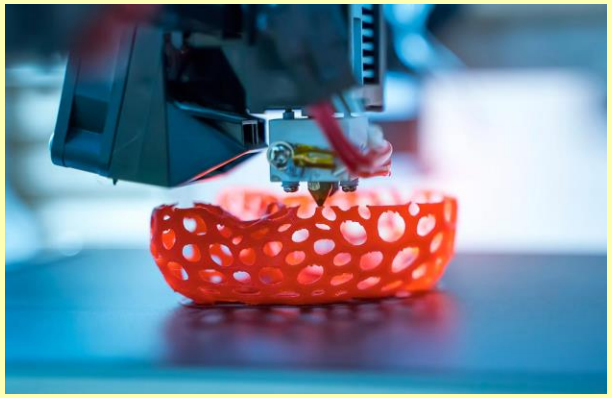
Determining a winner and prize!

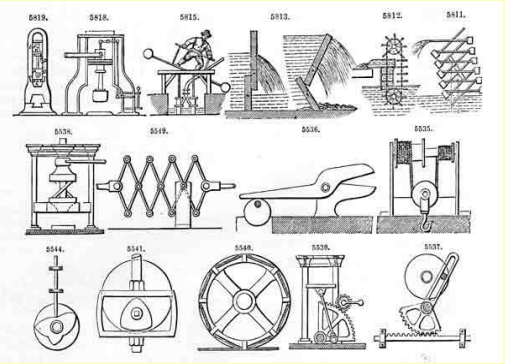
PRIZE:

- **3D printed Trophy**
- **Certificate**
- **Chocolate / candy**

Session 7: (write ur title here)

By Yiming





Template title

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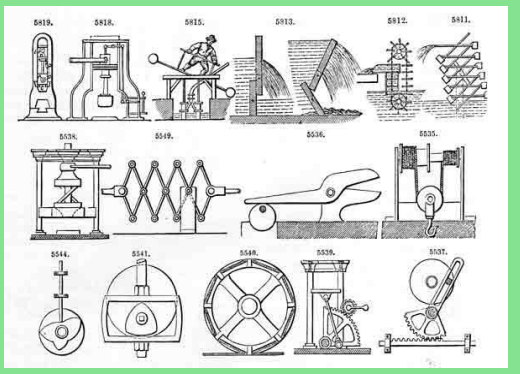
Session 8: (write ur title here)

By Thomas



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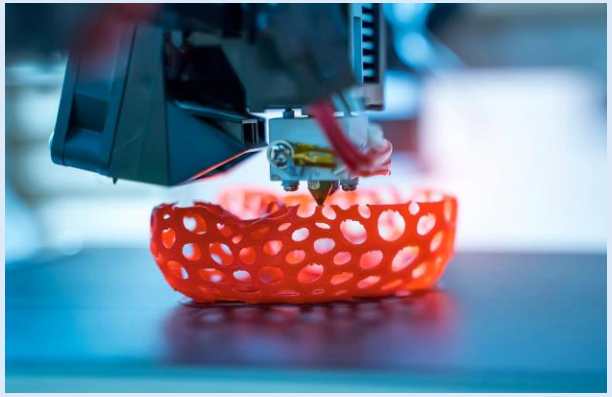
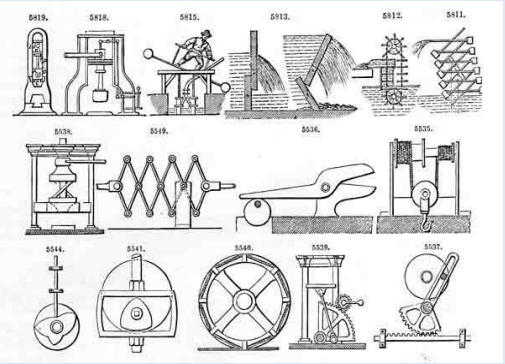
Session 9: (write ur title here)

By Junze





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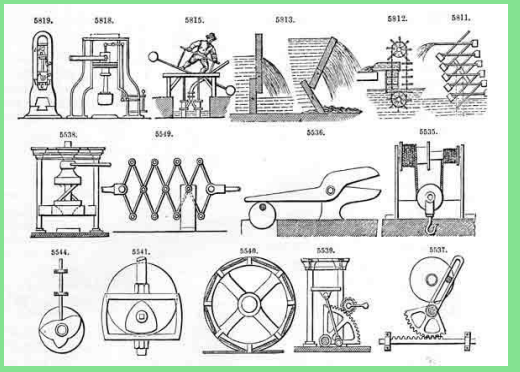
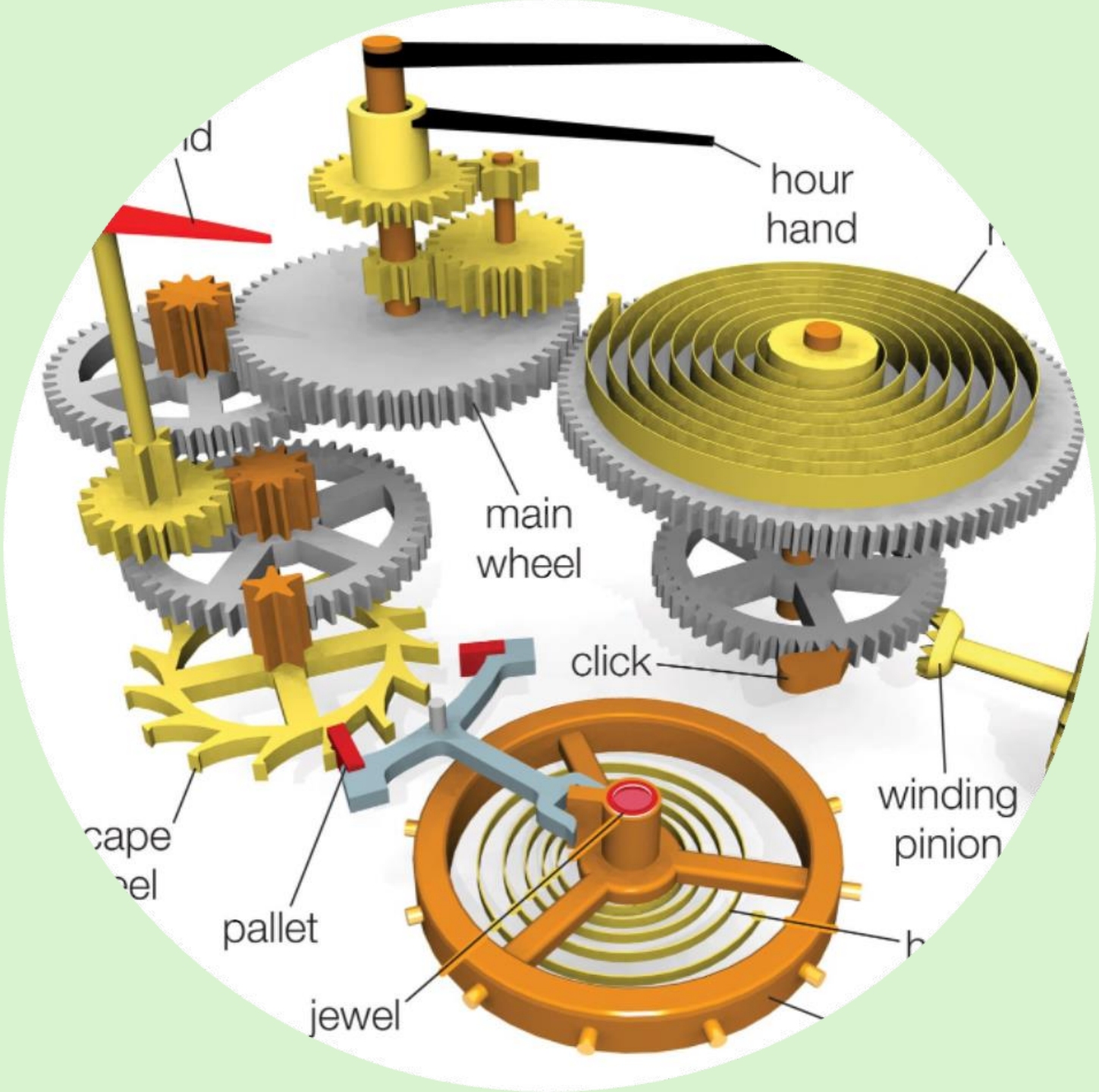
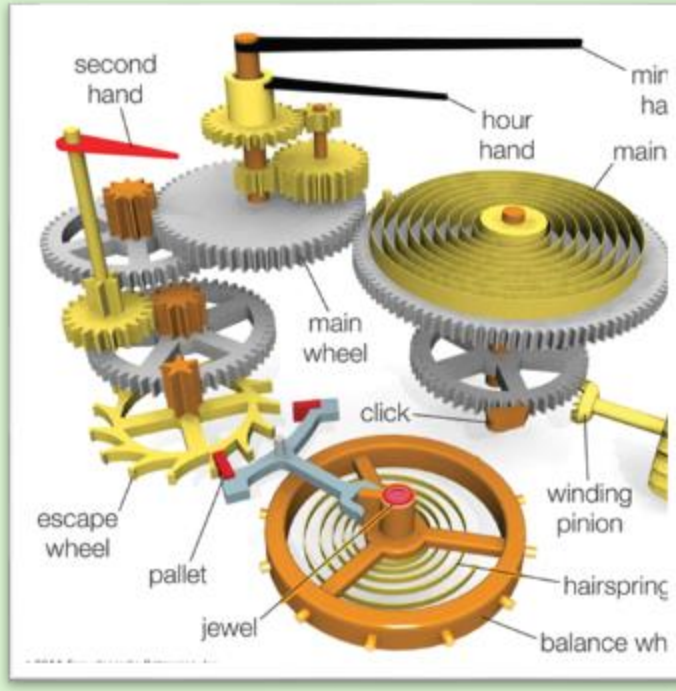
Session X: (Clocks)

By Thomas



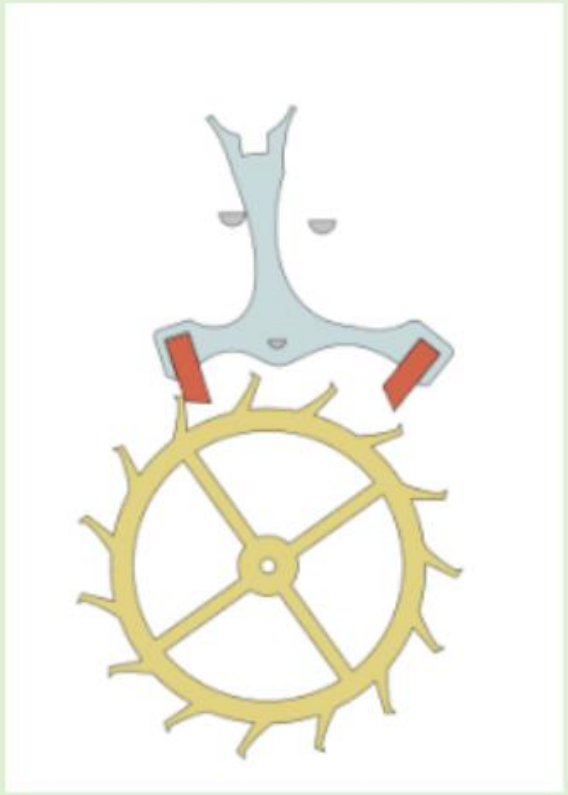
How do you think this works?





Using the the concepts of gears from last lesson

1. Potential energy is stored by torque in the main wheel and tightening winding pinion and gradually unfolds.



Template title

Write stuff here!