Week 1

Basic Info:

Topic Covered - What is Engineering?, Engineering Design Process, Machines

- Project: Breaking Apart and Understanding Toy Water Gun

What is Engineering?

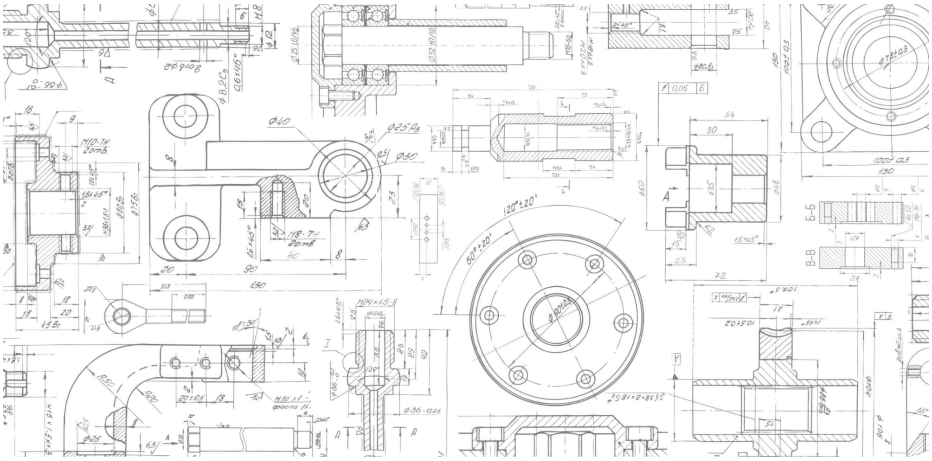
Engineering is a branch of science in which a set of technical principles are used to design, build, and analyze physical objects (machines, buildings, structures).

Aspects of Engineering:

- Designing
    - All designs made must abide by given constraints and criteria.

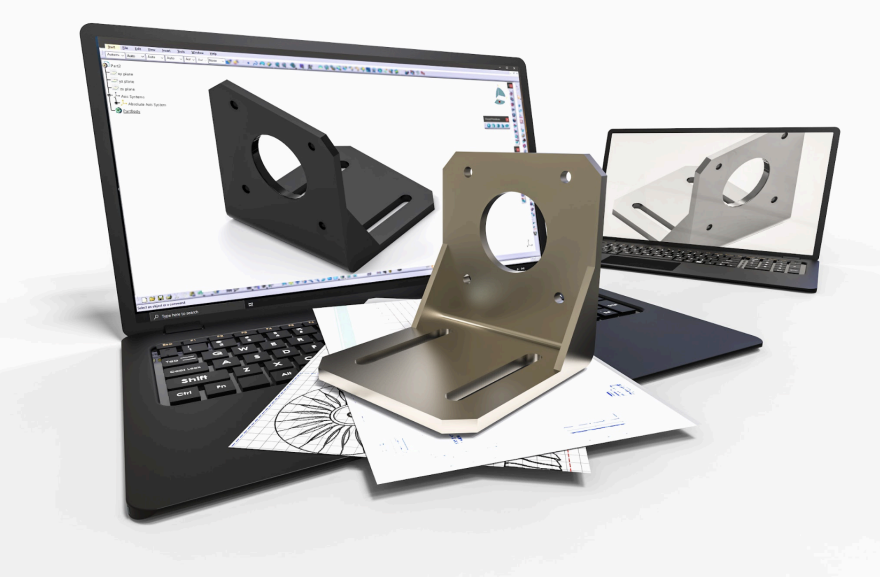
        - Constraints: Certain things you can and cannot incorporate into your design
        - Criteria: Standards that your design has to meet

- Paper and Pen - Visual Sketches on Paper
    - Blueprints provide insight to manufacturers/construction on measurements and angles of design



- 3D Modeling Tools - CAD Software (TinkerCAD, Fusion 360, etc.)
    - What is Cad?
        - CAD stands for Computer-Aided-Design
        - CAD is more versatile than sketching as you can visually see your entire finished design without actually building it yet

- Some CAD softwares even allow for users to animate parts to help users analyze motion involved with their product



- Building
    - Physically constructing your product
    - When complications occur during the building phase, you must head back to the drawing board and reevaluate your design

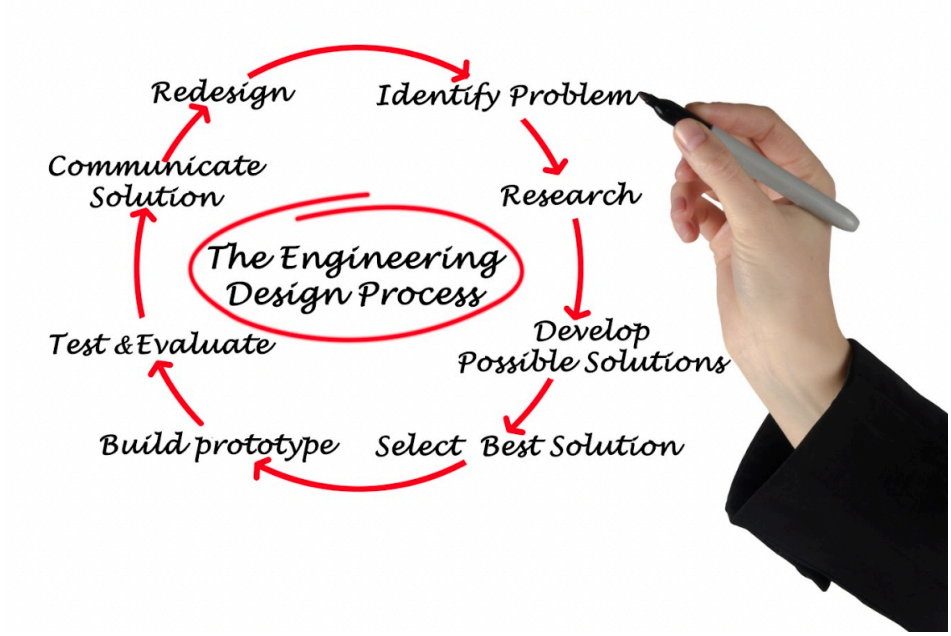
- Analysis
    - Determine the Pros and Cons
    - Look at where you can improve your product

- Improving
    - Improve Design, Analyze Again until you are satisfied with your final product

Engineering Design Process:

The Engineering Design Process is a set of steps engineers take to solve problems. A process in which you, as an engineer, learn by failure, repeating the steps how many ever times it needs to be done.

1. **Ask**: Raise a question and identify a certain problem. This step is where you can identify any constraints and criteria you need to meet.
2. **Imagine and Research**: Brainstorm different ideas to solve the issue raised in the first step. Research various solutions before finalizing on one. There are many different ways to approach the same problem. When researching information, look to improve on others' design, determine the pros and cons, and learn from failure.
3. **Plan**: In this step, figure out what you need to complete the build. (ex. Equipment, Tools, Money, Time, etc.) Then, begin to make detailed sketches and designs, utilizing available CAD softwares if necessary.
4. **Create**: Construct a prototype of your design. A prototype is a working model or sample used to test and analyze your initial design.
5. **Test**: Test and analyze your prototype. If necessary, create a more detailed prototype to perfect certain motions and aspects of your product.
6. **Complete**: Build your final product.



Machines:

What are Machines?

Machines are anything that performs a certain task through a group of interconnected parts.

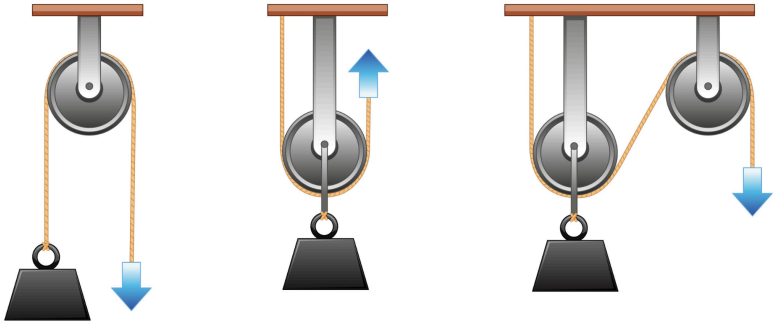
What are Mechanisms?

Mechanisms are a group of parts that work together in a certain machine.

Simple Machines:

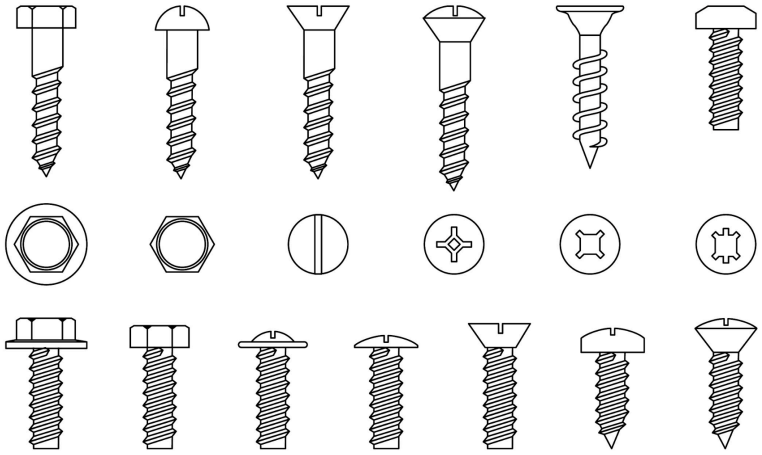
Simple machines are mechanical devices that rely on an applied force.

- Pulley



- Lever

- Wedge (Knife, Ax, Plow)
- Screw



- Gear
- Incline Plane

Complex Machinery:
Complex Machines are 2 or more simple machines put together to form a functioning device.

- Bicycle
- Lawn Mower
- Wheelbarrow

Project:

We will be breaking down a machine, more specifically a toy water gun, understanding what it took to get to the final product along the way.

Materials:

➔ Toy Water Gun (https://www.walmart.com/ip/Play-Day-Water-Blaster-8-inch-Water-Squirter-Outdoor-Summer-Water-Toy-for-Kids-3/640960655?wmlspartner=wlpa&selectedSellerId=0)

➔ Mini Screwdriver
(Use one found at home)

Project Pictures:

Quiz:

1. What are criterias and constraints?
2. What are the steps of the engineering design process (in order)?
3. What do you do during the analysis phase of the design process?
4. Which type of machines rely on applied force?
5. How are complex machines made up?

Week 2

Basic Info:

Topics Covered - Chassis, Chassis Attachments Overview (Motors, Servos, Sensors,etc.), Mechanical Systems

- Project: Begin building chassis, Start exploring and attaching Parts

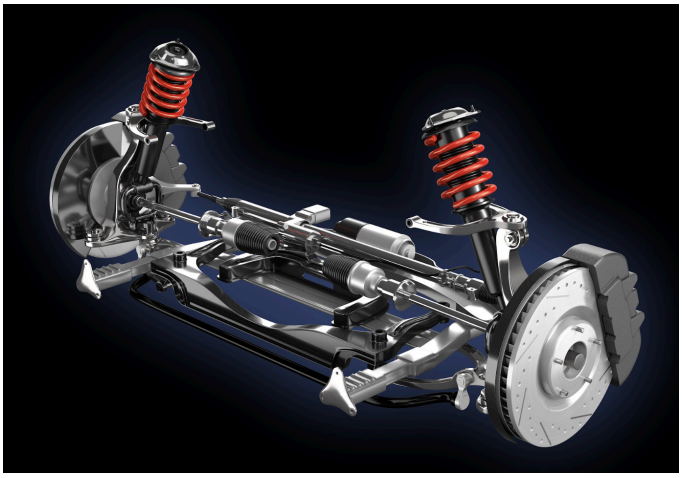
Chassis:

The base or framework of a vehicle/device

Importance of a Chassis -

- Transfer and/or absorb the force received by surroundings
    - Example: Driving over large rocks on the road, Hitting another vehicle
- Safety
- Aerodynamic Properties
- Supports the weight of parts

Suspension:



Collective system of shock-absorbing components

What do suspensions achieve?

- Absorbs the energy and transfers it throughout the body
- Keeps the ride smooth (in vehicles)
- Maximize friction (keeps vehicle “attached” to the ground)
    - More contact with the ground ensures less sliding

What are suspensions made of?

- The intricate system is mainly made up of springs and shocks
    - [Coil] Springs: Control the load received
    - Shocks (also known as dampers): Absorb and lessen the kinetic energy received

Law of Physics: All forces have magnitude and direction

Gears:

Toothed circular component that works with other gears/components to transfer motion

What are they used for?

- Industrial Machines (ex. robots)
- Vehicles
- House-hold Devices (ex. clocks)

Torque: The force which causes an object to move

Gear Classifications:

Shape -

- Circular (most common)
- Elliptical
- Triangular

Tooth Design -

- The teeth's attachment to the gear
- The space between the teeth and direction they point in
- Cross section of the teeth on the gear

Axes -

- Parallel

- Intersecting
- Miscellaneous

Gear Ratios:

Ratio between number of rotations of a driver gear to the number of rotations of a driven gear

- Determines the speed of the rotation of the gear

Example -

1:2 Gear Ratio

[A 15-tooth gear with a 30-tooth gear]

Types of Gears:

Spur Gear -

- Teeth are parallel to the shaft axis
- Noisier due to the teeth rolling through the mesh

Helical Gear -

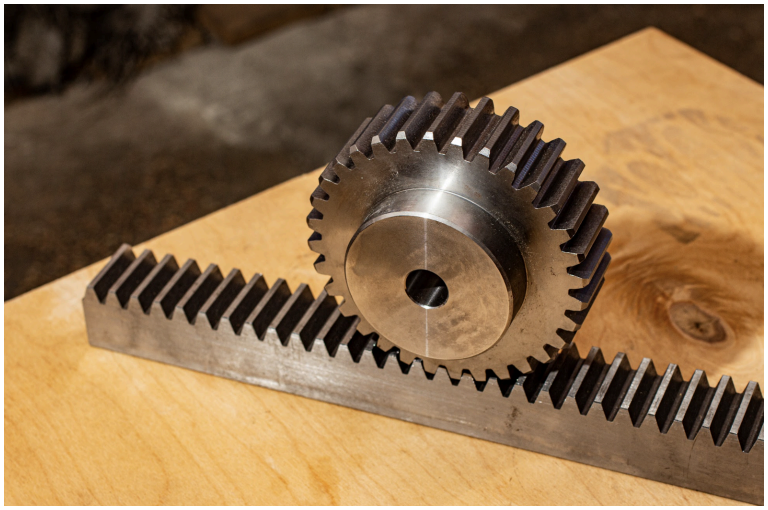
- Teeth are oriented at an angle to shaft
- More than one tooth is in contact at a point in time
- Quieter and smoother than spur gear

Bevel Gear -

- Intersects shafts at a 90 degree angle
- Used in right angle gear drive situations
- Can’t transmit as much torque

Rack and Pinion -

- Linear actuator that is made up of a circular gear and a linear gear
- Convert rotational motion into linear motion

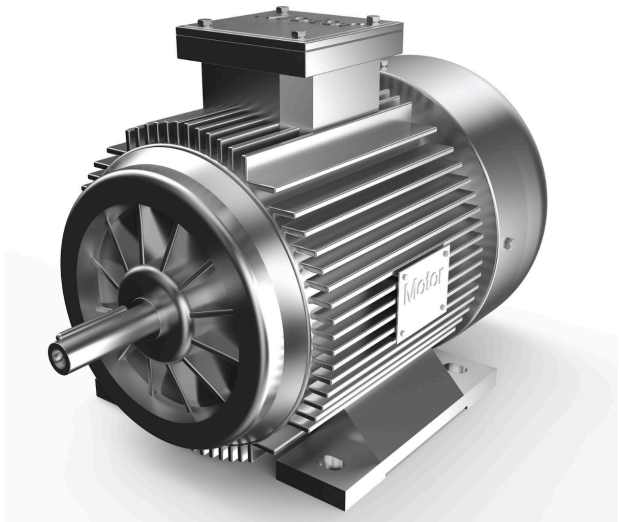


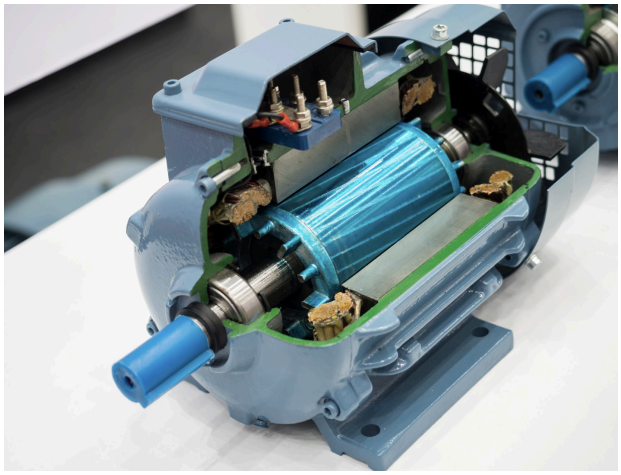
Motor:

Spinning machine that converts electrical energy to mechanical energy

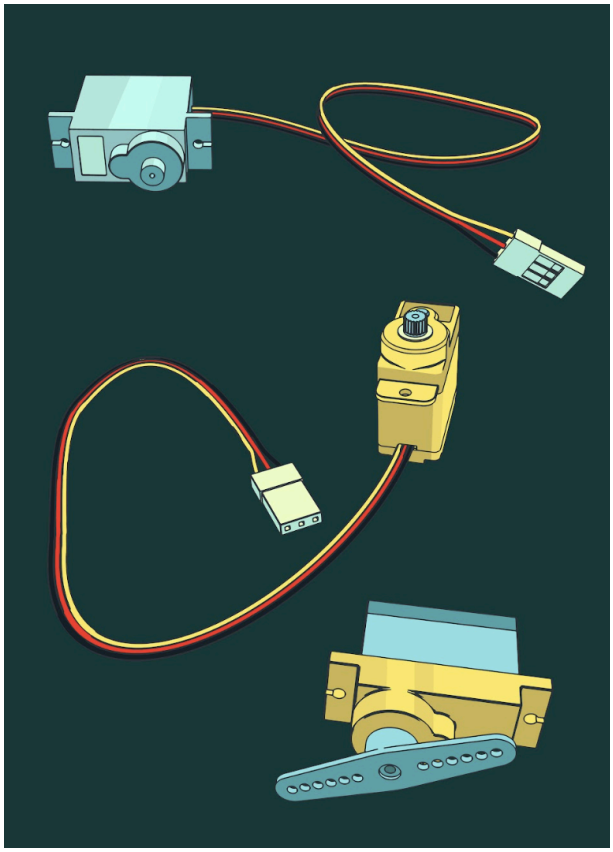
DC Motor -

- Used for simple applications (turntables, conveyors, etc.)
- Low speed/torque compared to other motors
- Electric current passes through a coil in in magnetic field → produces magnetic force → produces torque → turns the DC motor





Servos:



Simple feedback mechanism comprised of a DC-motor, gears, microcontroller, and potentiometer

Types of Servos -
Standard Hobby Servos:

- "Closed-loop servo" with range of 90 to 180 degrees
- Allowed to move servo to precise locations in the range of motion

Continuous Rotation:

- "Open-loop" system
- Control signal only controls direction and speed
- No feedback for position control

Quiz:

Why is the chassis of a vehicle important?
What is the importance of suspension?
What are the differences between shocks and springs in suspension?
Which type of gear intersects with another at a 90 degree angle?
How do motors and servos differ?

END OF PREVIEW