Mechanisms
What is a Mechanism?

A mechanism is the part of a machine which contains two or more pieces arranged so that the motion of one compels the motion of the others.

Generally used to:

– Change the direction of movement
– Change the type of movement
– Change the speed of movement
– Change the amount of torque or force available to do work
Mechanisms - Change Direction

• Meshed gears in a gear train always turn in opposite directions

• The flow of power is reversible only if you can make the input shaft turn by turning the output shaft
Mechanisms - Change Movement

Rotary

Oscillating

Reciprocating

Linear
Mechanisms - Change Speed

- Gear ratios compare the output (or driven gear) to the input (or drive gear).
- Gear Ratios can be determined using number (n) of teeth on the gear or diameter (d) of the gear:
  \[
  \frac{GR}{1} = \frac{n_{\text{out}}}{n_{\text{in}}} = \frac{d_{\text{out}}}{d_{\text{in}}}
  \]
- If the output gear is larger than the input gear the speed will decrease.
- If the output gear is smaller than the input gear the speed will increase.
Mechanisms – Change Force or Torque

A force is a push or pull in a straight line.

Torque is a push or pull in a circular direction.
Simple Gear Train

1. Input and Output Shafts parallel
3. A - Speed is constant
4. B – Speed is increased
5. A - Torque is constant
6. B – Torque is decreased
7. A - Ratio 1:1
8. B - Ratio
   36 teeth:60 teeth or 3:5
9. Flow of Power reversible
10. Gear direction – opposite
Where Do You Find a Simple Gear Train?

Two meshed gears will rotate in opposite directions.

11. Found in:
   – Watch
   – Sewing Machine
   – Motor

Watch gears

Two meshed gears will rotate in opposite directions.
Simple Gear Train with Idler

1. Input and Output Shafts parallel
3. Speed is constant
4. Torque is constant
5. Ratio 1:1
6. Flow of Power reversible
7. Input and Output Gears same direction

Without Idler Gear different direction
Where Do You Find a Simple Gear Train with Idler?

Two meshed gears will rotate in opposite directions.

An **Idler Gear** allows the drive and driven gears to rotate in the same direction.

8. Found in - **Paper Transport Rollers**
Bevel Gear

1. 90° Angle
2. Speed constant
3. Torque constant
4. Input > Output
   - Speed increases
   - Torque decreases
5. Gear Ratio 1:1
6. Flow of Power reversible
Where Can You Find a Bevel Gear?

7. Found in:
   • Hand drill
   • Car differential
   • Shaft-driven bicycle

• The bevel gear is used to change rotational motion at a 90° angle.
• Using gears with differing numbers of teeth will change the speed and torque.
Differential Gear

1. Gears used – Bevel
2. Axles turn – Same direction
3. Used in – Vehicles
4. Purpose – Wheels spin at different speeds when turning

[Link to Howstuffworks.com/differential]
Worm and Wheel

1. 90° Angle
2. Speed is decreased
3. Torque is increased
5. Gear Ratio 24:1
6. Flow of Power NOT reversible
7. Direction of Travel reversible
Where Do You Find a Worm and Wheel?

8. Found in:
   - Tuning mechanism on string instruments
   - Electric motors
   - Winch

- A worm is used to reduce speed and increase torque.
- The motion is not reversible; a gear cannot drive a worm.
Leadscrew

1. Input Movement
   rotary
2. Output Movement
   linear
3. Revolutions
   4.75
4. Flow of Power
   Not reversible
5. Force is increased
6. Direction of Travel
   reversible
Where Do You Find a Lead Screw?

- Jack
- Vice

- Changes rotary movement into linear movement
- Significantly increases force
- A person can put a little force into turning the handle to move a heavy car.
Rack and Pinion

1. Input Movement - rotary
2. Output Movement - linear
4. With a Larger Pinion Gear - the rack will move a longer distance
5. Flow of Power - reversible
6. Direction of Travel - reversible
Where Do You Find a Rack and Pinion?

7. Used in **steering systems** of cars to convert rotary motion of steering wheel to the side to side motion in the wheels.

• **Rack and pinion steering**

• Used to convert between rotary and linear motion.

• Provides gear reduction to make it easier to turn the wheels.
Universal Joint

1. Angular Range
   > 90° and < 270°

2-3. Speed and Torque constant

4. Ratio 1:1

5. Flow of Power reversible

6. Input & Output Shafts same direction
Where Can You Find a Universal Joint?

- Drive shaft of vehicles
- Power take-off

Universal joints are used to transmit rotary movement at an angle that is not 90°.
Chain Drive

2. Angle is parallel
3. Speed is increased
4. Torque is decreased
5. Ratio 18:30 or 3:5
6. Smaller drive gear – Speed – decreased  
   Torque - increased
7. Shaft direction same
Where Do You Find a Chain and Sprocket?

8. Found in:
   - Bicycle
   - Motorcycle

9. Advantage of Chain and Sprocket over spur gears:
   Transfer torque and speed over long distances
Belt Drive

2. Shafts parallel
3. Speed constant
4. Torque constant
5. Ratio 1:1
6. Larger drive pulley
   Speed – increased
   Torque - decreased
7. Open belt – same direction
8. Crossed belt - opposite
Where Do You Find a Pulley and Belt?

9. Found in:
   - Lawn mower
   - Car engine

10. Belts instead of chains:
    - Quieter
    - Less expensive
Crank and Slider

2. Input Movement
   rotary

3. Output Movement
   reciprocating

4. Slider Moves
   2 in. (or diameter of crank)

5. Increased Crank
   increased distance slider moves

6. Flow of Power
   not reversible
Where Do You Find a Crank and Slider?

7. Found in:
   • Steam train
   • Internal combustion
2. Input Movement
   rotary

3. Output Movement
   reciprocating

4. Follower moves up and down 1 time for every revolution of the crank

5. Flow of Power
   not reversible

6. Direction of Travel
   not reversible
Where Do You Find a Cam and Follower?

7. Found in: Cam shaft

- As a cam rotates, the flat follower is raised and lowered, converting rotary motion to reciprocating (back and forth) motion.
- The cam pictured here would be reversible, as it is symmetrical.
Image Resources