Gears are generally used for one of four different reasons:

- To reverse the direction of rotation
- To increase or decrease the speed of rotation
- To move rotational motion to a different axis
- To keep the rotation of two axis synchronized
Motion Transmission System

- **MOTION TRANSMISSION** is the mechanical function of relaying a motion from one part to another *without altering* the nature of the motion.
  - Translational to translational
  - Rotational to rotational
Motion Transmission System

A MOTION TRANSMISSION SYSTEM is a set of components that perform the function of transmitting this non-altering motion.
## Component Types

<table>
<thead>
<tr>
<th>TYPE OF COMPONENT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Driver component</strong></td>
<td>Component that receives the force required to <em>activate the system</em>.</td>
</tr>
<tr>
<td><strong>Driven component</strong></td>
<td>Component that receives the motion and <em>transfers it</em> to another part.</td>
</tr>
<tr>
<td><strong>Intermediate component (Idler)</strong></td>
<td>Component located between the driver &amp; driven components. (Not all systems contain an intermediate component.)</td>
</tr>
</tbody>
</table>
Component Types
Component Types

- In a bicycle, the pedals are the driver component.
- The rear gears are the driven components.
- The chain linking the pedals to the gears is the intermediate component.
Characteristics of Motion

- Systems that can transmit rotational motion can do so in two directions:
  - *clockwise* & *counterclockwise*. 
Characteristics of Motion

- A system is described as **reversible** when a driven component can become a driver and vice versa.
Gear Trains
1. Gear trains
- Contains at least two gears that meet and mesh together

<table>
<thead>
<tr>
<th>Direction of components</th>
<th>Alternates from one gear to another</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reversibility</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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Motion Transmission

When building a gear train, you must consider:

1. The Gear teeth
   (they must be evenly spaced, the same size and have the same direction)

2. The Gear types
   (straight gears vs. bevel gears)

3. The Gear size
   (the higher the number of teeth, the slower the rotation) The larger the diameter the slower the rotation
Chain & Sprocket System
# Motion Transmission

## 2. Chain and sprocket

- Connects components that are far away from one another.
- The gears do not mesh together; they are connected with a chain (or sprocket)

<table>
<thead>
<tr>
<th>Direction of components</th>
<th>The sprockets inside the sprocket will turn in the same direction.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reversibility</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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Worm & Worm Gear System
Motion Transmission

3. Worm and screw gear

- Consists of one endless screw and at least a gear
- It is not reversible

When building a worm and screw gear, you must ensure that:

1. The gear teeth match the worm’s grooves
2. The driver must be the worm
Friction Gear Systems
Friction Gear Systems - Types

SPHERICAL  STRAIGHT  BEVEL
Motion Transmission

4. Friction gear systems

- Similar to gear trains yet less efficient because the friction gears can slip.
- The larger the gear the slower the rotation.
Belt & Pulley Systems
Motion Transmission

5. Belt and pulley system

- When building a belt and pulley system, you must ensure:

1. Pulleys must contain a groove where the belt can fit
2. The belt must adhere to the pulleys
3. The smaller the pulley the faster it turns
<table>
<thead>
<tr>
<th>COMMON SYSTEMS</th>
<th>DIRECTION OF ROTATION OF COMPONENTS</th>
<th>REVERSIBILITY</th>
<th>DIAGRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GEAR TRAINS</strong></td>
<td>Alternates from one gear to another.</td>
<td>Reversible.</td>
<td></td>
</tr>
<tr>
<td><strong>CHAIN AND SPROCKET SYSTEMS</strong></td>
<td>Identical for sprockets touching the same side of the chain.</td>
<td>Reversible.</td>
<td></td>
</tr>
<tr>
<td><strong>WORM AND WORM GEAR SYSTEMS</strong></td>
<td>Varies with the direction of the threads on the worm screw shaft.</td>
<td>Irreversible</td>
<td></td>
</tr>
<tr>
<td><strong>FRICTION GEAR SYSTEMS</strong></td>
<td>Alternates from one gear to another.</td>
<td>Reversible.</td>
<td></td>
</tr>
<tr>
<td><strong>BELT AND PULLEY SYSTEMS</strong></td>
<td>Identical for pulleys touching the same side of the belt.</td>
<td>Reversible.</td>
<td></td>
</tr>
</tbody>
</table>
Speed Changes

- A **SPEED CHANGE** occurs in a motion transmission system when the driver does not turn at the same speed as the driven component or components.
Speed Changes

- **ENGINE TORQUE** increases the rotational speed in mechanical systems, while **RESISTING TORQUE** slows or stops the rotation.
Speed Changes - Increases

- The fewer the number of teeth on the driven gear, the greater the increase in speed.
- The smaller the diameter of the driven gear, the greater the increase in speed.

BIG → small
Speed Changes - Decreases

- The greater the number of teeth on the driven gear, the greater the decrease in speed.
- The greater the diameter of the driven gear, the greater the decrease in speed.

small → BIG
Speed Changes

Speed ratio = \text{DriveR diameter} = 20 \text{ cm} \over \text{DriveN diameter} = 4 \text{ cm}

Speed ratio = 5
Speed Changes

Speed ratio = \frac{\text{DriveR # teeth}}{\text{DriveN # teeth}} = \frac{14 \text{ teeth}}{7 \text{ teeth}}

Speed ratio = 2

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Speed Changes

Driver = \textbf{60 teeth} = 2
Driven = \textbf{20 teeth}

What does this mean?

But WHAT does this mean? It means that the DRIVEN gear makes TWO rotations for every ONE rotation of the Driving Gear.
Speed Changes

Driver = 25 teeth = 1/3
Driven = 75 teeth

What does this mean?

What does this mean? For every 3 rotations of the driving gear, the driven gear makes one rotation.
Revolutions per Minute (rpm)

In the following situation the driver gear rotates at 120rpm. How many revolutions does the driven gear make per minute?

\[ \frac{60}{30} = 2 \]

BIG → small = speed increase

\[ = 120 \times 2 = 240 \text{ revs/min} \]
Revolutions per Minute

Here, the driver gear rotates at 60 rpm. How many revolutions does the driven gear make per minute?

\[
\frac{75}{25} = 3
\]

small → BIG = speed decrease

\[
= \frac{60}{3} = 20 \text{ revs/min}
\]
Compound Gear Ratios

When faced with three gears the question can be broken down into two parts. First work on Gears A and B. When this has been solved work on gears B and C.

The diagram shows a gear train composed of three gears. Gear A revolves at 60 revs/min in a clockwise direction.

What is the output in revolutions per minute at Gear C?

In what direction does Gear C revolve?
Compound Gear Ratios

This means that for every THREE revolutions of GEAR A, Gear B travels once. Since we are going from a SMALLER gear to a LARGER gear we DIVIDE the Rpm's.

\[
\frac{60 \text{ rev/min}}{3} = 20 \text{ rev/min}
\]

Now find the gear ratio for B & C.

\[
\frac{\text{Driven}}{\text{Driving}} = \frac{10}{60} = \frac{1}{6} \rightarrow 1:6
\]

This means for every ONE rotation of gear B, gear C makes SIX rotations.

\[20 \text{ rev/min} \times 6 = 120 \text{ rev/min}\]
Is there an easier way?

\[
\frac{\text{Driven}}{\text{Driving}} = \frac{60}{20} \cdot \frac{10}{60} = \frac{10}{20} = \frac{1}{2} \rightarrow 1:2
\]

You can also multiply the two gear ratios together to get the TOTAL gear ratio. In the above figure we see that gear C will make TWO rotations for every one rotation of gear A. And since gear C is smaller than gear A we multiply.

\[
60\text{rev/ min} \cdot 2 = 120\text{rev/ min}
\]