Mini-Lecture Series

Team 3176 Off-Season

Engineering Orientation

Motors & Gearboxes (PART 2)

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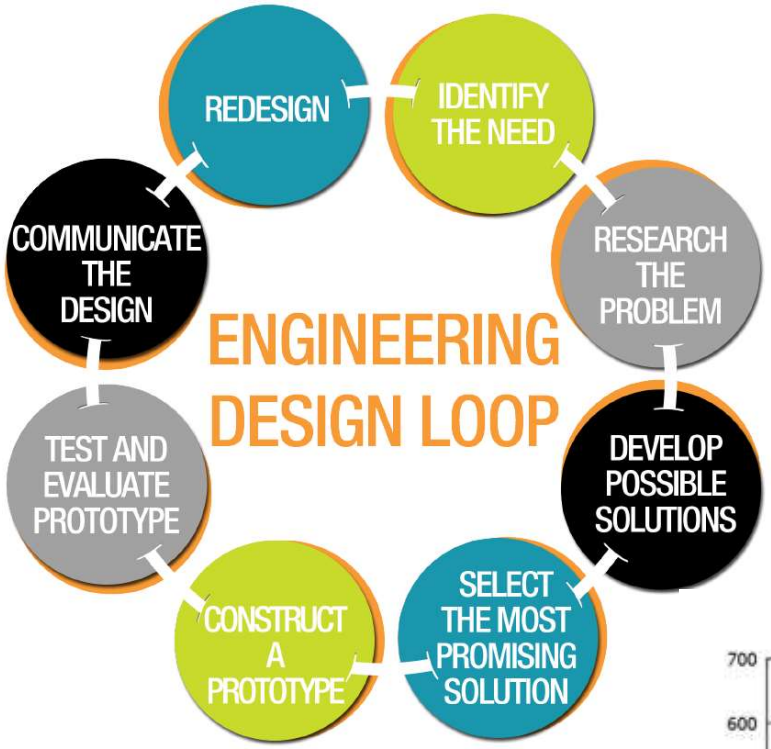
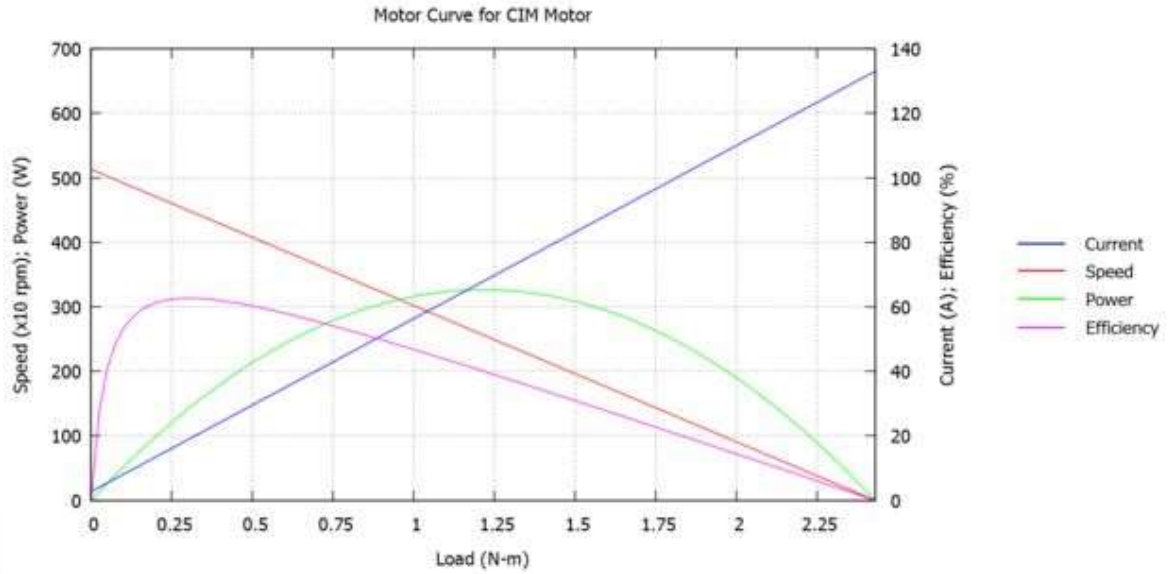
Previous Lectures…





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Gearboxes

- Without appropriate motor-gearbox combos, your team will find that your robot does not function as quickly and effectively as intended, and may have a tendency to burn out motors or shred gearboxes…
- In this mini-lecture, we'll cover
  - Some basic concepts
  - Types of gears
  - Selecting a gear set

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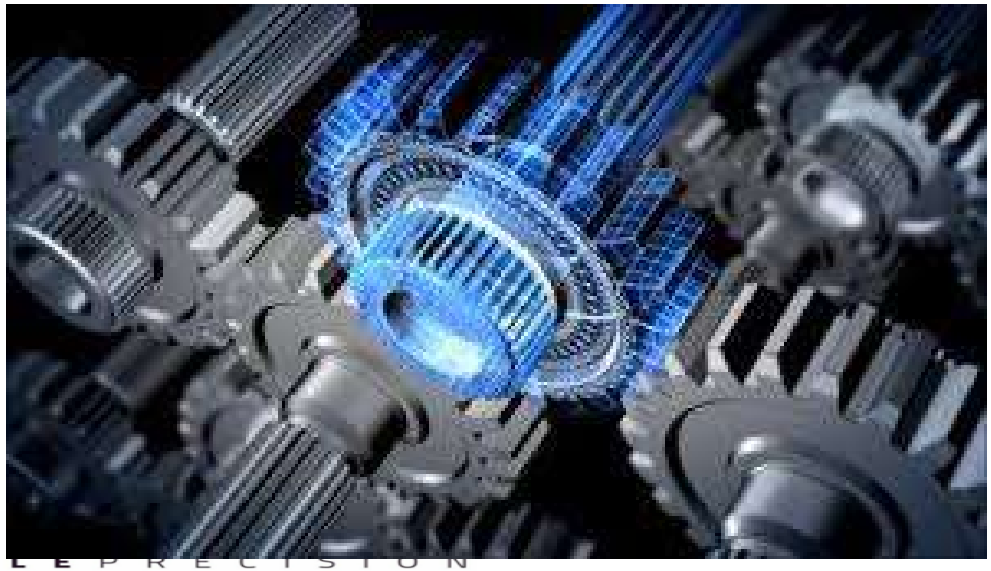
Why use Gears?

- Transmit rotation from the axis of one gear to the axis of another
- Exchange speed (ω) for torque (τ)
  - and vice versa
- Sometimes both…



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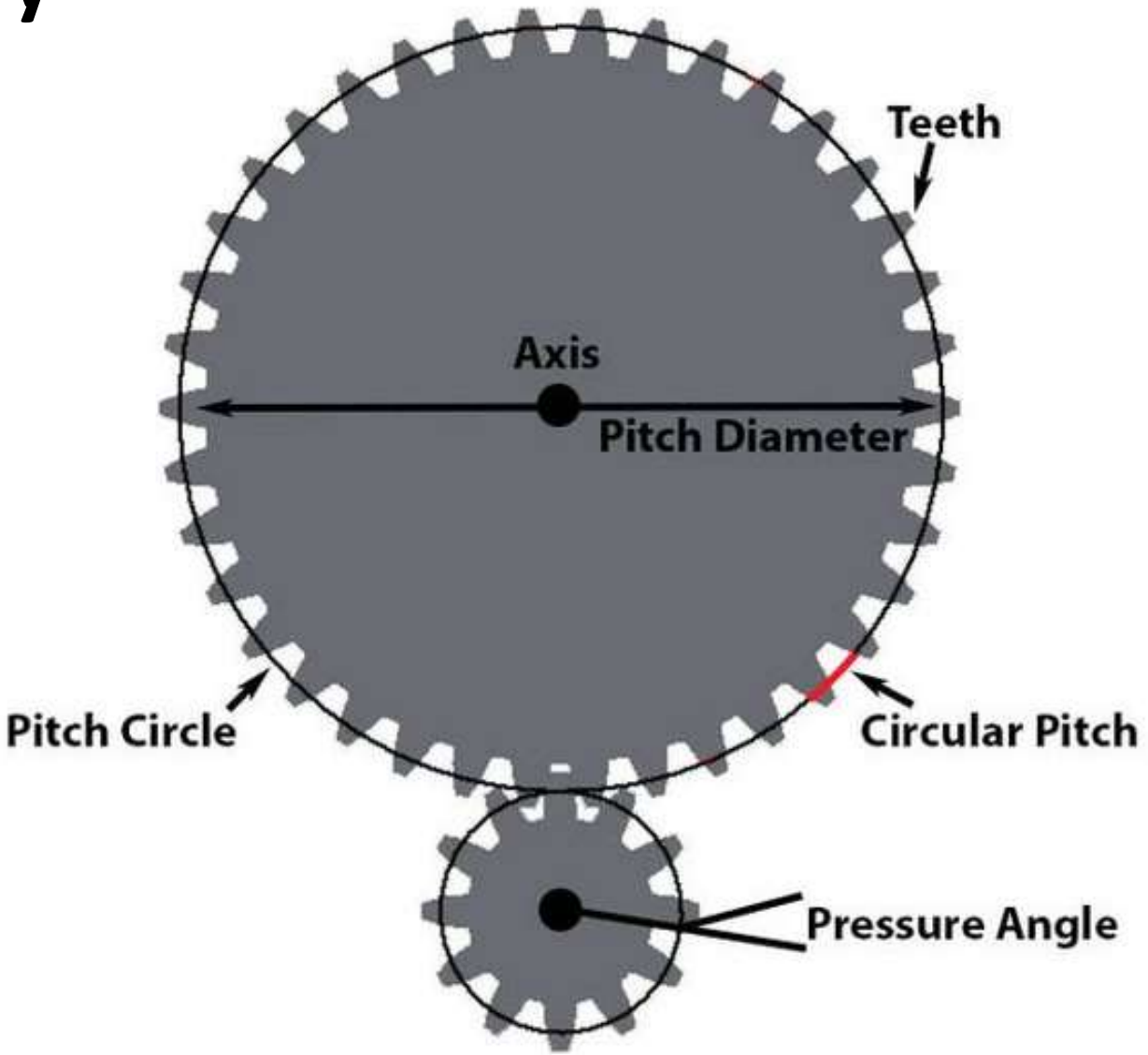
Gear Geometry

- **Pitch Circle** – the "size" of the gear
- **Tooth Count**
- **Pitch Diameter** – used to layout gear spacing
- **Diametral Pitch** – The ratio of the number of teeth to the pitch diameter. Two gears must have the same diametral pitch to mesh



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Gear Terminology

- **Driver** – gear with applied force
- **Follower** – gear doing useful work
- **Idler** – gear turned by driver & turns follower
- **Gear Train** – many gears in a row
- **Geared Up** – large driver, small follower to speed gear train up
- **Geared Down** – small driver, large follower to increase torque (turning force)
- **Compound gears** – combination of gears and axles where one axle has 2 gears often of different sizes.

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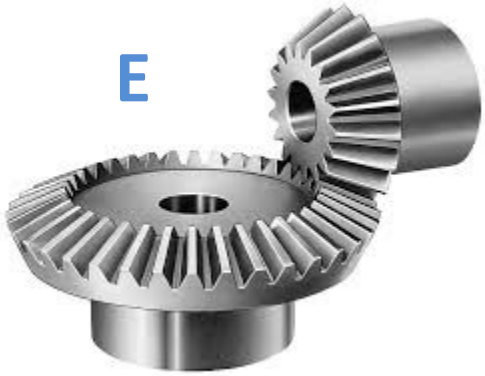
Types of Gears

1. Spur gears
2. Helical gears
3. Bevel gears
4. Differential gears
5. Worm gears
6. Planetary Gears



Vex PRO Planetary Gearboxes

Desired Ratio	Buy These Gear Kits	
12:1	3:1	4:1
15:1	3:1	5:1
16:1	4:1	4:1
20:1	4:1	5:1
21:1	3:1	7:1
25:1	5:1	5:1
27:1	3:1	9:1
28:1	4:1	7:1
30:1	3:1	10:1
35:1	5:1	7:1

- Modular planetary gearbox system designed specifically for use by FRC
- Adapts a variety of FRC motors
  - BAG, MiniCIM, RS-550, RS-775, AM-9015, and CIM)
- Six different planetary stages provide dozens of gearing options from 3:1 to 100:1

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Picking a gearbox

- Calculate load (τ = r x F) and power (how fast)
  - Translate to output torque and speed
- Refer to motor characteristics
  - Use the gearbox to keep the motor on the “left” side of the motor curve
  - Assume each stage to be 90% efficient
  - Allow for plenty of safety factor (max current draw)
- Understand physical interfaces (shafts / mounts)
- Which is best for a 50:1?

5:1 + 10:1 *OR* **7:1 + 7:1** OR **5:1 + 5:1 + 2:1**

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Questions?

Sources:
http://stanford.edu/~sebell/firstphysics.html
http://www.instructables.com/id/Understanding-Motor-and-Gearbox-Design
http://www.instructables.com/id/Basic-Gear-Mechanisms
http://geargenerator.com
https://frcdesigns.com/2013/06/24/behind-the-design-understanding-motor-and-gearbox-design/

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