FIRST® LEGO® League

TUTORIALS

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GEARING FOR LEGO ROBOTS

SESHAN BROTHERS

OBJECTIVES

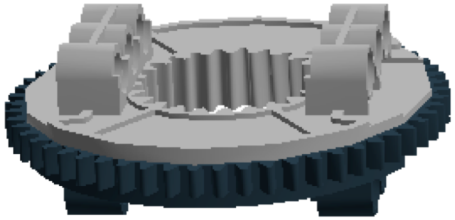
- Learn about the different types of LEGO gears and what you use them for
- Learn how to calculate gear ratios
- Learn some useful gearing techniques

WHAT IS A GEAR?

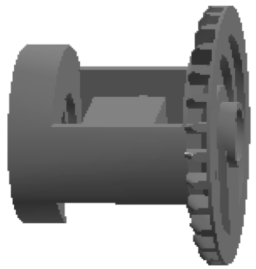
- A gear is a wheel with teeth that meshes with another gear
- There are many different kinds of gears
- Gears are used to
  - Change speed
  - Change torque
  - Change direction

COMMON LEGO GEARS

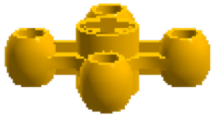
Turntable



Differential

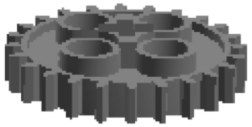


Knob Wheel

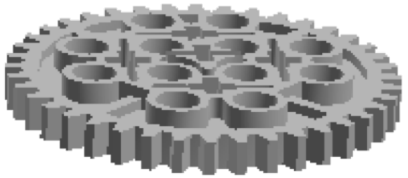


Rack Gear

Spur Gears



Crown Gear



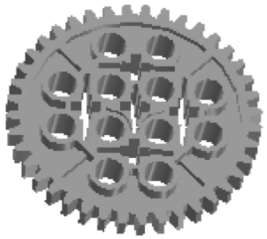
Double Bevel Gears

Single Bevel Gears

Worm Gear

NAMING LEGO GEARS

- LEGO gears are referred to by their type and the number of teeth they have



40 tooth spur gear

24 tooth spur gear

16 tooth spur gear

8 tooth spur gear

DRIVERS, FOLLOWERS & IDLERS

Driver: gear that applies force (the gear connected to the motor on a robot)

Follower: final gear that is driven

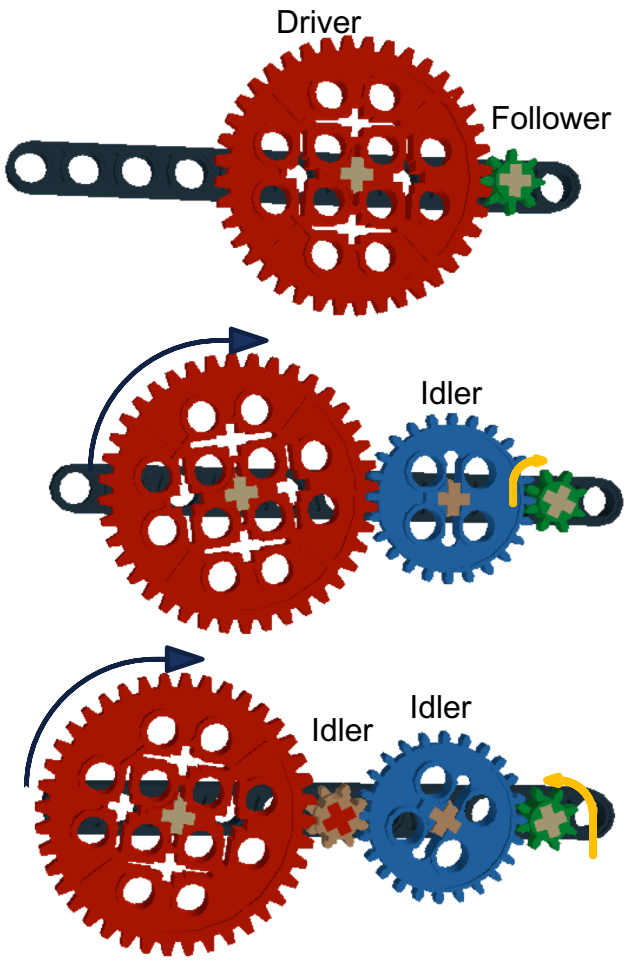
Idler: gear turned by driver which then turns the follower

Notes about gears:

1) When 2 gears mesh, the driver makes follower turn in the opposite direction

2) You need an odd number of idler gears to make driver and follower turn in same direction.

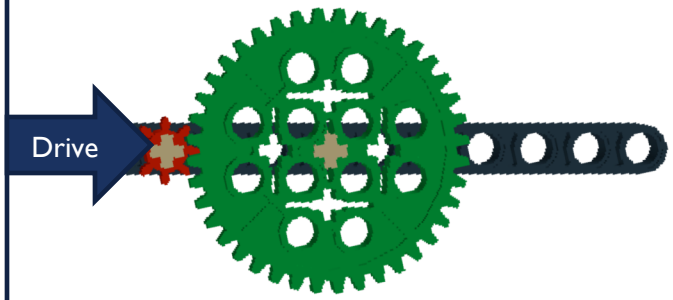
3) You need an even number of idlers (or none) to make driver and follower turn in opposite direction



GEARING DOWN AND UP

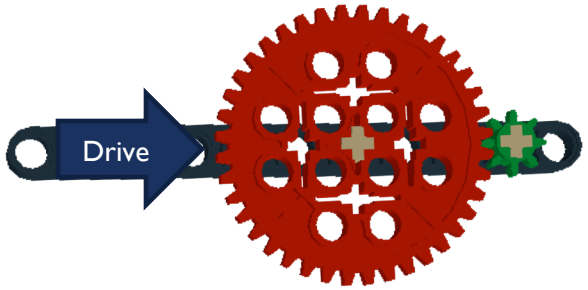
Gearing Down
(increases torque,
decreases speed)

Small Driver Large Follower



Gearing Up
(increases speed,
decreases torque)

Large Driver Small Follower

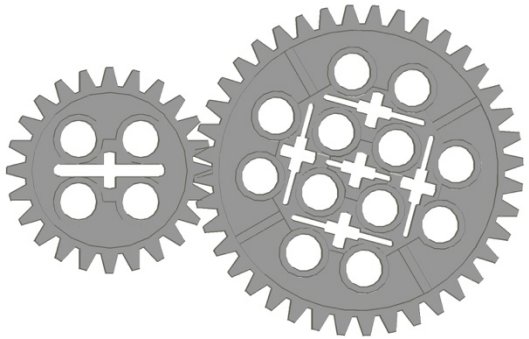


CALCULATING GEAR RATIOS

- Gear Ratio = number of teeth in follower: number of teeth in driver

Gearing Down
(increases torque,
decreases speed)

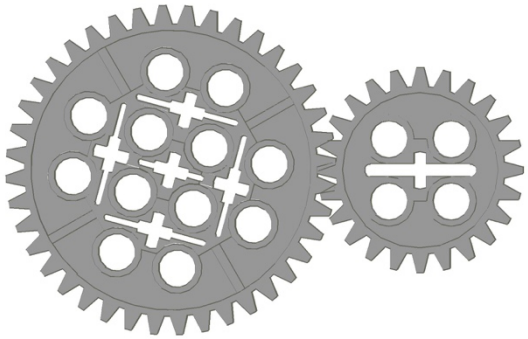
Driver Follower



40/24 = 5:3

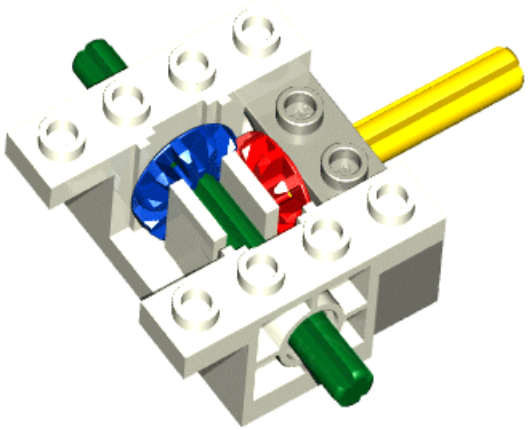
Gearing Up
(increases speed,
decreases torque)

Driver Follower

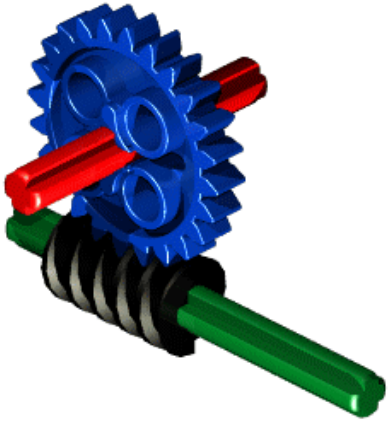


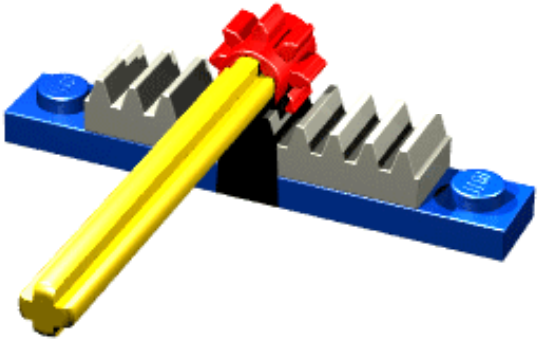
24/40 = 3:5

CHANGE THE DIRECTION OF MOTION



You can use gears to change the direction of motion.





Credits: All the animated images are from: http://technicopedia.com/fundamentals.html. To view them correctly, you will need to use “Slideshow Mode” on PowerPoint.

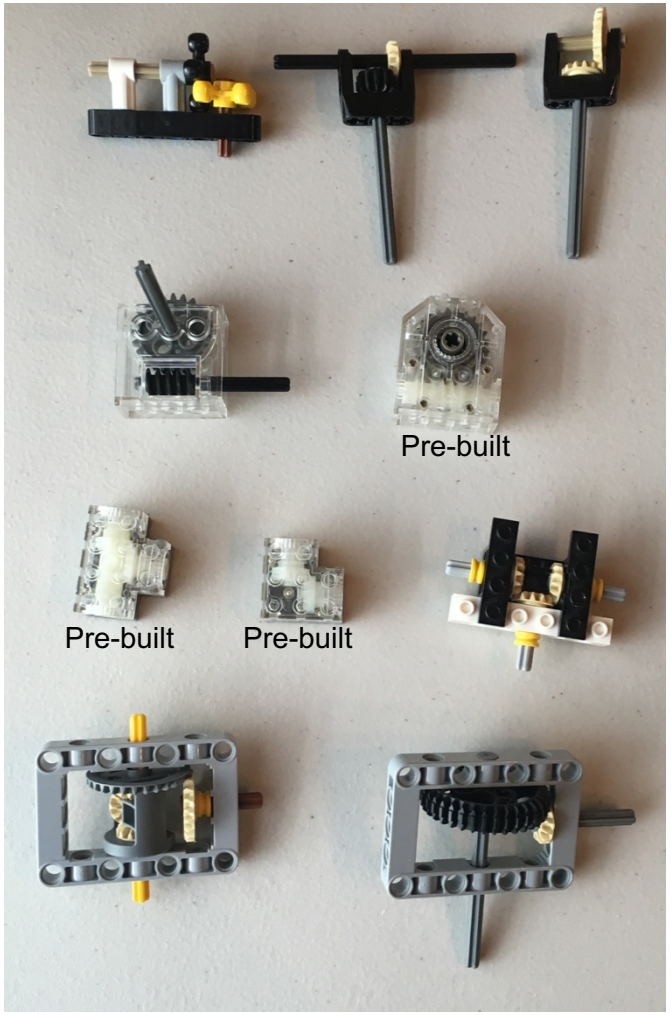
PROBLEMS WITH LEGO GEARS

- Two common problems that you might face:
  - Gear Slip: Slippage is when the teeth skip on the gears when you apply power
  - Gear Backlash: Backlash is space between the teeth where the gears mesh. When the space is too much, it is called slack/slop. When there is too little, you create too much friction.

Solution: Try to avoid long sequences of gears. Use a gear box. Mesh gears according to specification.

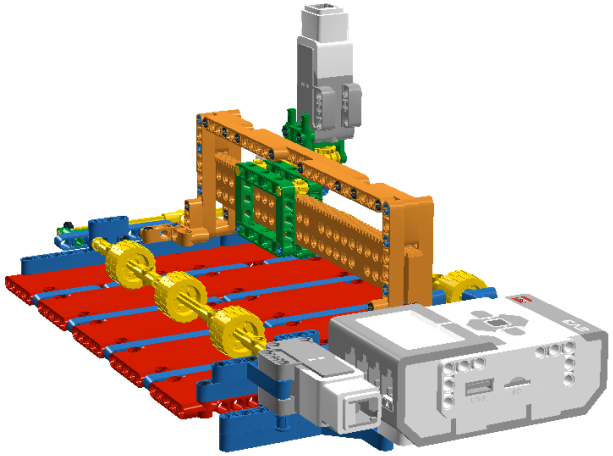
GEAR BOXES CAN BE HELPFUL

- Gear boxes can help reduce some of the issues you may face when building with gears.
- Some are pre-built (with gears included)
- Some need gears inserted into a gear box
- Some can be assembled from scratch using technic pieces

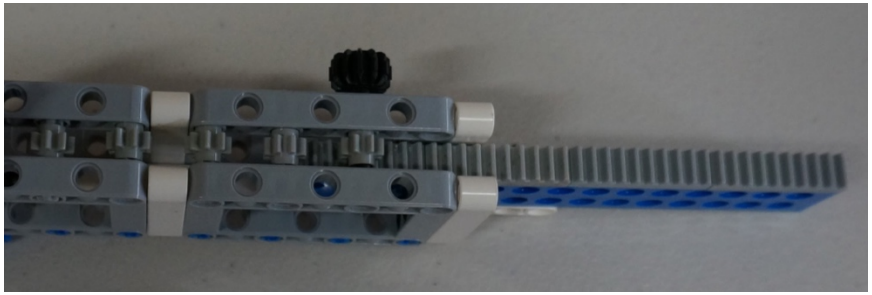


RACK GEARS FOR VERTICAL & HORIZONTAL MOVEMENT

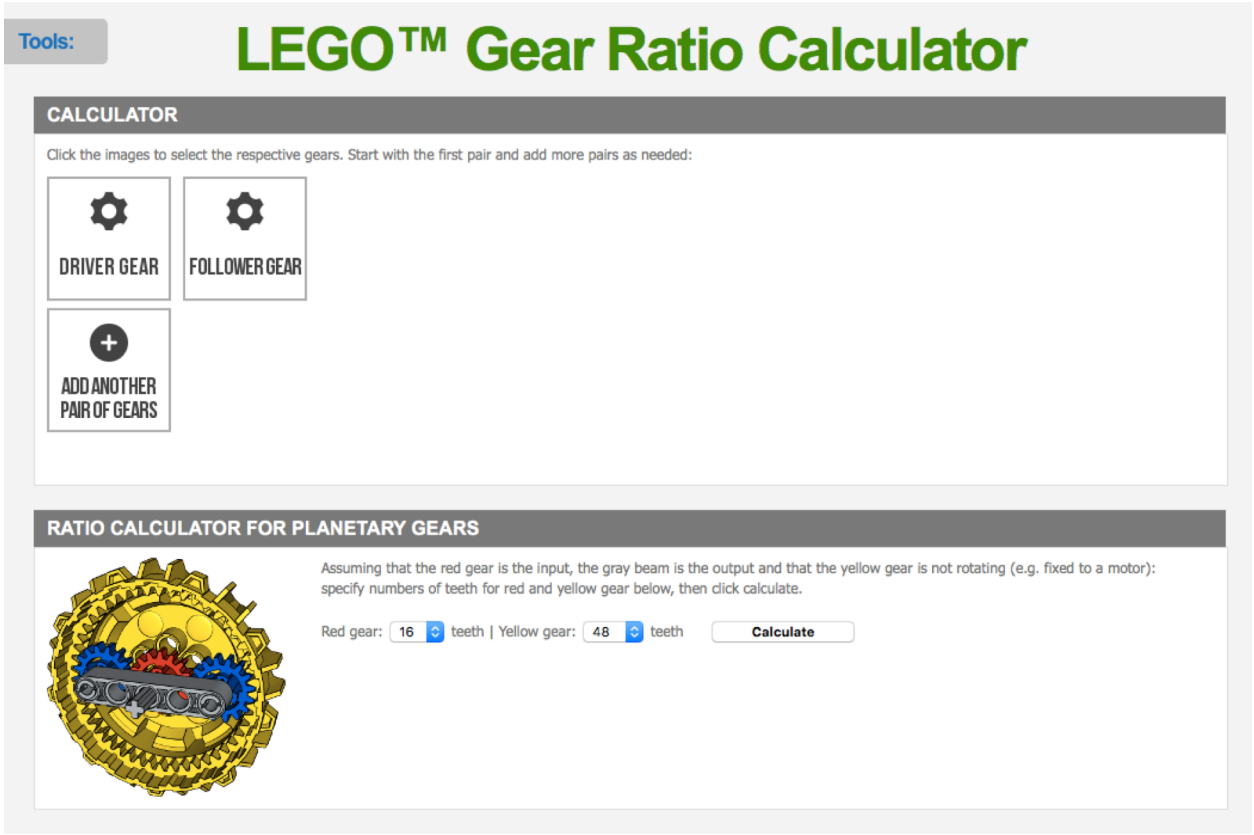
Support structure of Wall-E7 by Marc-Andre Bazergui is made with rack gears



PIX3L PLOTT3R by Sanjay and Arvind Seshan uses rack gears



USEFUL ONLINE GEAR TOOL



http://gears.sariel.pl/

OTHER USEFUL RESOURCES

- More about gears: http://sariel.pl/2009/09/gears-tutorial/
- Gear animations: http://technicopedia.com/fundamentals.html
- Technic Gearing: Books by Yoshihito Isogawa

CREDITS

- This tutorial was created by Sanjay Seshan and Arvind Seshan
- More lessons at www.ev3lessons.com and www.flltutorials.com