Activity J – Gears and More Gears

Performance Task For Youth

You will assemble and test gear sets to determine the direction of rotation and gear ratios. You also will explore compound gear ratios.

Success Indicators

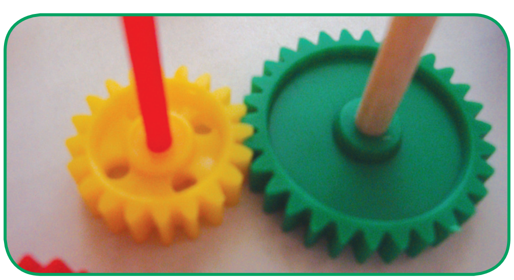
Youth will be able to describe a simple drive train using gears and calculate gear ratios, including compound gears.

List of Materials Needed

- Robotics Notebook
- Activity Supplies
  - – Axles (e.g., straws, nails, coat hangers, paper brads, dowels)
  - – Structure parts (drilled craft sticks), similar items and/or mounting backing (cardboard, pegboard, plastic canvas, etc.)
  - – Gears – various sizes of gears, optional worm and bevel gears from old toys or appliances or buy at science/tech supply stores
  - – Copies of handout/poster of types of gears and ratios on page 52
  - • Toolbox
  - – Low-temperature glue gun
  - – Small drill bits and hand drill
  - – Punches for making holes

Activity Timeline and Getting Ready

- Activity will take approximately 40 minutes.
- Make or obtain drilled craft sticks, gears, backing, and axles.
- Divide youth into teams of two or three.



Experiencing

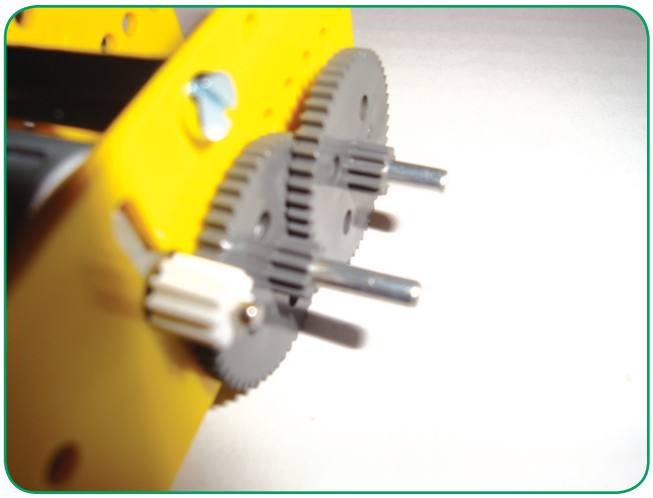
Step 1

1. Have gears available for participants to set up and test. Ask them to mount two gears on a drilled stick or piece of plastic canvas so that the two gears connect (mesh). Youth should turn one of the gears and observe the other gear. Have members record their observations about how gears function in their Robotics Notebook.
2. Using these two gears, have members count the number of teeth on the driver (the one they turned) gear (input) and the number of teeth on the driven gear (output). They should also record this in their Robotics Notebook and use the chart to calculate the gear ratio for those two gears.
3. Have the teams repeat Step 1 with different sizes of gears.

Step 2

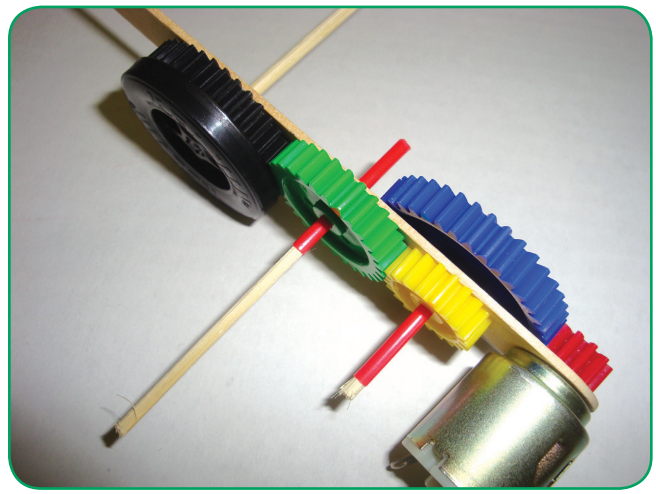
4. Have groups construct a drive train (gear set) that will satisfy the following criteria:
   - Use at least three gears.
   - Driven gear must turn at least three times faster than the first driver gear.
   - Driven gear must turn in the opposite direction of the first driver gear.
5. Ask youth to draw the gear set they designed and try to figure out the gear ratio from the first driver gear to the last driven gear and record the gear set in their Robotics Notebook. What might be a limitation to gear trains that are too fast or slow? (Size of gears has to be too large or too small.)

6. Ask a few general questions before moving to the next step:
   a. What do you think gears might be used for? In what tools or machines have you seen gears used? How were they used?
   b. Ask youth how the ratio from the last driven gear to the first driver gear is different from the ratio of just a two-gear set of the same size driven and driver gears? (The ratio is the same; the extra gears in between are just idlers, though direction of rotation might have changed.)



Step 3

7. Ask youth what they know about the meaning of the word "compound." Ask youth what they think is meant by a compound gear. Ask for a volunteer to draw a compound gear on the board or poster. From this sharing, ask how a compound gear could be designed (two gears together or on the same shaft or axle). What might be the advantage of using a set of compound gears? Share that they will now be designing and building a compound gear train.
8. Challenge teams to use craft sticks or other backing to support a gear train that will have at least an 8:1 ratio to either increase or decrease speed. They should use at least one compound gear, but may use more.
9. To get the gears to mesh, they may have to drill new holes in the craft stick for correct spacing and alignment of the gears.
10. Have them draw their gear train design and try to figure the overall ratio for this gear train in their Robotics Notebook. **Note:** The ratio of each two meshing gears is multiplied with the next two meshing gears from the compound gear. (The blue and yellow gears make up a compound gear. To figure overall ratio, calculate the ratio of blue and red gears and then multiply by the ratio of the green and yellow gears.)
11. **Optional:** If available, use a worm gear to increase the ratio, or use bevel gears to change the rotating axle plane.



Sharing and Processing

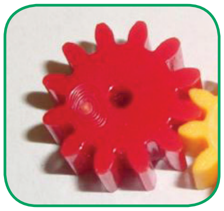
As the facilitator, help guide youth as they question, share, and compare their observations. Before they share with the group, have youth reflect on the activity in their Robotics Notebook. Use more targeted questions as prompts to get to particular points. There is no one right answer.

- How did the compound gears make a difference in the gear train?
- What was the hardest part of using the compound gears?
- How could you have designed a regular straight set of gears to get the same ratio in your gear train?

Generalizing and Applying

- Where do you think compound gears are used?
- Youth can apply what they have learned in Activity K.

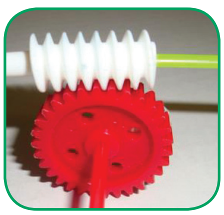
Some common types of gears



Pinion gear – usually a small gear used as a driver. It may be attached directly to a motor.

Spur Gear – the most common type of gear. Different size diameter gears are used together in a set to change speed or rotation direction.

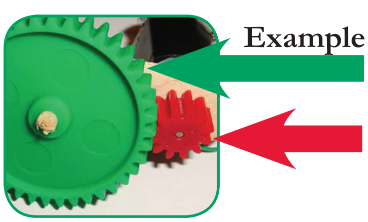
Rack Gear – can be used to convert rotation motion into linear motion, or vise a versa, either with the rack moving or the pinion moving across the rack.



Worm Gear – good for gear reductions as they have one spiral grove or tooth. They also have a locking quality in that the worm can easily turn the driven spur gear but the spur gear cannot make the worm turn. This is a good way to hold robot arms, wheels, or other gears in place or position.

Bevel Gear – useful to change direction of the rotating shafts — usually at 90 degrees — but some are made for other angles.

Compound Gear – two or more gears of different sizes (diameter) connected so they rotate together either on one shaft or as one piece. Used to compound or increase the gear ratios in changing rotational speed or ratio.



Example of how to figure Gear Ratios

Driven (green) spur gear (40 teeth)

Driver (red) pinion gear (12 teeth)

Ratio = Driven gear / Driver gear

Ratio = 40 divided by 10 = 40/10 = 4/1 = 4:1 ratio