Transmission Investigation #1: Effect of Transmission Ratio

Objective

To determine the best transmission ratio for a model solar car to perform to its full potential.

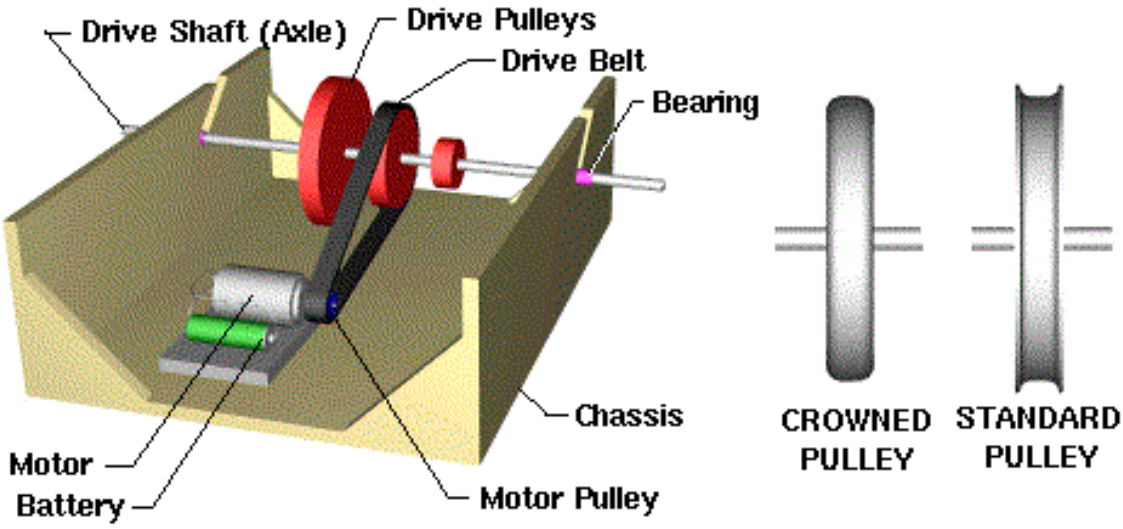
Materials Needed

- Motor and 3V power source
- Cardboard, foamcore, etc. for chassis
- 1 small pulley for motor shaft
- Rubber band or belt
- 3 larger pulleys for output shaft (axle)
- Shaft bearings
- 2 shaft axles
- Hot glue

Finding Materials

Search local hardware and craft stores for objects that can serve as pulleys, bearings, axles, etc. Some ideas for “pulleys” include: drawer pulls, videocassette reels, and thread spools. Video cassettes are also great sources of small smooth cylinders that can be used as bearings. Brass tubing (craft stores) or plastic tubing (drinking straws) can also make suitable bearings. You may want to find bearings before you select an axle.

Possible axles include wooden rods from hardware stores, wire hangers, and metal or plastic tubing from crafts stores. Note that shafts can be made larger (for mounting wheels, pulleys, etc.) by wrapping tape around the appropriate areas.



Procedure

1. Build a test transmission like the one shown above. Mount the motor on a piece of stiff material (using hot glue, good tape, etc.) that is easy to grip or attach to the chassis. Use it to adjust motor location and belt tension.

2. Explain to students that building a car without any knowledge of the best transmission ratio is risky because the car will not perform to its full potential (if it moves at all). The following test setup uses a belt and pulley transmission, but the ratio of the pulley diameters applies to all of the other types of transmissions as well (gears, friction drive). Optimizing the transmission ratio in your car is critical for good performance.

3. Have students experiment with the transmission in the following ways:

• Move the belt to different pulleys to see the results of different ratios.

• Try different bearings between the axles and the frame.

• Try adding or removing weight from the output shaft to see the effect on acceleration.

• Notice how flat rubber bands tend to crawl up the edges of a pulley—try a “crowned” pulley (convex profile). It’s counter-intuitive, but does work, and is used often in machines.

4. Conclude with a discussion based on these questions:

• Which ratios figure the highest speed, and which make the shaft easiest to stop with your fingers?

• Does the bearing material affect the speed or ease of stopping the output axle?
• What was the effect of adding or removing weight from the output shaft?
• How can you apply what you've learned to your model solar car design?

Sources: Adapted from *Junior Solar Sprint: Classroom Investigations*, by Andrew Heafitz for NREL, 2001; and materials created by Rick Butchart for the Chimacum School District in Washington; used with permission.