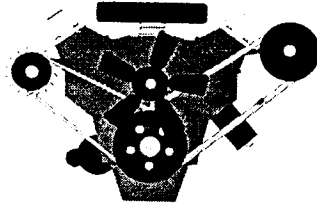


Gear Ratios



When you design and build your SUMO car, it should be remembered that the speed and power of a particular vehicle depends directly upon the size of the drive and the driven wheels. For clarification, the drive wheel is the gear or pulley that is connected to the motor. The driven wheel therefore is the gear or pulley that is connected to the vehicle drive axle. As a general rule of thumb, in any transmission type the large drive wheel will always rotate more slowly than the smaller drive wheel. However, while the larger wheel rotates more slowly, it also rotates with greater twisting force or torque than the smaller wheel. Diagrams A and B illustrate this relationship.

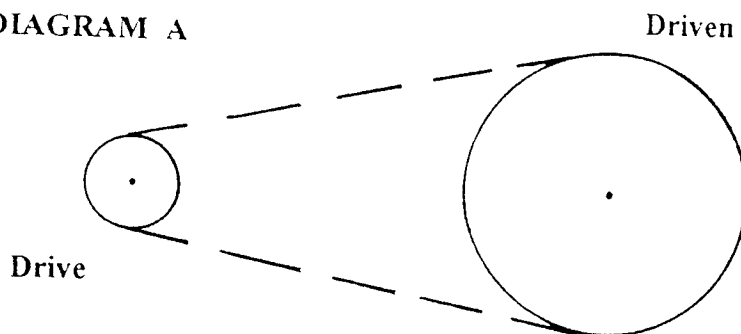
In Diagram A, the drive wheel is $\frac{1}{3}$ as large as the driven wheel which means that the drive wheel must revolve 3 times for every 1 revolution of the driven wheel. This 3:1 gear or wheel results in a low speed/high torque transmission.

Furthermore, in Diagram B, the drive wheel is 3 times as large as the driven wheel. This means that for every revolution of the drive wheel, the driven wheel must revolve 3 times. This 1:3 gear or wheel ratio results in a high speed/low torque transmission.

Therefore, depending upon the performance requirements of the SUMO Vehicle, a high speed/low torque or low speed/high torque transmission may be required. Ideally, a balance between speed and torque may be part of your design goal.

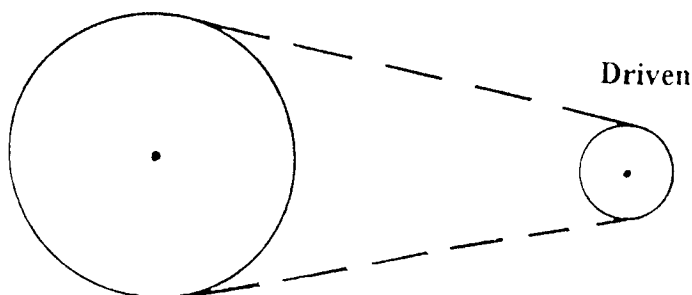
Other factors include the friction of your drive train, the weight of your vehicle, center of mass, properly wiring your switches, torque, craftsmanship etc.

DIAGRAM A



Low Speed / High Torque

3:1 Ratio



High Speed / Low Torque

1:3 Ratio

DIAGRAM B

Transmission

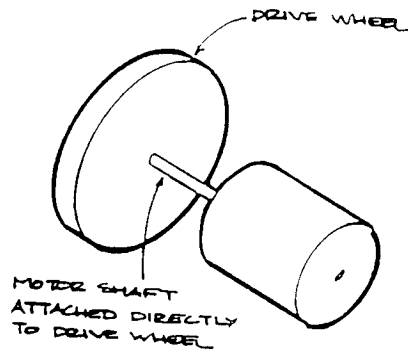
Purpose

A car's transmission transfers the power from the motor to the wheels. While doing so, it may make the wheels spin at a different speed than the motor.

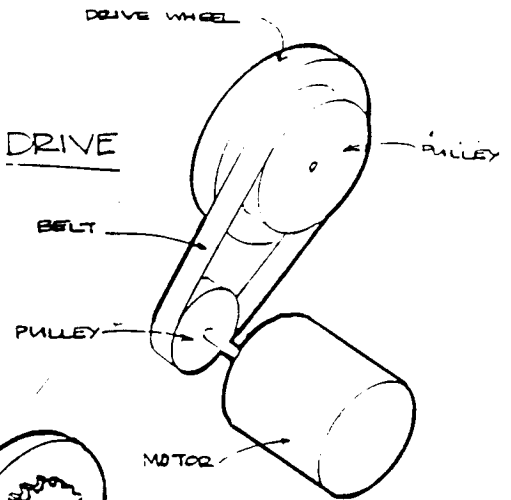
Ideas

There are different ways to transfer power from the motor to the wheels. Some popular techniques are direct drive, friction drive, belt drive, chain drive, and gears.

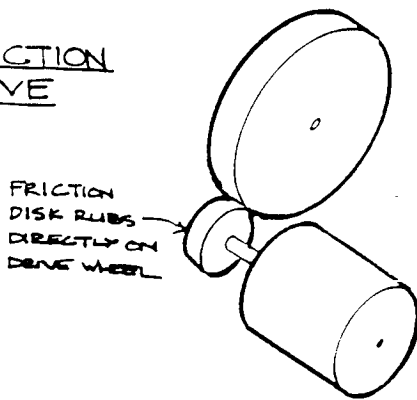
DIRECT DRIVE



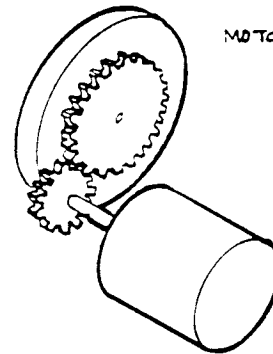
BELT DRIVE



FRICTION DRIVE



GEAR DRIVE



Some transmissions are easier to build than others, and not all are appropriate for a solar car.

Concept: Speed vs. Force

The most simple type of transmission is direct drive, which means the motor is connected directly to the axle of the driven wheel. Direct drives are not common in vehicles; one of the few vehicles that uses direct drive is a unicycle. Every time your feet make one revolution, the front wheel makes one revolution.

Belt Drive Transmission

Advantages

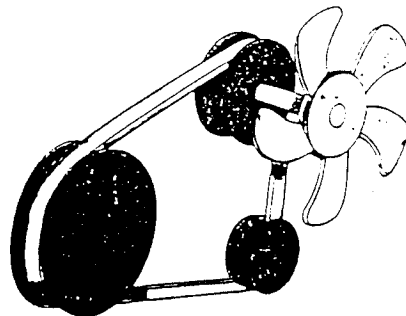
1. **Quite:** Belt drive is quieter than other transmission types due to less friction.
2. **Convertible:** Allows for easy pulley and ratio changes
3. **Easy to Build:** Probably the most popular transmission type among students
4. **Flexible:** Can easily be used in conjunction with other transmission types
5. **Less Friction:** Belt drive requires less power to run than other transmission types.

Disadvantages

1. **Slippage:** Speed between driving and driven gear not as precise as chain, gear, or worm drive.
2. **Belt Jumping:** Belts may jump off pulleys due to improper belt tension or high torque levels.
3. **Tension:** Tension between driving and driven pulleys may cause motor to come off of vehicle chassis. Electric motor should be properly braced to prevent this.

Modern Applications

1. Clothes Dryer
2. Automotive Engine Accessories: Alternator and Power Steering drive belts.
3. Sewing Machine
4. Record Player
5. Conveyor Belt



BELT DRIVE

Belt drives are similar in operation to chain drives, but they substitute a flexible belt for the chain and smooth wheels for the sprockets. Because of slippage between the belt and the wheels, the ratio of speed between one wheel

and the other is not as precise as in a chain drive. Belt drives are used when the speed ratio need not be exact. They are also used when the noise level produced by a gear or chain drive is unacceptable.

Chain Drive Transmission

Advantages

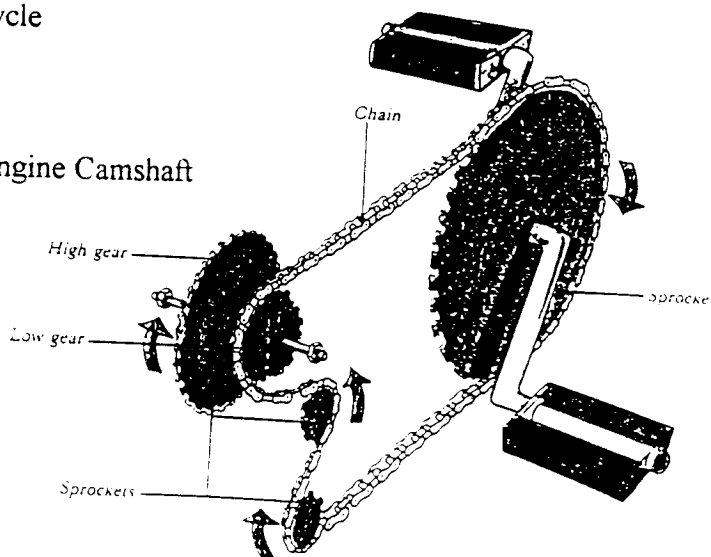
1. **No Slippage:** Precise ratio between driving and driven gear.
2. **Strong:** Able to handle higher torque loads than belt drive.
3. **Easy to Build:** Popular transmission used by student LEGO vehicle engineers.
4. **Flexible:** Can easily be used in conjunction with other transmission types.

Disadvantages

1. **Less Efficient:** Requires more power to run due to increased friction between gears and chain.
2. **Less Compact:** Requires greater clearance between components than belt drive.
3. **Noisy:** Increased friction results in greater noise levels.
4. **Limited:** Length of chain drive limited by finite number of chain links.

Modern Applications

1. Escalator
2. 10 Speed Bicycle
3. Motorcycle
4. Automobile Engine Camshaft
5. Chainsaw



BICYCLE CHAIN

Chain drives are similar to gears in that teeth are cut in the circumference of the discs, but the two discs are set apart from each other and a chain connects them. The discs of a chain drive are called sprockets; the chain is made up of a number of round links linked together so that they exactly match the distance between sprocket teeth. The two sprockets rotate in the same direction.

A bicycle uses a chain drive to transfer rotation from the front wheel to the rear wheel, which has on it sprockets of different sizes. In a high gear, the chain is moved to a small sprocket, so that the rear wheel moves faster than the pedals. In low gear, for going uphill, the chain is moved to a large sprocket. The rear pedals faster than the rear wheel. The rear wheel thus turns more slowly, but with great force.

Gear To Gear Transmission

Advantages

1. **No Slippage:** Precise Ratio between driving and driven gear.
2. **Strong:** Able to handle higher torque loads than belt drive transmission.
3. **Flexible:** Numerous gear ratio possibilities due to various gear diameters.

Disadvantages

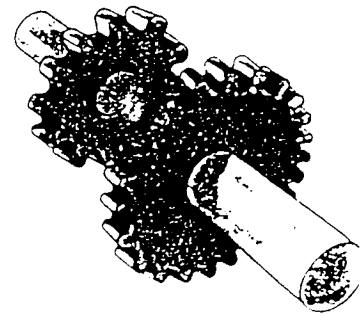
1. **More Difficult to Build:** To prevent binding and increased friction loads, precise mesh is required between gears for proper operation.
2. **Less Compact:** Requires greater clearance between components than other transmission types.
3. **Less Efficient:** Requires more power to run due to increased friction between gears.
4. **Noisy:** Mesh between gears results in higher noise levels.

Modern Applications

1. Draw Bridge
2. Toys
3. Winch
4. Automobile & Truck Transmissions
5. Electric Drill

GEAR

A gear is a disc rotating on a shaft. The disc has teeth cut into its outer edge, which mesh with mating teeth on an adjacent gear. One gear drives the other. The teeth on the driving gear push the teeth on the driven gear, causing it to rotate in the opposite direction. If the two gears are the same size, the driven gear will rotate at the same speed as the driver. But if the driving gear has 12 teeth and the driven gear has 24 teeth, the driven gear will rotate only half as fast as the driver. In this case, the larger gear can exert a greater force than the smaller one.



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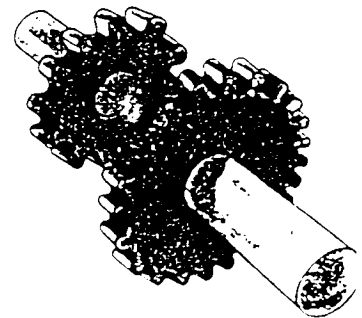
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Differential

Advantages

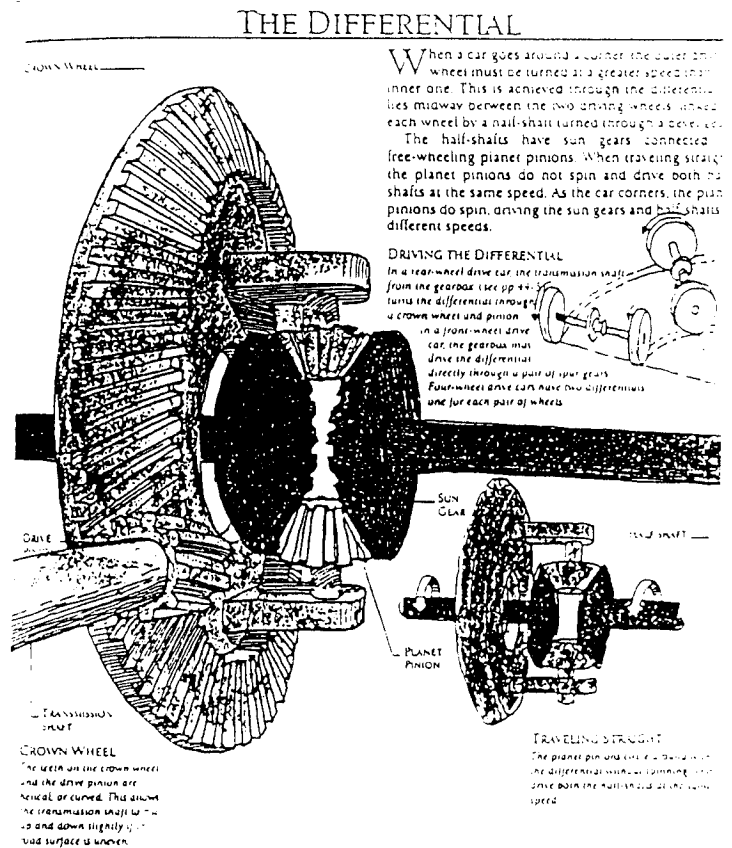
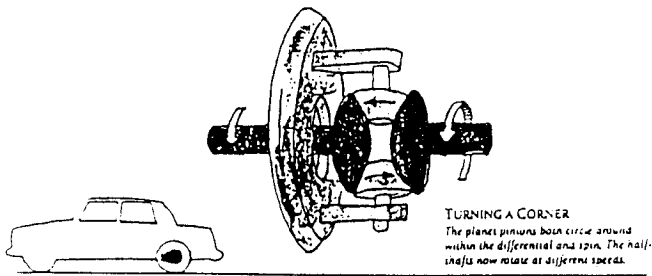
1. **Flexible:** Allows left and right rear axles to turn at different speeds.
2. **Improved Weight Distribution:** Allows longitudinal placement of electric motor.
3. **Convertible:** Can be used in conjunction with a solid axle to transfer equal amounts of torque to rear axles.

Disadvantages

1. **Level of Difficulty:** Harder to build than other transmission types.
2. **Tire Spinning:** Because a differential transmits power to the wheel with least resistance, tire spinning may result on inclined surfaces.
3. **Standardized:** Gear ratio changes harder to perform than other transmission types.

Modern Applications

1. Automobile and Truck Rear Axles
2. Bulldozer Track Drive
3. Four Wheel Drive Farm Tractor



Right Angle Transmission

Advantages

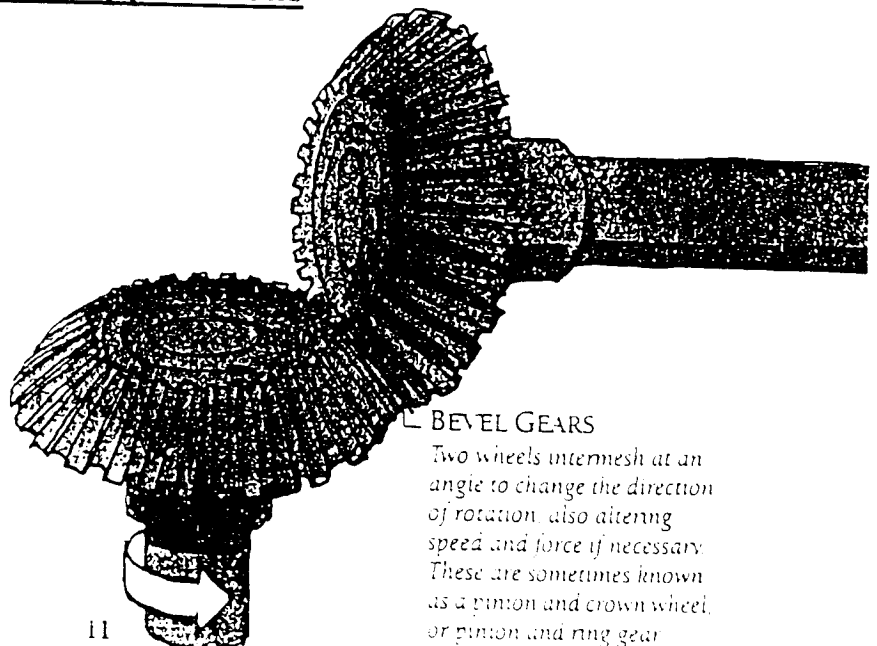
1. **Improved Weight Distribution:** Allows electric motor to be centrally located on vehicle chassis.
2. **Flexible:** Allows power to be transferred above or below the power source.
3. **Modular:** Can be used in unison with other transmission types. For instance, right angle and belt drive or right angle and chain drive.
4. **High Torque Production:** Right Angle transmissions are usually used in slow speed high torque applications.

Disadvantages

1. **Difficult to Build:** Harder to build than other transmission types due to additional supports and gearing.
2. **Less Compact:** Additional gears, driveshafts, and supports result in larger and heavier transmission.
3. **Less Efficient:** More power required to turn additional gears and driveshafts.

Modern Applications

1. Helicopter
2. Bakery Dough Mixer
3. Electric Food Mixer



BEVEL GEARS
Two wheels intermesh at an angle to change the direction of rotation, also altering speed and force if necessary. These are sometimes known as a pinion and crown wheel, or pinion and ring gear.