

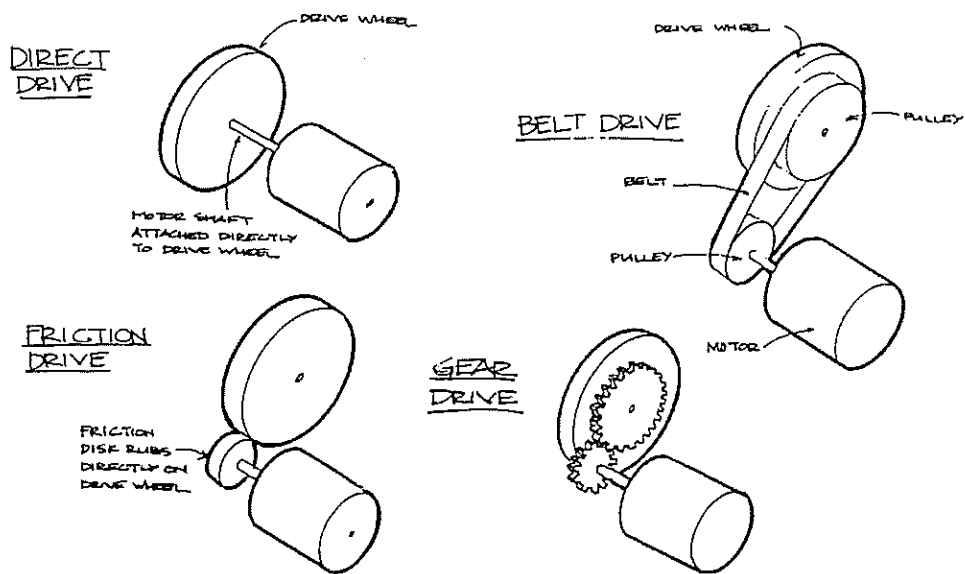
Transmission

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

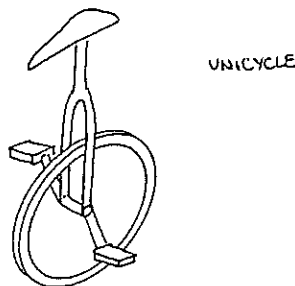
There are different ways to transfer power from the motor to the wheels. Some popular techniques are direct drive, friction drive, belt drive, and gears.



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

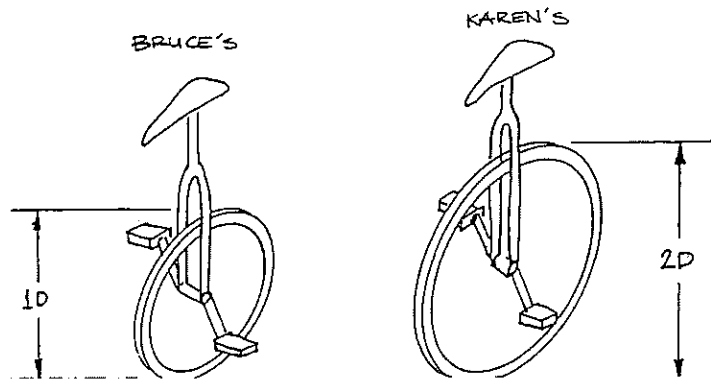
Concept: Speed vs. Force

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.



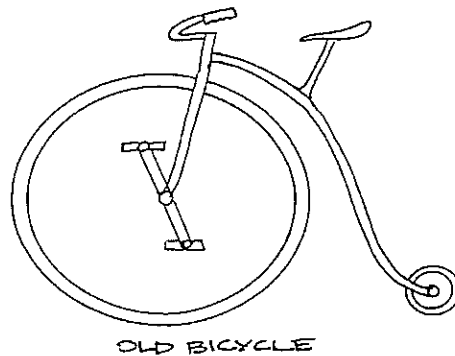
Speed

Imagine two of your neighbors have a unicycle race. Bruce's unicycle has a regular wheel, and Karen's unicycle has a very large wheel. If they both pedal at the same rate, which one of them will win?

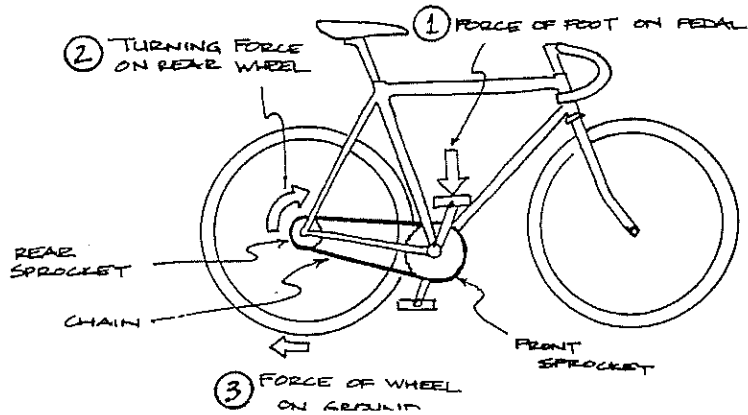


In both cases, each revolution of the pedal means one revolution of the wheel. But, one revolution of Karen's wheel will roll twice as far as Bruce's. So Karen would win if they pedaled at the same rate. If Bruce wanted to win, he would have to pedal twice as fast as Karen.

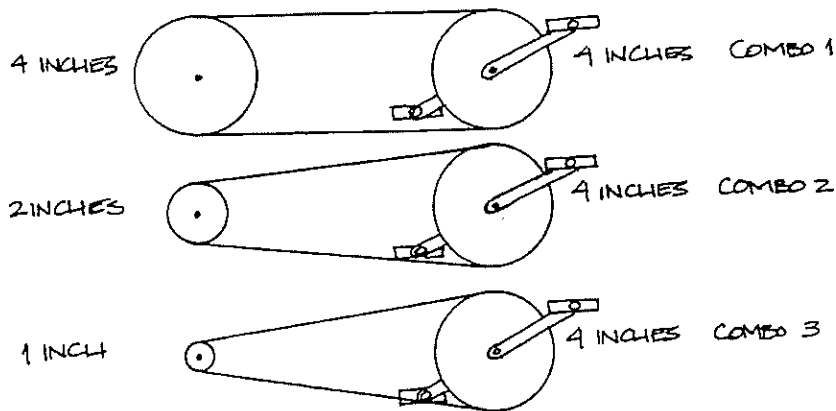
Have you ever seen pictures of very old bicycles that have huge front wheels? These bicycles allowed the rider to go faster without pedaling like a maniac!



As mentioned before, most vehicles are not direct drive, so let's look at another type of vehicle: a 3-speed bicycle. A bicycle uses a chain drive. It allows you to move the pedals, and the chain transfers the energy from the pedals to the rear wheel.



The chain glides over different sized sprockets, depending on the speed of the rider. Which sprocket combination will make the rider go the fastest, given the same pedaling rate, or “cadence”? (Hint: how many times will the back sprocket (and therefore the back wheel) turn with each revolution of the front sprocket?)



Each rotation of the front sprocket will make the back wheel rotate once in combo 1, twice in combo 2, and four times in combo 3. So, combination 3 will go the fastest. (These sprocket combinations can also be called *gear ratios*, because the new speed is calculated as the ratio of the driven (front) sprocket over the back sprocket.) So how does this affect the way a biker would use the bicycle? Well, when she starts out, she starts in first gear (combo 1). As she pedals faster, the bike starts going faster. After a while, her legs are moving very fast, so she switches to second gear (combo 2). Now her legs only go half as fast as a second ago, but the bike is still going fast. She can increase her cadence again and make the bike go even faster. Once her cadence is very high again, she can shift up to third gear (combo 3).

Well, the jump from first to second gear doubles the speed, and the step from second to third gear doubles it again. So, she is going four times as fast as in first gear. She is now going 20 miles per hour, but her legs are going the same rate as at the very beginning!

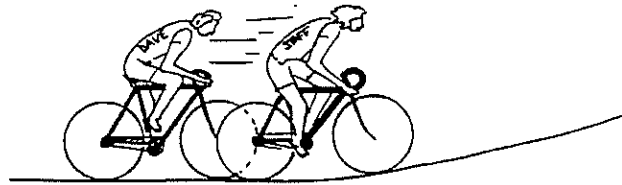
The term “3-speed” bike is not entirely correct, because a biker can go more than just three different speeds. As we saw in the previous example, our biker was able to continuously speed up from 5 mph to 20 mph. But the name comes from the fact that given one cadence, the three

gear ratios will give you three different speeds. Of course, your legs can pedal at many different rates, but “3-speed” bike sounds better than “3-gear-ratio” bike.

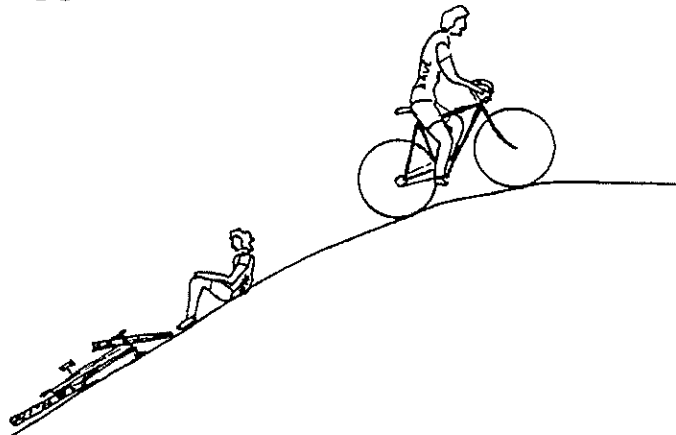
Force

You may ask, then, why isn't it the best to go for the highest speed possible? Well you can't get something for nothing! So what are you giving up when you gain speed? Let's investigate . . .

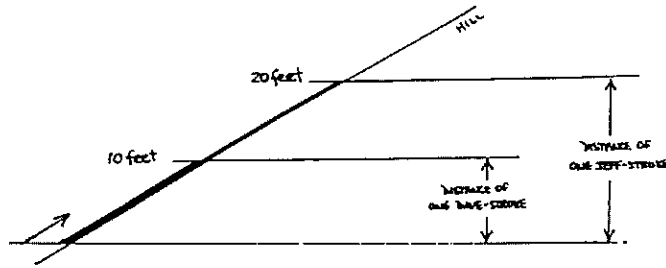
Imagine two bikers approaching a very steep hill. Jeff and Dave are both in third gear, because they are going very fast. Dave downshifts into second. But Jeff decides to stay in third gear, because he knows that third gear is for going fast, and he wants to go up this hill very fast.



Dave is going half the speed now, because he just downshifted. Jeff smirks as he blows by Dave. But Jeff hits the hill, and he suddenly realizes that his legs can't go very fast anymore – it becomes very hard to pedal! He gets slower and slower, and finally stops pedaling because it's too hard. Dave passes, slowly but surely, and makes it to the top of the hill. Jeff now owes him a new pair of bicycling gloves!

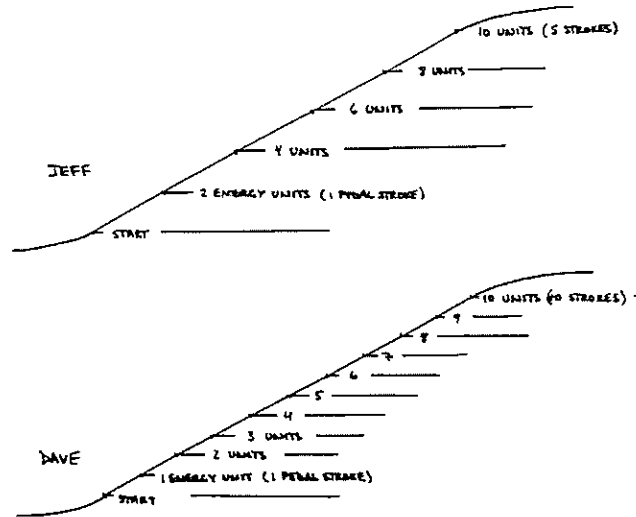


What happened? If only Jeff could've kept pedaling at the same rate, he would've beat Dave by a mile! Let's look at each pedal stroke. Each time Dave and Jeff pedal once, Dave's back wheel goes around once (let's say it travels 10 feet), but Jeff's back wheel goes round twice (20 feet).



Dave realizes that he only has to expend half the energy per pedal revolution than Jeff does, because Jeff goes twice as far each time. That is why Jeff started getting very tired, because his pedals were difficult to push. In other words, his pedals required more force than Dave's did. So does Dave expend less energy going up the same hill?

Dave expends half the energy per pedal revolution, but this is only because he goes half the distance per pedal, revolution. Dave has to pedal twice as many times to get up the same hill. So, the energy expended by both Dave and Jeff going up the entire hill is the SAME in either case.



So, the bottom line is, when we gain a speed advantage, we are losing the force advantage. The pedals are more difficult to turn. You can gain either speed or force advantage, but not at the same time.

Selecting the Proper Gear Ration

So, how can you choose the best gear ratio? Experimentation is probably the easiest way to find out.

The idea is that your motor, like your legs when you ride a bike, like to go a certain speed. They also have a limit as to how much force they can exert. First you must find the speed at which the motor gives the most power (this is usually half the speed the motor will rotate if there is no load, or force, exerted on the motor shaft). Try to keep the motor turning at approximately that speed

is too slow, or (like Jeff riding uphill) the force required to turn the wheel is too high. Try a different gear ratio!

Materials

The materials you choose vary greatly depending on the type of transmission you build., If you decide to build a belt drive, try stiff, rubbery materials for the belt – such as a slice of inner tube or an o-ring. Make sure your pulleys are pulled away from each other so that the belt is tight. One suggestion: one way to change the gear ratio on a pulley drive is to add or remove masking tape around a pulley, which changes its diameter.

If you use a friction drive, make sure you have enough traction on the *friction disk*, or it will slip (see materials section for wheels and bearings). Also, make sure the friction gears are pressed against each other snugly to ensure traction.

In all cases, you will need wheel-like parts to put on the motor shaft and the wheel, and you can get ideas from reading the suggestions for wheel materials.