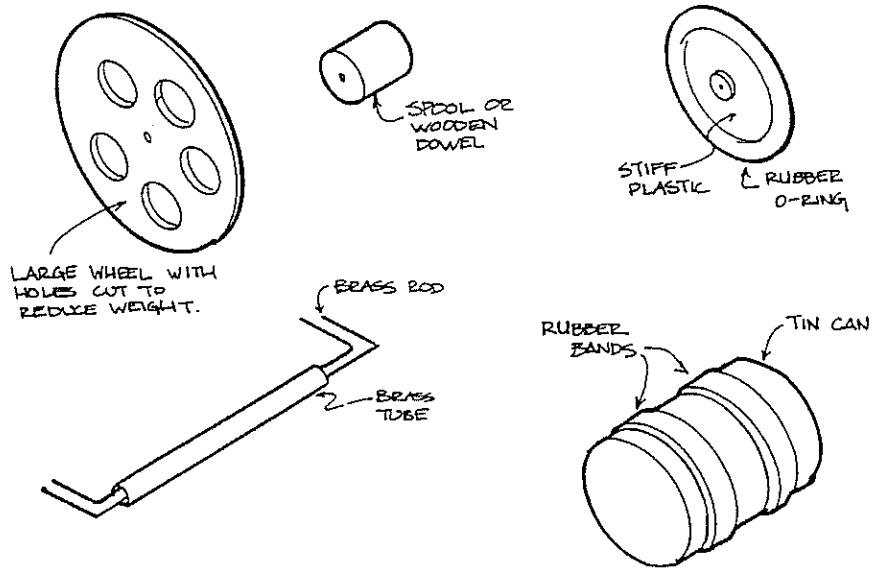
## Wheels and Bearings

### Purpose

Wheels support the chassis and allow the car to roll forward. Bearings support the wheel allowing them to rotate.

### Ideas

Wheels can be large, small, narrow, wide . . . here are some ideas to start you thinking:



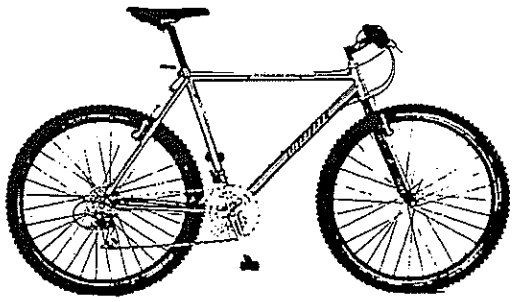

### Concept: Friction

Friction keeps things from sliding against each other. When you build your cars, there are some parts you want to slide easily, and there are other parts you don't want to slide at all.

### Tire Traction

When you have two things that must roll against each other, like a wheel rolling along the road, friction keeps them from slipping. This type of friction is also called "traction" and is important to remember when building your wheels.

Why do mountain bikes have big, fat, knobby tires? If you have to bike up to muddy hill covered with leaves, your tires will slip if they don't have enough traction. And the big knobs of rubber can grip onto the dirt and rocks and keep the tires from slipping on the ground.

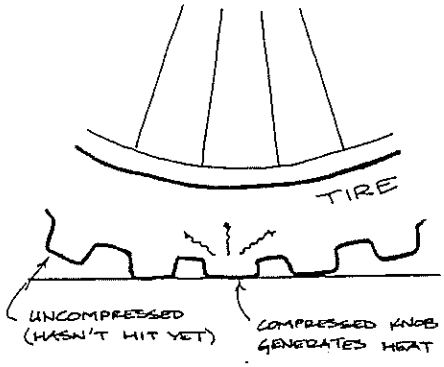


MOUNTAIN BIKE

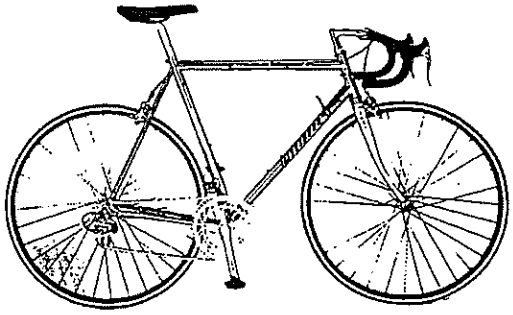
(Another reason for the thick tires, too, is because they are more rugged and can take the abuse from the trail!)

Now, the question is, why don't racing bicycles have fat, knobby tires if these wheels have good traction? Once again, there is a tradeoff in designing a wheel.

Mountain bike tires have two main disadvantages. The first disadvantage is the thick, knobby rubber which gives them such great traction also makes them inefficient. Every time a rubber "knob" is compressed and bent by the road, energy is lost. Where does this energy go? If you have ever felt an ambulance tire after it has been on the road, you probably noticed that it was hot. The energy it took to compress the rubber and air in the tire was lost as heat.




The other main disadvantage of mountain bike tires is their weight. Weight in tires is actually more difficult to move than weight in the chassis. Weight in the chassis has to be moved forward, but the weight in the wheels has to be moved forward and around in a circle. The heaver the wheel, the more energy it takes to get the wheel turning. Surprisingly, the bigger the wheel diameter (even if it is the same weight), the more energy it takes to get the wheel turning.

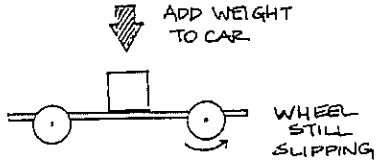



So, racing bicycles do not have the mountain bike tires, because traction is not as important. But what is important is efficiency, so that the bicyclist does not need to expend a lot of energy. The bicycle designers have made a conscious decision to use different tires designed for efficiency and not traction.

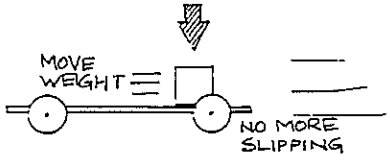
**Weight and Distribution and Traction**

Imagine your real-wheel –drive solar car has trouble – its back wheels are slipping. Your partner suggests adding some rubber bands around the wheel s to increase traction, and you agree.

The real wheel still slips some. Your other partner wants to add some weight to the car, like this:



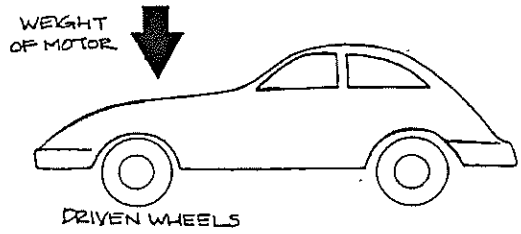

But it doesn't work. You tell him you have a better idea. You move the existing weight, and now it works! Why?




Remember that all of the force is transmitted through the driven wheels, so the moved weight increased the traction where it was needed. Weight distribution is very important, since you can increase traction just by moving existing weight from one part of the car to the other.

Have you ever heard that front wheel drive cars are better in snow and ice than rear wheel drive vehicles? Front wheel drive cars aren't heavier. But the engine is very heavy and is located

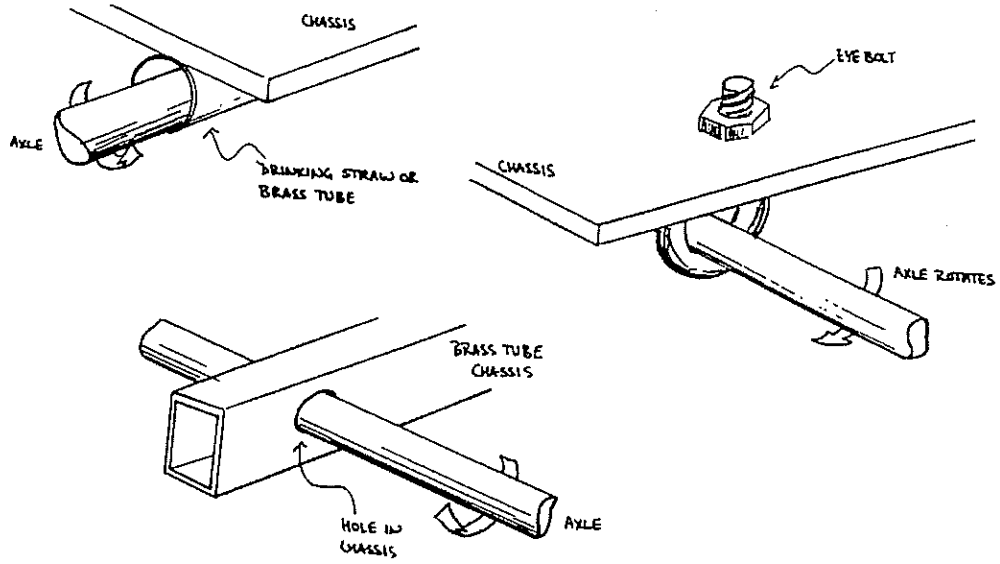
above the front wheels. This helps traction in front wheel drive cars because the weight is right above the driven wheels.




So, in summary, traction is important for transmitting the forces from the wheels to the road. If any of your wheels are spinning rather than rolling, you probably need more traction. Traction can be increased by adding a non-slip material around the wheels (like a tire) or by moving weight over the driven wheels. But, remember, it is also important to have efficient wheels, which are usually thin and lightweight.

## Bearings

When you have two things rubbing against each other and you want them to move freely, friction slows things down and wastes energy. For example, try sliding a coin and an eraser across the table. The reason the coin slides much more easily is there is less friction between the coin and the table than there is between the eraser and the table.




One case where friction is very undesirable is in the wheel axle. The axle must be supported and attached to the chassis, but still must be able to turn. Components which allow the relative motion of two parts are called bearings. Some ideas for bearings are sketched below:

Look at a bicycle or a Roller Blade. Hold it above the ground and spin one of the wheels. Between each wheel and its center axle is a type of bearing called a "ball bearing." The bearing

holds the wheel on the axle, but reduces the friction between them, so the wheel can spin for a long time without slowing down.

**Lubrication**

Lubrication helps parts slide against each other, so it is used in bearings to reduce friction.

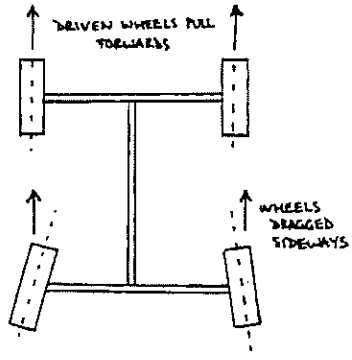
Let's try a small experiment. Rub your hands together very lightly and quickly. Your hands should feel warm. Where is the heat coming from? There is friction between you hands, some of the energy you expend rubbing is turned into heat. If you put a lot of hand lotion or cream between your hands and rub, your hands slide more easily and should not get as warm. That is because the lotion acts as a lubricant.

Different lubricants work better with different materials. In the case of machines, one generally uses oil or grease to help the parts slide together easily. On a water slide, the water acts as a lubricant. If you bake cookies, a little oil or butter on the cookie sheet keeps the cookies from sticking.

Some appropriate lubricants for the solar car bearings may be light oil, light grease, or graphite powder (crushed pencil lead). Try various lubricants and see which ones work best in your car.

**Wheel Alignment**

Another problem that wastes energy is poor wheel alignment. When the wheels on your vehicles are not lined up properly, some of the wheels must slide sideways. One way this might happen is sketched below.




When the driven wheels try to pull the car one way, but the rest of the car wants to roll the other way, the traction in the wheels (normally a good thing) wastes quite a bit of energy.

Also, make sure that the axle goes through the center of the wheel. One suggestion is to use a compass, rather than tracing a circle, if you cut a circle out of a material. The compass will show you where the center of the circle is.

Taking time to align the wheels carefully the first time will make a huge difference in how well your car runs.

**Materials**

For wheels: Look around for anything round, or things which can be cut into circular shapes . . . look at home, arts and crafts stores, and hardware stores. Hobby stores sell model wheels, but they are more expensive and are not designed for building a solar car. They may be much too heavy. Some materials we found were:

- thin plywood
- balsa wood
- foam core
- stiff plastic sheet
- Styrofoam
- cardboard tubes
- toy/model wheels
- tin can
- tape spool
- thread spool
- brass tube
- plastic pipe
- wood dowels.

For traction: Things that are rough or rubber-like usually add traction. A few things we found:

- rubber o-rings (hardware store)
- rubber bands
- rubber sheet
- cloth tape
- silicone or other caulking (hardware store).

For axle: The axle must be stiff, narrow, and round. Some ideas:

- nails
- brass rod
- brass tubing
- coat-hanger wire.

For bearing: Some ideas of things that would support the axle:

- screw eyes/eye bolts (hardware store),
- brass tubing
- hard material (wood, aluminum, etc.) with a hole drilled into it
- brackets with screw holes pre-drilled holes drilled directly into chassis