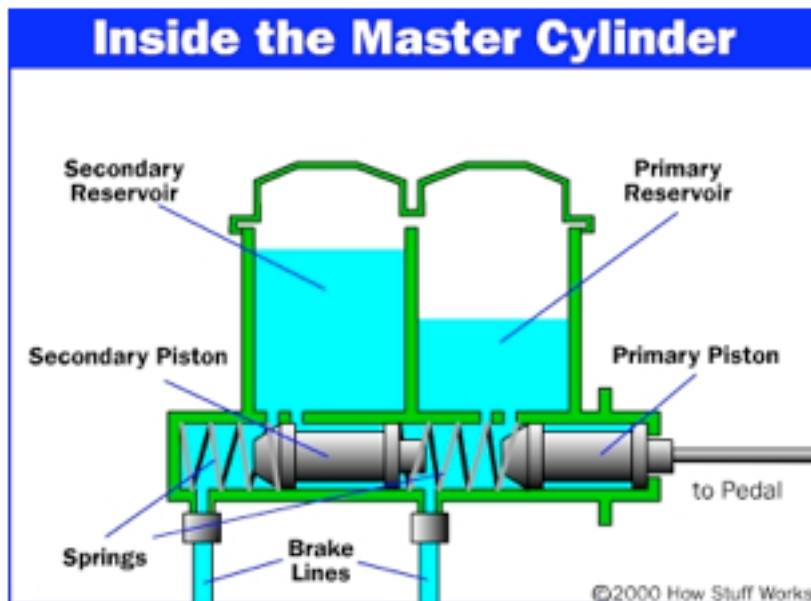


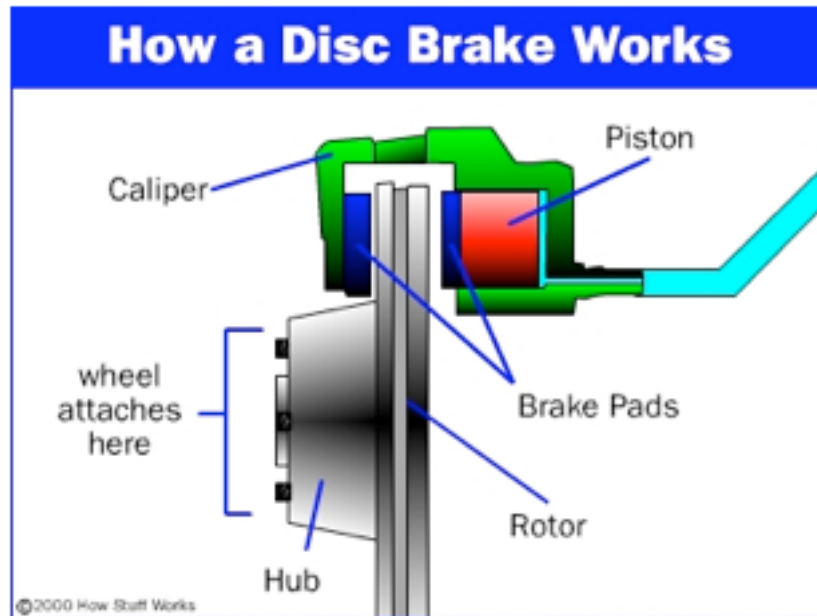
BRAKING CONCEPT

We have decided to use hydraulic disc brakes on all four wheels of the car. The main reasoning behind this is that it is a less complicated system and requires less maintenance than mechanical brakes. When the driver steps on the pedal, a pushrod acts on the piston in the master cylinder, causing the brake fluid to compress and pressure to build up in the cylinder and in the brake lines. The brake lines connect the master cylinder to the caliper, located at the rotor at the wheel. The brake fluid then travels through the brake lines and pushes on a piston in the caliper. The image below shows the pushrod (on the far right) pushing on the primary piston, compressing the fluid and sending it out the brake lines. To see a schematic of this in action, visit <http://auto.howstuffworks.com/master-brake1.htm> and click on the image titled "How a Master Cylinder Works".



When the piston in the caliper is acted upon, it causes the brake pad to squeeze against the rotor. Since the rotor and the wheel are mounted to the same axle, when the rotor slows down, the wheel also slows down. In the picture below, the light blue on the right represents the brake fluid

reaching the caliper through the brake line. The brake fluid pushes against the piston, shown in red, which causes the dark blue brake pads to push against the rotor.



CURRENT WHEELS

We've ordered wheels from NuGen Mobility Inc which are special to solar cars. The World Solar Challenge requires tires with a tread at least 1.5mm deep so NGM has been talking to Bridgestone about having new tires made. The wheels cost \$650 each and the tires cost \$100 each.

PARTS INVOLVED

CALIPER

Calipers can either be single-piston floating calipers or have pistons on both sides. In the case of the single-piston caliper, the piston forces one brake pad to move and squeezes the rotor against the brake pad on the other side of the caliper. With pistons on both sides, two pistons are

moving the brake pads to squeeze against the rotor. However, this latter scenario causes the caliper to be wider, and since we are limited with the amount of lateral distance we have from the outside of the frame to the wheel, we chose to use a single-piston floating caliper.

The caliper we have selected is the MCP 650 Caliper (\$105) from [American Power Sports Karting](#):



This caliper is used typically on go-karts, has a 1" piston, and is spring-loaded, which is common for go-kart brakes. The benefit of a spring-loaded caliper is that when the brakes are not in use, the brake pads are not touching the rotors at all. In a normal car, the brake pads will always be in contact with the rotors, even if it's ever so slightly. However, in a solar car, this resulting friction is more energy for the car to overcome and takes away from the car's efficiency.

The mounting bracket pictured above (in the lighter gray color) is a weld-on bracket to mount to the suspension upright. Since welding is permanent and the suspension upright is an important piece to machine, we are also considering the option of mounting this bracket with screws that will not interfere with the rotor and will allow this part to be removed when necessary.

To use a wider rotor in the caliper, we will need to order spacers (shown as the metal line on the caliper). **These are also from [American Power Sports Karting](#) - MCP668 (\$1.13ea), 0.03" Steel Caliper Spacer.**

ROTOR

The rotor is the metal disc acted upon by the brake pads in the caliper. Typically with go-karts and ATVs, these discs have holes drilled into them to allow for cooling since the friction from the brake pads causes the rotor to get very hot. These holes also help reduce weight. **The rotor we have selected is the MCP711S Rotor (\$30) from [American Power Sports Karting](#). This rotor has a 7 1/8" diameter, is 1/8" thick, and weights 0.92lb. It has a 3" bolt circle with 5/16" bolt holes.**



MCP711S Brake Rotor
7 1/8" Diameter X 1/8" Disc
3" Bolt Circle

HUB & SPINDLE

Most solar car teams machine these parts and we will likely do the same. The purpose of the hub is to join the wheel and the rotor. Therefore, one side of it must align with the wheel's bolt circle, and the other side must align with the rotor's bolt circle. We are seeking machinists' advice with regards to the best way to machine this part. It will be made out of aluminum and will mount to a bearing on the wheel axle.

We met with Dennis and Scott in the Physics Machine Shop in SciTech and they were very willing to work with us. They said Larry McMaster, the head machinist, would return from vacation on August 11 so it would be a good idea to meet with him with our specific designs so he could work us into their schedule. Costs are typically \$60/hour + materials and occasionally, depending on the project, they'll let the costs slide a little bit.

The spindle is mounted to the suspension upright and does not rotate. It

passes through the rotor and the wheel and both are mounted to it with bearings. Since this part bears a lot of loading, it will be machined from steel.



<http://quad4x4.com/images/spindle%20kit.jpg>
Spindle from a 4x4

MASTER CYLINDER & PEDAL ASSEMBLY

The regulations call for two individual braking systems and specify that a dual chamber master cylinder is not considered two individual systems. Therefore we will have two individual master cylinders, one for the front brakes, and one for the rear brakes.

The master cylinder we have selected is from Wilwood Brakes, Part No. 260-2636 (\$45-55). It is aluminum with a 0.625" bore, 1.4" stroke (the distance the piston gets pushed inside the cylinder), and 1.4oz reservoir.



<http://www.wilwood.com/Products/006-MasterCylinders/005-CSBMC/pic.gif>
Wilwood Brakes, Part No. 260-2636

Two of these will be mounted to a pedal assembly. When the driver steps on the brake pedal, two individual pushrods act on the two master cylinders, sending brake fluid to both the front and rear brake systems. The pedal assembly acts as a leverage to increase the force acting on the pushrods from the driver stepping on the pedal. The pedal assembly also has a "bias bar" or "balance bar" to determine how much of the force is sent to the front and rear brakes.

The pedal assembly we have selected is also from Wilwood Brakes, Part No. 340-1285 (\$100-115). It mounts to the floor and has a leverage ratio of 6:1.



<http://www.wilwood.com/Products/005-PedalAssemblies/001-FMP/fmbp/Forward-Mount-Brake-Pedal-A.jpg>
Wilwood Brakes, Part No. 340-1285