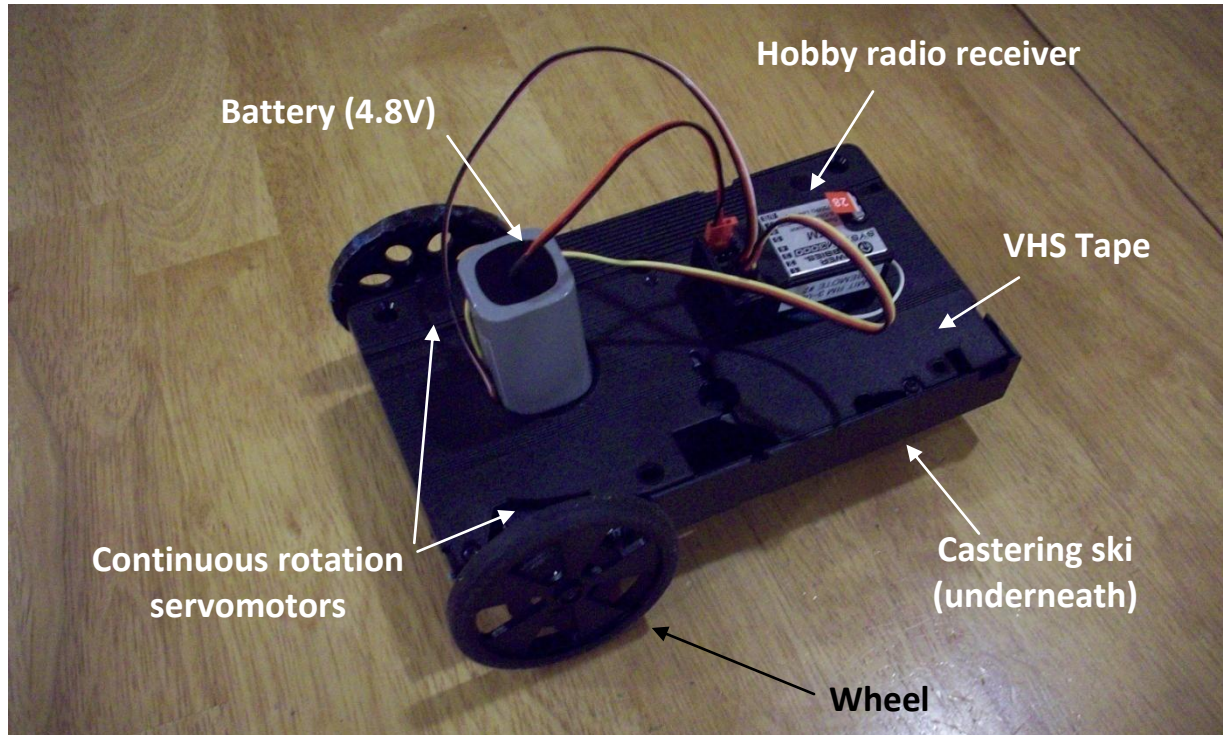


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2.007 Design and Manufacturing I  
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## Fabrication of a Simple Car

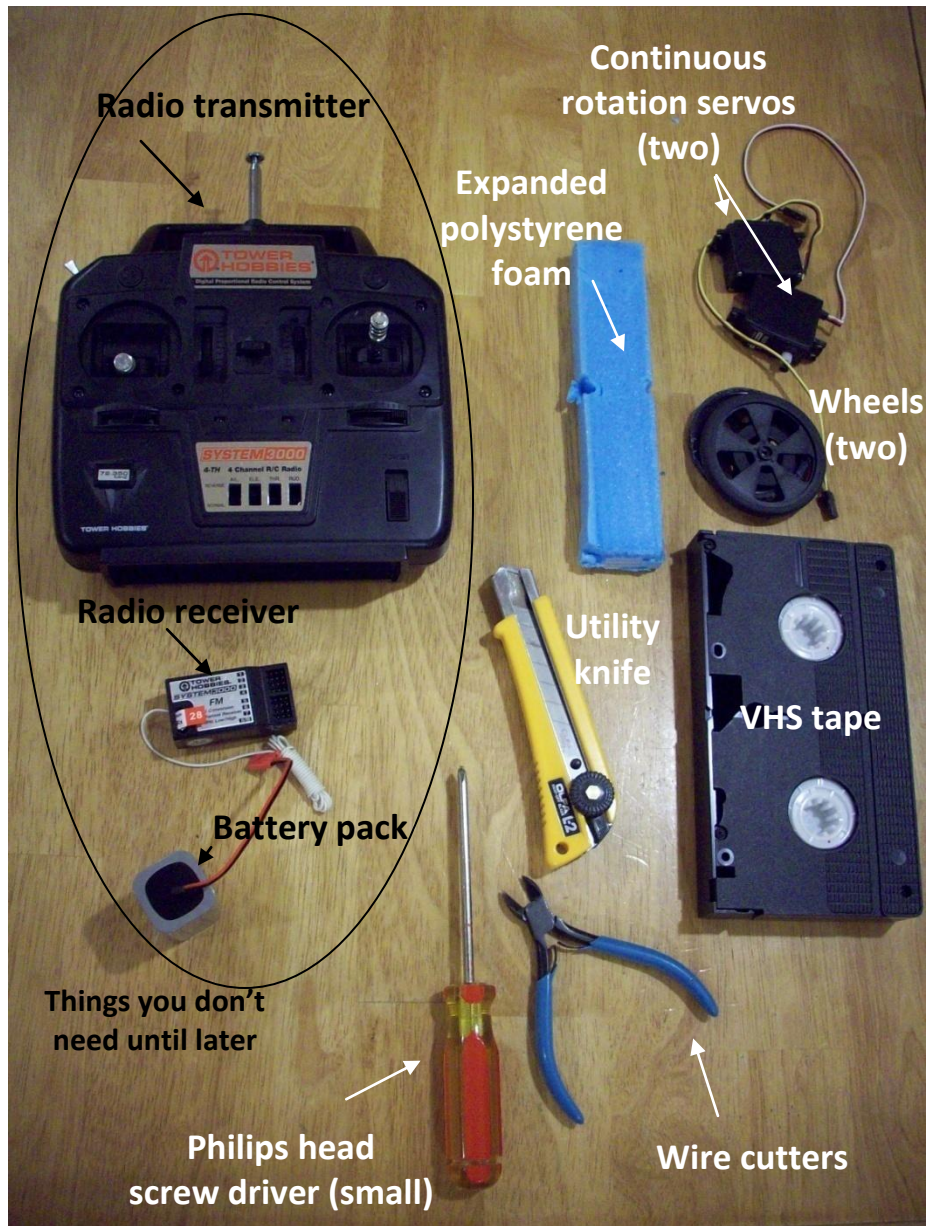


In the course 2.007, Design and Manufacturing I, it is generally a good idea for students to make a simple car early in the term. Making a simple car provides a means to explore the possibilities and challenges of the design contest, to get a quick exposure to some fabrication techniques, and to practice driving a robot. In some cases the simple robot will also serve as a platform for evolving a more complex robot.

The particular simple car design here is meant only as a point of departure. Students probably won't make this very same design, or else they will make it and modify it almost immediately. Also, many students may start with a completely different design, either their own concept or another option they've seen. This is all to the good. It will be helpful to the class as a whole if a variety of simple car designs are made so that we can readily assess the design features that work well and those that cause problems. I would encourage development of a gallery of simple cars. Look for a small gallery of cars to appear soon in the lab.

This instruction set is written in an informal format without formal engineering drawings. It's more like instructions for assembling Ikea furniture (<http://www.ikeafans.com/forums/ikea-instructions/>) or similar to a howtoon (<http://www.howtoons.com/toon/soda-bottle-sub/>). Engineering drawings will come later.

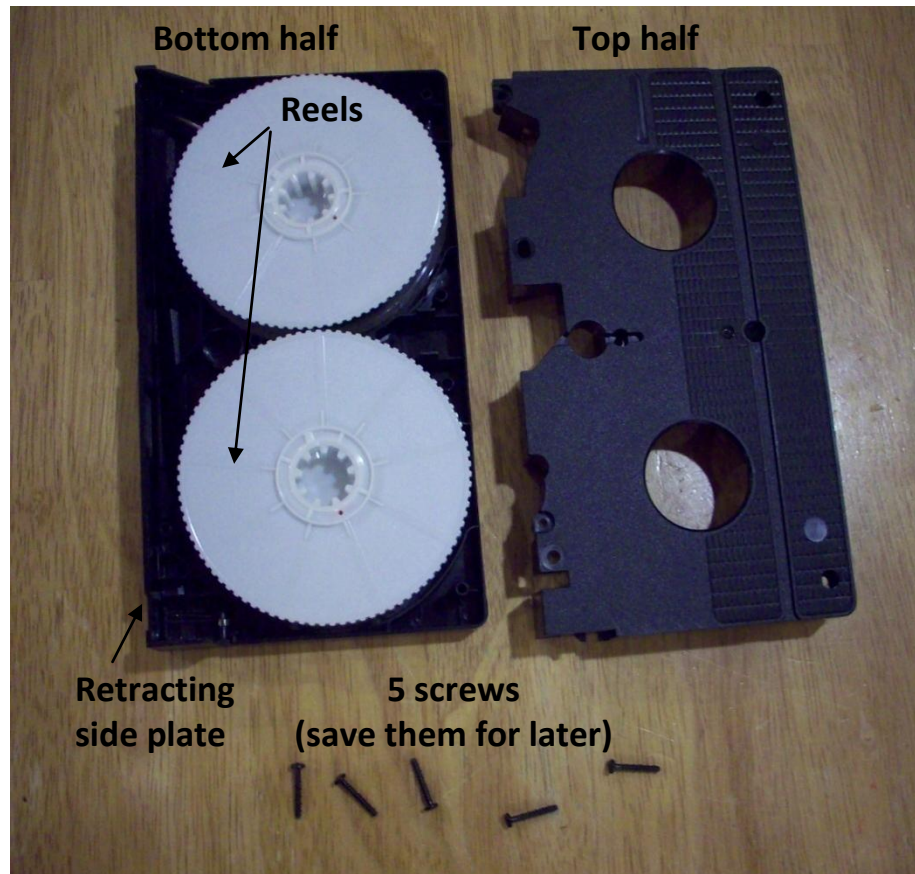
**Gather Materials, Components, and Tools**



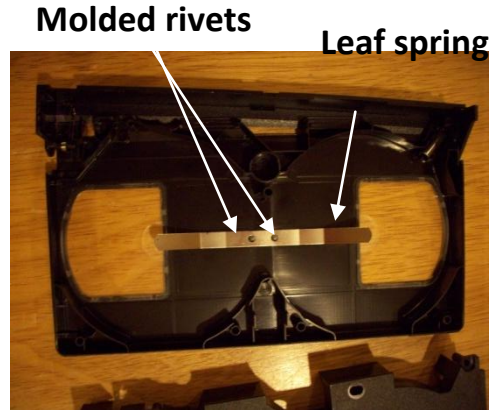
Gather the components and tools you'll need. Most of the needed items are in your kits (tool kit and contest kit). The VHS tape can be found from some recycling waste stream (like my basement). The EPS foam is generally available in the Papallardo lab and can also be purchased in home improvement stores where it is sold as insulation boards.

### Fabrication steps

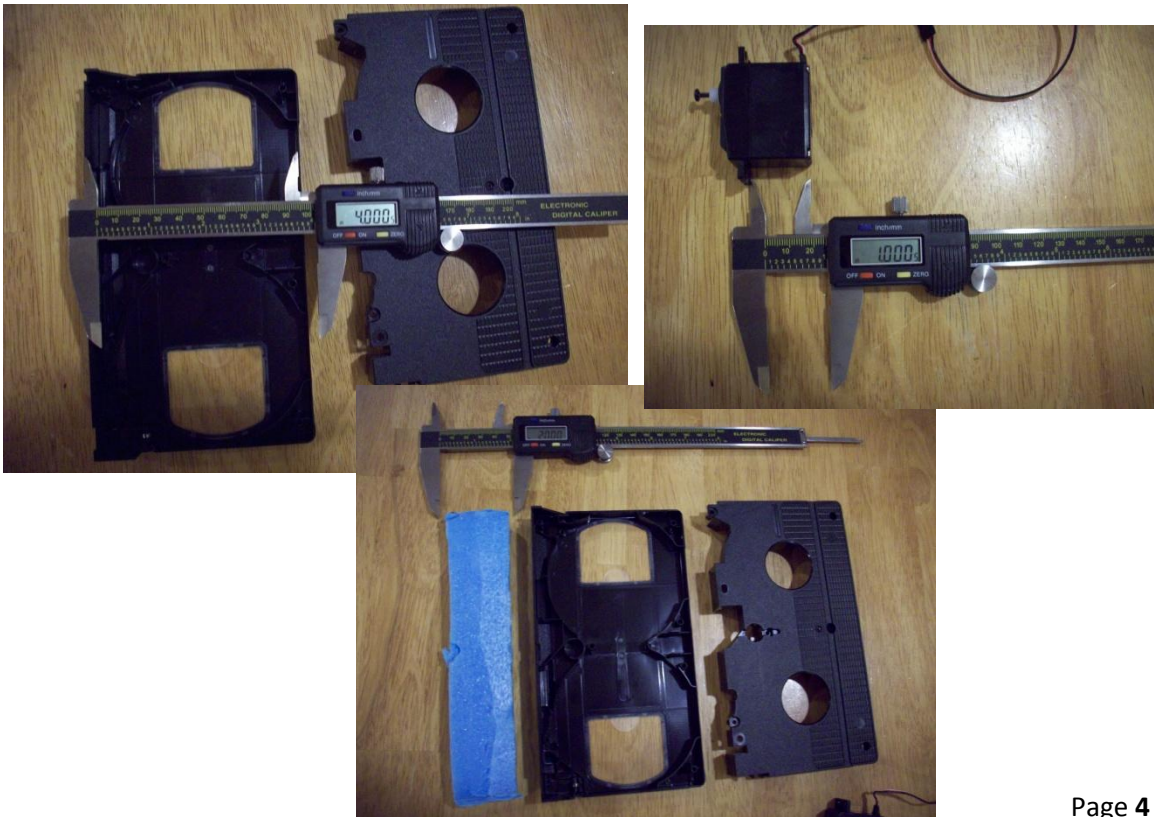
Disassemble the VHS tape by removing the five screws from the back. The reels that hold the tape will not be used in this version of the simple car, but might be incorporated in your own version of the design. So you might want to save these reels. Recycled material is generally allowed in 2.007 machines this year.



Remove the leaf spring from the bottom side of the case. This can be accomplished by shaving away the molded plastic “rivets” that hold it on and then gently pulling it away from the case.



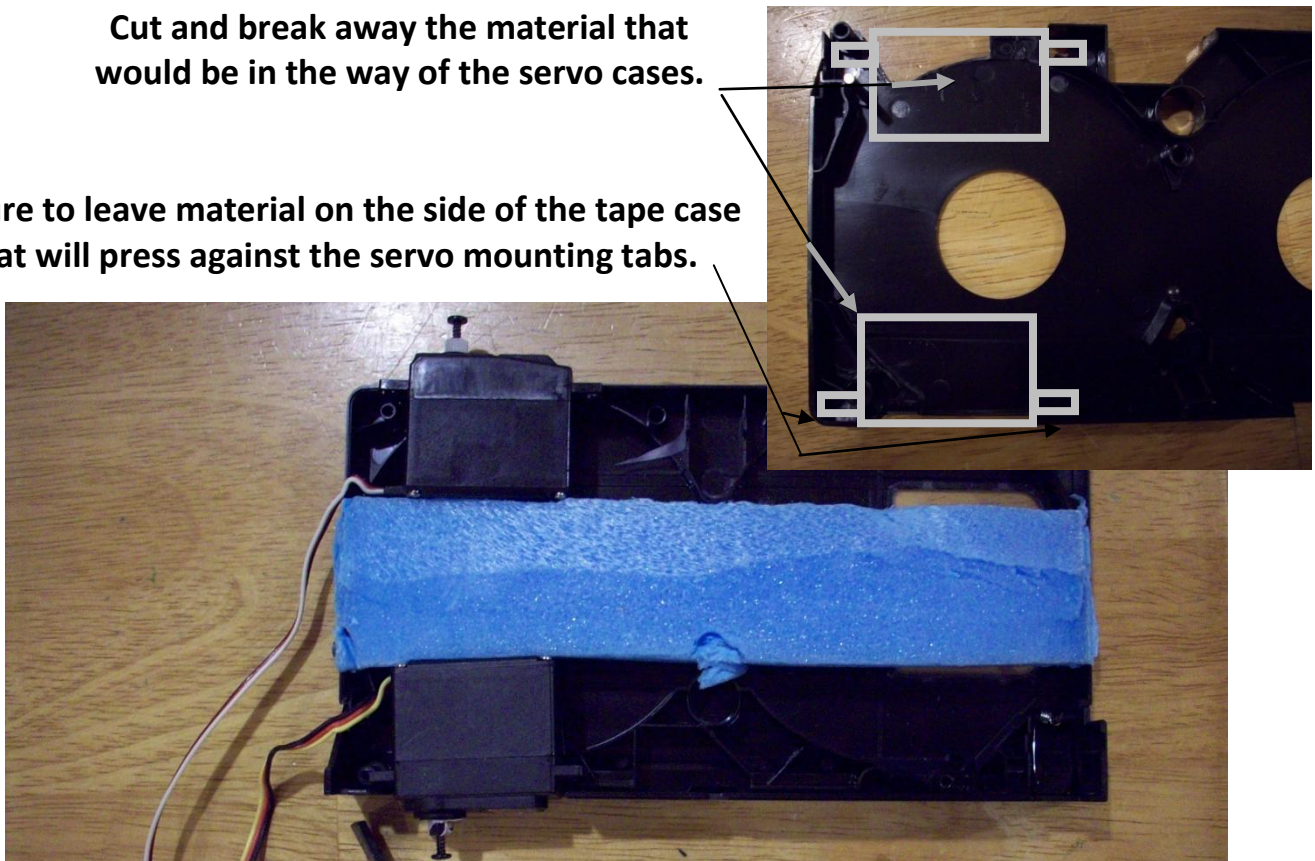
Since the case is about 4 inches wide, and the servo extends about 1 inch below the mounting brackets, a two inch wide piece of foam will serve to sit between the servos and hold them in position against the sides of the tape case. The foam strip can be made the full length of the tape case so that it can't displace longitudinally. NiChrome wire can be heated by flowing current through it and will cut the foam quickly and leave a good surface.



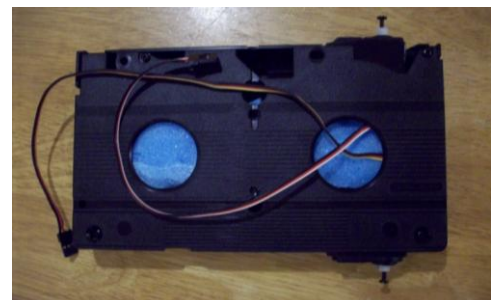
The servos sit in the case as depicted below. The mounting horns are inside the VHS case and press against the inside faces of the case. Cut away the features that are in the way of the servo preventing it from resting on the bottom of the case. This involves making a rectangular cut on both sides of the case. The material is soft as can easily be cut with a utility knife or snipped with a wire cutter. Be sure to wear safety glasses as plastic tends to fly when cut away. The tape case material is also weak and can be broken away with pliers without much force, but take care not to damage the material that is to be left behind. Milling away the material would also work well and provide a nice result (but the whole section probably can't do this in a reasonable period of time). Even if we proceed very efficiently, this step of removing material from the case is probably the longest step in the process. Take your time (1/2 hour would be reasonable).

**Cut and break away the material that would be in the way of the servo cases.**

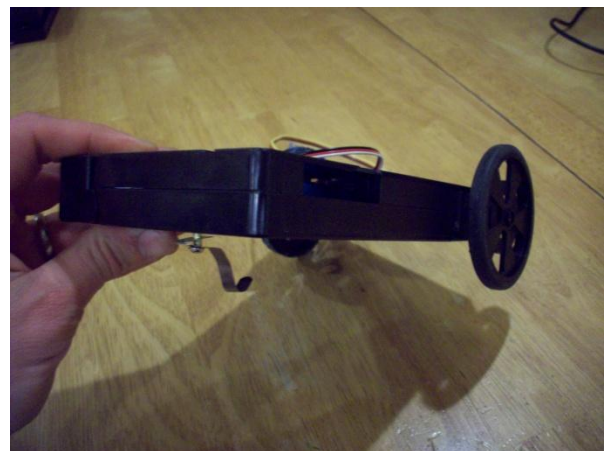
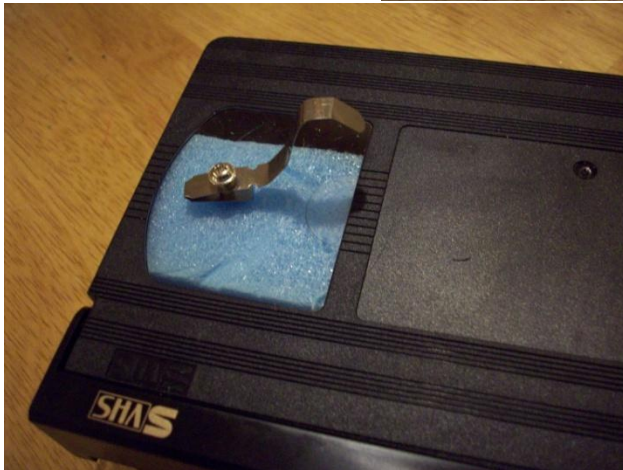
**Be sure to leave material on the side of the tape case that will press against the servo mounting tabs.**



Put the case together. Route the cables through an existing hole and make sure they won't be pinched or damaged during re-assembly. Get the case to nest together properly and put the screws back where they were before disassembly. After this, the servos should be in place firmly and the whole assembly should be stiff.



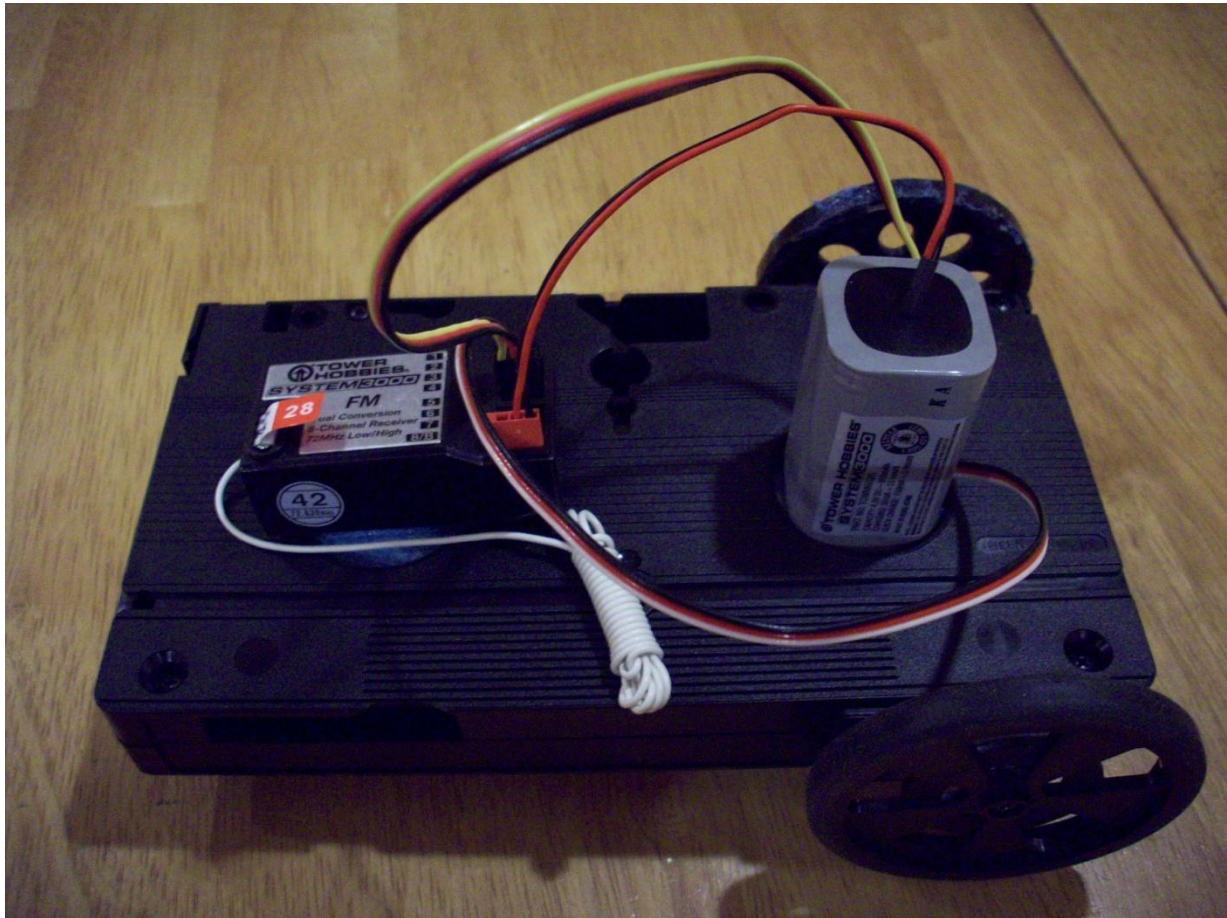
Get the leaf spring you previously salvaged from the VHS tape. Fashion a casting ski. Use a fastener and grommet from the standard servo box (there's a hardware kit inside of each one).



Drill a hole in the top side of the case on the center (in this case, the hole is in the clear plastic part of the VHS case). The fastener can cut its own threads in this material. Choose a drill size about 0.020" smaller than the thread outside diameter so the fastener can cut some threads when you screw it in. If you have the same fastener depicted here, a 1/16 inch bit should work.

Fold the metal spring back onto itself so the two holes align. Put the grommet through the holes. The leaf spring will tend to grab the grommet and the grommet should turn freely on the fastener. Shape the leaf spring to form a ski. The ski should sit far enough out that it supports the weight of the tape and still only contacts the case near the fastener. The whole ski assembly should cast as the vehicle executes turns.

Assemble the whole car. Place the wheels on the continuous rotation servos. Note the features that hold the wheel on the output shaft. The ridged surface is called a “spline” and is a good way to transmit torque. Use the screws provided with the servos to fasten the wheel on through the threaded hole in the middle of the output shaft. Place the battery pack on the top and secure it in the hole (it should press into place and stay).



Use two-sided velcro tape to make a detachable fastening means for the radio receiver. Standards often make life simpler. Let's agree in the course that the hook side of the velcro always goes on then receiver and the loop side of the velcro always goes on the robot. That way every receiver will attach to every robot.

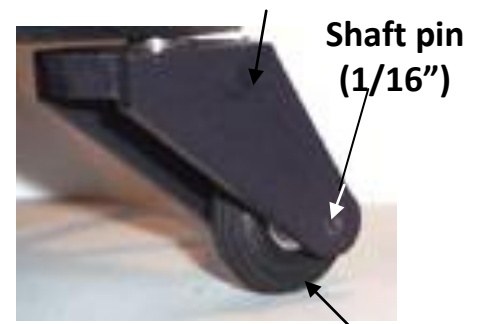
Connect the servo and battery wires. The black wires usually go the the right side. Use channel 2 for right and 3 for left to get tank-style steering. If a control lever works the opposite way that you intended, reverse its action by flipping the switch in the recessed area on the bottom, middle of the transmitter.



The simple ski might be replaced by the castering wheel from the 2.670 robot. For those who did not take 2.670 this year, here is a description of the caster wheel assembly.

A 1/16" shaft pin goes into the small holes on the side of the black polyurethane caster body. After the pin is inserted part way, place a shaft collar on the shaft, then the rubber wheel, then another shaft collar. When all these three components are on the shaft in a stack, push the shaft into the hole so that it is supported on both sides. Tighten the set screws in the shaft collar. Attach the castering wheel to the front bracket using a 4-40 fastener and a white delrin spacer.

### **Polyurethane caster body**



**Rubber wheel**