

Build a Robotic Arm!

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The robotic arm in the picture is a lot of fun to make and use. It uses a first and third class lever, and has a fun linkage for the grabber. It can grab, pick up, and move to the side. A great first project to warm you up using levers and hydraulics.

You can peg the small pieces that hold the long arm (as I have), but it takes very precise drilling, so your best bet is to glue the small cross pieces. Once the glue is set though, drilling and pegging will make this model last forever (maybe longer).

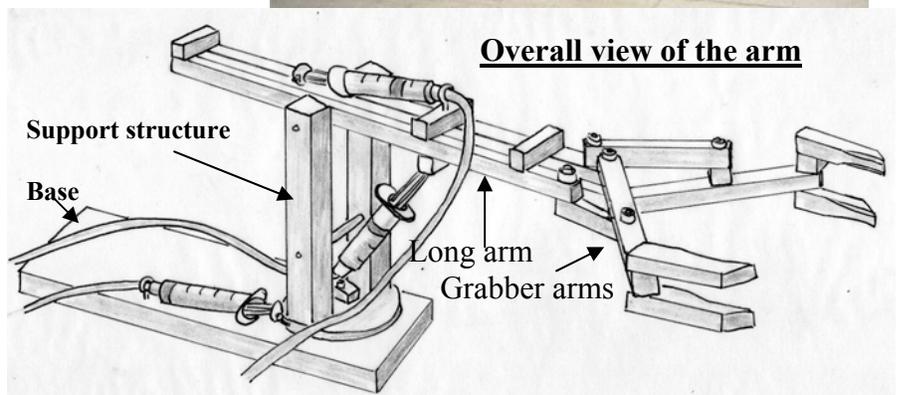


First thing to do is:

Gather the parts!

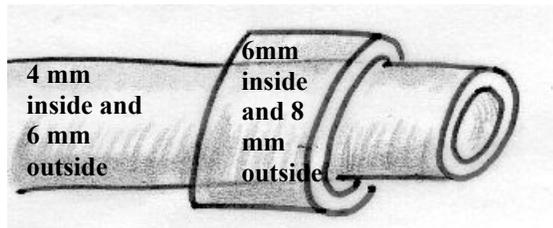
You will need

- 6 – 5 ml syringes
- 4 screw eyes big enough for a 3/16 dowel
- 93 cm of tubing to fit the syringes, - 6 mm outside diameter
- 166 cm of 1 x 1 cm sticks
- base –this can be any size, however, mine is 2 cm thick, 8.8 cm wide x 26 cm long (an 11” piece of 1” x 4” wood)
- a small disk about 7.5 cm diameter – you can cut some plywood for this, or use the precut wheels
- 30 cm of 2 cm x 2 cm wood – for the stand – any size close to this is OK though
- 50 cm of dowel - 14 cm more if you are going to peg the small crossbars for the arm



Tubing

You need two kinds of tubing:



- the tubes for the syringes are 1/8” inside, 3/16” outside dimension
- (this is 4 mm inside and 6 mm outside dimension)
- and the holder tubes – to go around the dowel and the tubing and hold them in place
 - this tubing is 3/16” inside and 1/4” outside dimension, (this is 6 mm inside and 8 mm outside dimension)

Cut the 1 x 1 cm wood and drill the holes

The center of the holes near the ends are 6 mm away from the end.

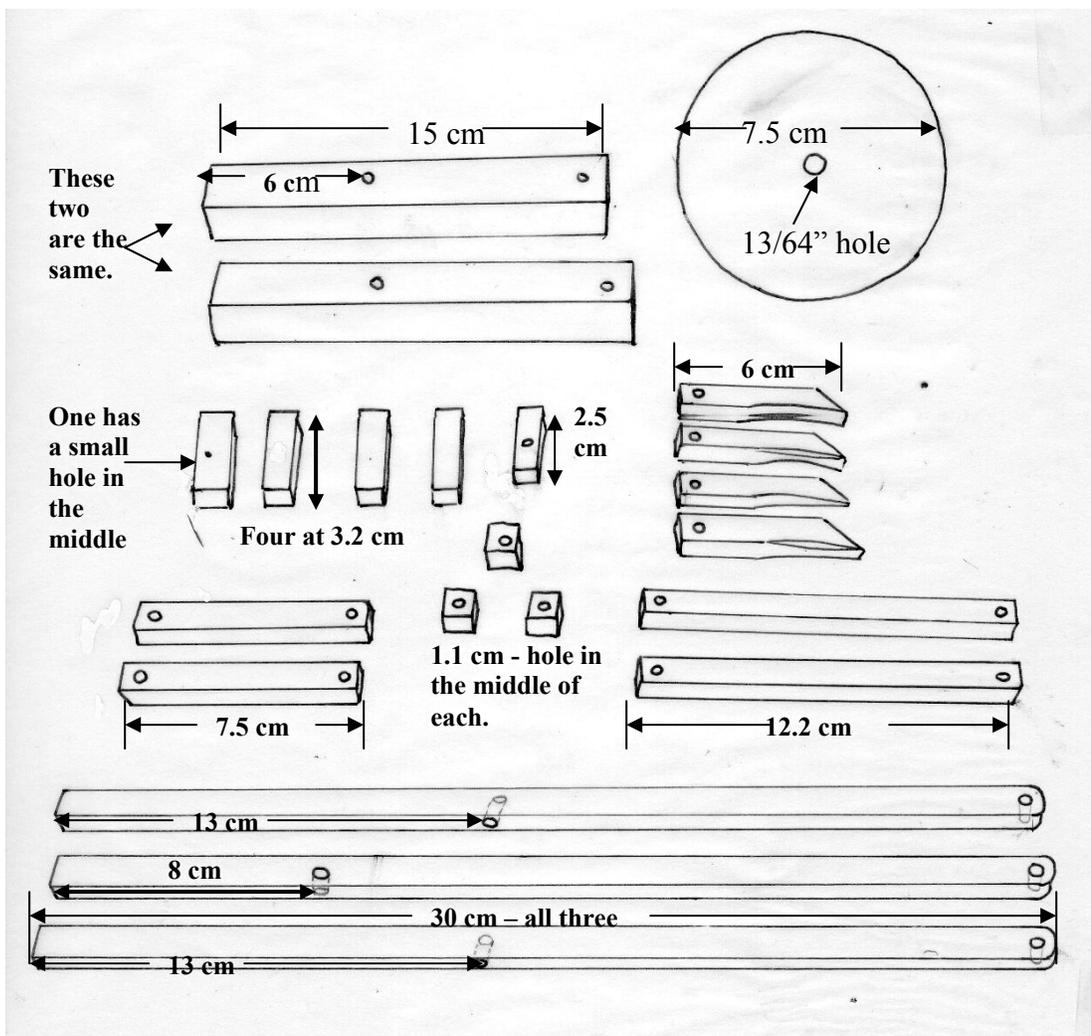
When you drill holes in pieces the same length, lay them on top of each other and drill, that way the holes will be exactly the same distance apart.

Important! – all 3/16” dowels are not the same! I find that if I use a 3/16” drill bit for the holes, the dowel is so tight in the hole it will not move. So, I use a 13/64” drill bit and the dowel is snug so the piece doesn't wobble, but is loose enough that it moves in the hole with some friction. You really should test your dowel in a scrap piece to make sure the fit is correct (snug, but not too snug so it doesn't move).

With the 1x1 cm wood cut the following pieces:

- 3 - 30 cm pieces – rounded at one end
- 2 - 12.2 cm pieces, round off the ends
- 2 – 7.5 cm pieces
- 4 – 6 cm pieces, cut on an angle and sanded on the inside edge
- 4 - 3.2 cm pieces one has a small hole in the middle (use the smallest bit since it is just for a bit of wire)
- 1 – 2.5 cm piece – drill a 13/64 hole in the middle
- 3 – 1.1 cm pieces – drill a 13/64 hole in the middle

The pieces should look like this!

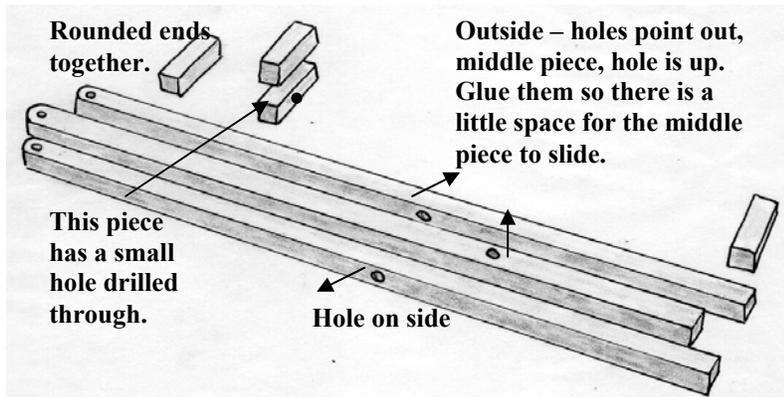


Cut 2 – 15 cm pieces with the 2 x 2 cm wood and cut the base.

Cut a 7.5 cm diameter circle disk out of 1/4” plywood. Drill a 13/64 hole in the middle.

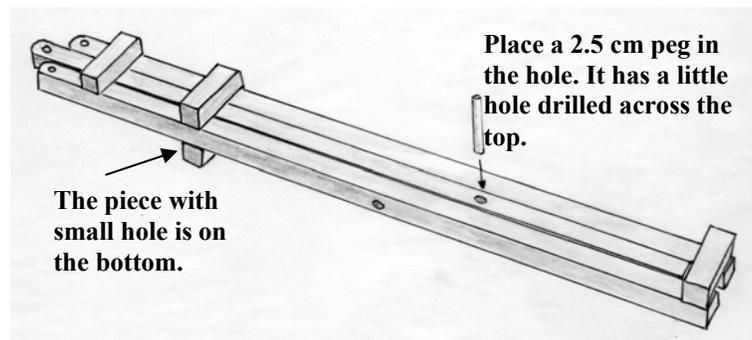
If there is no measurement for the hole, the center of it should be .6 cm from the end of the wood (this is most of them).

Make the long part of the arm, use the small 3.2 cm pieces to join them. The middle bottom piece should have a small hole in the middle for a piece of wire later on.

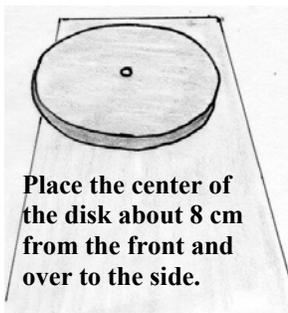


Assemble the pieces as shown here. Carefully glue the small 3.2 cm pieces to the outside 30 cm pieces – make sure the holes are pointing out.

Let the glue harden (dry?) and assemble the base.



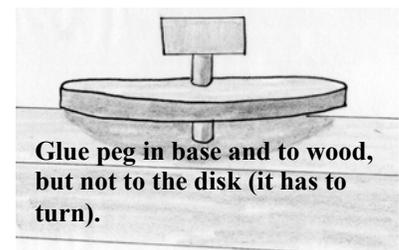
The Base!



Place the center of the disk about 8 cm from the front and over to the side.

Drill a hole in the base 8 cm from the front and to the side so the disk is close to one side. This will leave room for the piston that moves it on the other side.

Cut a 4 cm dowel and glue it in the base. Slide the disk over the dowel and glue down the 2.5 cm piece over the disk. This way the disk will rotate, but not come off!

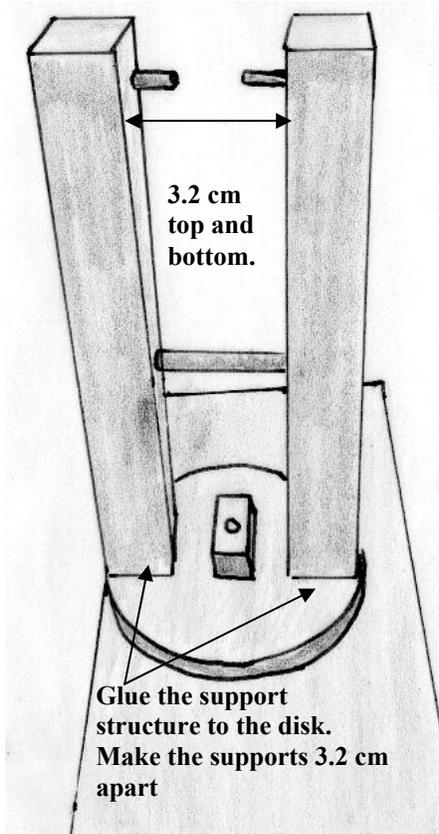


Glue peg in base and to wood, but not to the disk (it has to turn).

The right side of the support structure has two screw eyes, the one on the inside is big enough for the syringe tube and is 2.5 cm up from the bottom. The one on the outside can be smaller since it only will have a wire in it, and it is .5 of a cm from the bottom and .5 cm from the back (the long side of the base is the back). You can use a big one on the outside if that is all you have. Screw them in before you glue the pieces to the disk since it is easier (especially the inside one).



Cut a piece of dowel to fit in the holes 6 cm from the bottom. It should be long enough to go to the outside edge of the support structure (that's what I call this part), so the structure is exactly 3.2 cm across. The long arm should be 3.2 cm across, (measure your drying long arm) so the space here has to be that wide. **The 15 cm pieces are glued to the disk.**



- 3 at 3 cm long
- 4 at 4 cm long

The dowels will insert into the holes and a tube is pushed over the end to hold them in place.

So you need 10 tubes cut .5 of a cm. This is the 6mm tubing that is a bit bigger than the tubing you use for the syringes. Did you get all that?

To finish, place the 4 cm dowel through the long arm, through a wooden spacer and then through the bottom arm, as shown here. Do the same for the other side and you are ready for the claws! Place tubing over the dowels to hold them in place. There should be .5 cm on each side of the arm for the tubing.

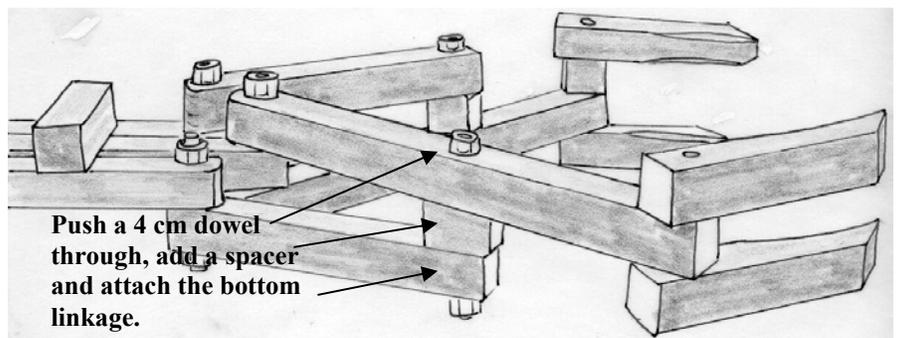
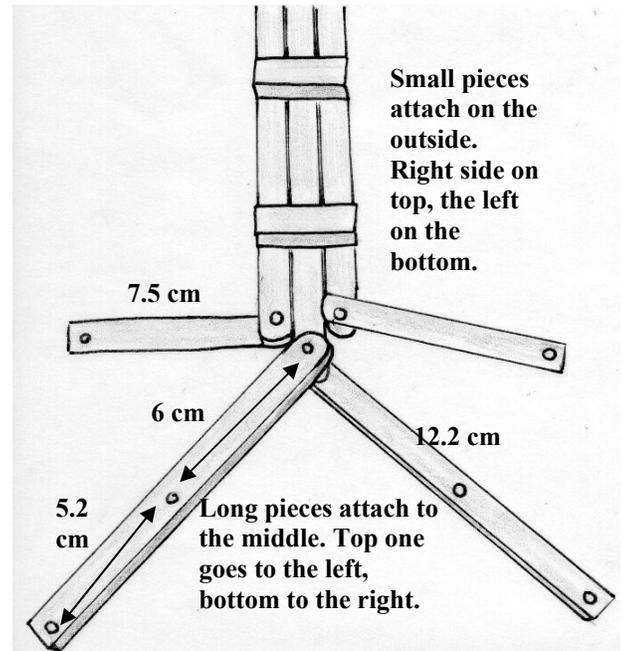
Insert pegs in the top holes so they stick in 1 cm, this will hold the long arm. They don't need to be glued since there is no motion that will work them loose, and it's nice to be able to remove them. Let this dry and go on to the grabber arms.

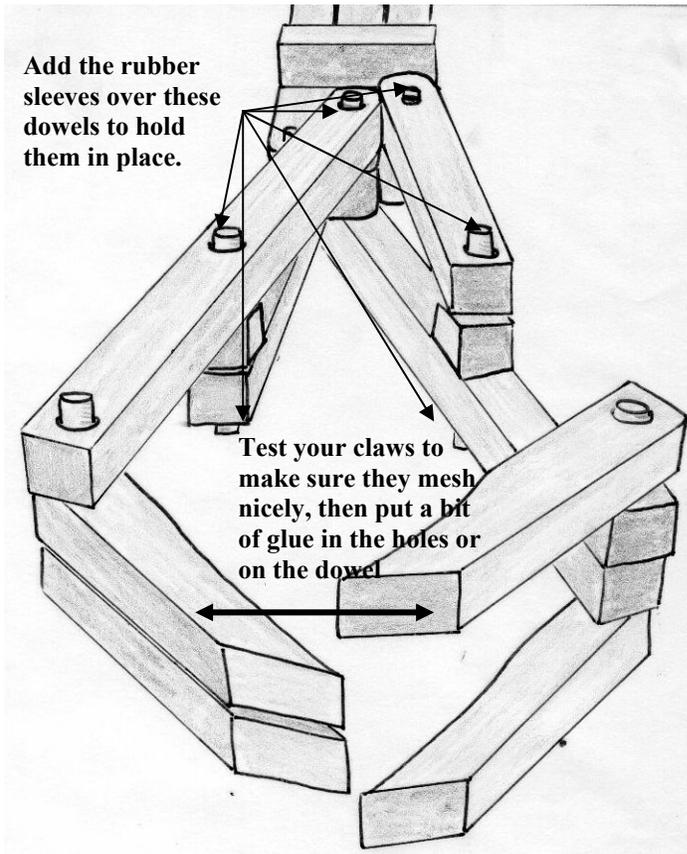
The Grabber Arms

This is the part that shows if you have cut and drilled with accuracy!

Start off by looking at the diagram and checking out where things will go.

For the Grabber arms you will need 7 pieces of cut dowel.





The claws!

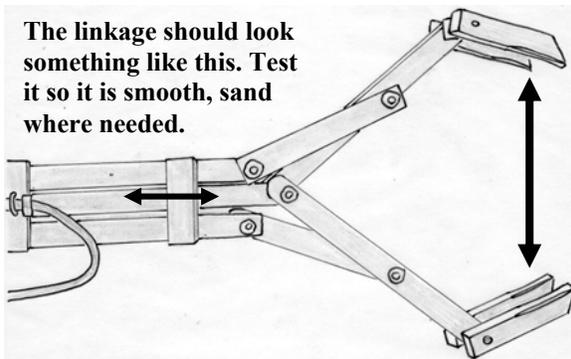
There are two ways you can attach them. If you look above they both have a space between them, and here there is no space between one of them. Our researchers have decided that they are both fine and you can use whichever technique you want (in a vote 42 to 5).

Either way, you need a wooden spacer on the arm on the right.

On these pieces the dowel doesn't need a rubber holder since they are going to be glued and the dowel should be flat on the claw. Trim the dowel with a pair of small wire snippers if they are too long.

Move the linkage in and out with your hands and adjust the claws so they are at the correct angle, and they don't bind with each other. If they hit each other and don't nicely mesh then take them off and sand them so they slide together. Once they are smoothly

meshing and at an angle that you like, put glue on the dowels and push them in.

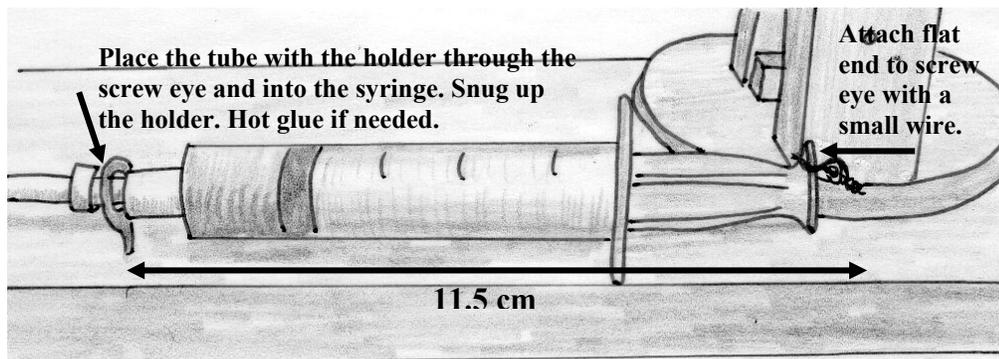


Now for the hydraulics!

As you have seen there are three syringes to move the parts, and three to push them. You will need to drill a small hole in the top or side of the syringe, so you can attach it to the arms with a small piece of wire.

Each syringe is held in place by a screw eye, and a plastic tube (like the wooden dowels).

Attach the base-turning piston



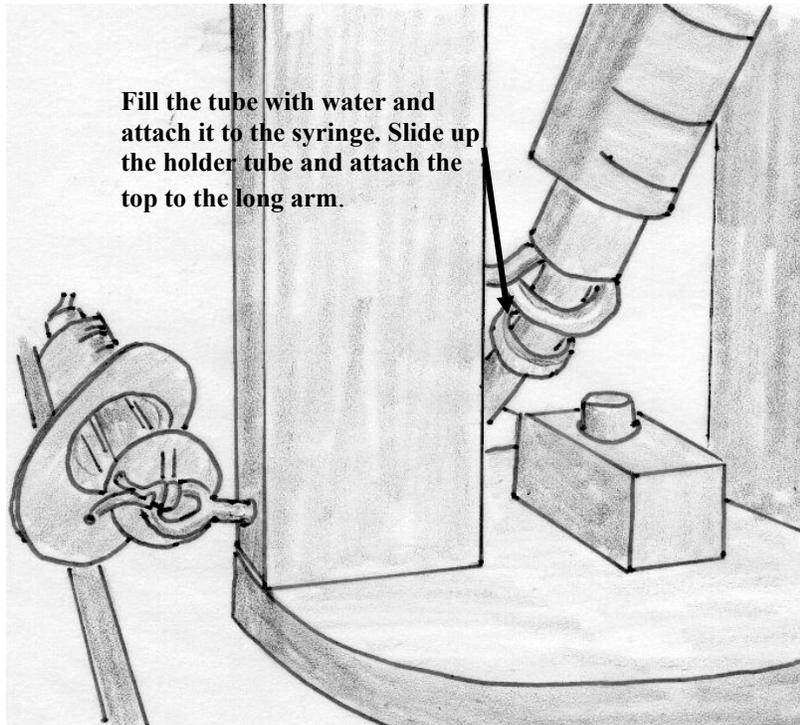
Take one of the syringes (they can also be called **pistons**, since that's what they are called when they are used in hydraulics) and fill it with water. Coloured water (use food colouring) is best since you can easily see which

piston pushes which – you will have three.

Place the .5 cm outer tube over the 20 cm tube and leave it close to the end.

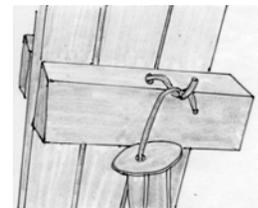
Fill the piston with water; attach the tube (the small outer tube should be on the opposite end). When the piston and the tube are full, (get as many bubbles out as you can), place it through the screw eye and onto the other syringe (which should be empty and pushed all the way in. Then push some water in and attach the flat top to the screw eye on the base with a small piece of wire. There you have it. Push and pull, it should move around! If the holder tube slides along the tubing, you may need to get out the glue gun and glue it so it stays put.

Now for the long arm

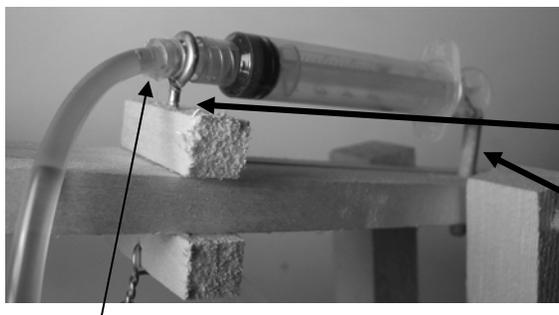


Fill the tube with water and attach it to the syringe. Slide up the holder tube and attach the top to the long arm.

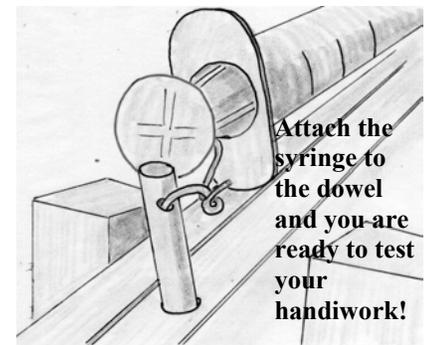
Cut about 25 cm of tubing, place a .5 cm tube over one end and fill the syringe and tube so it is full. Place the tubing through the screw eye in the middle of the support arms and over the other syringe and you have number two almost done. Attach a wire through the top of the syringe, and through the wooden piece (you did put in a hole didn't you?). Twist it so the attachment is snug and check your work. The arm should go up and down! Adjust the small holder tube at the bottom so it is snug.



The Claw mechanism (you can almost taste this it is so close!)



Place a screw eye into the crossbar and a piece of dowel with a small hole in it in the center long arm. Fill the syringe as usual (I hope you are using different colours). Slide up the .5 cm



Attach the syringe to the dowel and you are ready to test your handiwork!

holder tube and then attach the syringe to the dowel with some wire at the other end.

Your model should be done! Test it out and see if you can move things around the desk – I like to grab the salt and pass it to friends at the dinner table, it is both fun (for me) and annoying (for them). Seeing how much weight you can lift, and how far it will turn is also interesting. If you can figure out a way to turn the model so it will pour what it lifts, I'd sure like to know! Have fun and send me a picture of your model! derekwulff@pathfindersdesignandtechnology.com

Congratulations, if you made this you can do anything! - but get a license if it involves driving. Try some of the other models, get a discovery kit and make up your own! E mail me at the above address with comments or ideas, our researchers are standing by!