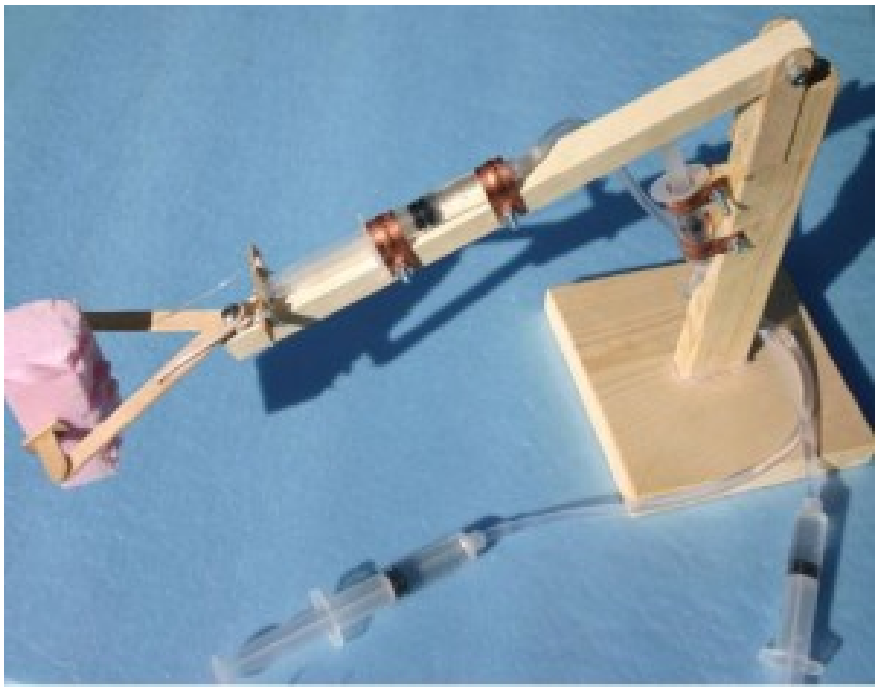
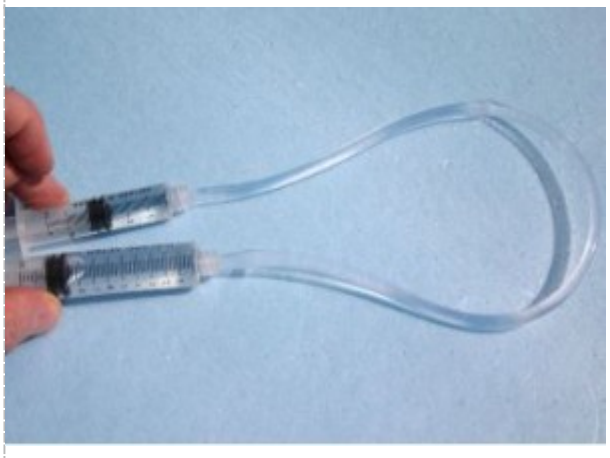


Syringe Hydraulic Arm by Bill Kuhl

Hydraulics is used in many applications we see or use every day. The brakes in an automobile or the lift on the bucket of a tractor are two very common applications. We can experiment with simple hydraulics using plastic syringes for cylinders and small plastic tubing for the hydraulic hose. One definition I read for hydraulics was, “the movement of pressurized liquids through confined spaces”.

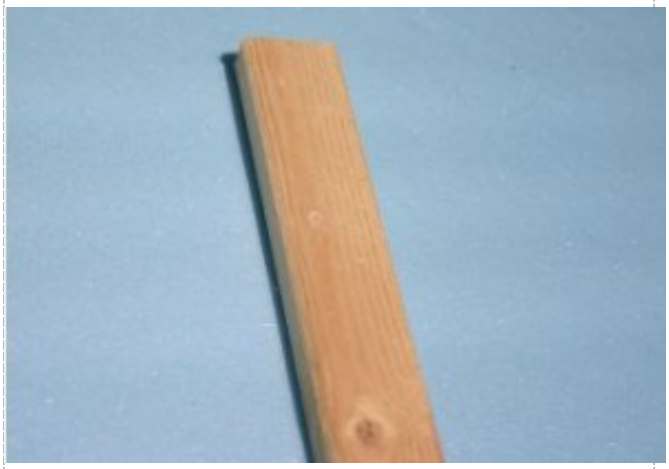
Like working with gears, pulleys, or levers; a mechanical advantage can be realized by using different size cylinders on the end of the hydraulic connections. By trading distance moved with the amount of force the advantage is realized.



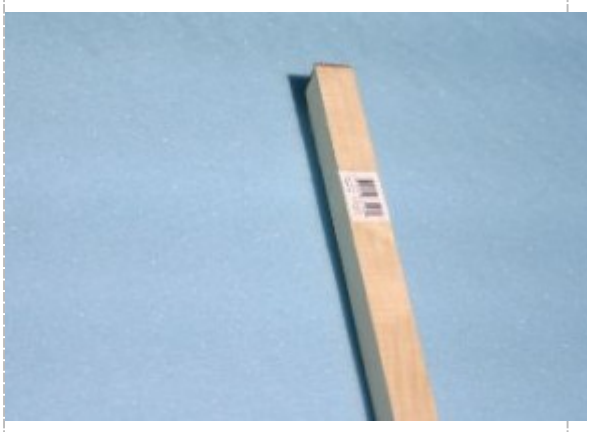
| | |
|---|---|
| Moving the larger cylinder between 1 mark moved the smaller cylinder 2 marks. | Hydraulic cylinders for lifting and tilting bucket are easily seen in this tractor my father constructed. |
|  |  |
| FuelMyBrain kids built a slightly different version of the hydraulic arm. | Large flat container was used to hold water to fill the hydraulic arms. |
|  |  |

| | |
|---|---|
| The tubing I used was the type used for aquarium airlines. Fuel line for model glow engines would work but is more expensive. There could be medical sources also. Then I found 1/8" ID x 3/16" OD tubing at a Fleet Farm store which is a tight fit. | Syringes can be purchased where farm supplies are sold. I used the 12cc size as the pump and the 6cc size as the actuator cylinder. |
|  |  |
| I used one flat washer on the pivot point of the gripper part of the arm, not sure it is needed. | 8/32 Machine screws were used to hold clamps on and for pivot points. |

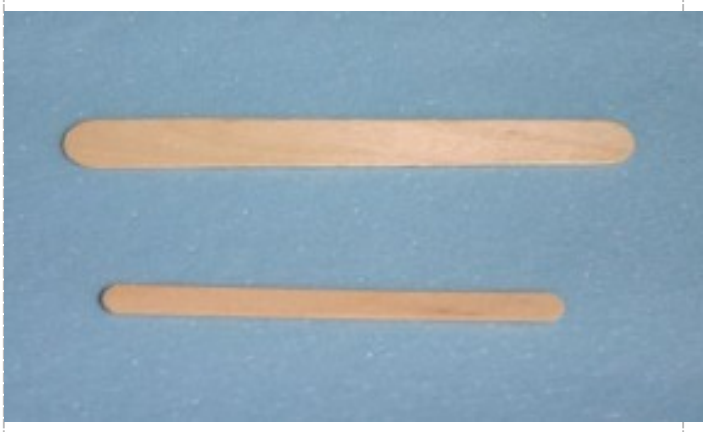

I used these copper plated ½” tube straps to fasten the actuators (syringes) to the wood.



The upright part of the arm is a furring strip. This inexpensive wood is used when installing drywall.



For the horizontal part of the arm, I used 5/8” square stock that comes in 36” lengths. Normally found next to the round dowels.



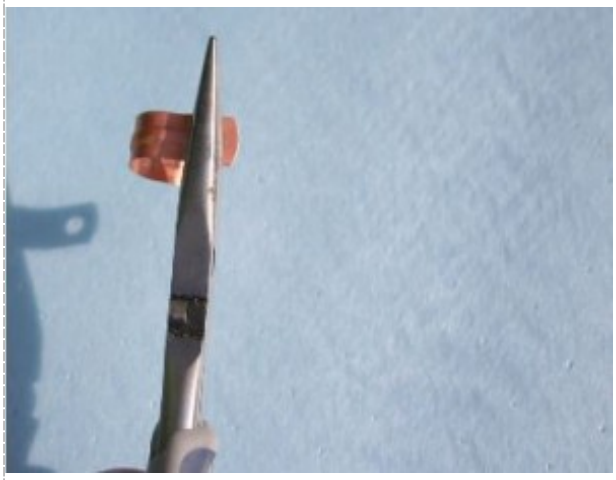
Two sizes of craft sticks are used in this project, one on top is the size of a tongue depressor and the bottom one is the size of a Popsicle stick.

The base can be made from scrap boards also, best to pick out the better boards as some are warped.

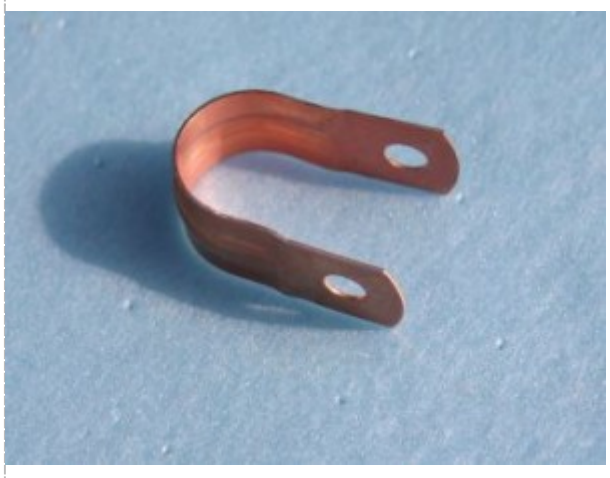
This board was labeled as 1” x 6” but true dimension was smaller.

## Making Up the Parts

Normally I am making up kits for a class, so I will get all the parts fabricated first. That way few tools are needed to complete the project and it is safer for them not having to use saws or drills.

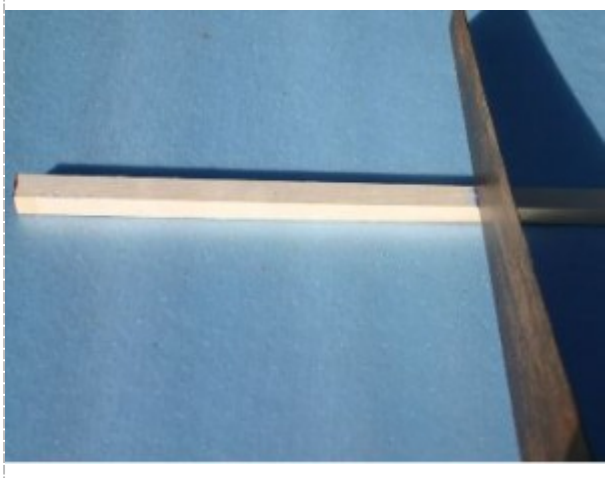


Straighten the bend in the straps with a pliers.

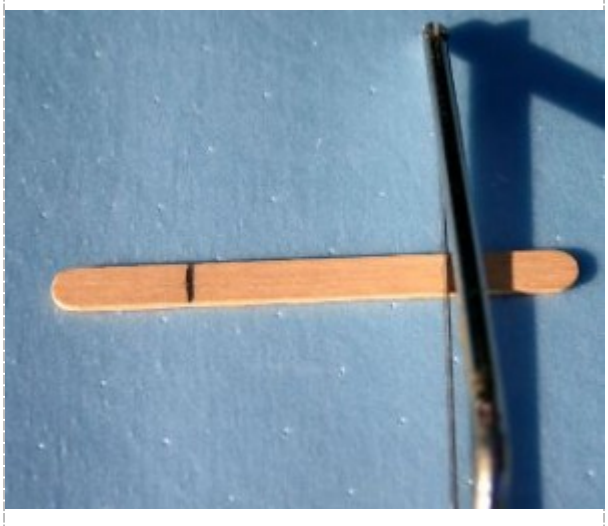


The straps should look like this after 90 degree bends have been removed.

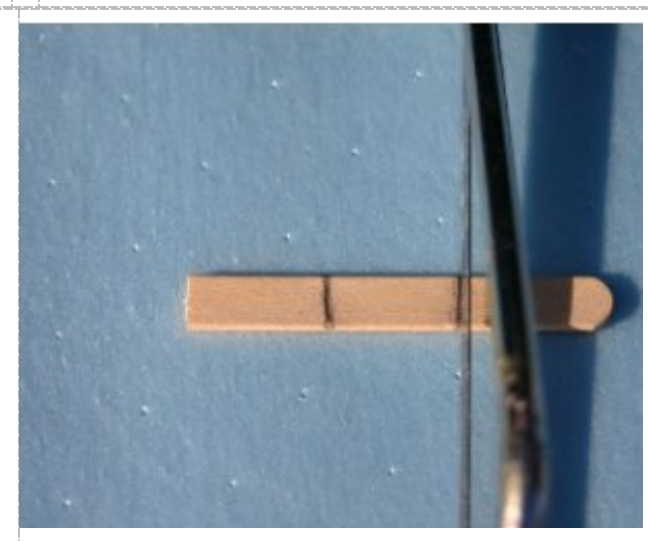
Cut the furring strip to 8 ½” in length.



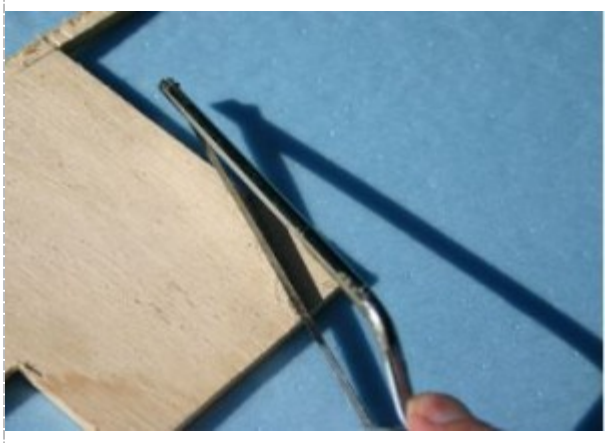
Cut the 5/8” square stock to 11” in length.



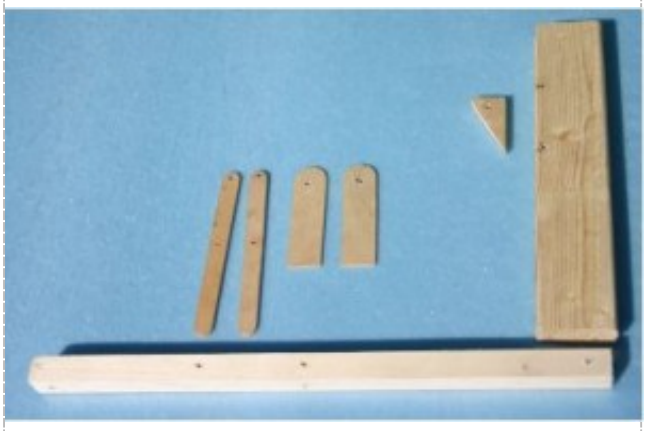
Cut 1” from both ends of craft stick, the ends are used for building gripper parts and the center is used to connect syringe to pushrods.



Gripper pads are ¾” long cut from smaller craft stick material.



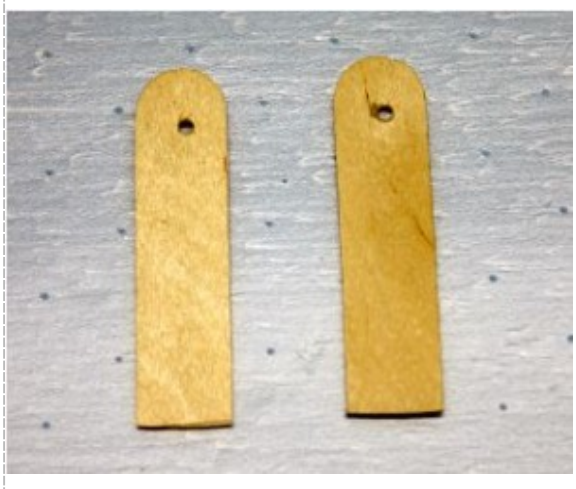
A “right triangle” is cut from scrap wood that is at least ¼” thick. The long side is 1 ½” long and shorter side is ¾” long.



These are the wood parts needed before drilling the holes. The small triangle piece can be made from a scrap piece of ¼” wood.

## Construction

Drill holes for bearing pieces on the boom, I drilled both pieces together.



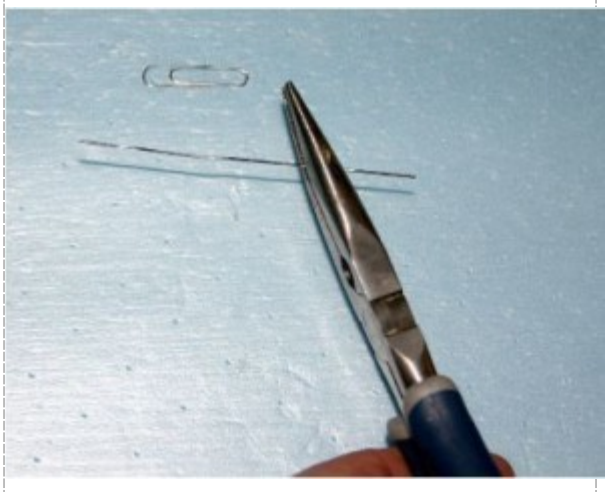
Bearing pieces after drilling the two holes at once.

Drilling the two holes on boom to mount the actuator (syringe). There is also a hole at the far right that is
the pivot for this portion of the arm.

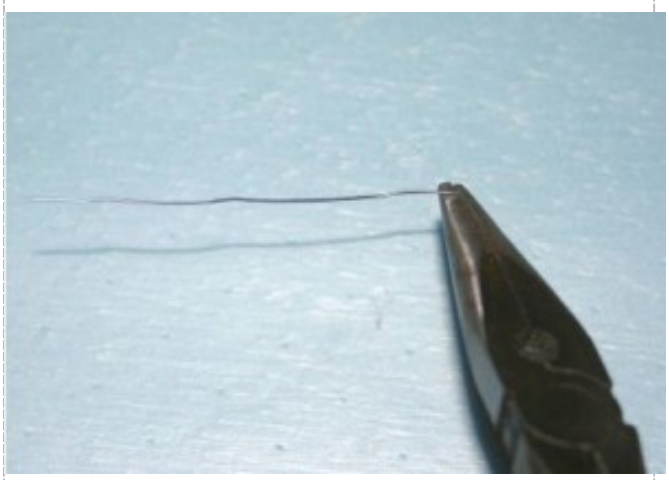
Drilling hole at end for gripper assembly, this is drilled 90 degrees from the other holes.

Hole for strap on the main support is close to the edge so be especially careful when drilling.

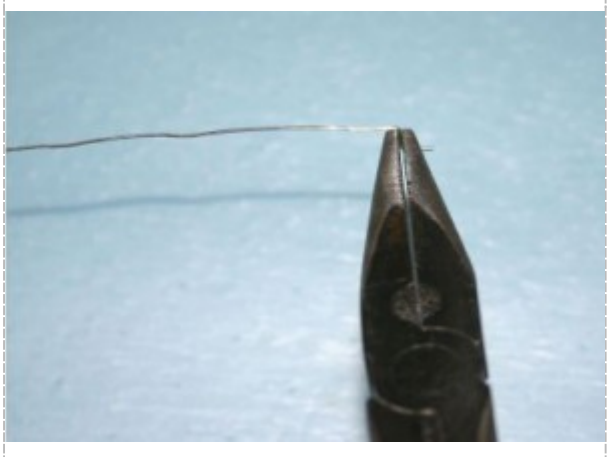
Larger holes on the ends are pivot point and smaller holes in the middle is where pushrod attaches.



The pushrods for the gripper section can be made from paper clips that are straightened. Bend the curves out with your fingers and further straighten with a pliers.



One end of the pushrods will attach to the wood by making two 90 degree bends in the wire. Pictures shows the first bend, for this bending a needle nose pliers is needed.



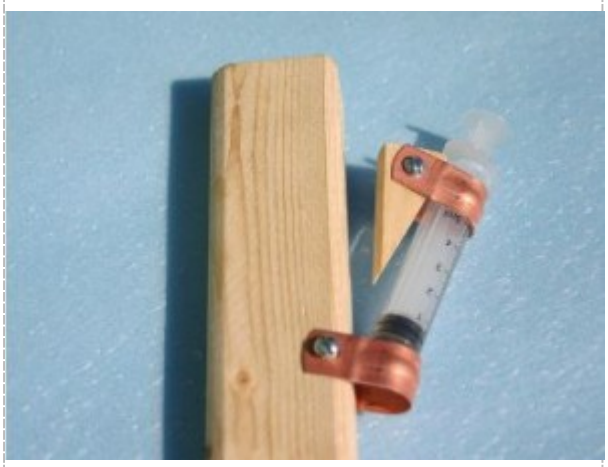
Make another bend a short distance from the previous bend in the opposite direction.

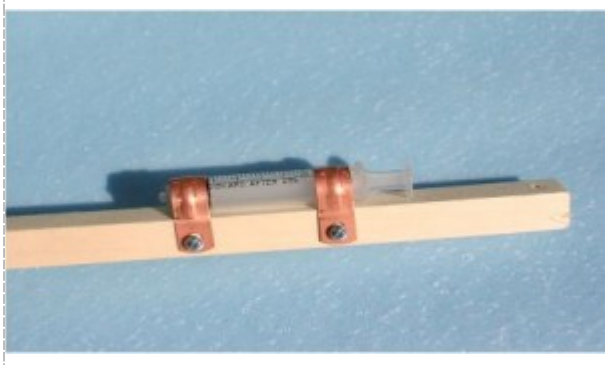
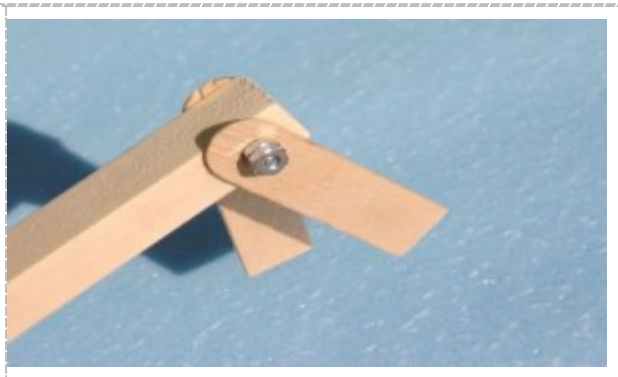
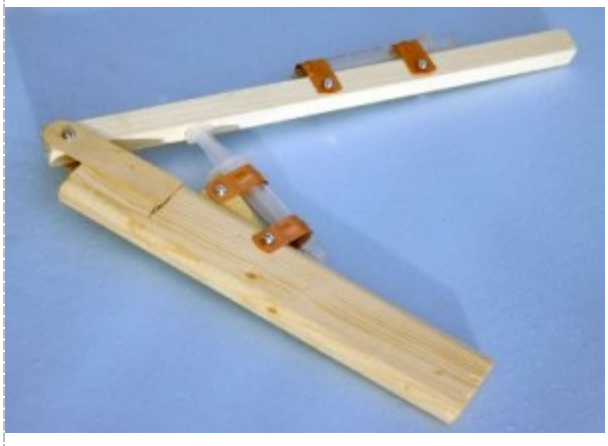
This is what the pushrod should look like, two will be needed. I was going to use music wire which is stiffer but it is also harder to bend.

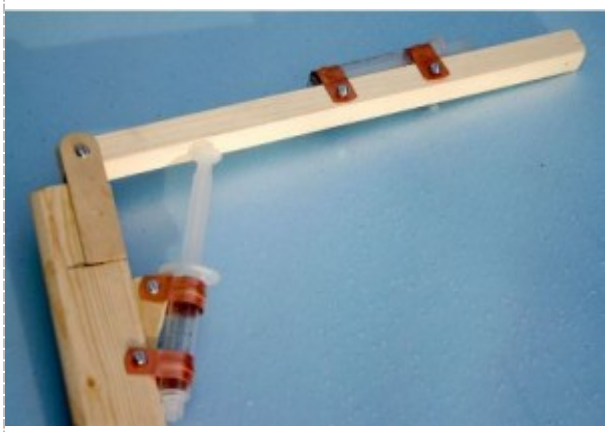
Plastic tubing to be used at a bearing for the wire pushrod can be cut from the tubing in a pen.

**Putting it Together**

It is at this point that the students would start assembling the parts that had been fabricated.

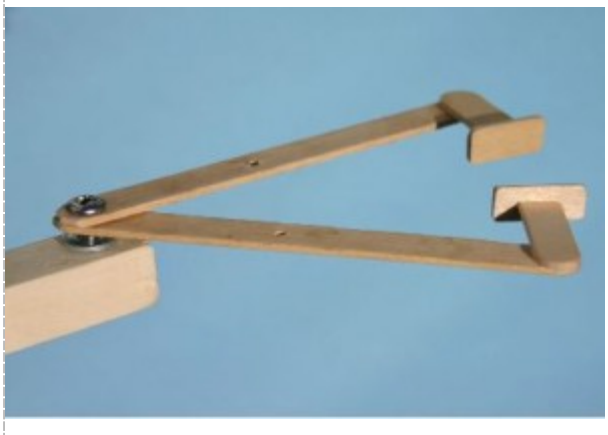


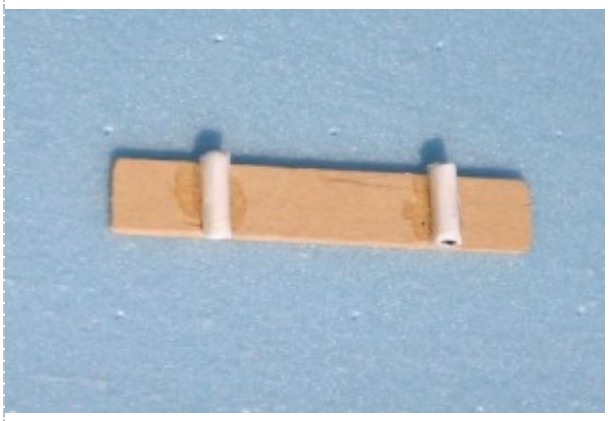
| | |
|---|---|
| Mounting the actuator to lift the arm. I find it easier to test the fit of all pieces before gluing the wood wedge. | Actuator to lift the boom is securely strapped at the correct angle. I should have mounted this slightly higher. |
|  |  |
| The straps need to be pulled over the syringe very tight so that it does not shift when pressure is applied. | Using two nuts tightened against each other should allow the nut to<br>the inside to have a small gap from<br>the wood and not come off.<br>The two thin pieces of wood need to turn freely on the bolt. |
|  |  |

| | |
|---|---|
| To position the two craft sticks that will be part of arm bearing make sure that the arm will come down to where the actuator is almost pushed in. | Also make sure the arm can swing upwards without the binding at the hinge location. |
|  |  |
| There needs to be enough room inside the joint so the arm can move up and down. | Syringe actuator in extended position should lift arm above horizontal position. |
|  |  |
| I built the two halves of the gripper using Duco cement so I used clothespin to hold parts together | The pads are added next, no real way to clamp it but the Duco is sticky at the start and tends to hold pieces |

while glue dries when possible.

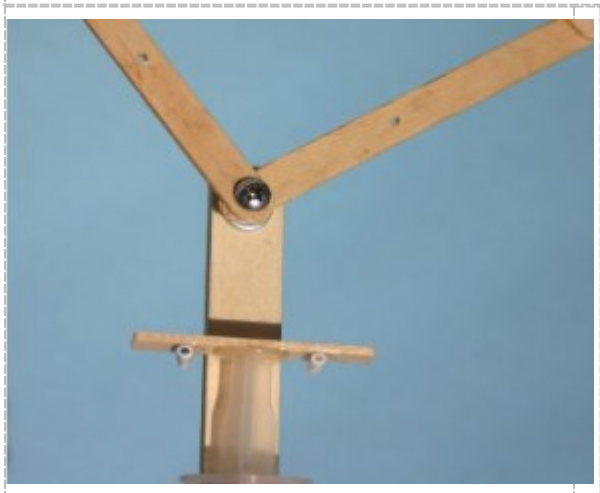
together.

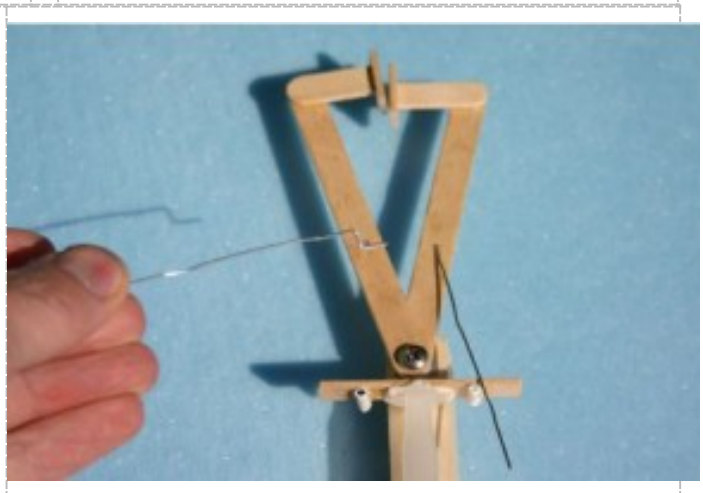




Note washer on the bolt at the pivot point should help the wood parts move easier. Do not tighten the head of the bolt down too tight, the parts must be free to move easily.

Plastic tubes attach one end of the pushrods to the syringe actuator.



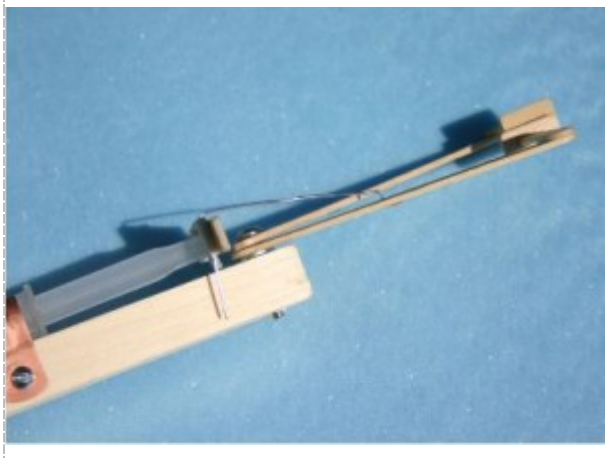


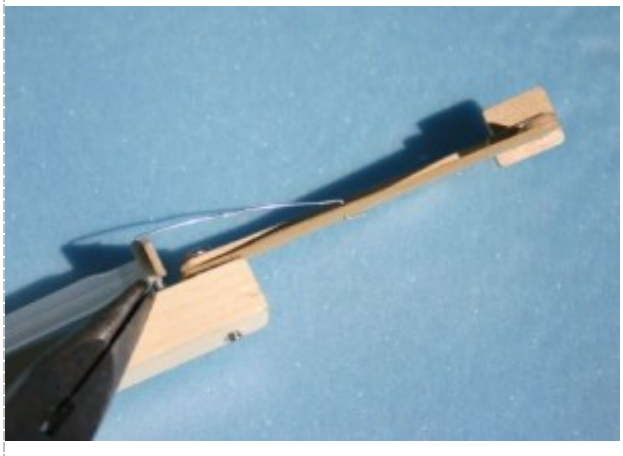
The wood piece with plastic tubes is glued to the end of the syringe actuator. Hot glue holds fairly well or you can use small wood screws to

Bring the gripper plates together, pull the actuator out to almost full extension, and insert the pushrod ends with the

attach the wood to the end of the syringe.

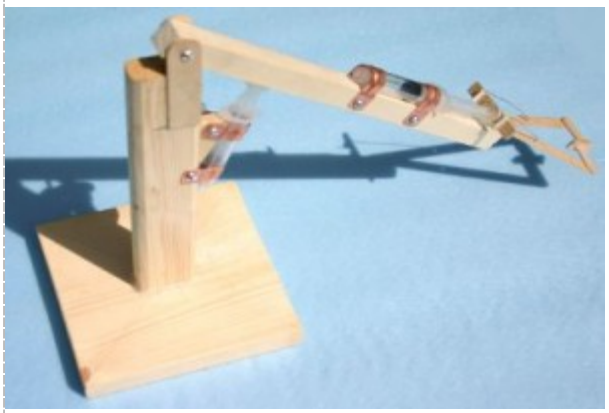
90 degree bends into the small holes.

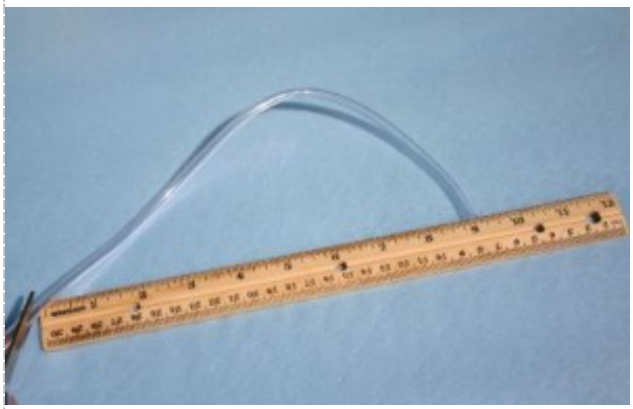




Bend the wire 90 degrees downward into the plastic tubes.

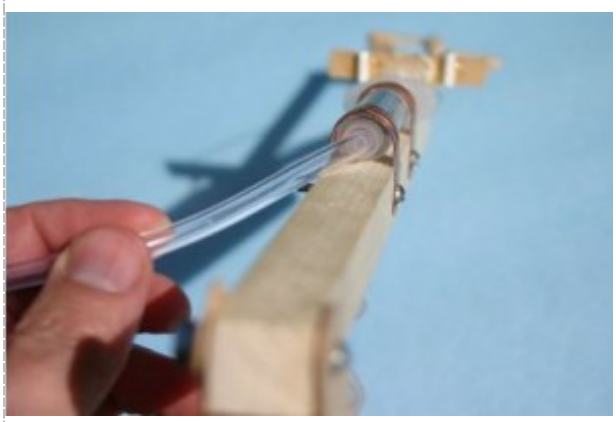
Carefully bend the wire back so the pushrods do not fall out. I was going to use music wire which would have been stiffer but the paper clip material is much easier to bend.



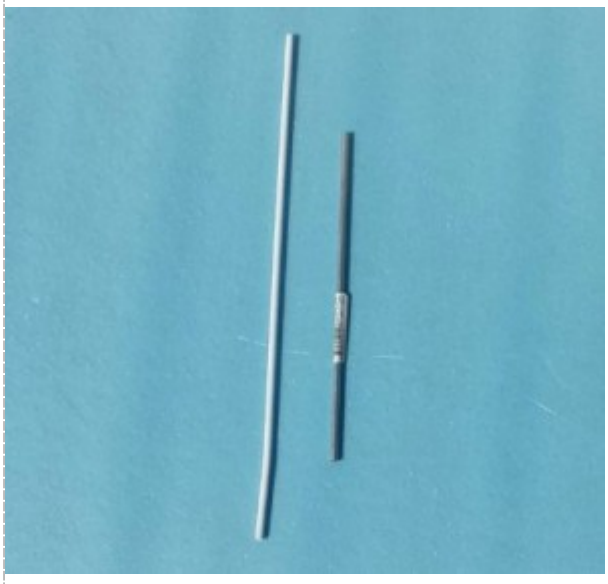


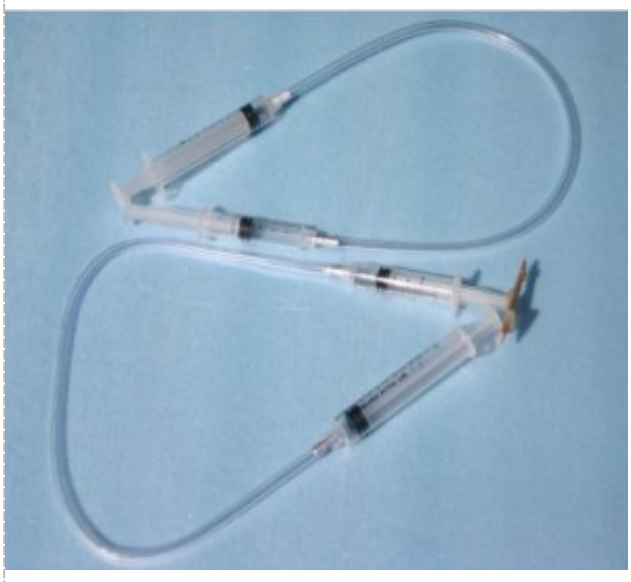
Mark the center of the base and glue the upright portion of the arm to the base. I used hot glue for this and held it for a

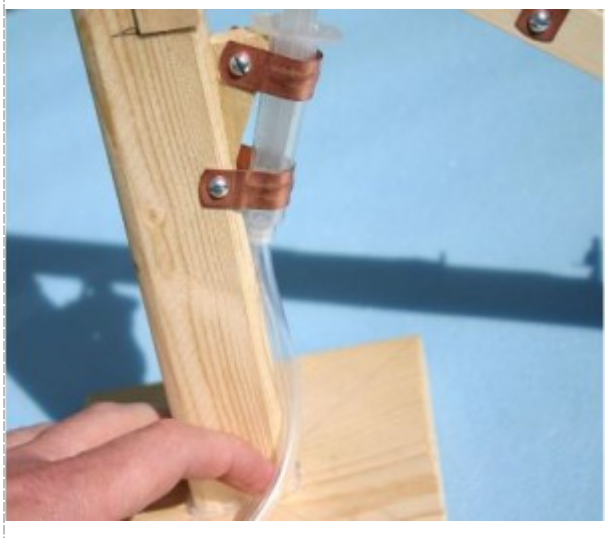
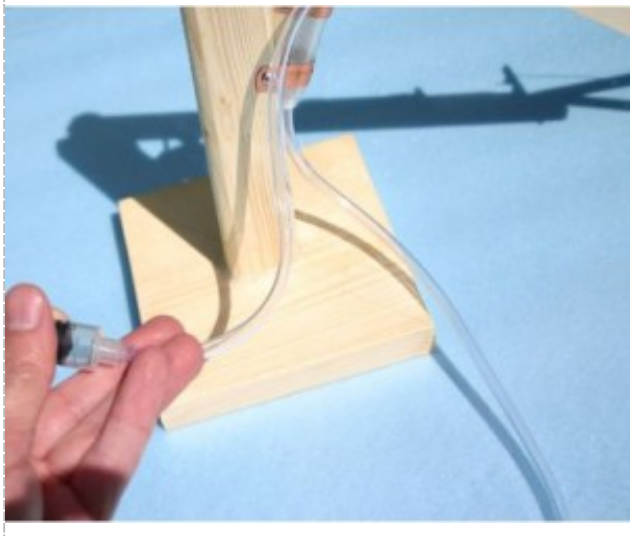
Cut off two lengths of the plastic tubing at least 12 inches long for each.

| | | | |
|---|---|---|---|
| couple of minutes to make sure it was<br>hard. | | | |
|  | |  | |
| Push the tubing on the syringe where the<br>needle would normally attach. If the fit of the tubing<br>is too loose, stretch the<br>ends of the tubing while heating it<br>will shrink the tubing at the ends.<br>Too much heat is not good, just<br>enough to shrink the tube slightly for<br>a tighter fit on the syringe. | | Actuator for gripper attached to boom. It must be<br>placed at the correct spot so amount of travel is<br>correct for the gripper. | |


*1/8" ID x 3/16" OD Tubing Fits the Syringe Tight*





| | |
|---|---|
| Either 3/16" OD plastic or aluminum tubes can fit over the end of syringe to make a tight connection with clear tubing if using 3/16" ID tubing. | With the tubes on the end of the syringes the clear tubing fits tight. |
|  |  |
| Attach one end of the other piece of tubing to the lower syringe. | Attach the larger 12 cc syringes to the opposite ends of the plastic tubing. |

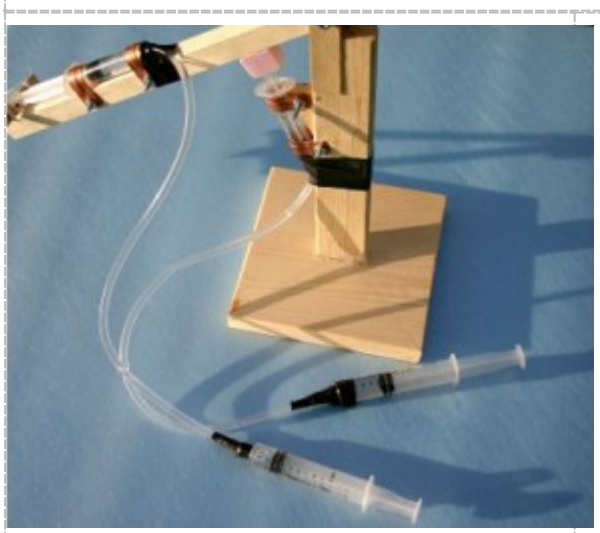
## Filling the Cylinders

Part of the key to success with this project is getting as many of the air bubbles out of the lines as possible. In automobile brake lines this is known as “bleeding the brakes”. I am not sure I have the best procedure for this
but I will give some suggestions.

Bring the actuator cylinder plunger down, pull the line off and pull in some water into the line with the larger cylinder. Put the line back on the small cylinder and push water into it. When it is full, turn the actuator cylinder upside down so the water does not drain out.

The next steps are to pull water into the large syringe and line, repeating this until the air bubbles are gone. No doubt it will take several strokes of pulling water through and pushing some of it out until the bubbles are gone.

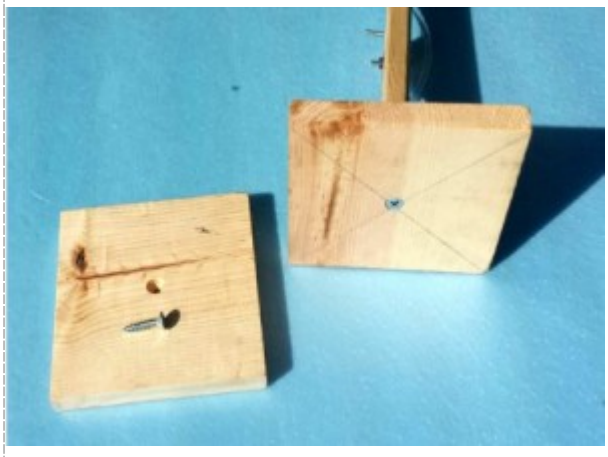
Small actuator cylinder with water to top of syringe end when positioned upside down.



I found that even after shrinking the ends of the tubing, some people were pulling the syringes off so I am taping the connections

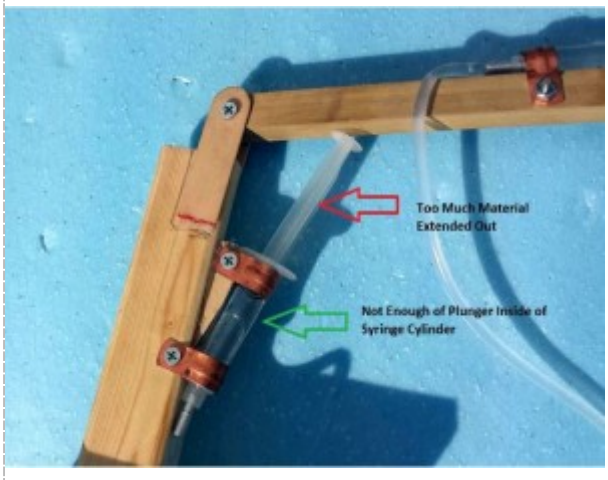
If glue is not holding the small piece of wood to the end the syringe, two small wood screws into the plastic should hold.

after the line is full of water.



Now using large wood screw countersunk to hold arm to base.

College for Kids class built 12 of this project.





One addition that could be added is a way to limit the upward travel as there is not enough support for the plunger when it pushes out to the extreme causing arm to bind .

Syringe Hydraulic Arm was a Big Hit at my Booth for STEM Day at MN State Fair