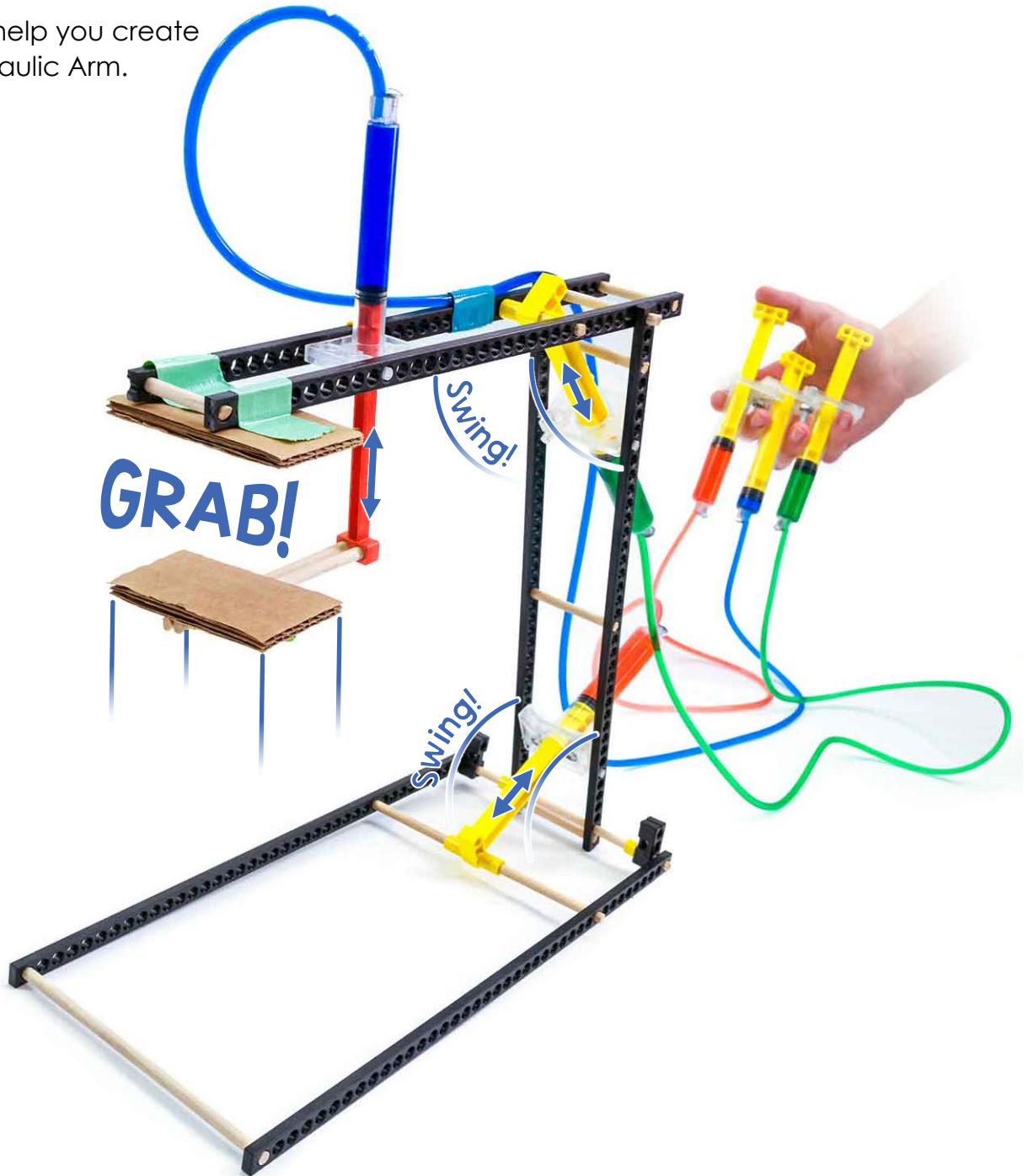


# Hydraulic Arm Build



Hydraulics are *AMAZING!*  
Use the power of water to control a machine.

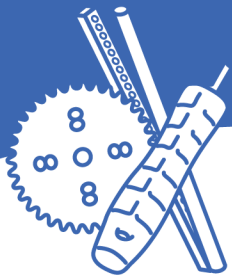
This guide will help you create  
your own Hydraulic Arm.



**THINKING AHEAD**  
What kinds of objects can  
you move with different  
gripper designs?



Download Documents  
at [teachergeek.com](http://teachergeek.com)

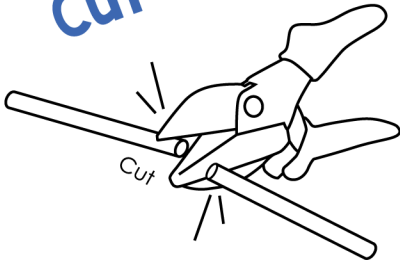


# TeacherGeek Build Guide

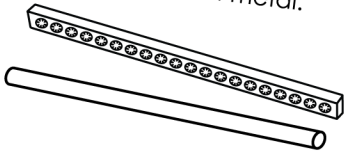


What do you need to know to make something out of TeacherGeek?

## Cut

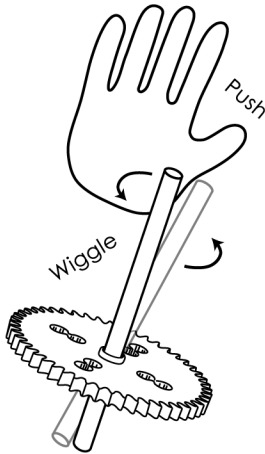


**Multi-Cutters** cut wood & plastic (like **dowels** and **connector strips**). They do not cut metal.

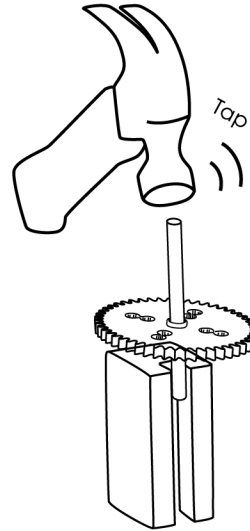


## Push, Wiggle,

Push, wiggle or tap **dowels** into holes.



## Tap



Use a **hammer** and **slider block** to tap **dowels** farther thru holes.

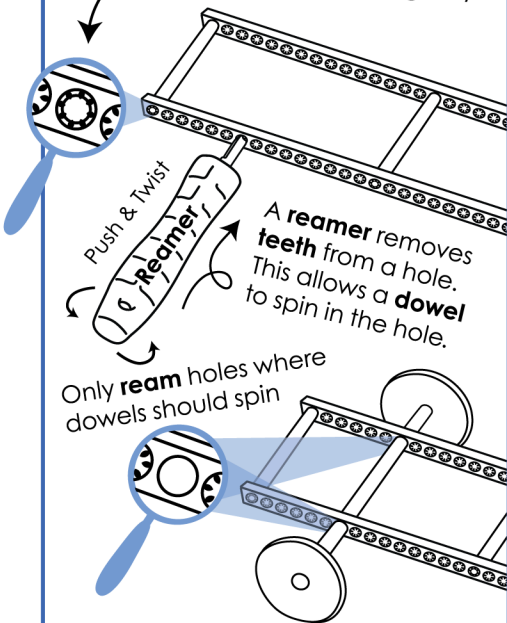
## Quick Tip!



Use a **crayon**, or **soap** on the end of a **dowel** to make building easier.

## Ream

Most parts have holes with **teeth**. The **teeth** hold **dowels** (keep dowels from falling out).



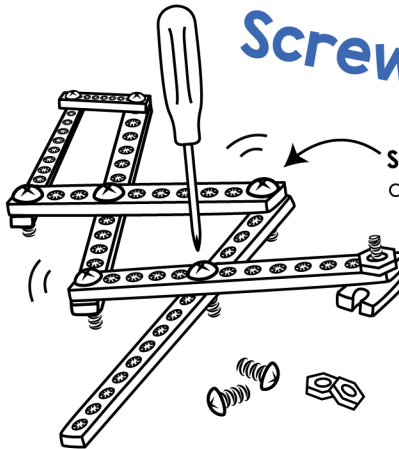
A **reamer** removes **teeth** from a hole. This allows a **dowel** to spin in the hole.

Only **ream** holes where dowels should spin

Never **ream** pulleys, gears, wheels, or any hole a **dowel** stays stuck into.

## Screws & Nuts

Do not **ream** holes you will put **screws** into.



**Screws (without nuts)** can connect parts, and allow them to rotate.

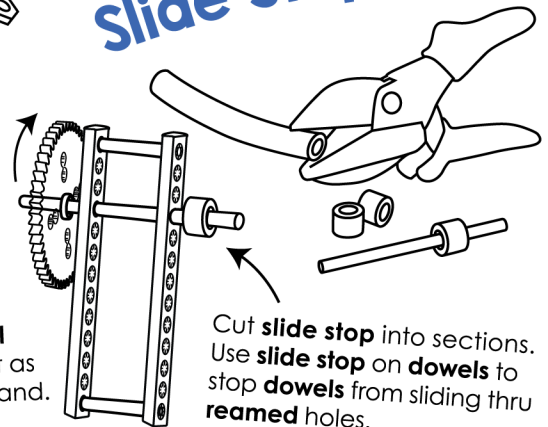
**Screws (with a nut)** can connect parts, and keep them from rotating.

## Stop Clip



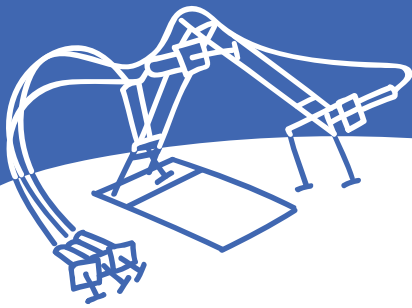
Press a **stop clip** onto a **dowel** to keep it from sliding or use it as a hook for a string / rubber band. It takes little force to get it on.

## Slide Stop



Cut **slide stop** into sections. Use **slide stop** on **dowels** to stop **dowels** from sliding thru **reamed** holes.

More resources available at [teachergeek.com](http://teachergeek.com).  
Adult supervision required for children 12 and under.



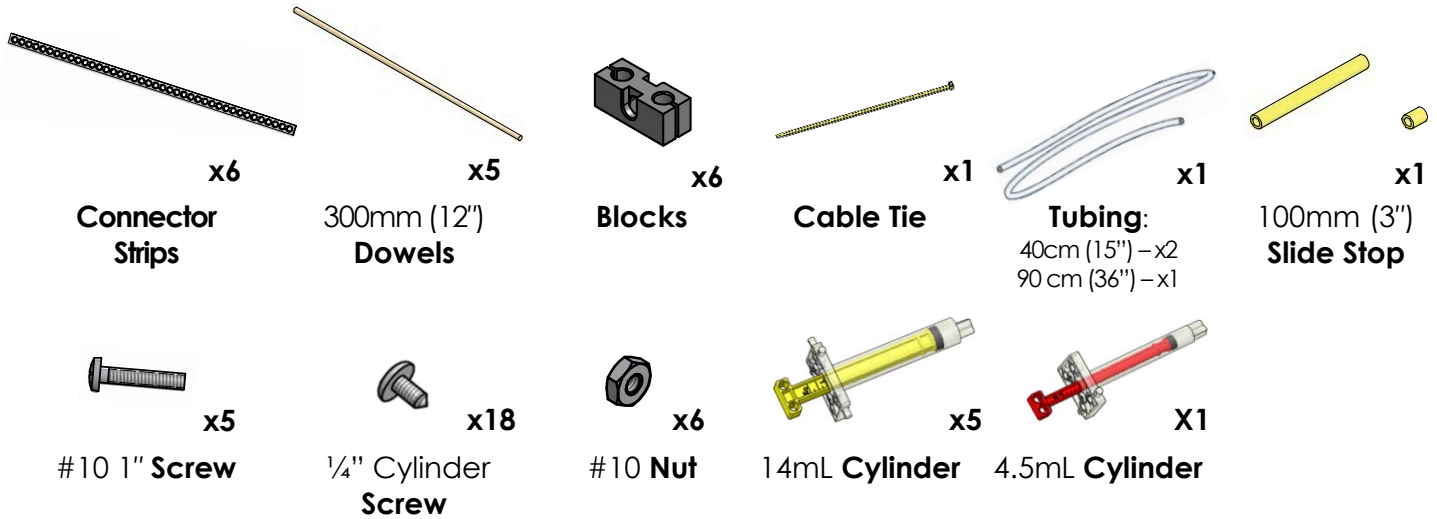
# Hydraulic Arm Build



## TeacherGeek Components

For One Hydraulic Arm

Below is the list of "ingredients" you'll need for each Hydraulic Arm Build. Available as a 10 pack, which includes extra parts for your own innovative creations!



## TeacherGeek Tools You'll Need

Easy to Share in Groups

Perfect for sharing in groups of 3 and 4!

Time to break out those tools and start building! Remember to be kind and share with others.



**Multi-Cutter**



**Reamer**



**Screwdriver**



**Pliers**

## Materials You Supply

Go on your own scavenger hunt to find these items. Try building with all kinds of materials!



**Safety Goggles**



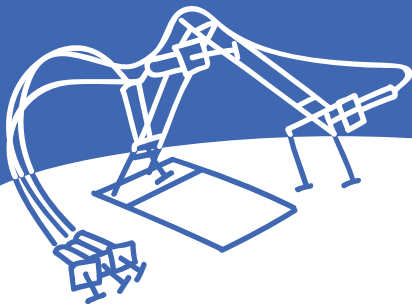
**Tape**



**Crayon** (rub on dowels to make sliding them easier into holes of components)



**Recycling Materials**  
What else could you use for a gripper?



# Hydraulic Arm Build



## Let's Get Started

**Hydraulic Systems** are the foundation of how this build design functions. Follow the steps below to **connect** and **fill** cylinders to create your own hydraulic system.



Please note: in order to work properly, there can be no air bubbles in the cylinders or tubes.

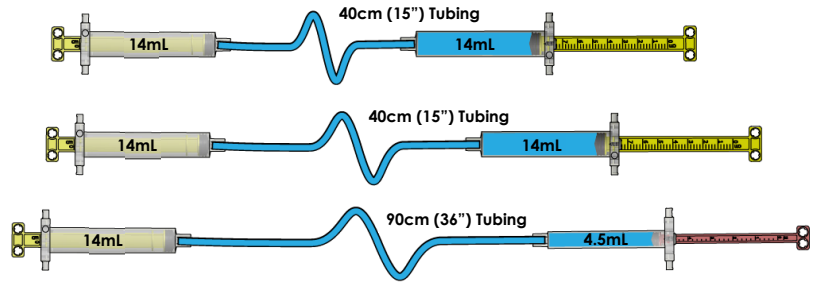
### 1 Cut tubing into the following lengths:

Two 40cm (15")



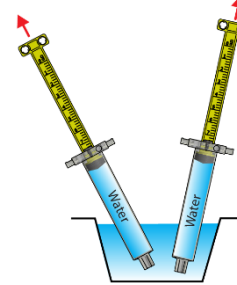
If you're using an **activity pack**, the tubing has been **cut for you**.

One 90cm (36")



### 2 Fill the five 14mL cylinders and one 4.5mL cylinder with water by pushing the piston all the way in and submerging the tip under water; pull back to fill completely with water.

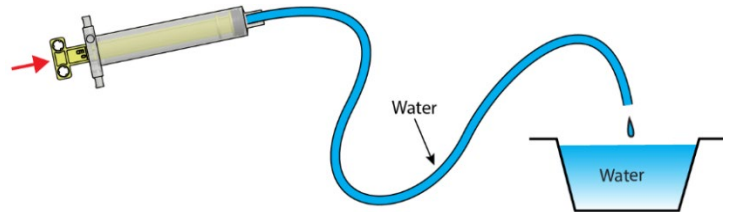
**Remember:** no air bubbles



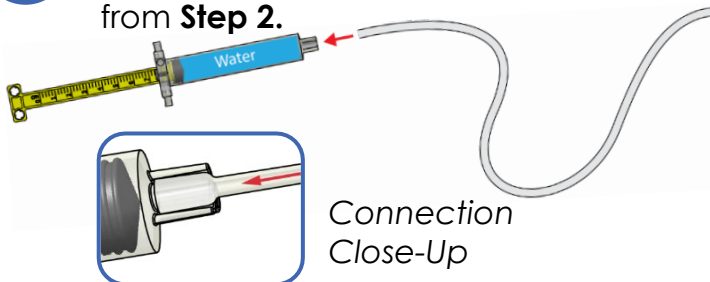
#### Quick Tip

Use food coloring to make seeing the water easier.

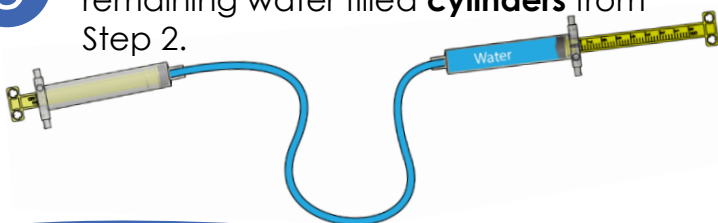
### 4 Over a cup, push the cylinder piston to completely fill the tubing with water. Remember: no air bubbles



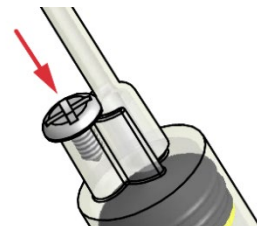
### 3 Attach the cut tubing pieces from Step 1 to four of the filled cylinders from Step 2.

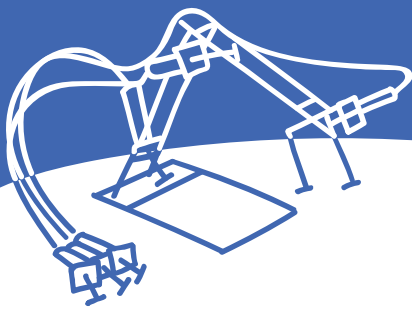


### 5 Attach the water filled tubing to the remaining water filled cylinders from Step 2.



### 6 Insert a 1/4" cylinder screw into the hole next to the cylinder's tip to prevent the tubing from disconnecting.



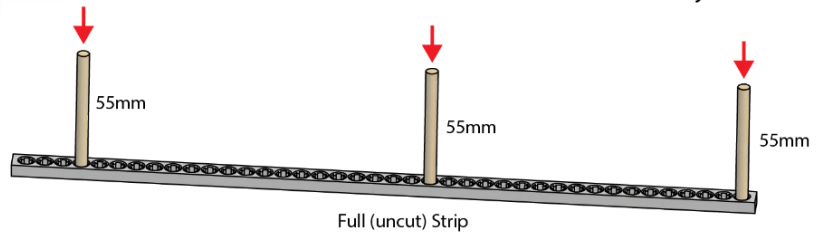
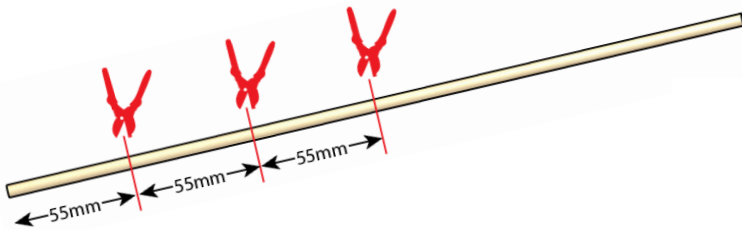


# Hydraulic Arm Build



**7** From the end of a **dowel**, **measure** and **cut** three 55mm (2 1/8") sections - *save the extra, you will use this later.*

**8** Push, wiggle or tap the 55mm (2 1/8") **dowels** into the **holes** of a **connector strip** as shown below.



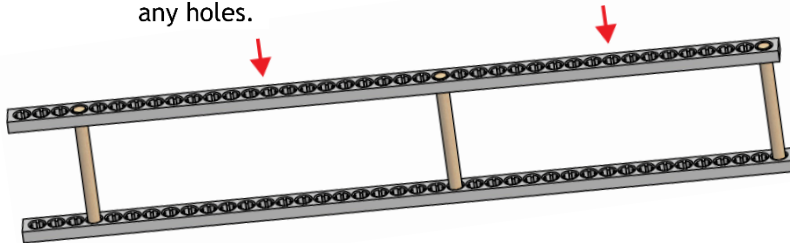
Do not ream any holes.

**9** Push, wiggle or tap a second **connector strip** onto the 55mm (2 1/8") **dowels**.

**10** **Ream** the two **holes** marked with a .

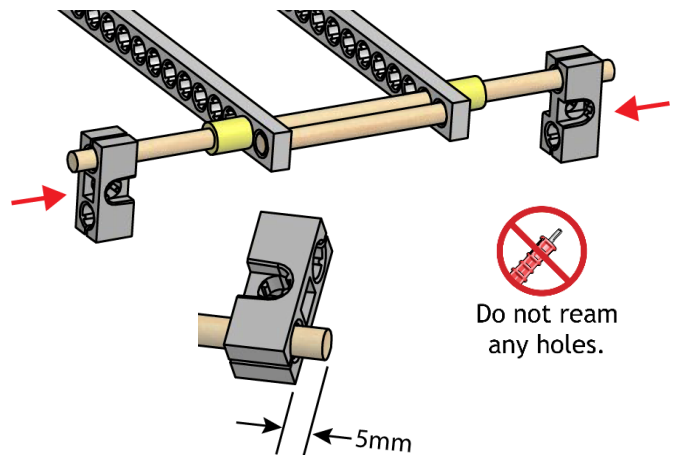
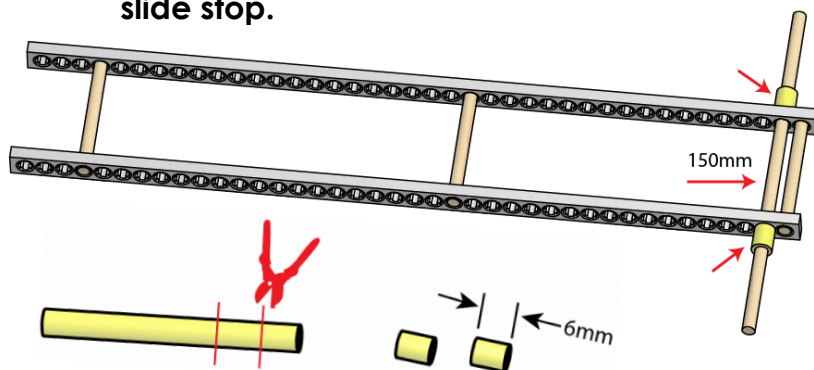


Do not ream any holes.

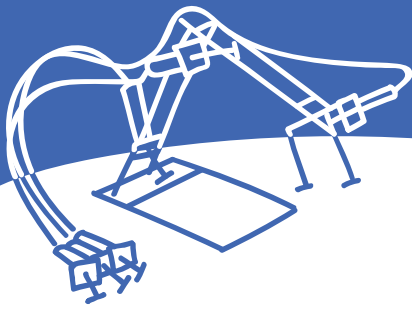


**11** **Cut** a new **dowel** to get two **150mm (6") dowels** and **slide one** through the **reamed holes** from **Step 10**. Hold in place with two **cut 6mm (1/4") sections of slide stop**.

**12** Push, wiggle or tap two **blocks** onto each **end** of the 150mm (6") **dowel** and leaving 5mm (1/4") of space on the ends.



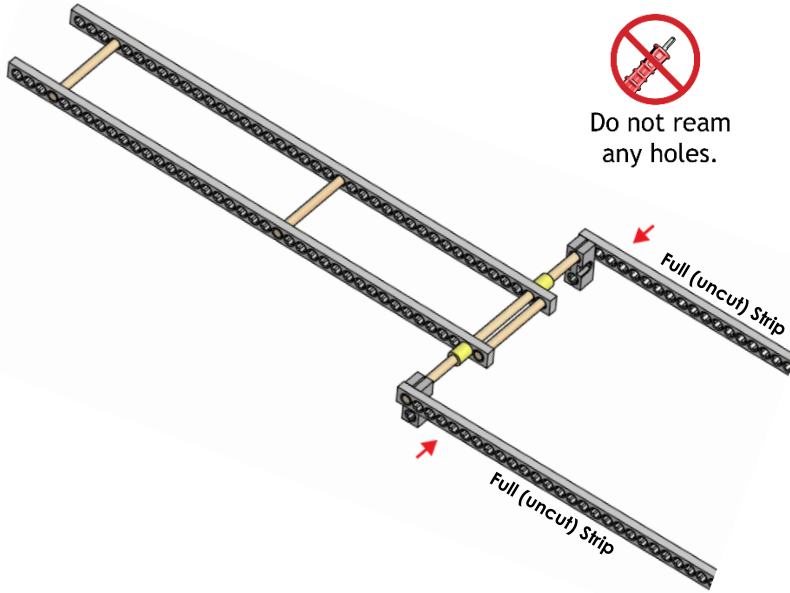
Do not ream any holes.



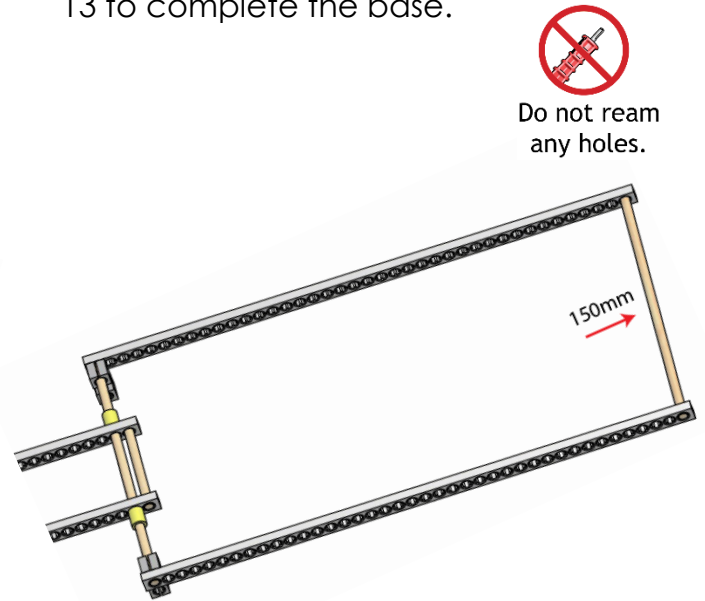
# Hydraulic Arm Build



- 13** With the **blocks** pointing down, **attach** the **ends** of two **connector strips** to each side of the 150mm (6") **dowel**.

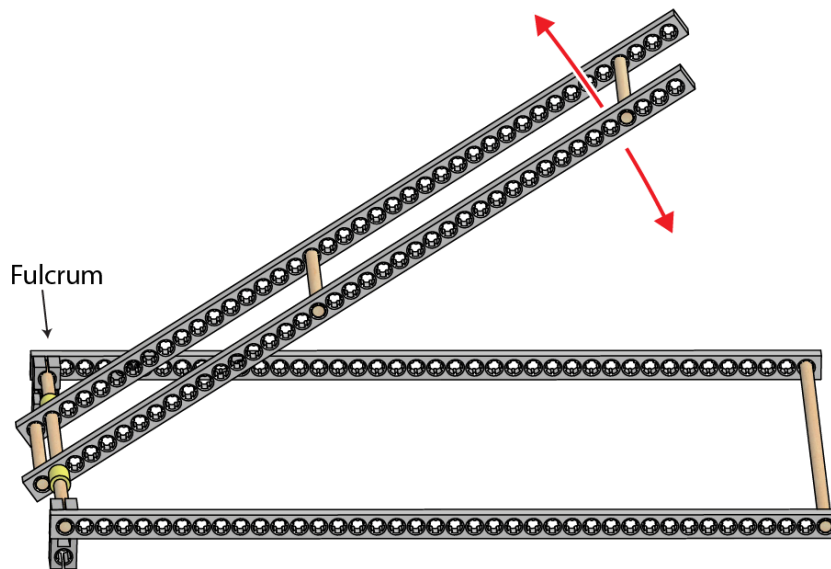


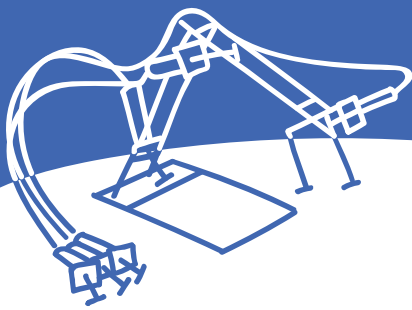
- 14** Push, wiggle or tap the leftover 150mm (6") **dowel** from Step 11 in between the ends of the **connector strips** from Step 13 to complete the base.



## Good job!


You just completed the **base** and first **boom** of your hydraulic arm. You should be able to pivot the boom at the fulcrum.

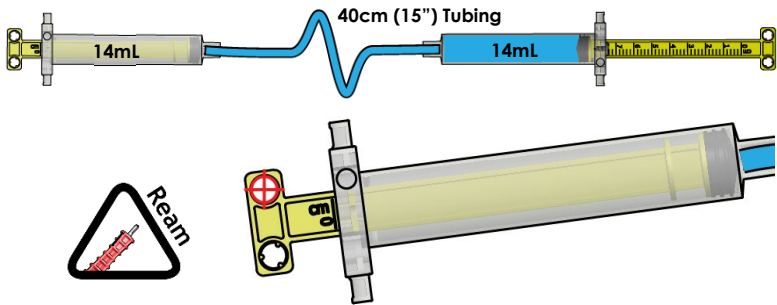




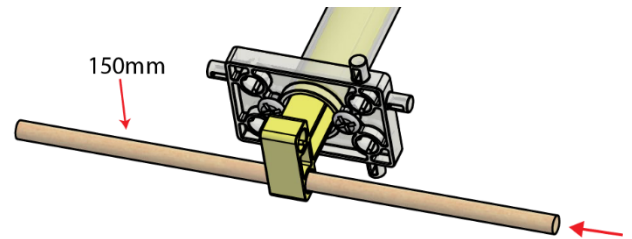
# Hydraulic Arm Build



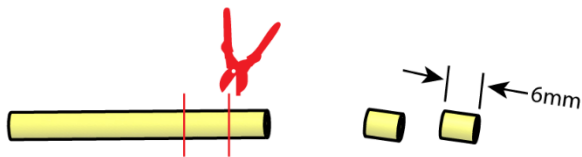
**15** With the **40cm (15") hydraulic systems** from **Steps 1-6**, ream the hole marked with a  on one of the **cylinder's pistons**.



**16** Cut a **150mm (6") dowel** and insert through the **reamed hole** from **Step 15**.

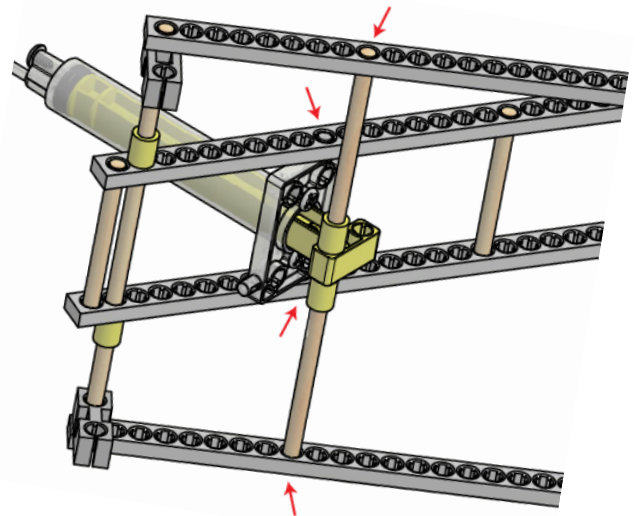
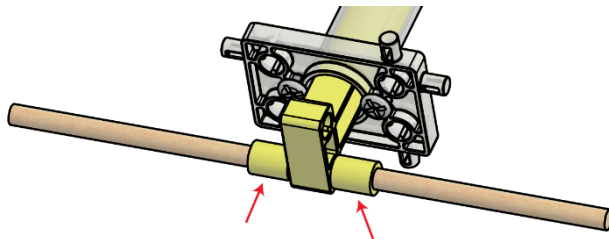


**17** Cut two **6mm (1/4") sections of slide stop**



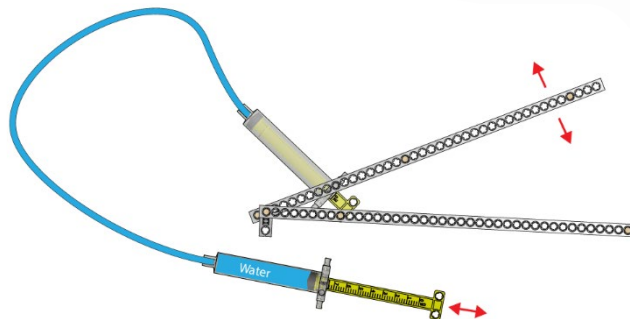
**18** Insert the **150mm (6") dowel** in between the base **connector strips** and **insert the pegs of the cylinder** in between the boom **connector strips**. (You can change this position later).

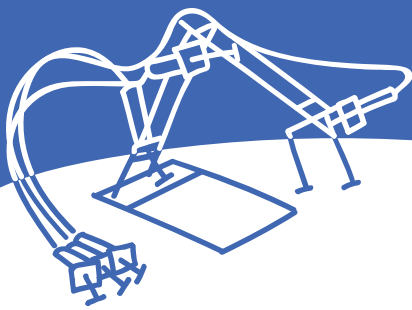
Slide onto both **ends** of the **150mm (6") dowel** all the way to the **center**, touching the **piston's handle**.



## Quick Experiment!

Does changing the placement of the piston move the lever with the same distance or force?

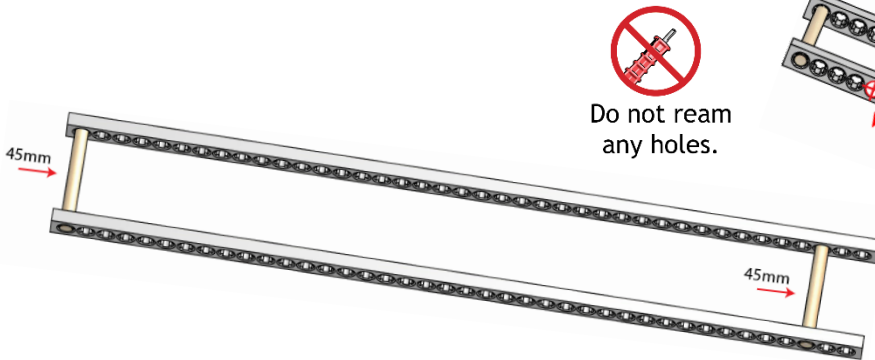





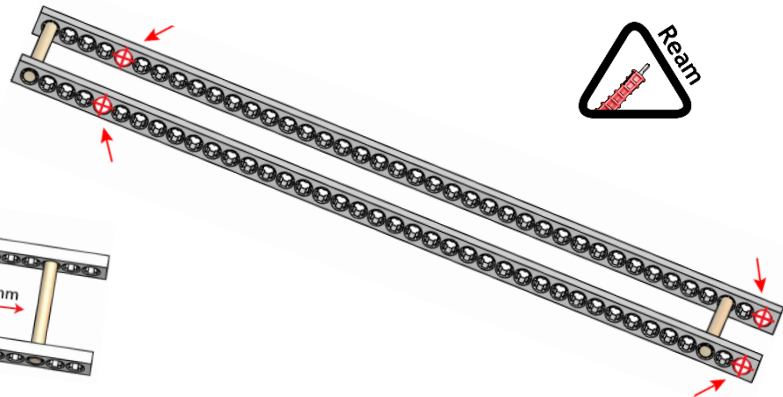
# Hydraulic Arm Build



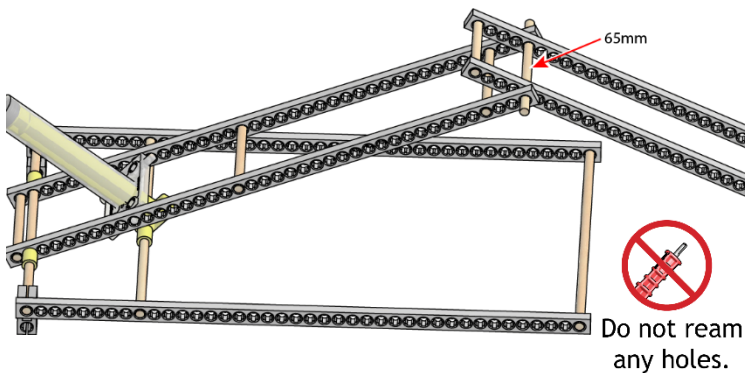
**19** Create a **second boom** by cutting two 45mm (1¾") **dowels** and inserting them between two **connector strips**.




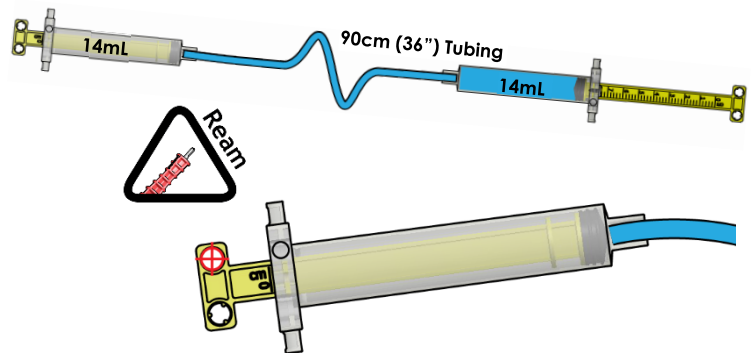
**20** **Ream** the four **holes** marked with a .



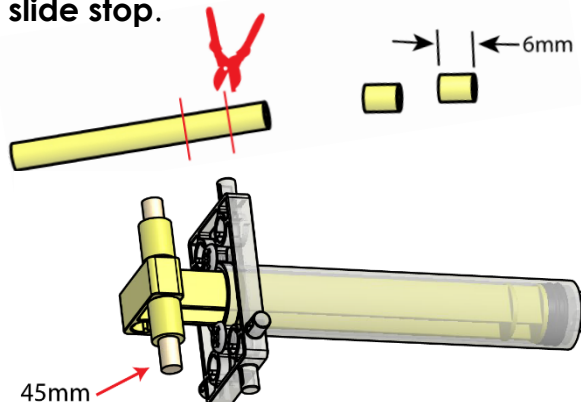
**21** **Cut** a 65mm (2½") **dowel** and **slide** through the **reamed holes** to **connect** the **first** and **second boom**.



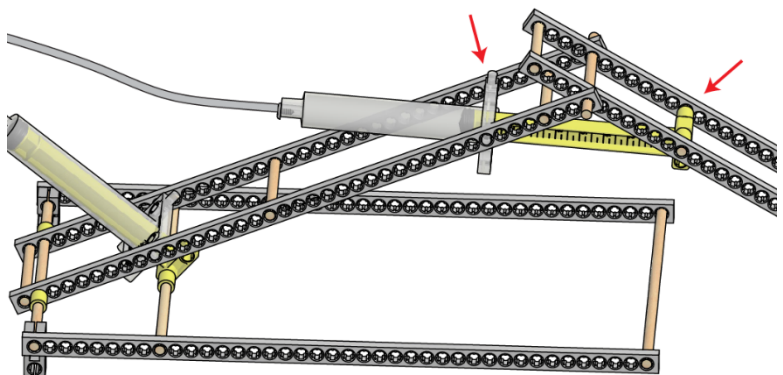
**22** With the **90cm (36") hydraulic systems** from Steps 1-6, **ream** the **hole** marked with a  on one of the **cylinder's piston**.



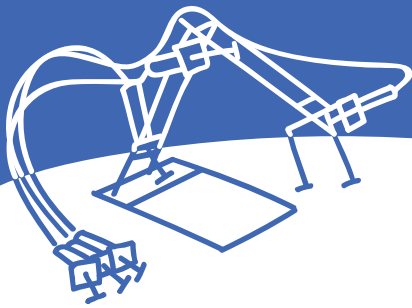
**23** **Cut** a 45mm (1¾") **dowel** and **insert** into the **reamed hole** from Step 22. Hold in place with two **cut 6mm (¼") sections of slide stop**.



**24** Place the **cylinder assembly** from Step 23 in between the first and second boom **connector strips** (you can change this position later).





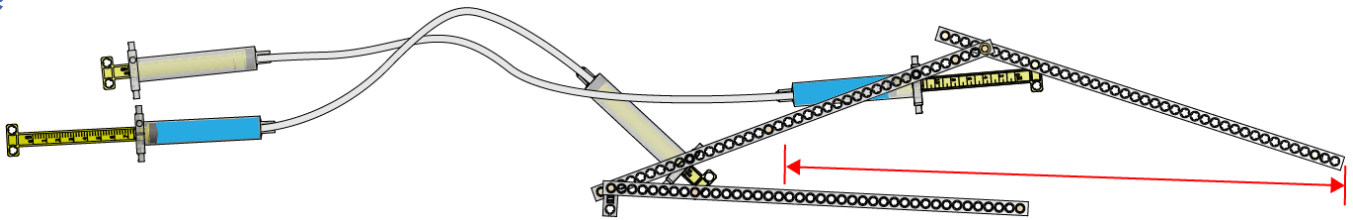


# Hydraulic Arm Build

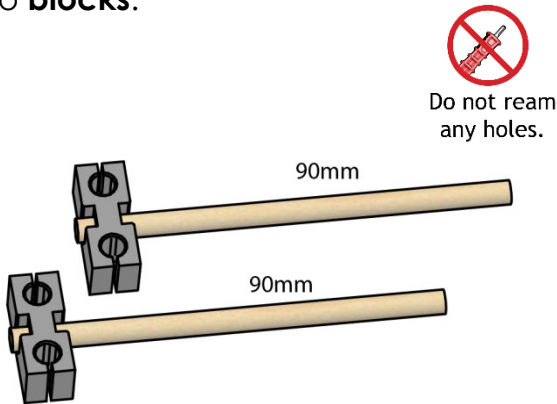


## Quick Experiment!

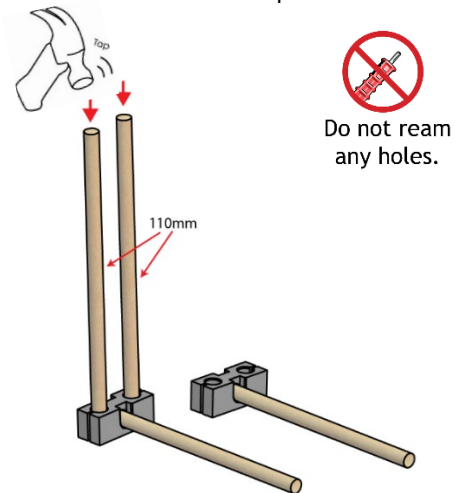
Change where the cylinders **attach** to your arm to allow it to move as **far in** and **out** as possible.




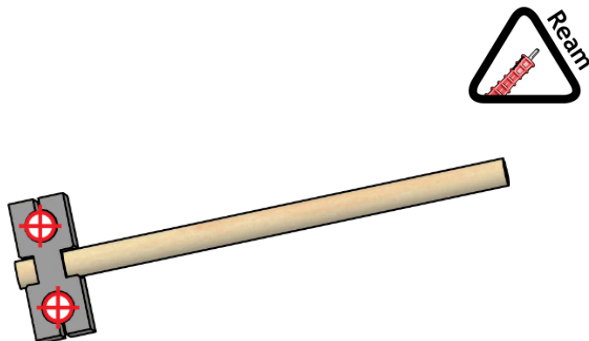
**25** Start to create the **gripper** by **cutting** two 90mm (3½") **dowels** and push, wiggle, or tap into the **center holes** of two **blocks**.



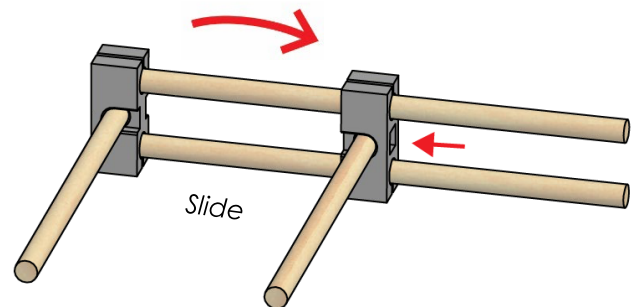
**26** **Cut** two 110mm (4¾") **dowels** and push, wiggle, or tap into the **outside holes** of one of the **blocks** from Step 25.

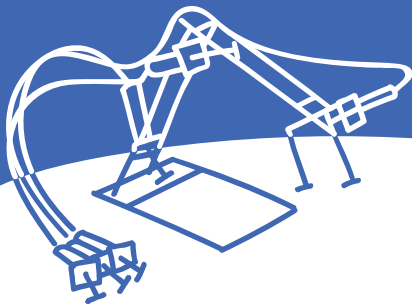


**27** **Ream** the **holes** marked with the  on the leftover **block/dowel** from Step 25.



**28** **Slide** the **reamed block** from Step 27 onto the 110mm (4¾") **dowels** from Step 26.

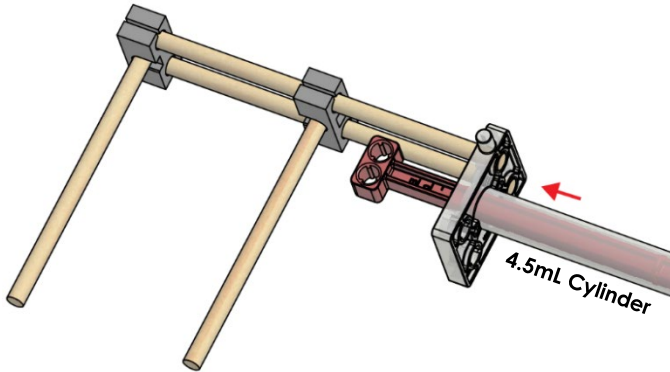




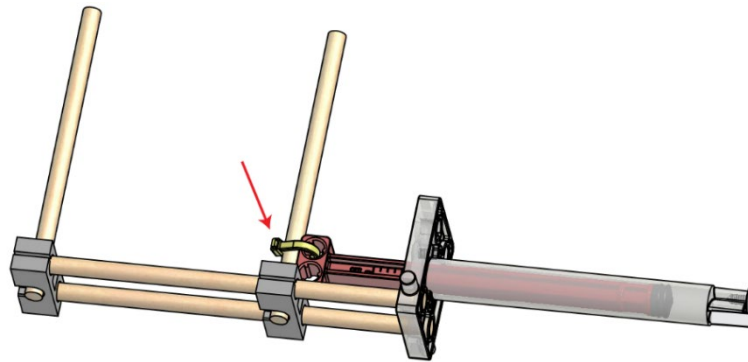
# Hydraulic Arm Build



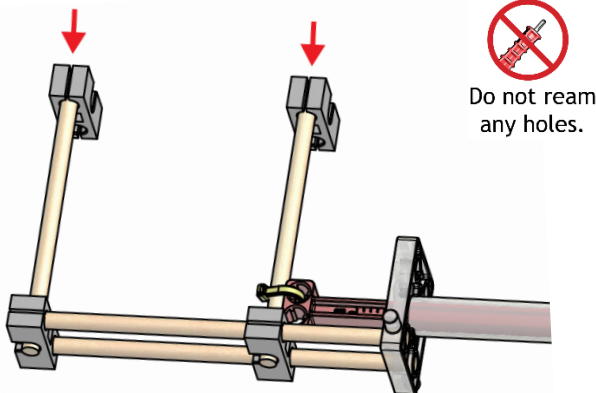
- 29** Use the remaining **hydraulic system** from Steps 1-6 (the 13mL **cylinder** connected to the 4.5mL **cylinder**) and **insert** the two **dowels** into the holes of the **4.5mL cylinder**.



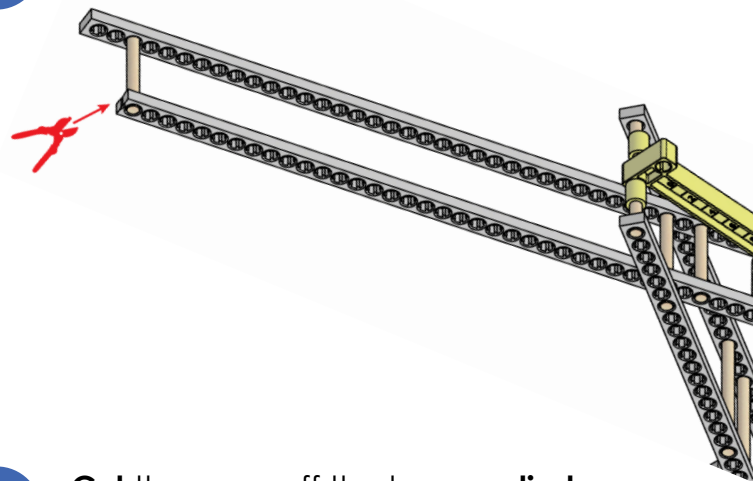
- 30** Use a **cable tie** to attach the **cylinder's piston** to the **dowel** with the **sliding block**.



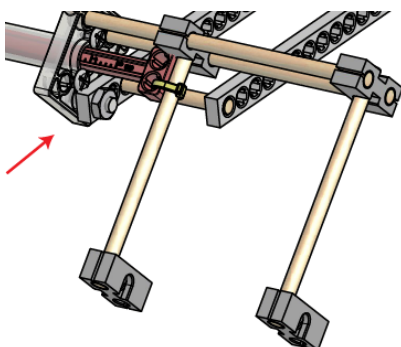
- 31** Place two **blocks** on the ends of the 60mm (2 3/8") **dowels** to complete the **gripper**.



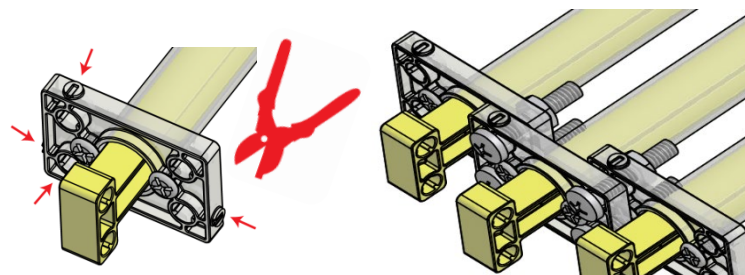
- 32** Cut the **last two holes** off one of the **connector strips** of the **second boom**.

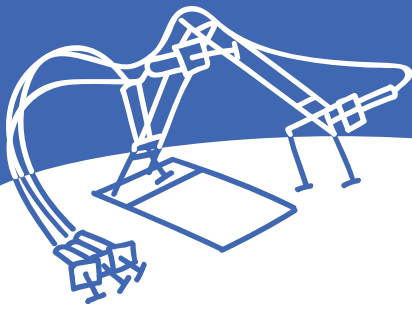


- 33** Use a **screw** and **nut** to attach the gripper to the **second boom**.



- 34** Cut the **pegs** off the loose **cylinders** and use #10 1" **screws** and #10 **nuts** to **attach** the **cylinders** together to form a control panel.



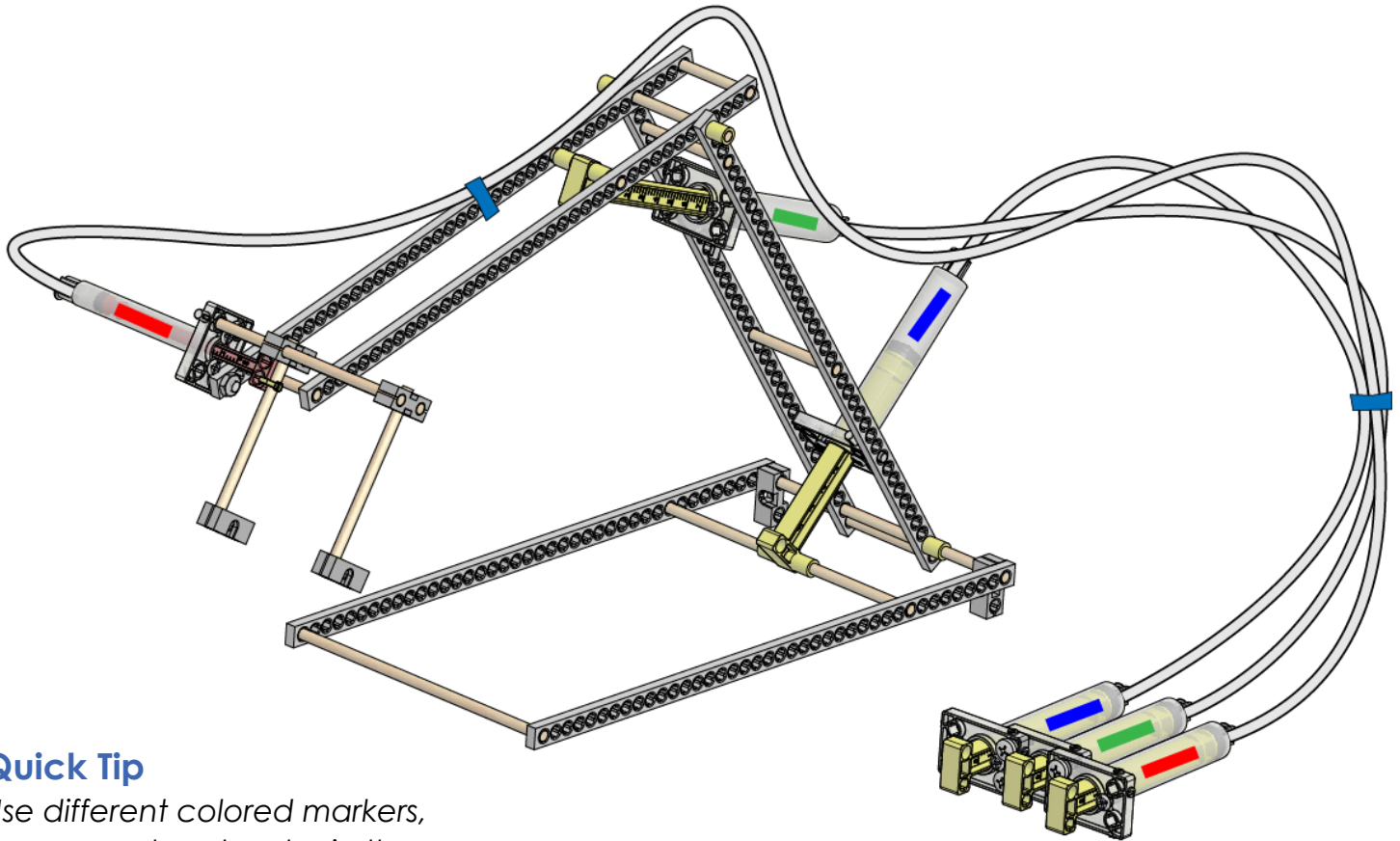


# Hydraulic Arm Build



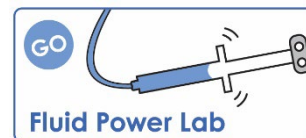
35

**Tape** the **tubing** to the **arm**, but be careful not to crimp or smash the **tubing**.



## Quick Tip

Use different colored markers, tape, or colored water in the cylinder tubing to identify which control panel cylinders connect to which arm parts.



If you are going to do the optional *Fluid Power Lab*, now's the time!

Documents at [teachergeek.com/learn](http://teachergeek.com/learn)