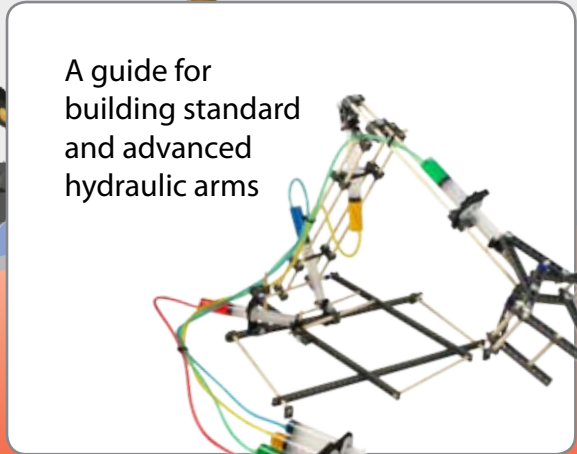
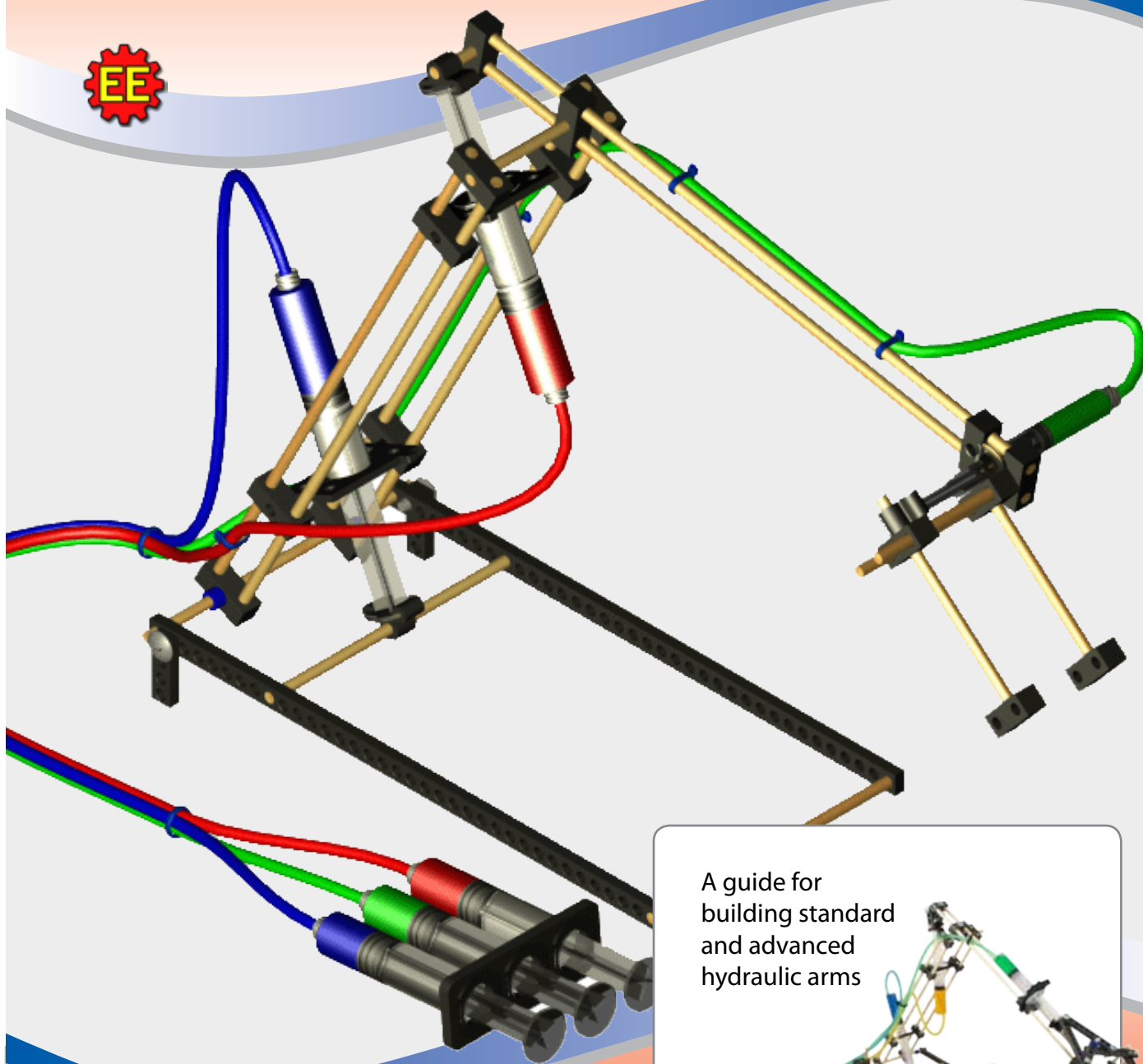


HYDRAULIC ARM BUILD GUIDE





"KIT" CAN BE A BAD WORD:

Don't think of this as a kit. Think of it as a bag full of endless solutions. Although the end of this guide contains step-by-step instructions for creating a hydraulic arm, we encourage you to try and develop new and different designs.

Because, in design and engineering, there is never one right answer...

TeacherGeek Easy Engineering Series products allow for great innovation and alternative designs.

Because, your first idea is rarely your best...

TeacherGeek Easy Engineering Series products are designed to be redesigned; they allow you to quickly change and evolve your designs.

Because, possibilities are endless...

TeacherGeek Easy Engineering Components can be easily combined with other materials and products (Recycling, wood, metal, broken toys, etc.)

HYDRAULIC ARM COMPETITION IDEAS:

Design an arm that will:

- reach the greatest distance to deliver a given object
- pick up the heaviest possible object
- deliver the most objects in a given amount of time
- function in an assembly line
- have a system to weigh the object it picks up
- battle against another arm for an object
- rotate as well as reach and grab
- dig and recover objects



Dowels vary in diameter because they are made of wood. We have provided you with extra dowels to make up for dowels which may be too large or too small to use. *When constructing your arm, only use dowels which fit properly. Odd sized dowels can be recycled and used on other projects.

OTHER DOCUMENTS THAT COULD HELP YOU WITH THIS ACTIVITY:

Download ▼

Document:	Path:	Access Code:
Easy Engineering Guide	teachergeek.org/easy_engineering_guide.pdf	No Code Required
Easy Engineering Ruler	teachergeek.org/ruler.pdf	No Code Required
Fluid Power Lab	teachergeek.org/fluid_power.pdf	No Code Required



DOWELS AND HOLES

Easy Engineering™ Components come with holes made for a press fit.



Press fits are good for structural connections.

A press fit is one where the dowel is fixed and not able to rotate or slide once it's in the component hole. A press fit is good for creating rigid structures.



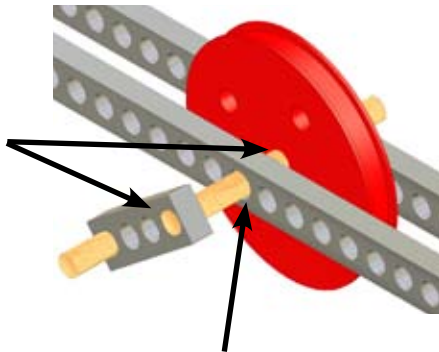
Press fits are good for gears, pulleys and levers that turn together on the same dowel (axle).

REAMING HOLES

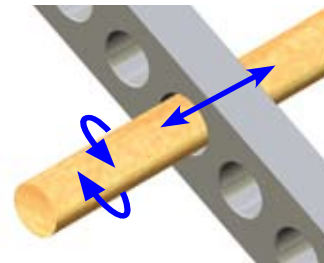


The reamer creates a hole that dowels can freely rotate in and slide through.

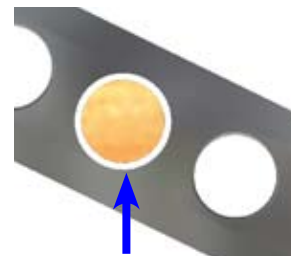
The crank and pulley are press fit (not reamed) on the dowel so they turn together.



The link strip holes that the dowel needs to rotate in were reamed to make them larger



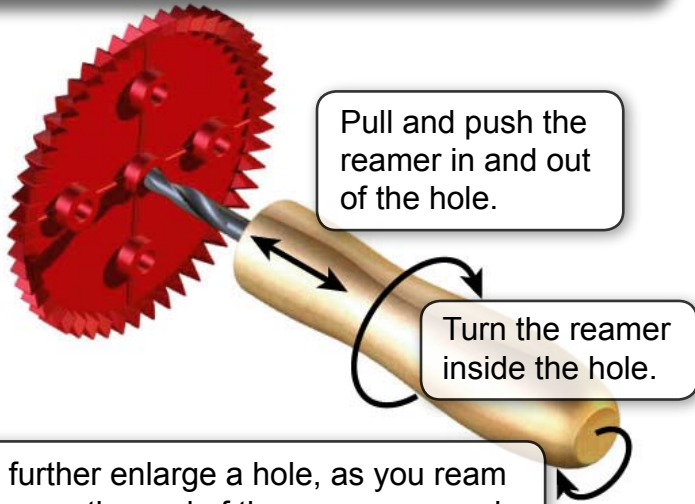
The dowel moves freely in the loose fitting hole.



The Reamer creates a hole that is larger than the dowel.



HOW TO REAM HOLES



Pull and push the reamer in and out of the hole.

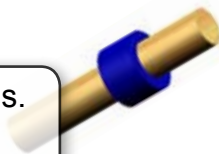
Turn the reamer inside the hole.

To further enlarge a hole, as you ream it, move the end of the reamer around so it is not in line with the hole.

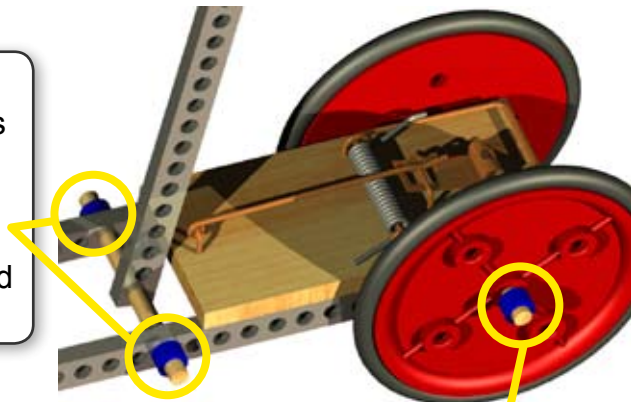
SLIDE-STOP MATERIAL



Slide-Stop Material comes in long lengths. It must be cut into 6mm (~1/4") sections before it can be used.



Slide-Stop Material keeps dowels from sliding back and forth in "loose" reamed holes.



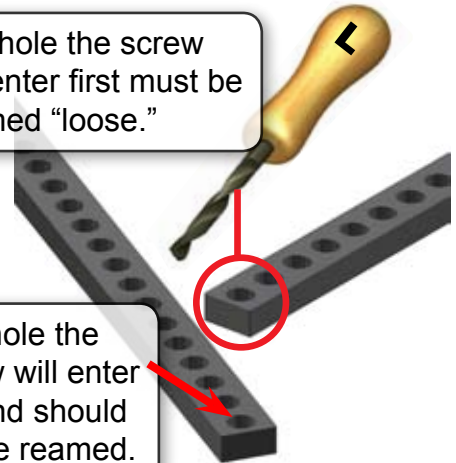
Slide-Stop Material keeps components with "loose" reamed holes from sliding back and forth on dowels.

SCREWS



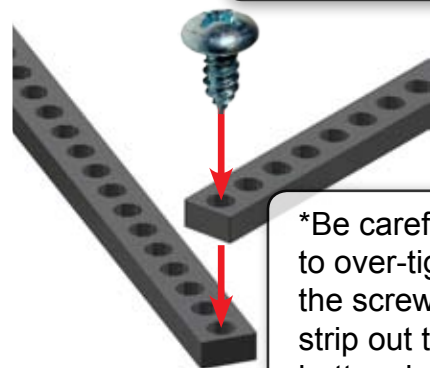
Screws can be used to attach two components together.

The hole the screw will enter first must be reamed "loose."



The hole the screw will enter second should not be reamed.

Turn the screw into both components.



*Be careful not to over-tighten the screw and strip out the bottom hole.

Tighten the screw completely to keep components from rotating.

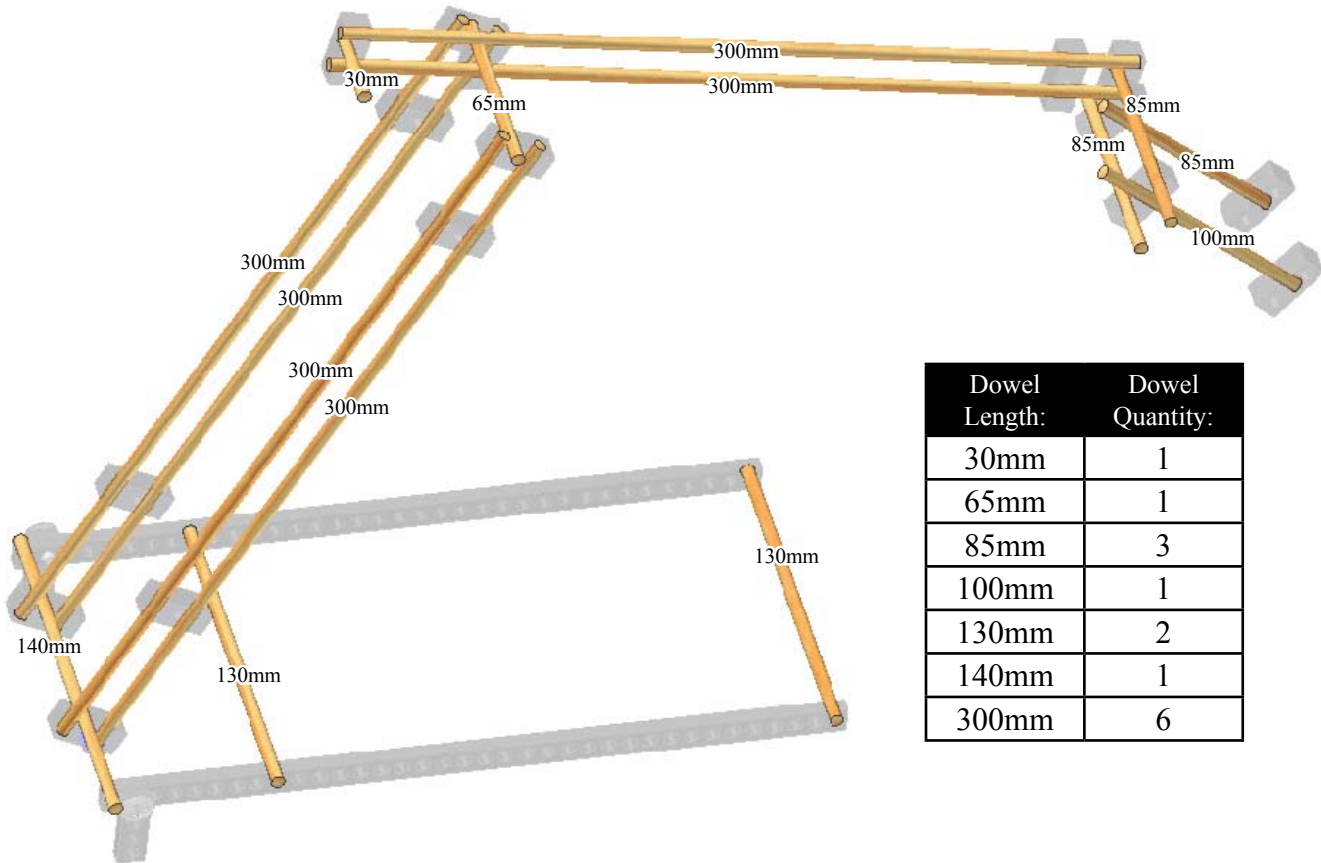
OR

Leave the screw a 1/4 turn from tight to allow components to rotate/pivot.



STEP 1: CUT THE DOWELS

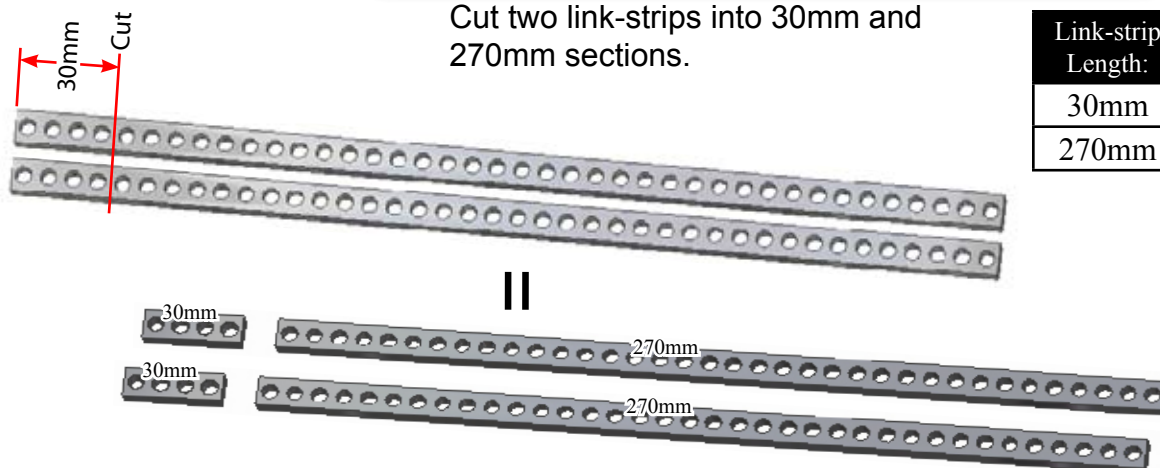
Cut dowels to the given lengths.



Dowel Length:	Dowel Quantity:
30mm	1
65mm	1
85mm	3
100mm	1
130mm	2
140mm	1
300mm	6

STEP 2: CUT THE LINK-STRIPS

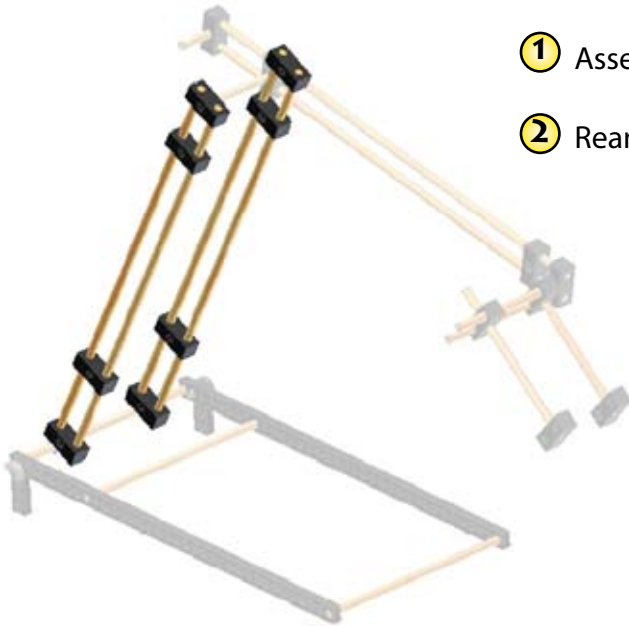
Cut two link-strips into 30mm and 270mm sections.



Link-strip Length:	Link-strip Quantity:
30mm	2
270mm	2

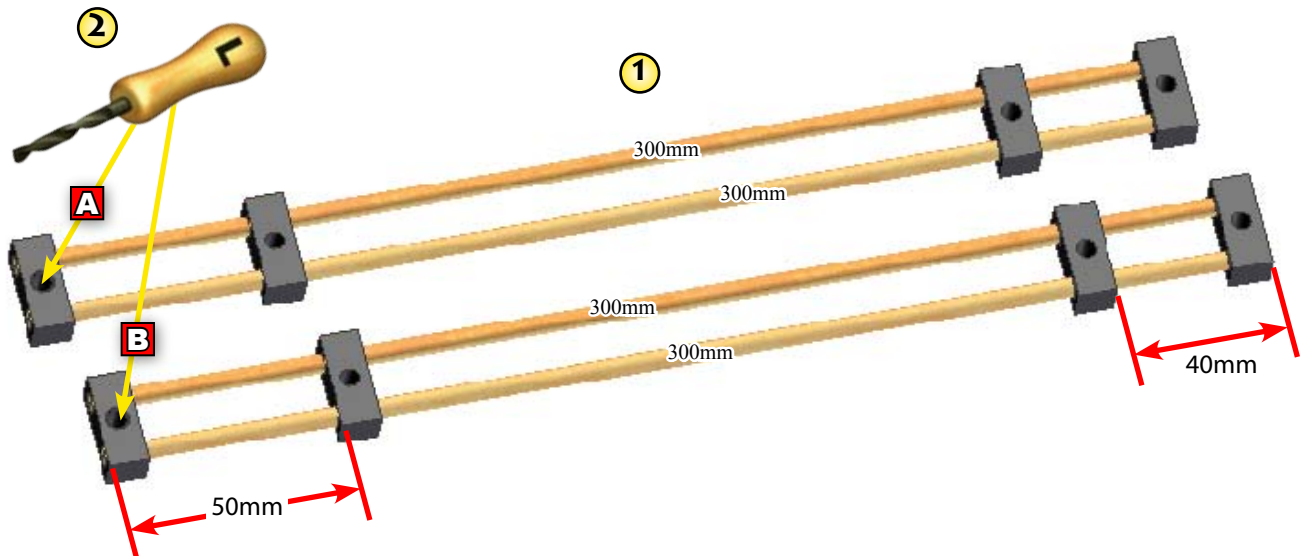


STEP 3: ASSEMBLE THE LOWER ARM MEMBERS



- 1 Assemble the lower arm sections shown below.
- 2 Ream holes **A** and **B**.

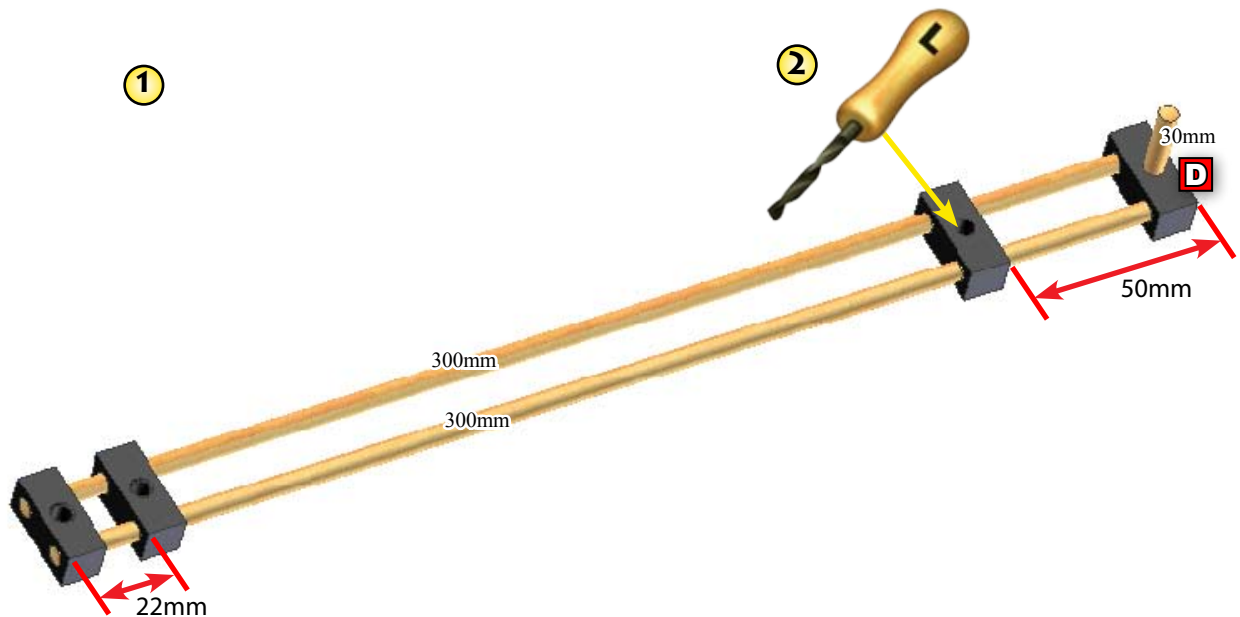
Tip: Mark the reamed perpendicular adaptors so you can easily tell which ones they are.





STEP 4: ASSEMBLE THE UPPER ARM MEMBER

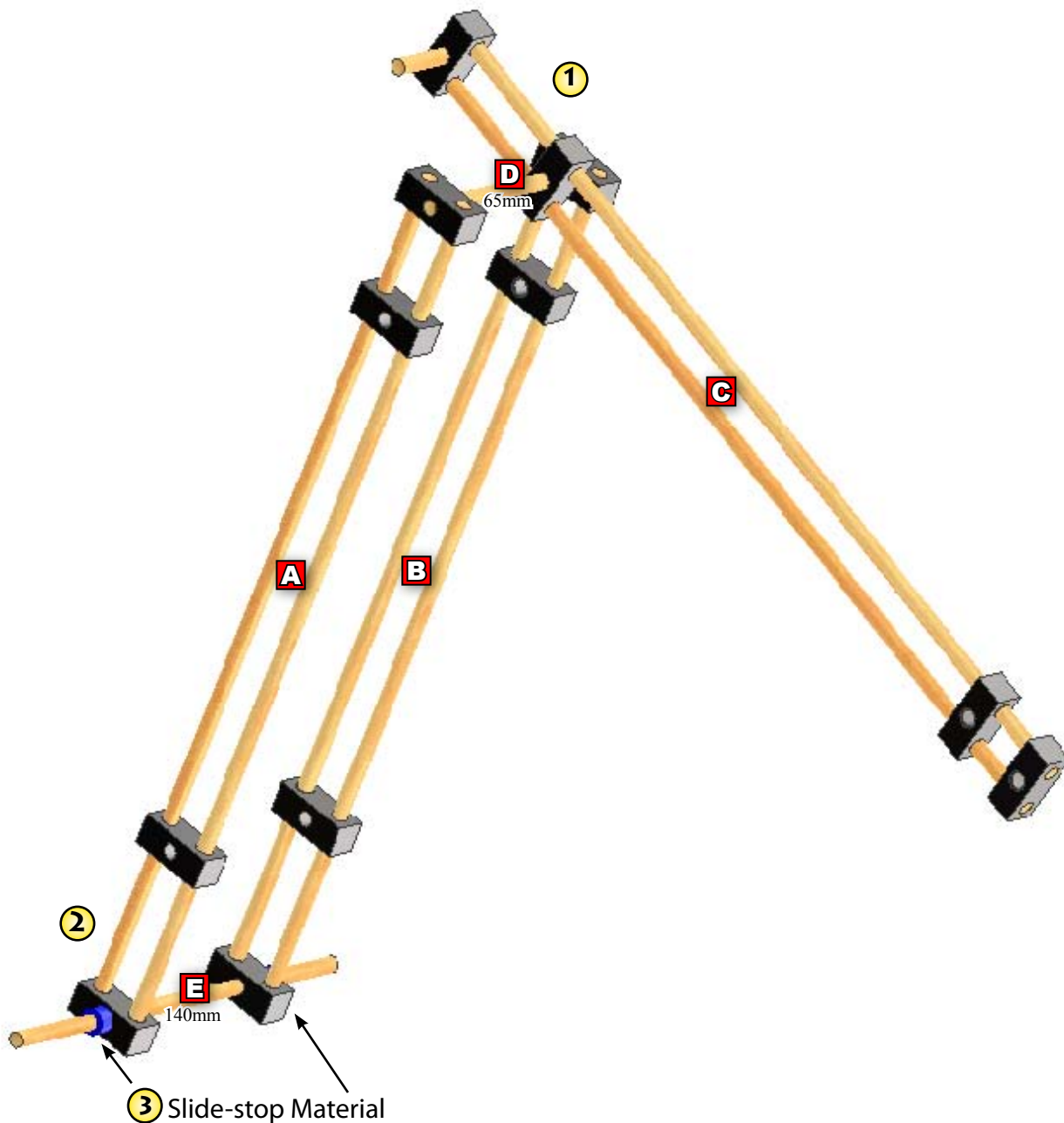
- 1 Assemble the upper arm section shown below.
- 2 Ream hole **C**.





STEP 5: PUT THE ARM MEMBERS TOGETHER

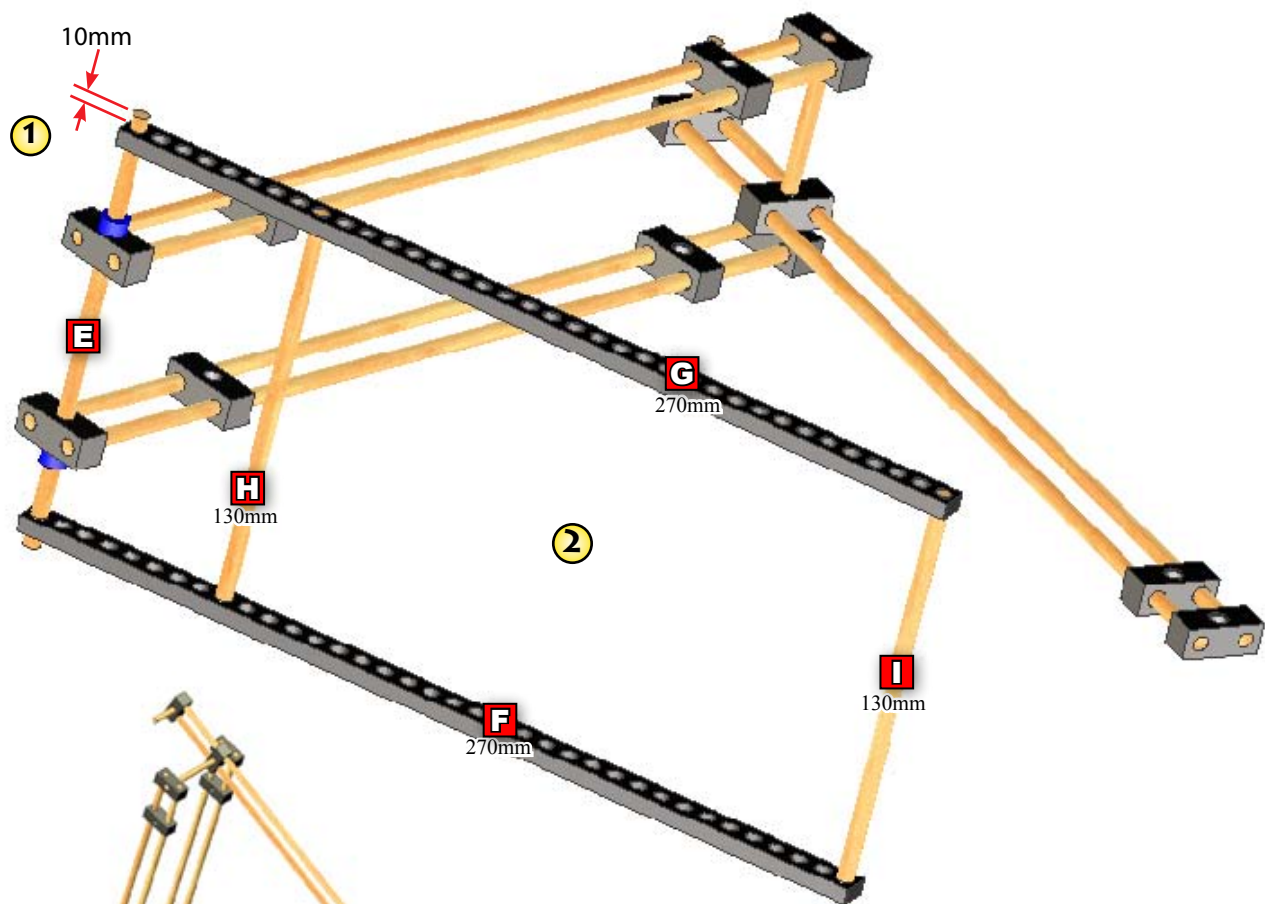
- 1 Slide the upper arm (C) onto the 65mm dowel (D). Then slide dowel D into the top of members A and B.
- 2 Slide the 140mm dowel (E) into the bottom of members A and B. Center dowel E on members A and B, while keeping members A and B 45mm apart.
- 3 Cut two 10mm sections of slide-stop material and place them outside of members A and B on dowel E. Members A and B should still be 45mm apart.





STEP 6: ASSEMBLE THE BASE

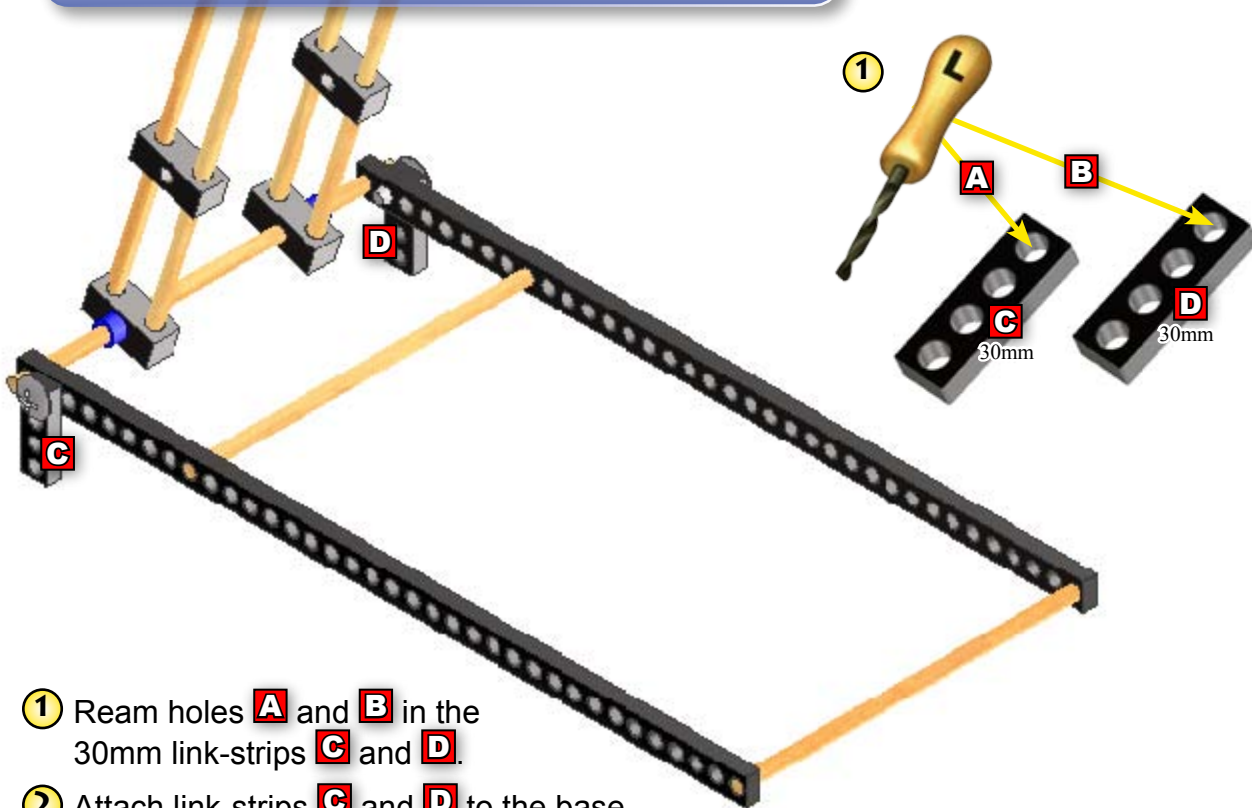
- 1 Place link-strips **G** and **F** onto dowel **E** (dowel **E** from step 5). Dowel **E** should extend 10mm past link-strips **G** and **F**.
- 2 Place 130mm dowels **H** and **I** in between link-strips **G** and **F** (as shown).



Step 6, Finished



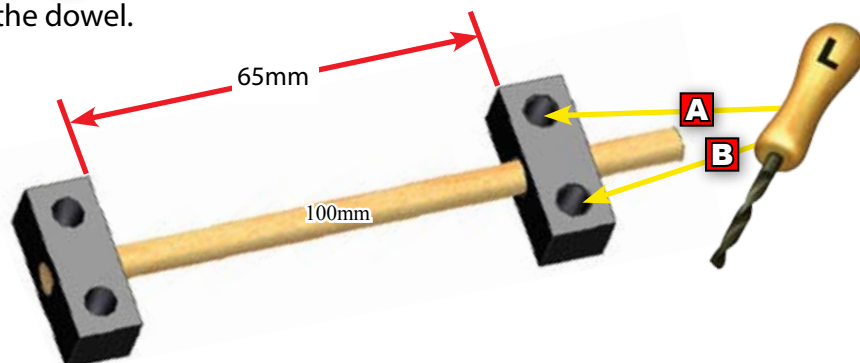
STEP 7: GIVE IT LEGS



- 1 Ream holes **A** and **B** in the 30mm link-strips **C** and **D**.
- 2 Attach link-strips **C** and **D** to the base by screwing them through reamed holes **A** and **B**.

STEP 8: ASSEMBLE THE GRIPPER FINGER

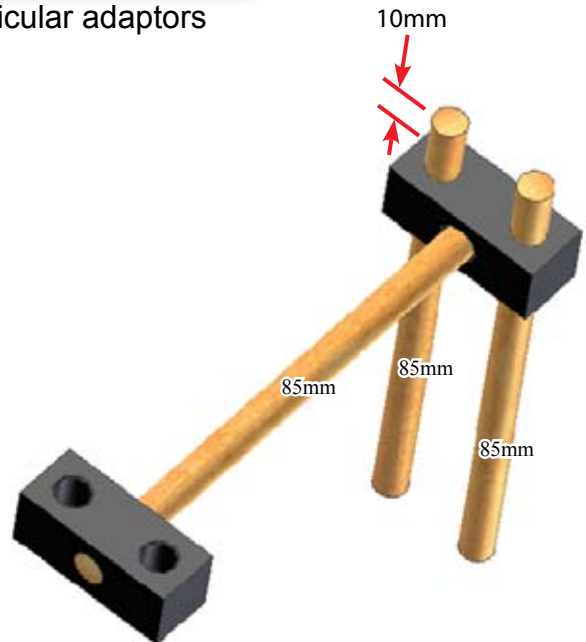
Place 2 perpendicular adaptors, 65mm apart, on the 100mm dowel. (as shown). Ream holes **A** and **B** in the perpendicular adaptor which is in from the end of the dowel.





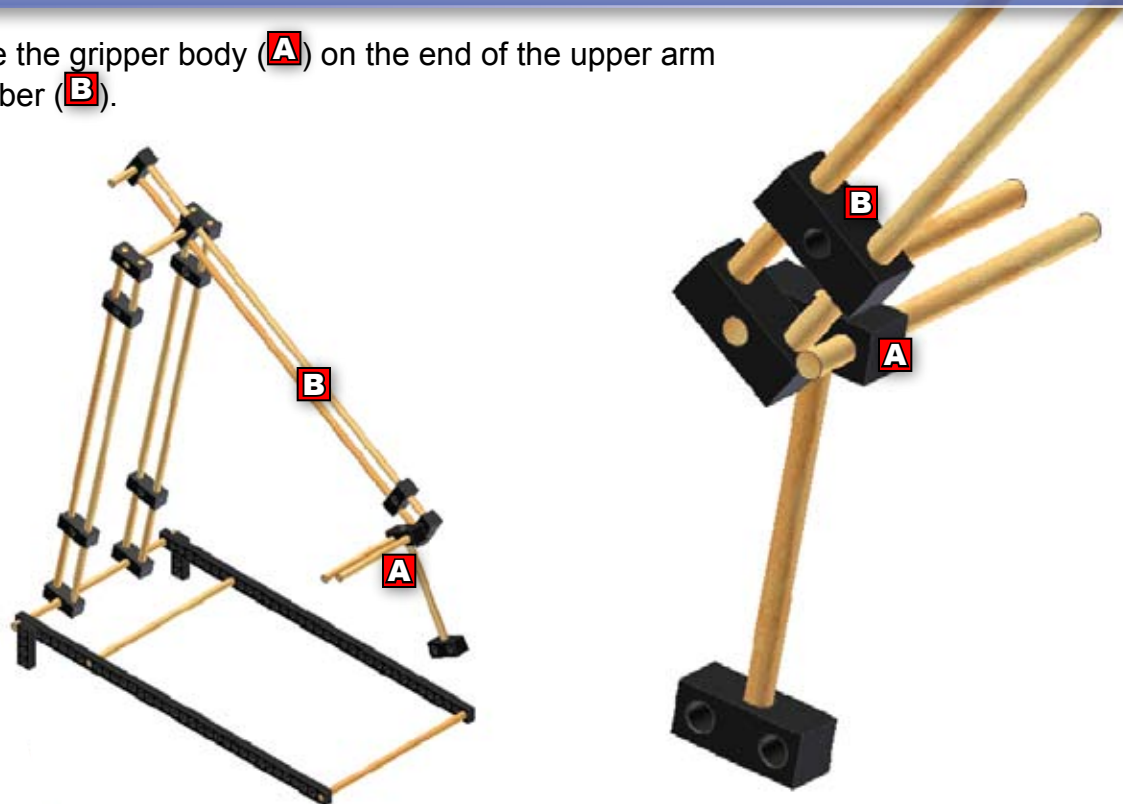
STEP 9: ASSEMBLE THE GRIPPER BODY

Create the gripper body using two perpendicular adaptors and three 85mm dowels.



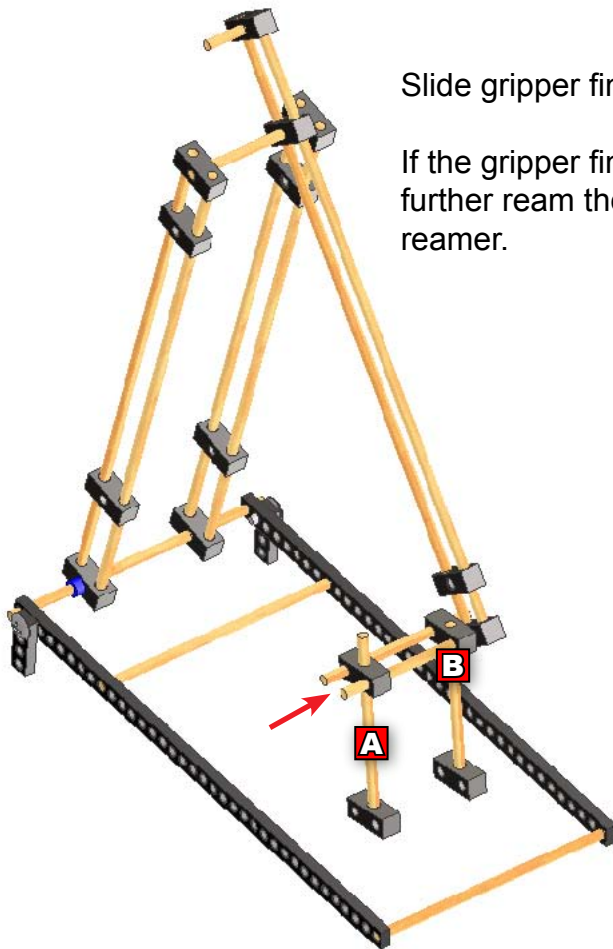
STEP 10: ATTACH GRIPPER BODY TO THE UPPER ARM

Place the gripper body (A) on the end of the upper arm member (B).



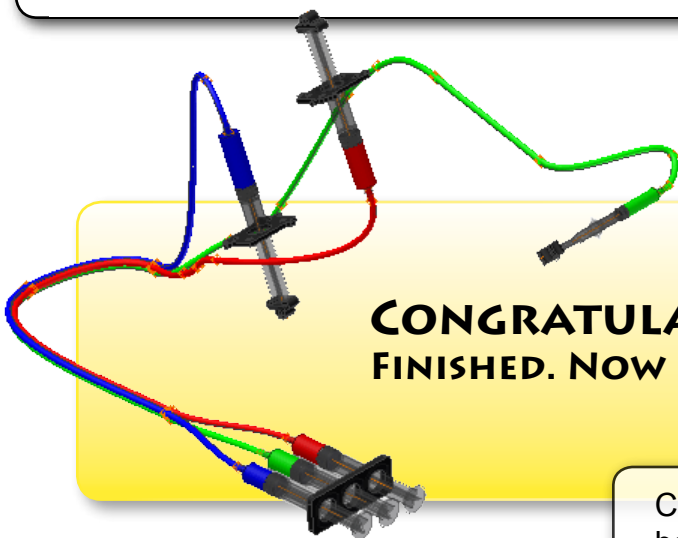


STEP 11: FINISH THE GRIPPER



Slide gripper finger **A** (from step 8) onto gripper body **B**.

If the gripper finger does not slide freely on the dowels, further ream the holes in the gripper finger with a "loose" reamer.

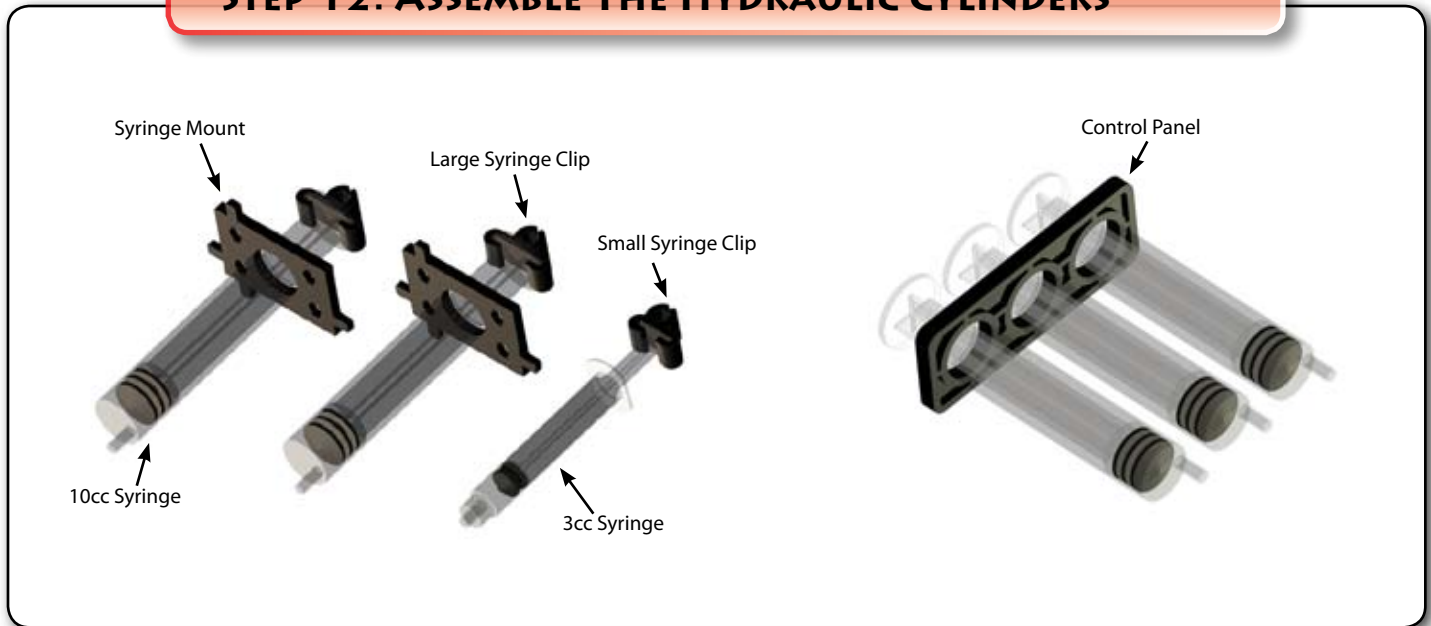


CONGRATULATIONS!!! YOUR ARM FRAME IS FINISHED. NOW LET'S START THE HYDRAULICS.

Caution: Wood dowels can not get wet. If they become wet, they swell and cause joints to stick.



STEP 12: ASSEMBLE THE HYDRAULIC CYLINDERS

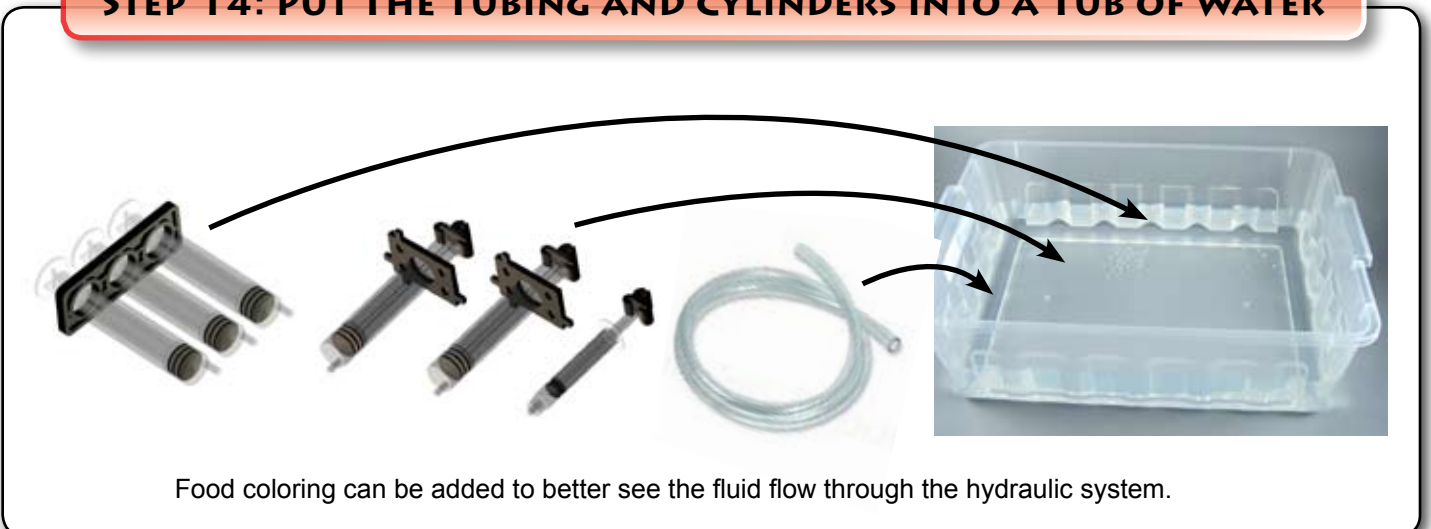


STEP 13: CUT THE HYDRAULIC LINES

Cut three sections of clear 1/8 I.D. vinyl tubing:



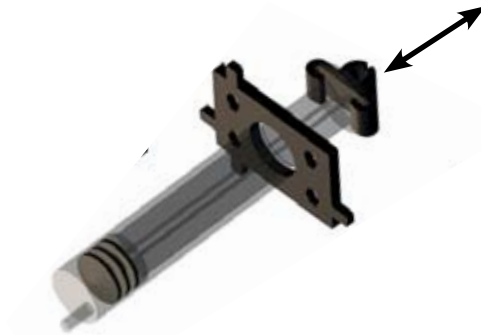
STEP 14: PUT THE TUBING AND CYLINDERS INTO A TUB OF WATER





STEP 15: PURGE THE AIR FROM THE CYLINDERS

Push and pull the plungers to purge all air from the cylinders.



PERFORM THIS PROCESS UNDER WATER.

STEP 16: FILL CYLINDERS WITH WATER

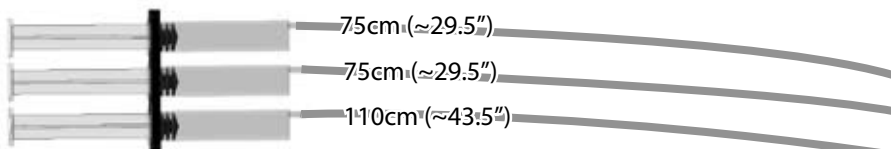
Fill the cylinders with water by completely pulling back the plungers.



PERFORM THIS PROCESS UNDER WATER.

STEP 17: ATTACH TUBING (TO THE CONTROL PANEL)

Attach tubing sections to the syringes on the control side of the hydraulic system.



Leave the other end of the tubing sections loose

PERFORM THIS PROCESS UNDER WATER.



STEP 18: PURGE AIR FROM THE TUBING

Push in the plungers on the control panel syringes. Leave them pushed in.



PERFORM THIS PROCESS UNDER WATER.

STEP 19: UNATTACHED CYLINDERS SHOULD BE FULL OF WATER

Pull back the plungers and draw water into cylinders that have no tubing connected to them.

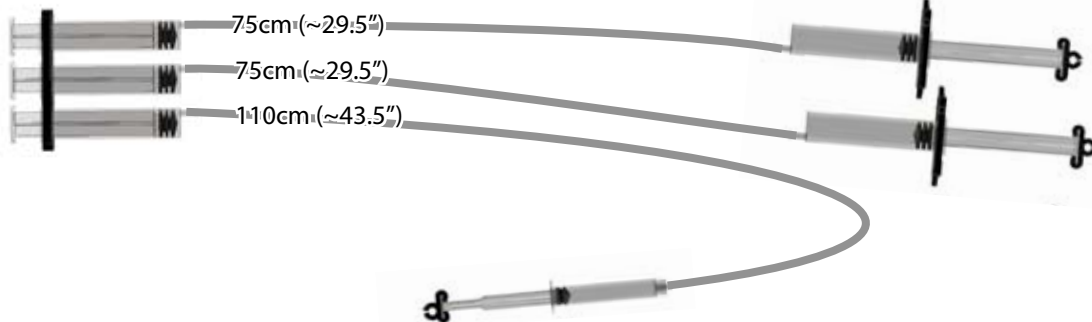


Note: Keep the control panel plungers pushed in.



PERFORM THIS PROCESS UNDER WATER.

STEP 20: CONNECT THE UNATTACHED CYLINDERS



PERFORM THIS PROCESS UNDER WATER.



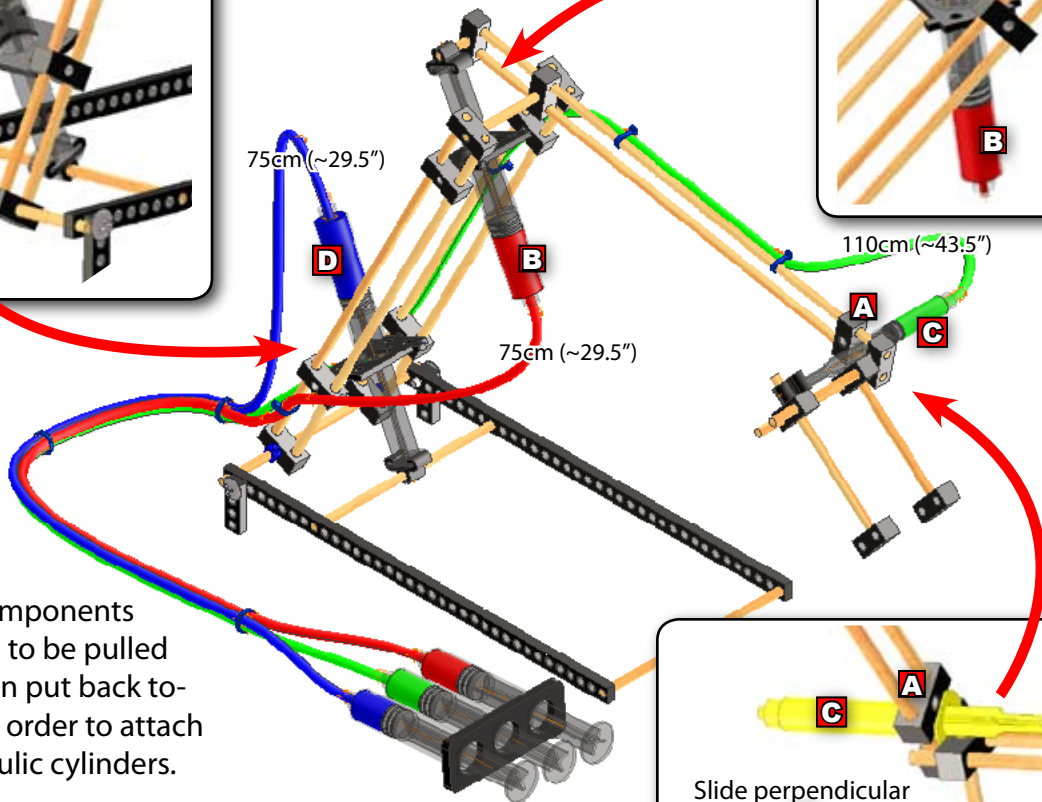
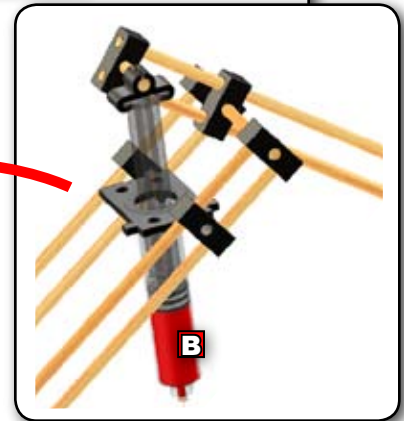
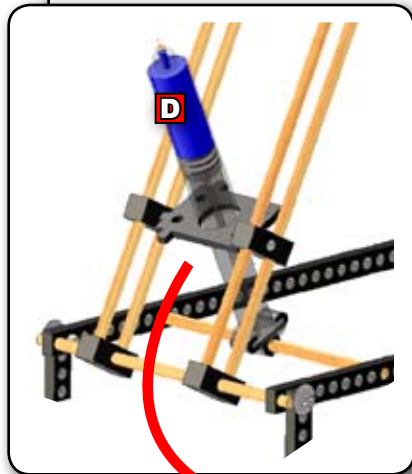
STEP 2 1: ONE LAST CHECK



Move the plungers on the hydraulic cylinders. Do they have enough throw (travel)? If not, you may need to place the hydraulic system back under water where you can pull the tubing from a cylinder to add or remove water from the system.

STEP 2 2: COMBINE THE FRAME AND HYDRAULICS

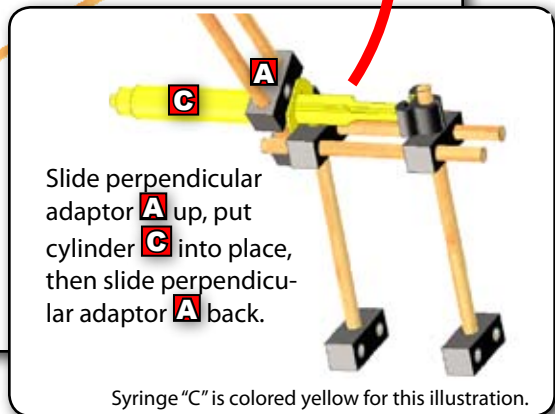
Attach the hydraulic cylinders to the frame.



*Some components may need to be pulled apart (then put back together) in order to attach the hydraulic cylinders.



Zip ties can be used to organize the tubing.

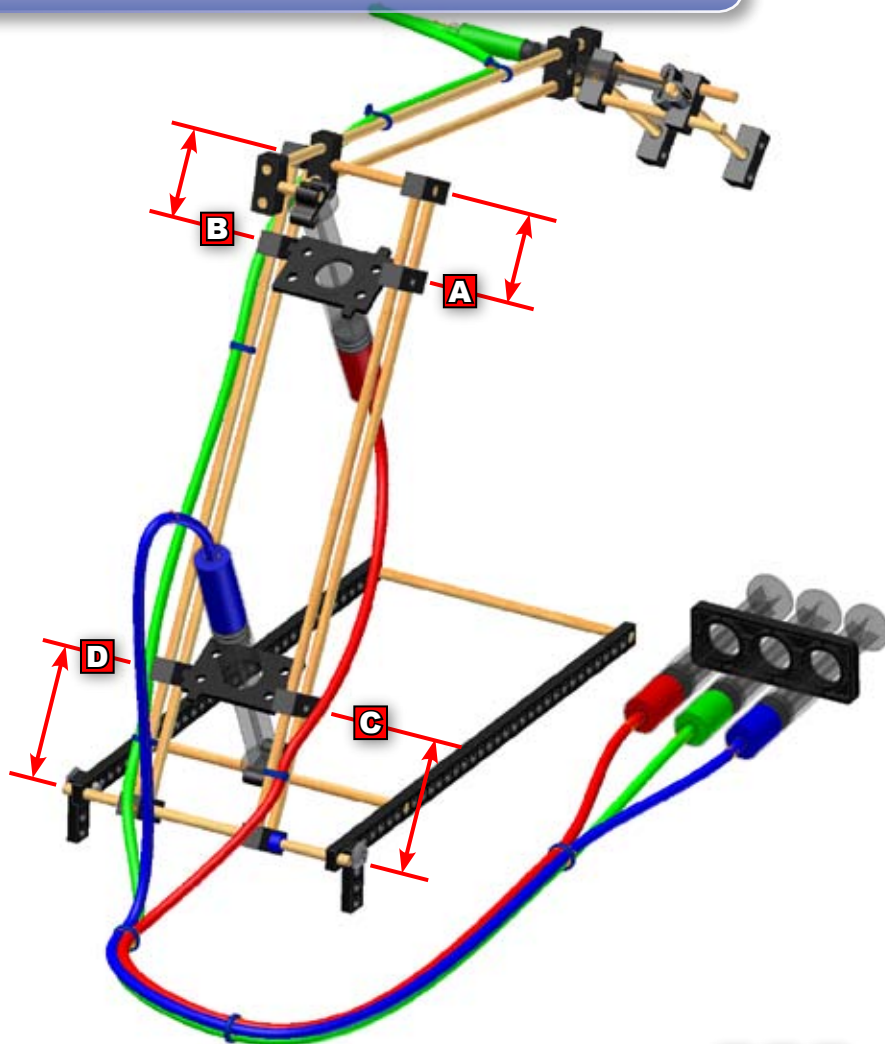


Slide perpendicular adaptor **A** up, put cylinder **C** into place, then slide perpendicular adaptor **A** back.

Syringe "C" is colored yellow for this illustration.



STEP 23: ADJUST THE ARM



Sliding the perpendicular adaptors attached to the syringe mounts (**A**, **B**, **C** and **D**) changes the travel/mechanical advantage of the arm.

Perpendicular adaptors **A** and **B** should always be horizontal with each other. Perpendicular adaptors **C** and **D** should always be horizontal with each other.

CONGRATULATIONS!!! YOUR HYDRAULIC ARM IS FINISHED.



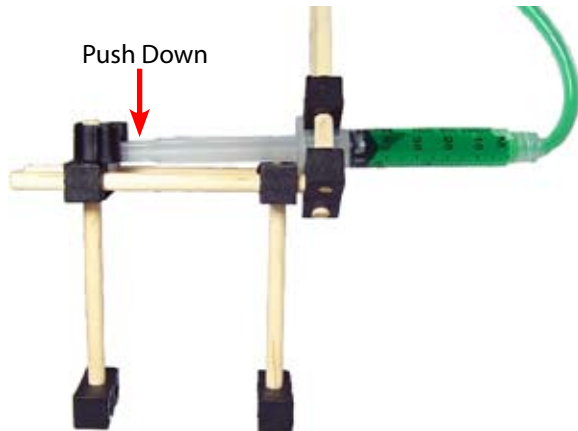
TIPS AND TRICKS



GLYCERIN

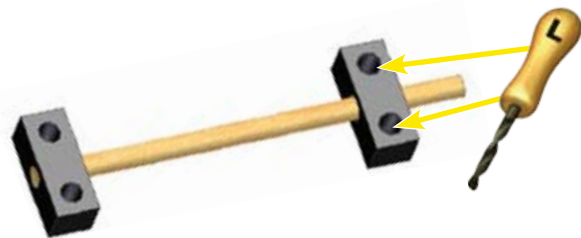
Adding a small amount of glycerin to the water in your hydraulic lines can keep cylinders from sticking after sitting without use.

FIXING A "STUCK" GRIPPER

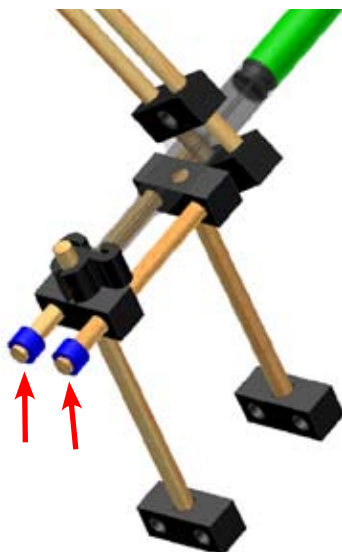


1 Push the plunger down into the syringe clip (toward the gripper fingers).

3 Further enlarge the holes that the gripper finger slides on (same as step 8).

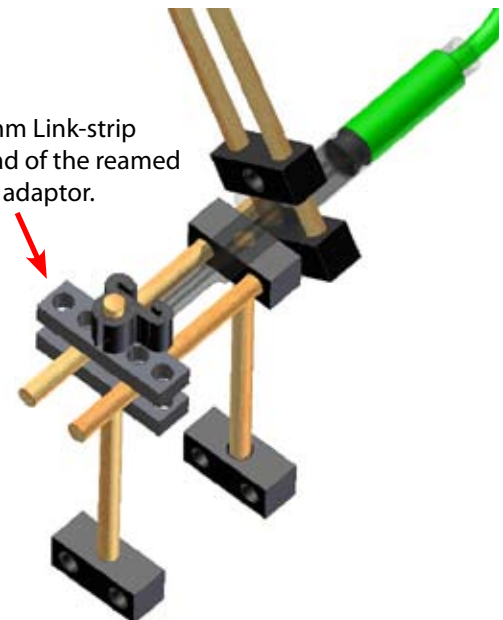


4 Try an alternative gripper finger design.



2 Add slide stop material to keep the gripper from opening too far and getting stuck.

Use two 37.5mm Link-strip sections instead of the reamed perpendicular adaptor.





BLEEDING THE LINES...

Air in the hydraulic lines will degrade the performance of your hydraulic arm. There are a few ways to easily bleed the lines (get rid of the air).

BY PULLING A HOSE



- 1 Pull the air (from the lines) into a cylinder.
- 2 Turn the cylinder so its tip is its highest point.
- 3 Remove the hydraulic line (tubing) from the cylinder.



- 4 Push the plunger so the air is forced from the cylinder. Stop pushing when the water level reaches the top of the cylinder tip.
- 5 Re-attach the hydraulic line to the cylinder. *You may need to push air from the hydraulic line before attaching it to the cylinder.

USING AN EXTRA SYRINGE

This process requires an extra (loose) syringe.



- 1 Fill a loose syringe with a little water.
- 2 Detach a hydraulic line and attach it to the loose syringe.

- 3 Hold the loose syringe so it is at the highest point in the hydraulic system, with its tip down. Push and pull it to collect air in its chamber.



- 4 Push enough water out of the loose syringe to adequately fill the system.
- 5 Pull the loose syringe off the hydraulic line. Re-attach the hydraulic line to its original cylinder.