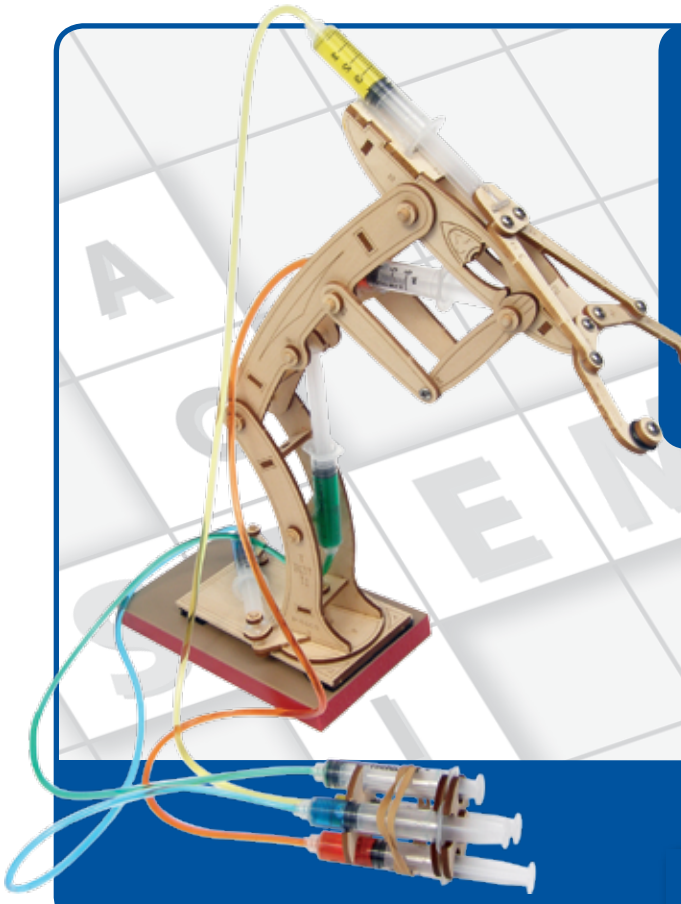


T-Bot® II Hydraulic Arm

User Guide

PITSCO EDUCATION

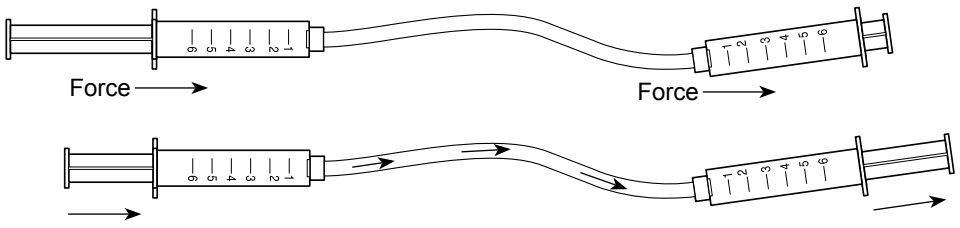
59474 V1212

Cautionary and Warning Statement:

- This kit is designed and intended for educational purposes only.
- Use only under the direct supervision of an adult who has read and understood the instructions provided in this user guide.
- Read warnings on packaging and in manual carefully.
- Always exercise caution when using sharp tools.

Hydraulics

A hydraulic system is one that uses fluid as a force. The principle behind a hydraulic system is simple: Force applied at one point is transmitted to another point using a fluid.



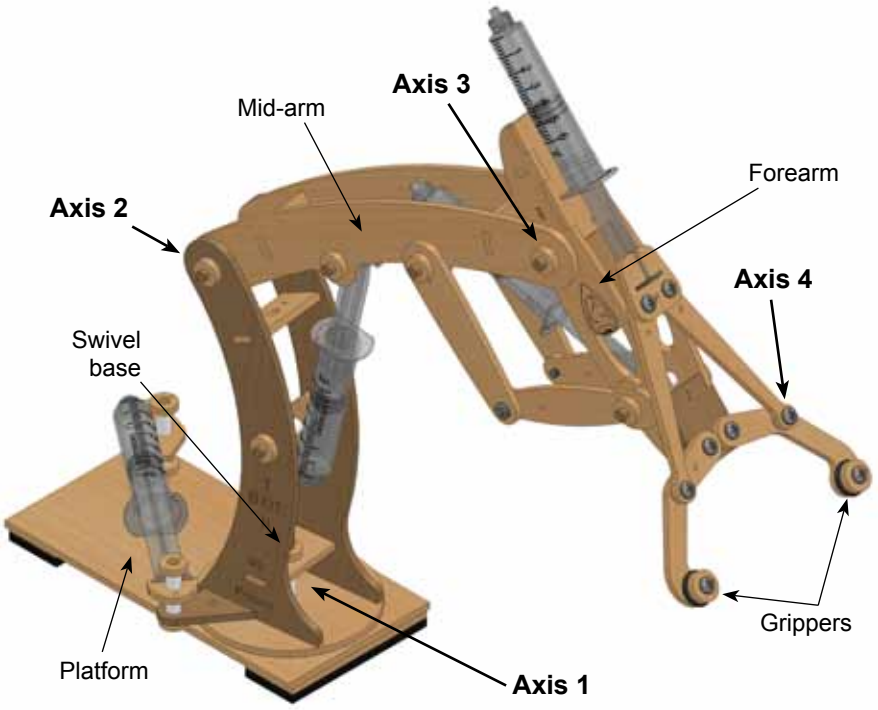
Pushing on one end of a syringe filled with water (a hydraulic system) creates an equal and opposite reaction on the other syringe. On the T-Bot® II, syringes are connected by tubes filled with water to a mechanical part of the robot. Force is what causes the part to move.

Robotics

A robot is something that performs human movements or imitates and repeats tasks that humans do. Most robots are programmable and work automatically – sometimes even autonomously. Robots can be used in a variety of tasks but frequently do jobs that are repetitive and dull or too dangerous for humans.

Axis

An axis is the point at which a body or a part rotates. The T-Bot II has four axes: Axis 1, where the swivel base connects to the platform; Axis 2, where the mid-arm connects to the swivel base; Axis 3, where the mid-arm connects to the forearm; and Axis 4, where the grippers connect to the forearm.



Lever

A lever is a bar, called the lever arm, on a pivot point, called a fulcrum. A fulcrum can also be an axis. The T-Bot II uses a third-class lever in each of its four axes of motion. A third-class lever is a lever where the force is applied anywhere between the fulcrum and the load. Levers and axes give the T-Bot II more movement than a single lever.

Included Materials

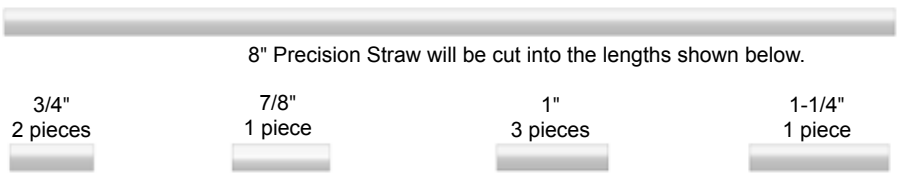
- 4 basswood sheets with pop-out parts
- 8 syringes
- 1 – 1-1/8" dowel
- 1 – 1-1/2" dowel
- 4 – 1-3/4" dowels
- 3 – 2" dowels
- 1 – 2-1/2" dowel
- 8 – 3/8" screws
- 2 – 1/2" screws
- 2 O-rings
- 2 nylon spacers
- 1 Precision Straw
- 8 feet of clear tubing
- 1 strip of hook-and-loop fastener (like Velcro™)
- 1 rubber band
- 1 resealable plastic bag

Tools and Materials Required (not included)

- Cool-melt glue gun and glue slugs
- White glue such as HD Bond or wood glue
- Scissors
- Ruler (English)
- Base, such as a piece of wood larger than the T-Bot II platform
- Cup of water
- 4 different food colorings (optional)
- Small Phillips screwdriver

Preparation

1) Write your name on the plastic bag (store your robot parts in the bag to keep from losing them).
2) Carefully pop out the wooden parts from the basswood sheets.
3) Cut the clear tubing into four equal lengths. Each should be approximately 2 feet long.
4) Cut the straw into the following lengths: one 1-1/4" piece, three 1" pieces, one 7/8" piece, and two 3/4" pieces.



5) Cut the strip of hook-and-loop fastener into two even pieces.
6) Remove the syringes from their containers (containers can be discarded or recycled).

Gluing Tips

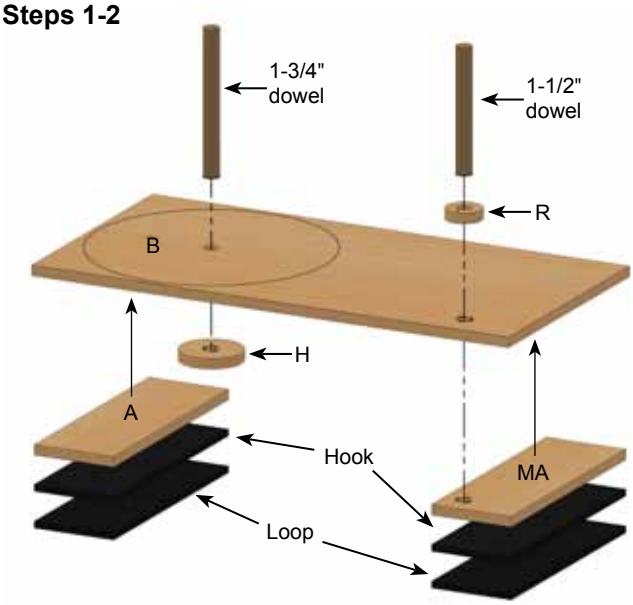
- Edge gluing is when you apply glue to the edge of each part that will be in contact with another part.
- Face gluing is when you apply glue to the flat sides of two pieces to make them stick together.
- When using cool-melt glue, apply it in thin layers while lightly spreading the glue with the gun's tip

Building the Platform

Gather: Parts A, MA, B, H, and R; 1-1/2" and one 1-3/4" dowels; and hook-and-loop fastener (2)

1) Using white glue, face glue A, MA, and H on the underside of B as shown. Make sure the holes line up.
2) Turn over the platform and glue the R and the 1-1/2" dowel into the corner hole. Glue the 1-3/4" dowel into the hole in the etched circle.
3) Remove the backing off of one side of the hook-and-loop fastener. Adhere one each to Part A and MA under the platform. Take care not to break a dowel.

Steps 1-2

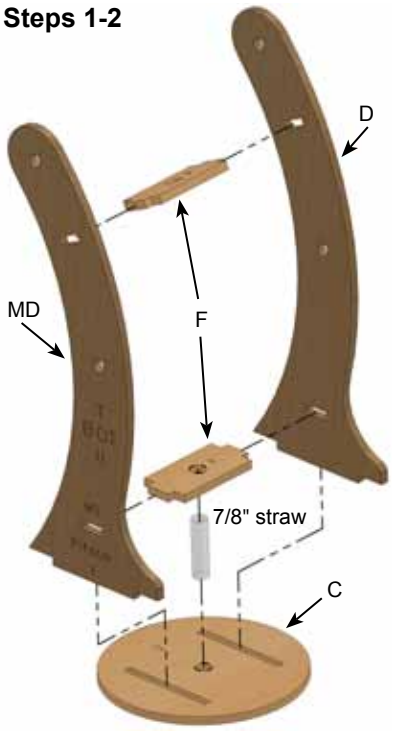


Building the Swivel Base

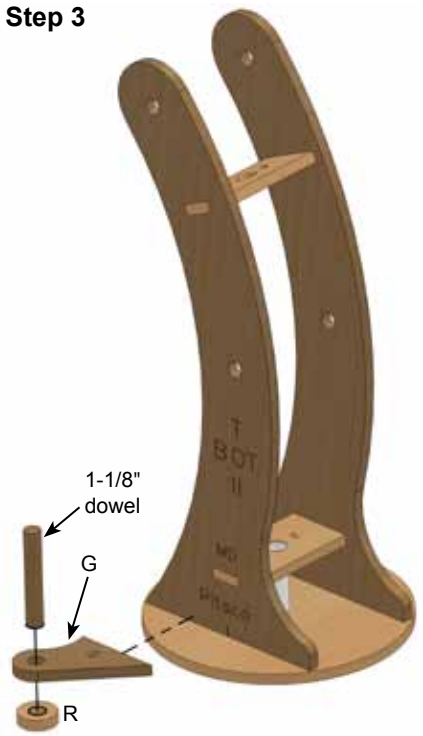
Gather: Parts C, D, MD, F (2), G, and R; 1-1/8" dowel; and 7/8" straw piece

1) With white glue, edge glue the two Fs into D. Glue MD on the other side. Glue this unit onto C.
2) Slide the straw piece into the holes in F and C. If it is above the top of F, trim it so it is flush. Apply glue to hold it to the wood.
3) Face glue R on the bottom of G, lining up the holes. Glue the 1-1/8" dowel flush to the bottom of R. Face glue G onto C, lining it up with the etched mark on MD as shown.

Steps 1-2



Step 3

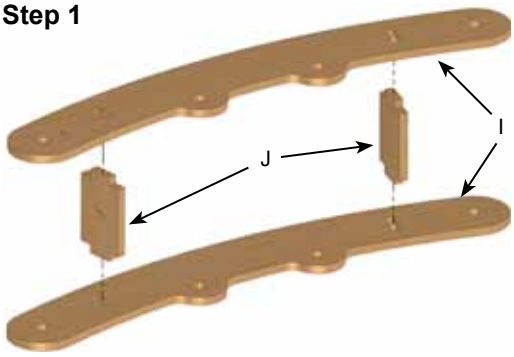


Building the Mid-Arm

Gather: Parts I (2), and J (2)

1) Using white glue, edge glue the I's into a J. Glue the second J on the other side as shown.

Step 1

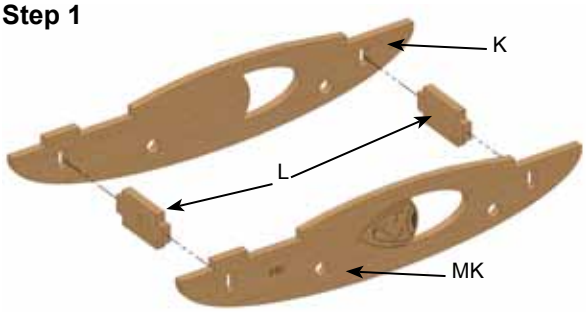


Building the Forearm

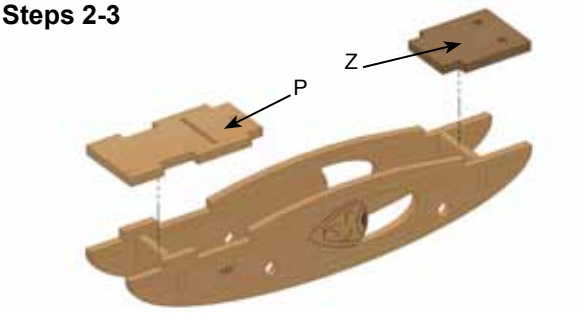
Gather: Parts K, MK, L (2), P, and Z

1) With white glue, edge glue the Ls into the rectangular holes on K. Glue MK on the other side.
2) Glue P on top behind the "eyeballs."
3) Glue Z on top in front of the eyeballs.

Step 1



Steps 2-3

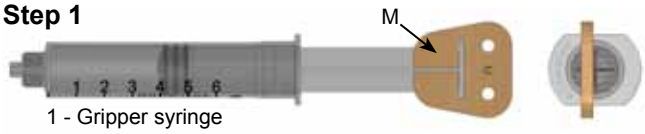


Building the Syringe Assemblies

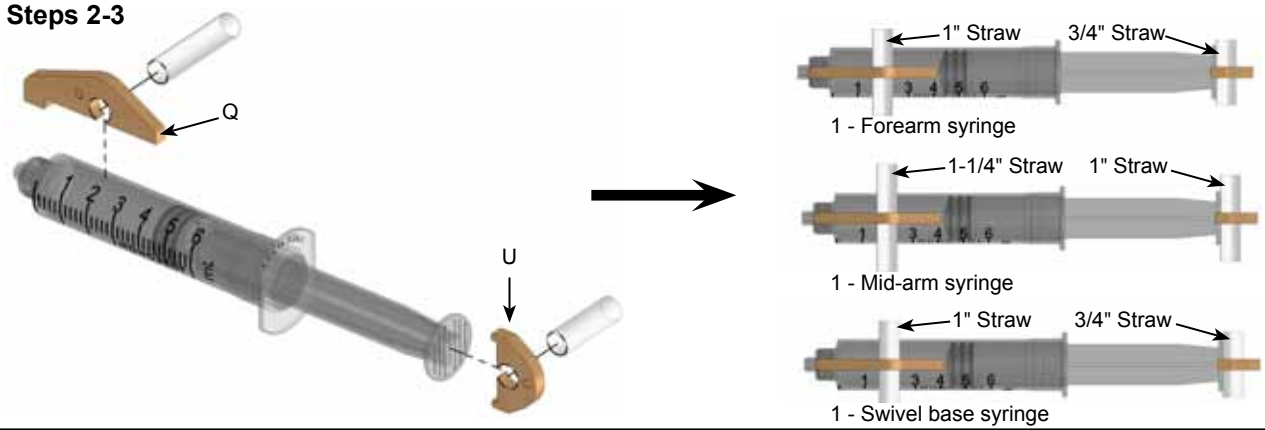
Gather: Parts M, U (3), and Q (3); 4 syringes; and remaining straw pieces

1) Place M on the plunger of one syringe as shown and cool-melt glue it in place – be careful not to use too much glue, or you may have trouble attaching parts later.
2) Take the other three syringes and glue a U on each plunger end.
3) Cool-melt glue a Q on each syringe with the notch hanging over the syringe body by the nozzle. Make sure each Q is centered between the flat sides of the syringe lip.
4) Center the straws in the Qs and Us of the last three syringes as shown below. Use a small amount of cool-melt glue to secure them in place.

Step 1



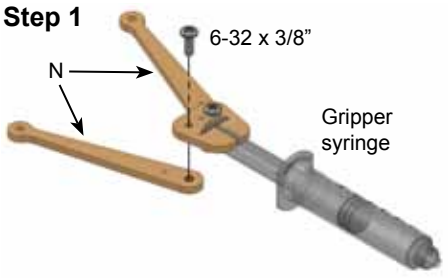
Steps 2-3



Attaching the Grippers

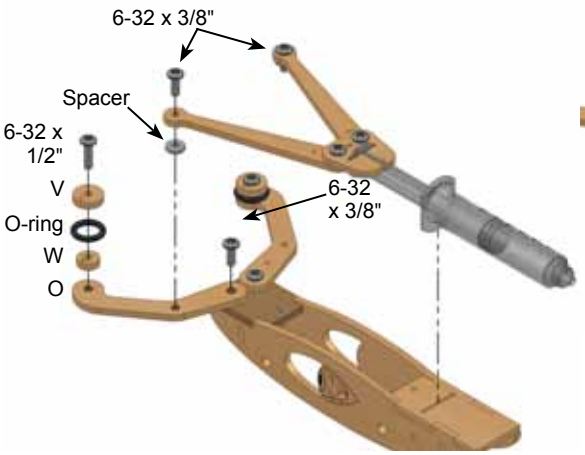
Gather: Forearm; gripper syringe; Parts O (2), N (2), W (2), and V (2); O-ring (2), nylon spacer (2), 3/8" screw (6), and 1/2" screw (2)

Step 1

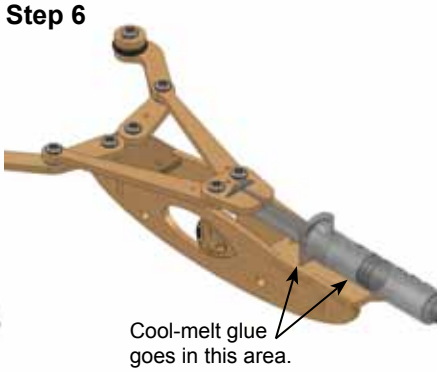


1) Hold an N so the wide end lines up under a hole in M. Fasten these with a 3/8" screw. Repeat on the other side.
2) Place an O-ring around a W and place a V over it so the holes are aligned. Thread a 1/2" screw in the holes so the screw head is on top. Screw this into the hole as shown. Repeat this with the other W, V, O, O-ring, and 1/2" screw. These are the grippers.

Steps 2-5



Step 6

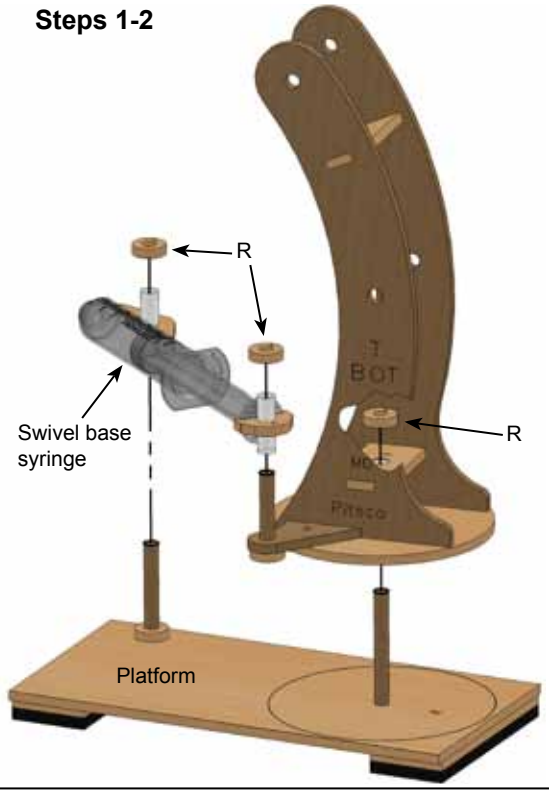


3) With a 3/8" screw, attach each gripper onto the forearm so they curve toward each other. Make them snug but not completely tight.
4) Place the syringe in the slot on top of the forearm. Make sure M is facing up.
5) Take the free end of an N, place a spacer under it, and screw it into the remaining hole on the O on the same side with the remaining 3/8" screws. Repeat with the other spacer, N, and O.
6) Spread cool-melt glue on both sides of the syringe body, securing it to the forearm.

Connecting the Bottom Half

Gather: Platform; swivel base; mid-arm; swivel base and mid-arm syringes; Part R (8); 1-3/4" dowel; and 2" dowel (2)

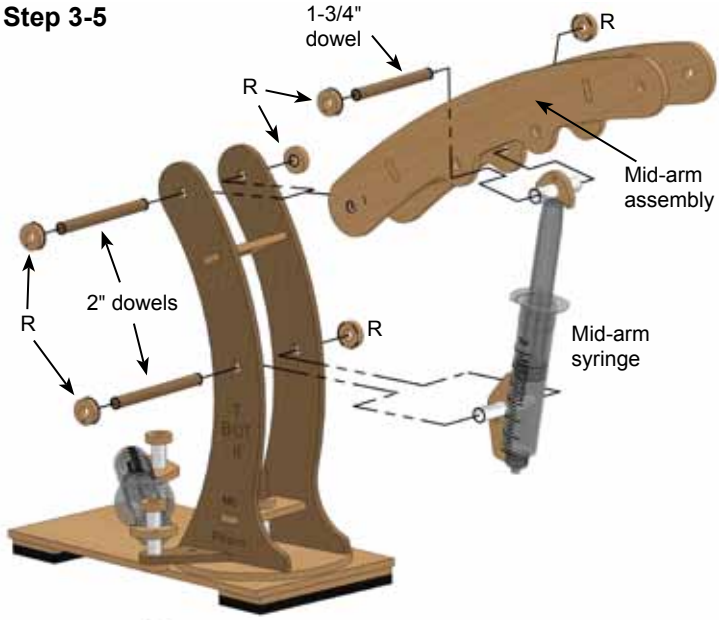
Steps 1-2



1) Place the swivel base on the dowel in the platform's circle with the straws over the dowels as shown. Place an R over the top of the dowel and put a dab of white glue where the top of the dowel touches R.
2) Place the swivel base syringe over the dowel ends so U is attached to the swivel base dowel and Q is attached to the platform dowel. Place an R on top of each dowel and white glue the top of the dowels to the Rs.

3) Line up the mid-arm end with the swivel base's top holes as shown. Center a 2" dowel through these holes and place an R on each dowel end. White glue the Rs to the dowel without gluing them to the swivel base.
4) Line up the mid-arm syringe's Part Q straw in the swivel base's middle hole as shown. Center a 2" dowel through the base and straw and place an R on each dowel end. White glue the dowel ends to the Rs.
5) Line up the Part U end of the syringe to the mid-arm's second holes. Center a 1-3/4" dowel through these holes and place an R on each end. White glue the Rs on the dowel ends.

Step 3-5

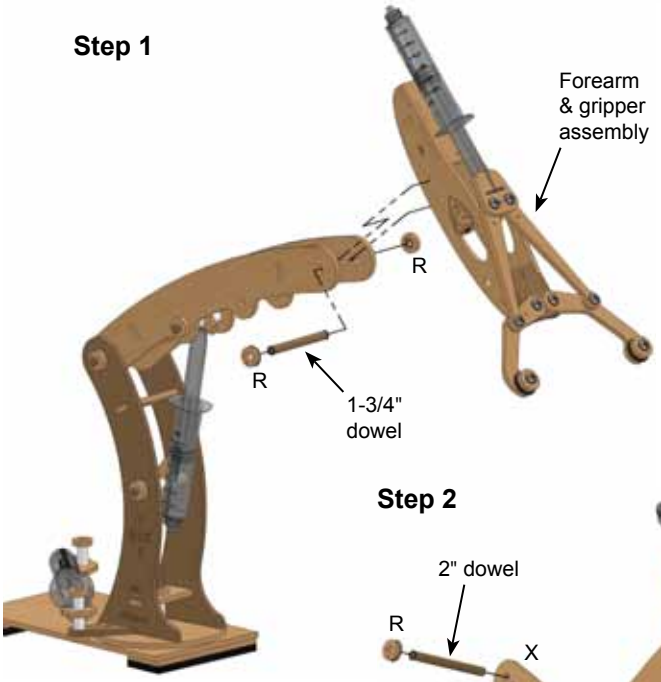


Connecting the Top Half

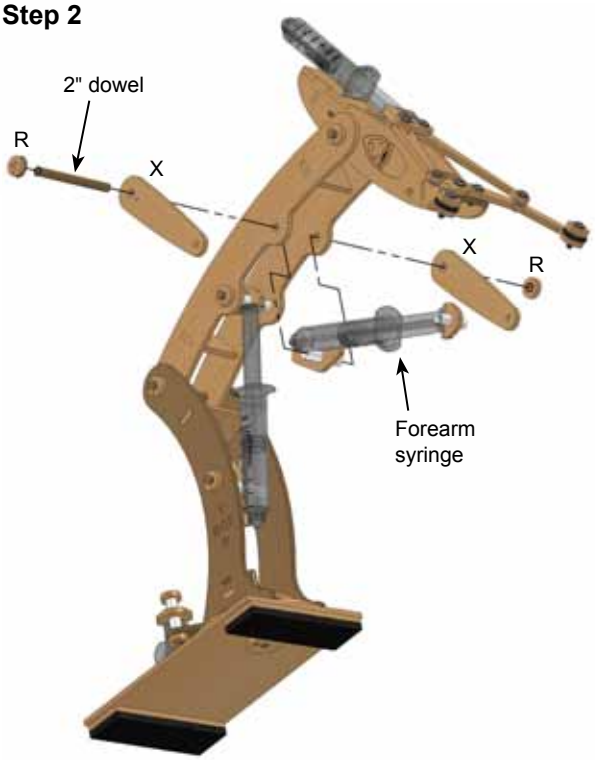
Gather: Forearm syringe; forearm and gripper; Parts R (6), X (2), and Y (2); 3/8" screw (2); 1-3/4" dowel (2); 2" dowel; and a base

1) Line up the forearm holes behind the eyeball to the top hole of the mid-arm. Center a 1-3/4" dowel through these holes and place an R on each end. White glue the Rs to the dowel ends.
2) Line up the syringe's Part Q straw between the last set of holes on the mid-arm. Center a 2" dowel through these holes. Place the wide end of each X over the dowel ends. Place an R on each dowel end and white glue them to the dowel ends.

Step 1

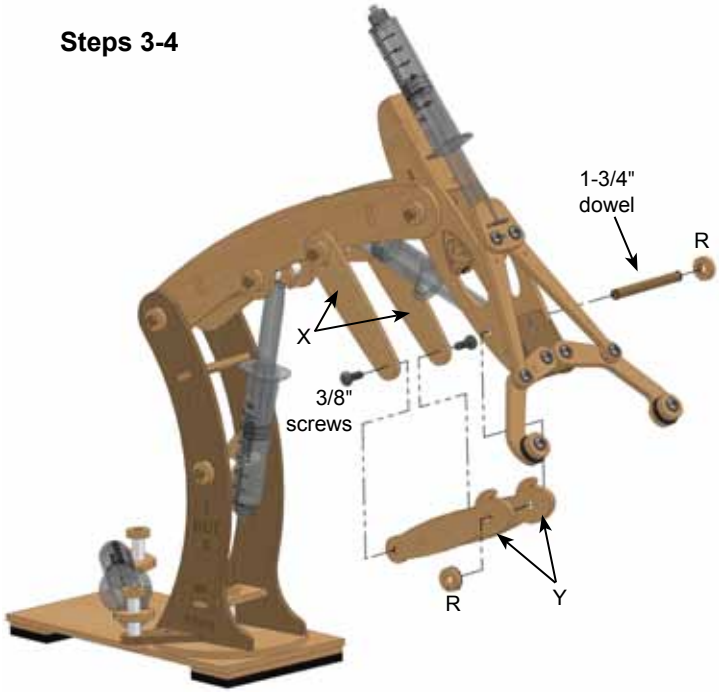


Step 2



3) Pull the other end of the syringe to the last set of holes in the forearm. Center a 1-3/4" dowel through these holes. Place the "hand" end of each Y over the dowel ends. Place an R over each dowel end and white glue them to the dowel ends.
4) Line up the holes in the free ends of a X and Y and screw them together as shown. Repeat on other side.
5) From the bottom of the robot, remove the paper backing from the hook-and-loop fastener. Line up the front of the T-Bot II to one edge of the base and press down firmly (see T-Bot II on the base on the cover).

Steps 3-4



Filling the Syringes

Gather: Syringes (4), tubing (4), water, and food coloring (if using)

Note: If using food coloring, make four cups of water and dye each a different color. Fill each syringe with a different color.

1) Take a syringe and push in the plunger. Dip the syringe nozzle into the water and pull out the plunger. Attach a piece of tubing over the syringe nozzle.
2) Depress the plunger until the tubing is full of water.
3) Place the free end of the tubing into the water and pull back the plunger until both the tubing and syringe are full of water.
4) Select a syringe on the robot to attach to the syringe unit. Completely depress its plunger. Attach the free end of the tubing to the nozzle of the syringe on the robot.
5) Repeat Steps 1-4 for all remaining syringes.

Step 3

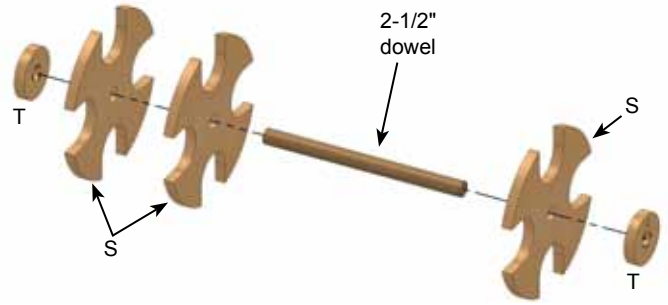
Step 4

Building the Syringe Holder (optional)

Gather: Parts S (3) and T (2); 2-1/2" dowel; and rubber band

1) Slide the dowel through the center of all Ss. Position the Ss so there is one 1/4" from each end of the dowel and the third is between the other two, but just a 1/4" away from the end S.
2) Place a T on each dowel end; put a dab of cool-melt glue on each to hold them in place. Let dry.
3) Put the free ends of the syringe unit in the openings of the holder as shown. The syringe lips should be in the 1/4" gap between two Ss. Wrap the rubber band around the entire syringe-and-wood-holder unit.

Steps 1-2



Assembled holder

Operating the T-Bot II

To operate the robot alone, push or pull the plungers of the syringes in the syringe controller. Each syringe will run a different axis. Or, remove the syringes from the controller and have four people operate a different part of the robot.

Step 3

Troubleshooting

Over time, air might get into the syringe units. A little air is OK. If a lot of air gets into the line, empty and refill the syringes. To do this, pull back the plunger on the free end of the syringe unit and detach the tube from the syringe attached to the robot. Empty the syringe and tube, and then refill them according to the directions on page 7.

Storage

When finished using the T-Bot II for the day, make sure the plungers are halfway depressed. By leaving the syringes like this, it is less likely that air will seep into the syringes.

Activity Suggestions

- The T-Bot II uses a third-class lever; research the different types of levers and have students discuss why the T-Bot II doesn't qualify as a first- or second-class lever. Discuss the uses, advantages, and disadvantages of each lever type.
- Have students discuss how mechanical advantage is used with the T-Bot II and how it could be modified to increase or decrease mechanical advantage – and what trade-offs in robot operations there might be with those modifications.
- Try this as a timed activity for team building: Students compete as teams of four to move five foam cubes (cubes should be one-inch squares) from one location to another. Whichever team completes the task with the fastest time.

PITSCO EDUCATION
P.O. Box 1708 • Pittsburg, KS 66762
www.pitsco.com
Toll-Free Orders 800-835-0686