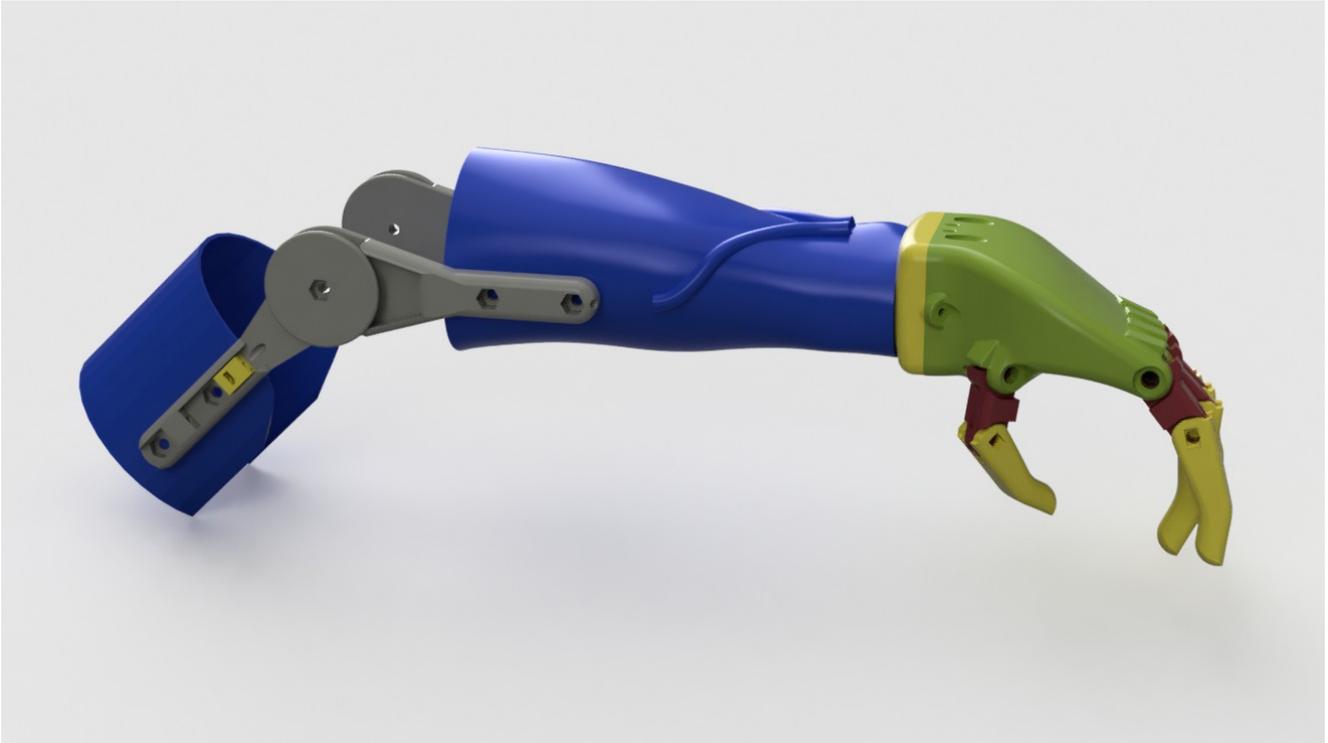


Lionel Arm Project

Assembly Instructions

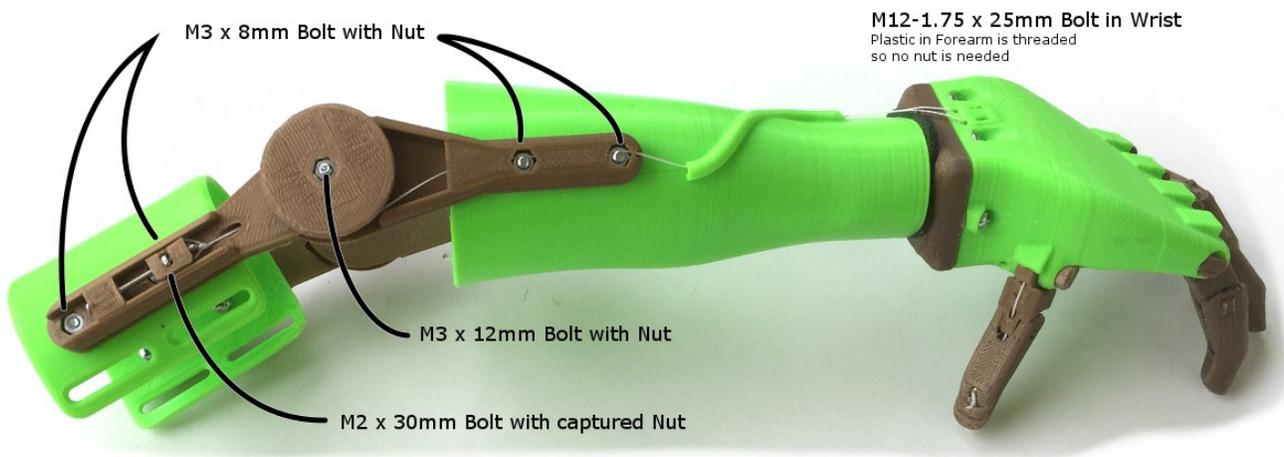


3D Printing Suggestions

- I print with 4 bottom and top layers for good thermoforming.
- Most parts I print with 35% honeycomb infill. Except the forearm, which I printed with the lowest possible infill to save on weight.
- Most parts are clear which is the flat side to print down.
- Print the Tensioner with the nut capture opening up.
- The Hinge Middle has a wide 9mm span, you may want to add scaffolding.
- You may want to add scaffolding under the finger tips.
- The Palm can have scaffolding added under the thumb connection, and the bolt retaining bump (inside the palm).

Non-Printed Parts

- Eight - M3 x 8mm bolts with nuts. These attach the hinges to the arm and cuff. If you use longer bolts they will interfere with the path of the Bowden cable.
- Two – M3 x 12mm bolts with nuts. These hold the center of the hinges together. 10mm bolts might work.
- One- M12-1.75 x 25mm bolt with hex head. This holds the wrist to the forearm. The wrist has a capture for the hex bolt head. The forearm is threaded plastic so make sure the thread count matches 1.75.
- Two – M2 x 30mm bolts with nuts. These are the tensioner bolts. The nut is captured in the tensioner itself. If you use the long tensioner then this should be a 22mm or 24mm length.
- Six – small screws. These hold the palm to the wrist. Either 14mm or 12mm long, 2mm diameter thread, less than 6mm head width.
- Bowden thread. I use Spectra. Include some sort of bead or thick knot to stop at end of fingers.
- Rubber washer between forearm and wrist.
- Padding. The padding design for the cuff and the socket are extremely important and beyond the scope of these instructions.



Assembling Hand

The fingers are the same as the RIT Arm V2.

When all the fingers are attached to the palm, they should swing freely and smoothly at the joints.

Threading the Hand

Threading the fingers in the hand is a real balancing act. There are two whippetrees in the hand. The closing lines along the bottom of the fingers attach to the lower whippetree. And all the opening lines along the top of the fingers attach to the upper whippetree. Tie the thumb lines to the top of the corresponding whippetree. Cut a very long thread and attach to the top of each whippetree, and pull those two threads through the holes in the top of the palm.

Before closing the hand, be sure the two threads properly open and close the hand. This can take a lot of adjustment. The motion of the whippetree will take the entire space inside the palm. The when the fingers are fully closed one whippetree is as far into the hand as it can get and the other is as far out as it can get. Likewise when the fingers are fully open. The tension between the thumb and fingers must also be properly adjusted.

- I put a dot of superglue on every knot once I am happy with it. Just to make sure it doesn't come undone.

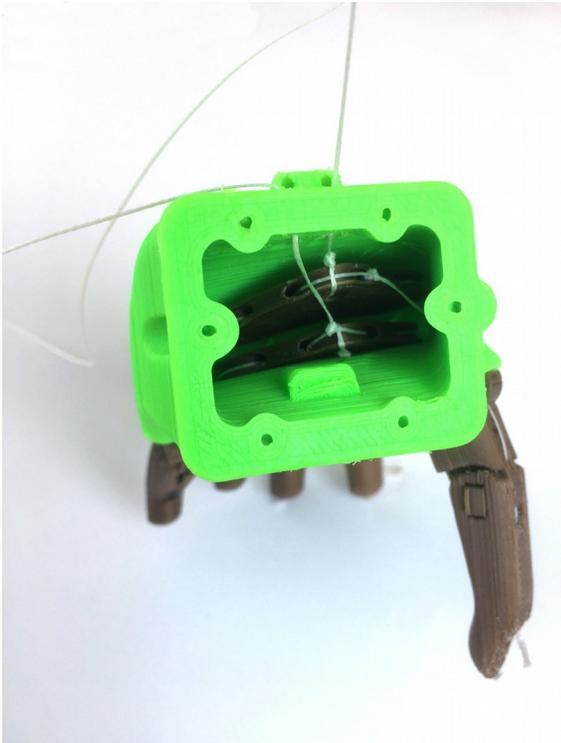


Illustration 1: Testing fingers fully open

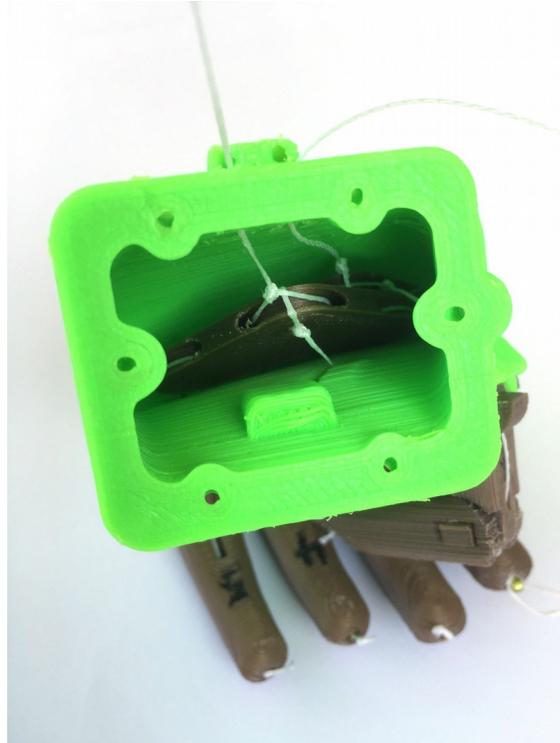
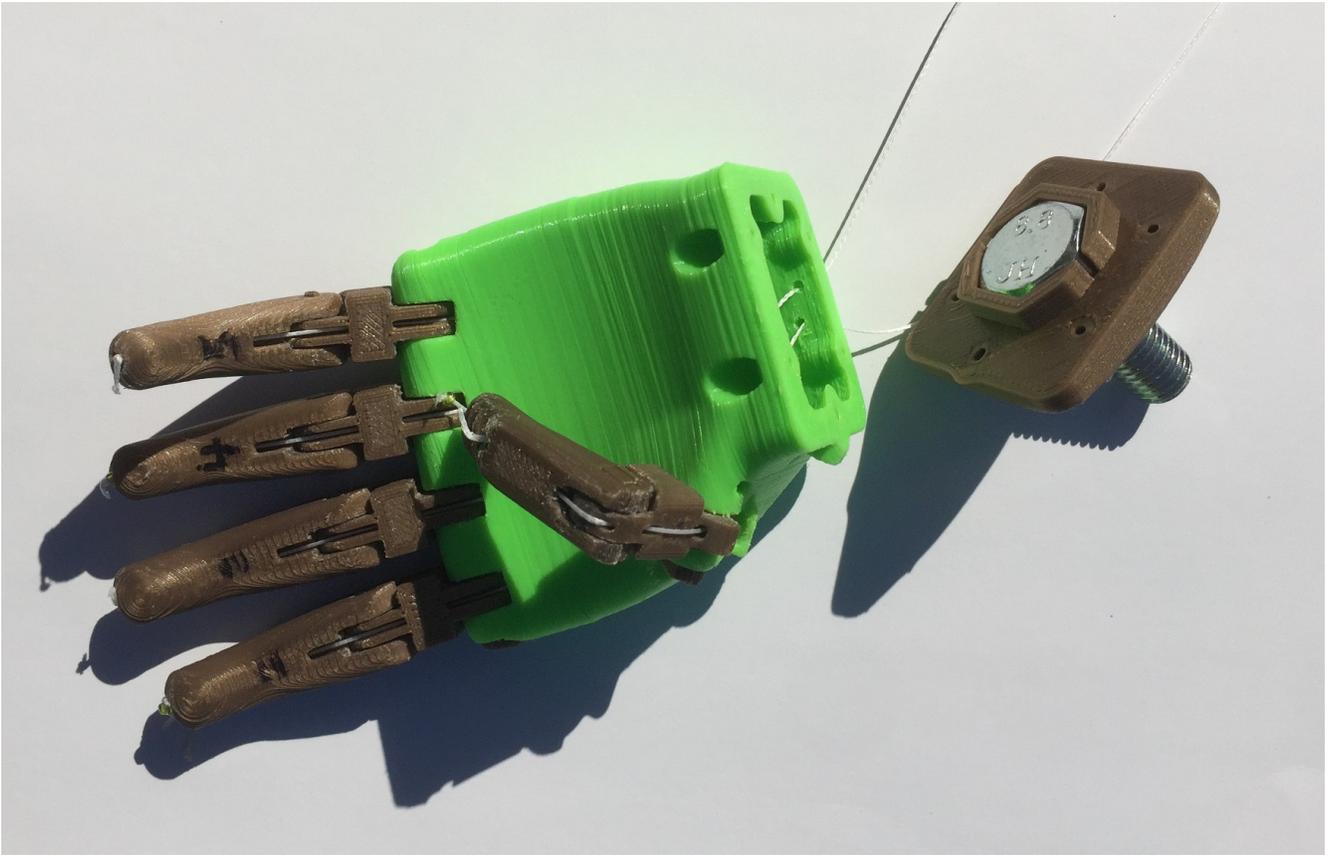


Illustration 2: Testing fingers fully closed

Attaching Hand to Wrist

The M12 bolt hex head is capture in the wrist and the small screws hold the palm to the wrist.



Assembling the Remainder of the Arm

The cuff must and the socket must thermoformed to fit the recipient. How to do that is beyond the scope of these instructions.

The two hinges must be aligned parallel to each other, and holes drilled in the socket and cuff. How to do this alignment is beyond the scope of these instructions.



Threading the Arm

Once the arm is bolted together the Bowden threads from the top of the hand can be threaded through the guides on the forearm and the guides on the hinge. One thread is guided around the top of the hinge and the other around the bottom, corresponding to whether the thread is the opening or closing thread.

If you are using the short tensioner block to get maximum tensioning range be sure to hold the Bowden thread away from the tensioning bolt when you first tighten the tension. Otherwise the action of the tensioner bolt will cut the Bowden thread. I included a longer tensioner that avoids this problem. But then range of tension adjustment is limited.

Using Elastic Openers Instead of Two Whippetrees

I find that balancing the action between the two whippetrees is very difficult. If you have time I would explore using elastics for finger opening rather than a Bowden cable. If the elastics are durable, I think this will be a better option.

When threading the hand. Instead of threading a second whippetree, thread elastic line up the back of the fingers through the palm of the hand (skipping any whippetree) and back out the second finger. The elastic line for thumb is knotted in the palm and knotted at the end of the thumb.

With elastic is used to open the hand, the second hinge and tensioner can be used for the thumb closing action. Rather than tying the thumb closing thread to the top of the whippetree, run that line from the end of the thumb all the way out the arm, using the second hinge that was used for opening. But,

running the thread on the bottom of the hinge to match the other hinge for the fingers. This allows for a separate tensioner for the thumb and fingers.

If using the elastic is a better idea I would revert some of the palm design to be more like the RIT V2. I would make it possible to rethread all the elastic without needing to open the hand. The idea is the recipient's parents could rethread the elastic easily if it breaks or gets worn out.