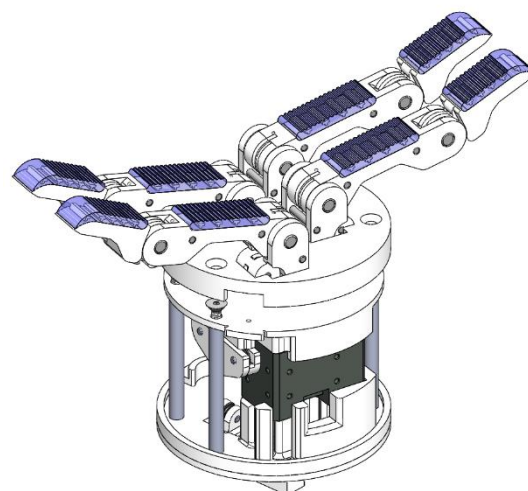
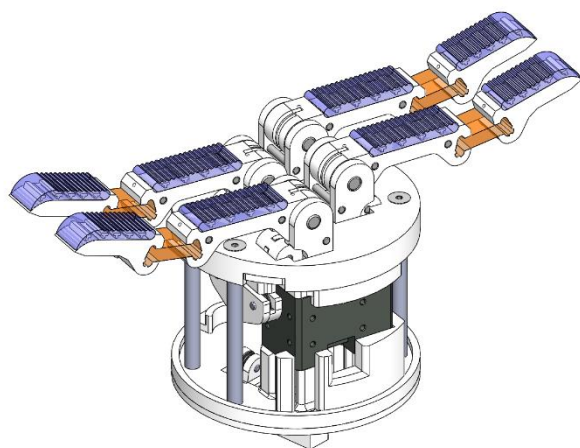
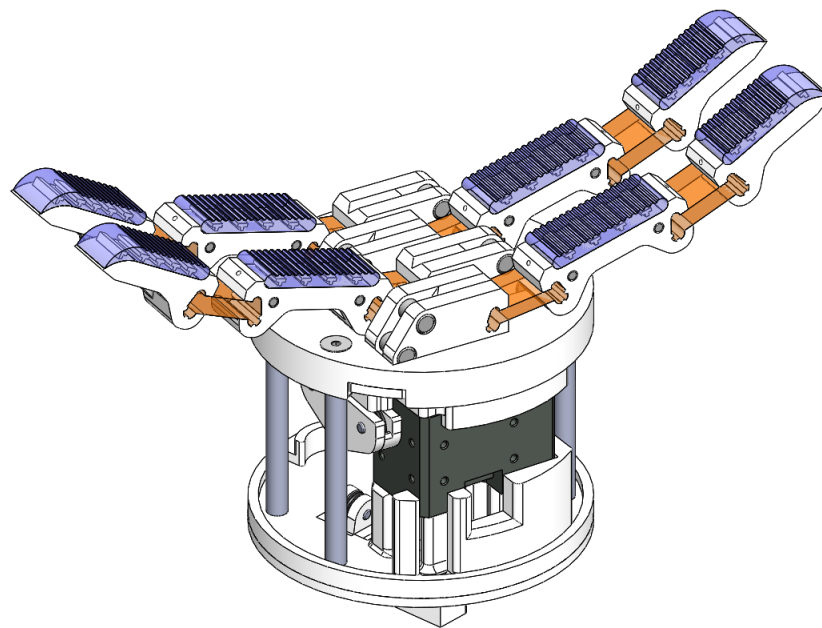




OpenHand

Model T

Version 2.0



Assembly Instructions

Last updated: July 16, 2019



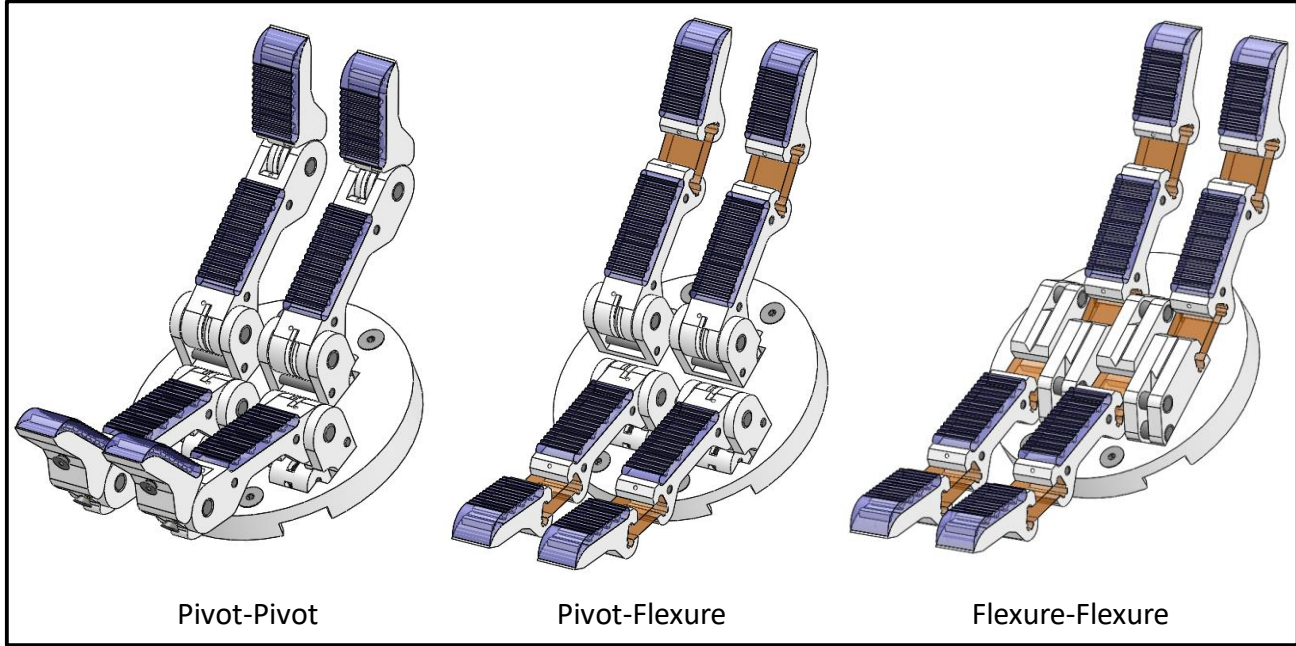
OTS Parts List

Part Name	Quantity	Description	Vendor
Power Pro Spectra	1	Tendon	Amazon [link]
PMC-780 Urethane	1	Finger Joint Urethane	Smooth-On [link]
Vytaflex 30 Urethane	1	Finger Pad Urethane	Smooth-On [link]
Ø1/4", L2-1/2", 8-32 zinc-plated female standoff	4	Support	McMaster [92474A029]
Ø1/4", L1" steel dowel pin	4	Joint pin	McMaster [98381A542]
Ø1/4", L5/8" steel dowel pin	8	Joint pin for Pivot-Pivot	McMaster [98381A539]
Ø1/8", L1" steel dowel pin	4	Routing pin	McMaster [98381A475]
Ø1/8", L5/8" steel dowel pin	12	Tendon routing pin	McMaster [98381A472]
Ø1/8", L3/8" steel dowel pin	12	Tendon routing pin	McMaster [98381A470]
8-32, L3/4" countersunk bolt	8	Support bolt	McMaster [92210A197]
M2, L5 socket head bolt	2	Horn Fastener	McMaster [91290A012]
4-40, L0.135" heat-set insert	12	Insert for bolt anchors	McMaster [93365A120]
4-40, L1/4" countersunk screw	12	Tendon/spring anchors	McMaster [91253A106]
Torsion spring, 0.340" OD, 0.028" wire diameter	4	Return spring, alternative to extension springs	McMaster [9271k605]
Extension spring, 0.188" OD, L3/4", 0.016" wire diameter	8	Return spring, alternative to torsion spring at proximal	McMaster [9654k955]
Ø3/8", nylon pulley	9	Tendon-routing pulley	McMaster [3434t31]
Dynamixel XM430-W350-R	1	Actuator	Various [Link]

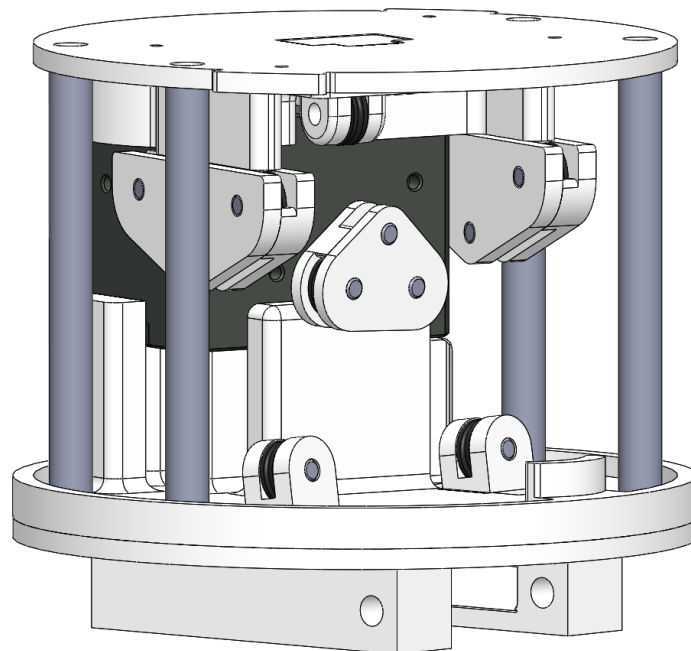


Overview

Finger Options



Actuator Base





Finger Sub-Assembly

Pivot-Flexure

Parts

finger_pf_torsion_o.stl
 - or -
 finger_pf_ext_o.stl
 - or -
 finger_pf_mold1_torsion_A_o.stl
 finger_pf_mold1_B_o.stl
 finger_pf_mold[2-4]_o.stl
 - or -
 finger_pf_mold1_ext_A_o.stl
 finger_pf_mold1_B_o.stl
 finger_pf_mold[2-4]_o.stl

(x4)

PMC-780 (2:1)

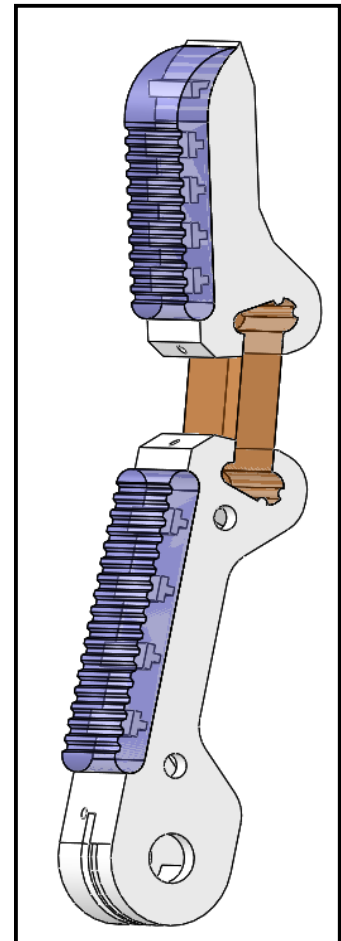
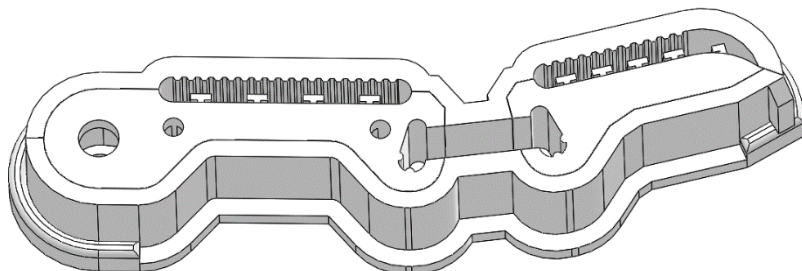
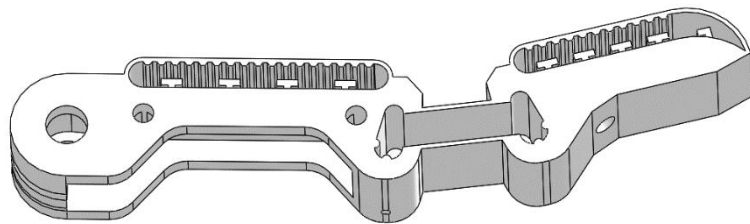
Vytaflex 30 (1:1)



Go to page 5 for Pivot-Pivot finger sub-assembly

Go to page 9 for Flexure-Flexure finger sub-assembly

You have a choice of pivot or torsion spring base, and the option of using whether a thin-wall mold or multi-part mold. Refer to the *OpenHand Finger Guide* for more detail on casting these pads and flexures



Skip to page 7



Finger Sub-Assembly

Pivot-Flexure

Parts

Pivot-Flexure Forefinger (x4)

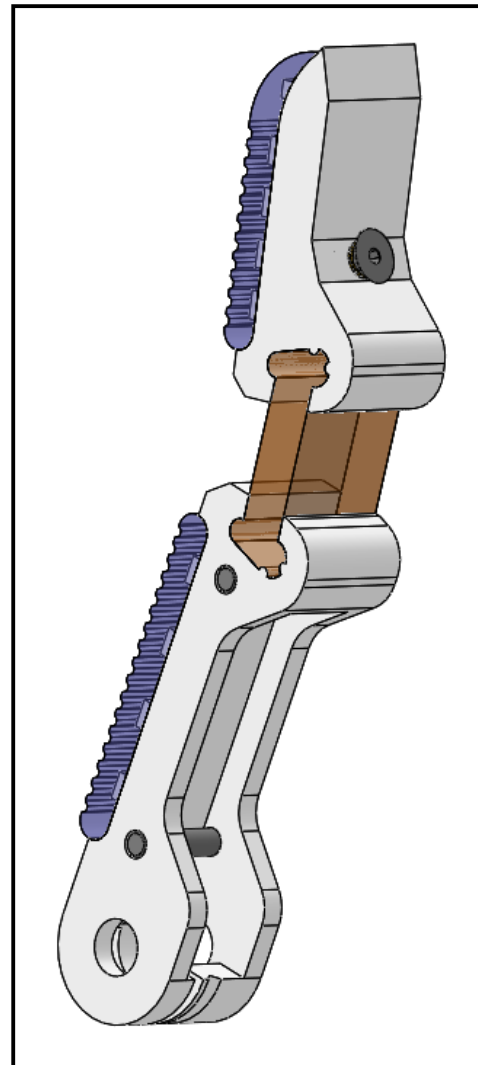
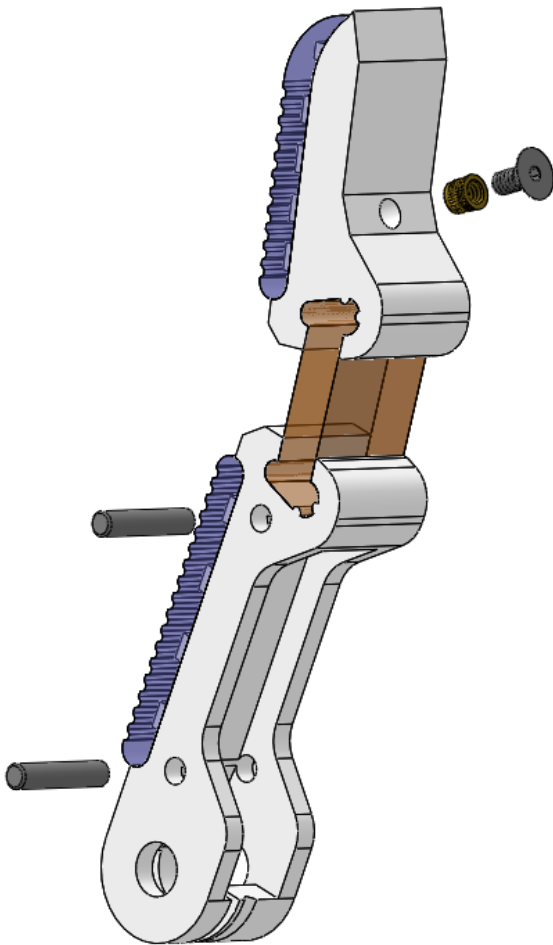
4-40, L0.135" heat-set insert (x4)

4-40, L1/4" countersunk screw (x4)

$\varnothing 1/8"$, L5/8" steel dowel pin (x8)



Press fit the 1/8" dowel pins for tendon-rerouting into the proximal link and back of the fingers. Use a soldering iron to install the heat-set insert into the distal link. The heat-set insert can be skipped in favor of using a nut for tendon termination.





Finger Sub-Assembly

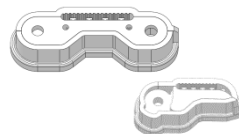
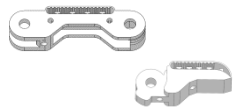
Pivot-Pivot

Parts

- finger_pp_torsion_A_t.stl
- finger_pp_B_t.stl
- or -
- finger_pp_ext_A_t.stl
- finger_pp_B_t.stl
- or -
- finger_pp_torsion_mold1_A_t.stl
- finger_pp_mold[2-4]_A_t.stl
- finger_pp_mold1_B_t.stl
- finger_pp_mold[2-4]_B_t.stl
- or -
- finger_pp_ext_mold1_A_t.stl
- finger_pp_mold[2-4]_A_t.stl
- finger_pp_mold1_B_t.stl
- finger_pp_mold[2-4]_B_t.stl

(x4)

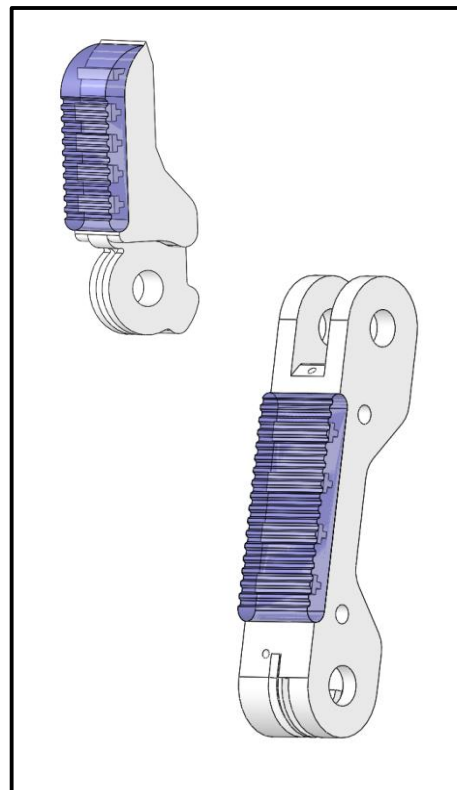
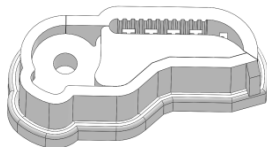
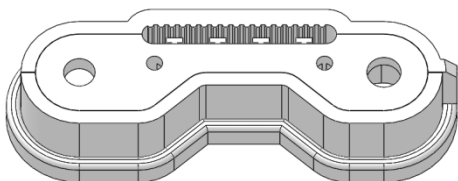
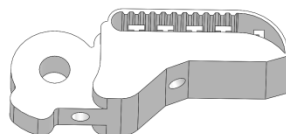
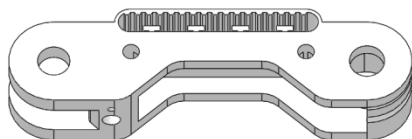
Vytaflex 30 (1:1)



Go back to page 3 for Pivot-Flexure finger sub-assembly

Go to page 9 for Flexure-Flexure finger sub-assembly

You have a choice of pivot or torsion spring base, and the option of using whether a thin-wall mold or multi-part mold. Refer to the *OpenHand Finger Guide* for more detail on casting these pads. There are no flexures needed for Pivot-Pivot finger design





Finger Sub-Assembly

Pivot-Pivot

Parts

Pivot-Pivot finger distal link (x4)

Pivot-Pivot finger proximal link (x4)

4-40, L0.135" heat-set insert (x12)

4-40, L1/4" countersunk screw (x12)

Ø1/8", L5/8" steel dowel pin (x8)

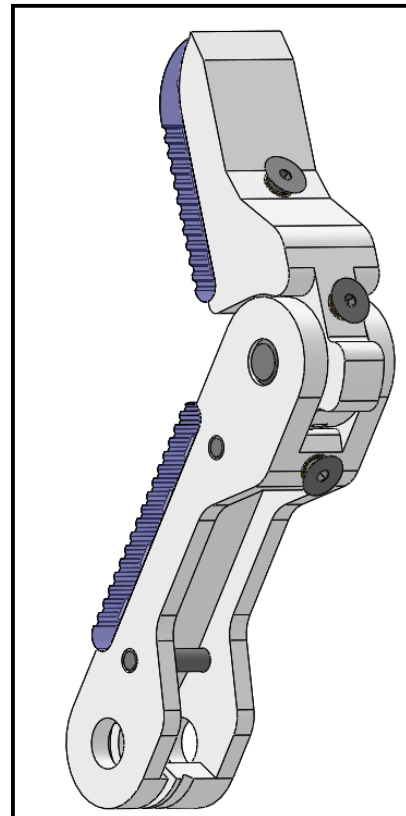
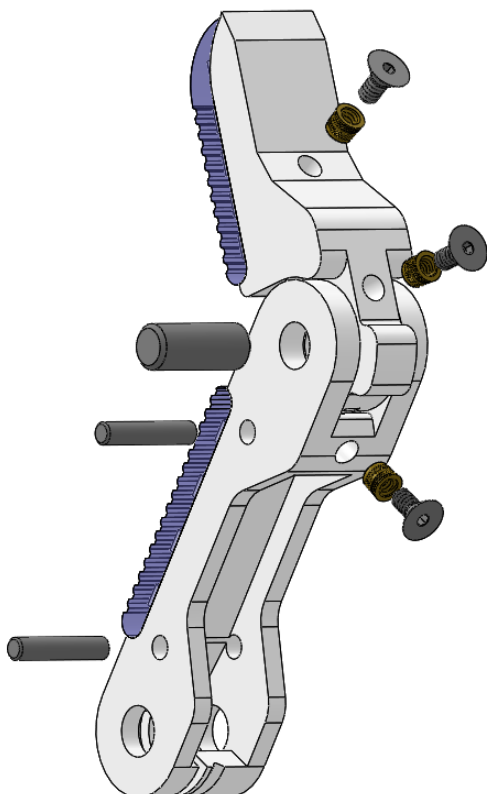
Ø1/4", L5/8" steel dowel pin (x4)

Extension spring (x4)



Install the 4-40 inserts for the distal joint spring and the distal tendon anchor. You can alternatively thread a bolt directly into the specified points. An extension spring or elastic band should be anchored on bolts threaded into the inserts closest to the distal joint.

Tendon routing pins (1/8") and joint pin (1/4") can be pressed in by hand, but a large pair of pliers or a vice may be helpful.





Finger Sub-Assembly

Pivot-Flexure of Pivot-Pivot

Parts

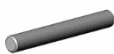
a1_p_t.stl

c1_t.stl (x4)

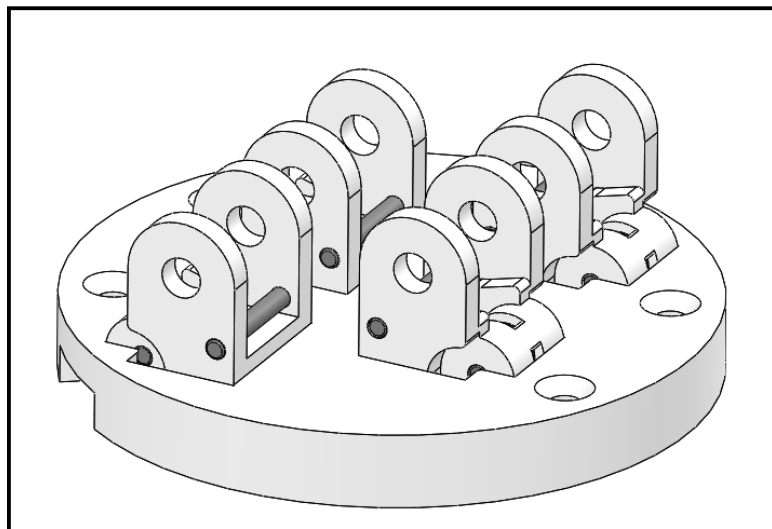
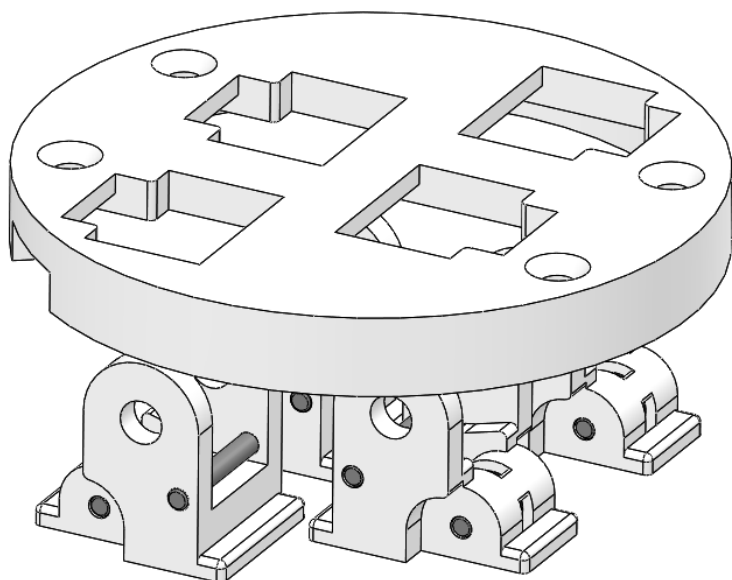
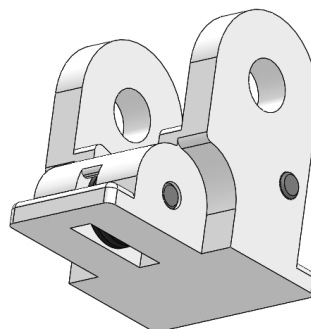
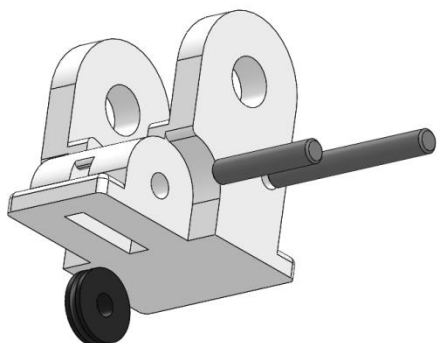
Ø1/8", L1" steel dowel pin (x4)

Ø1/8", L5/8" steel dowel pin (x4)

Ø3/8" nylon pulley (x4)



For either the Pivot-Flexure or Pivot-Pivot fingers, the support sub-assembly is the same. Ensure that the nylon pulley is spinning freely after assembly.





Finger Sub-Assembly

Pivot-Flexure of Pivot-Pivot

Parts

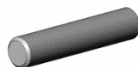
Pivot-Flexure finger sub-assembly
- or -
Pivot-Pivot finger sub-assembly
(x4)



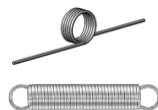
top sub-assembly from previous page



Ø1/4", L1" steel dowel pin
(x4)

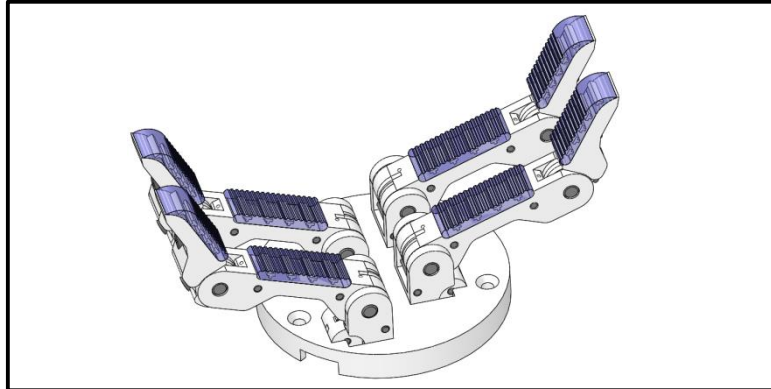
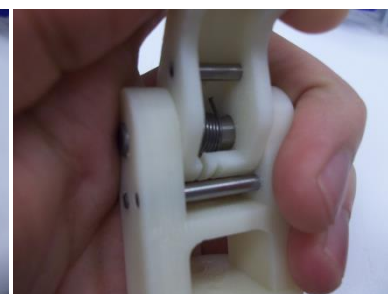
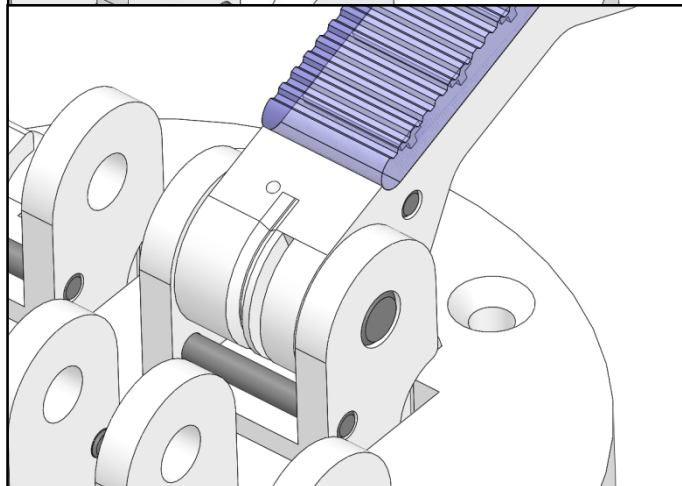
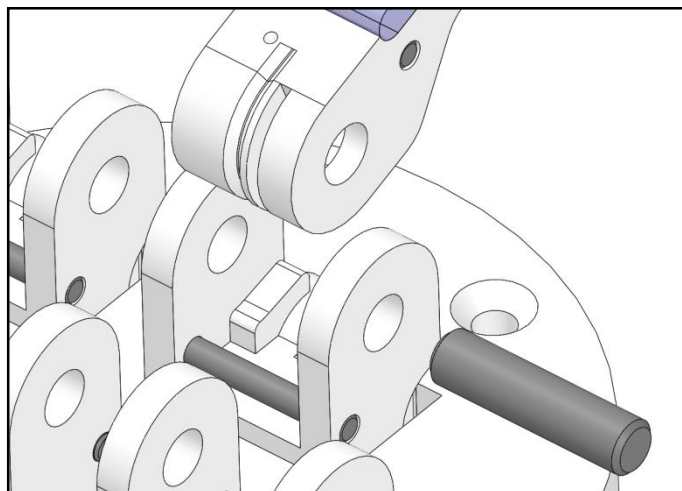


Torsion spring
- or -
Extension spring
(x4)



For either the Pivot-Flexure or Pivot-Pivot fingers, the installation onto the base part *c1_t.stl* is the same. The finger is held in place by a press-fit 1/4" steel dowel pin. Refer to the *OpenHand Finger Guide* for how to install the torsion spring or extension spring at the base joint.

Example shown below is from the Model O, but the spring implementation is nearly identical.



Skip to page 12



Finger Sub-Assembly

Flexure-Flexure

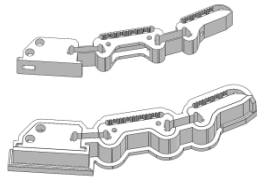
Parts

finger_ff_t.stl
- or -
finger_ff_mold1_[A-C]_t.stl
finger_ff_mold[2-4]_t.stl

(x4)

PMC-780 urethane (2:1)

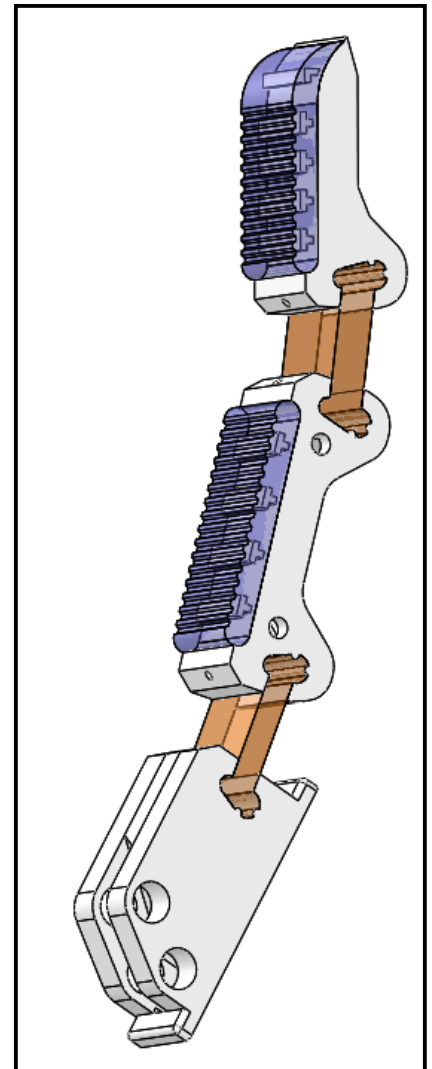
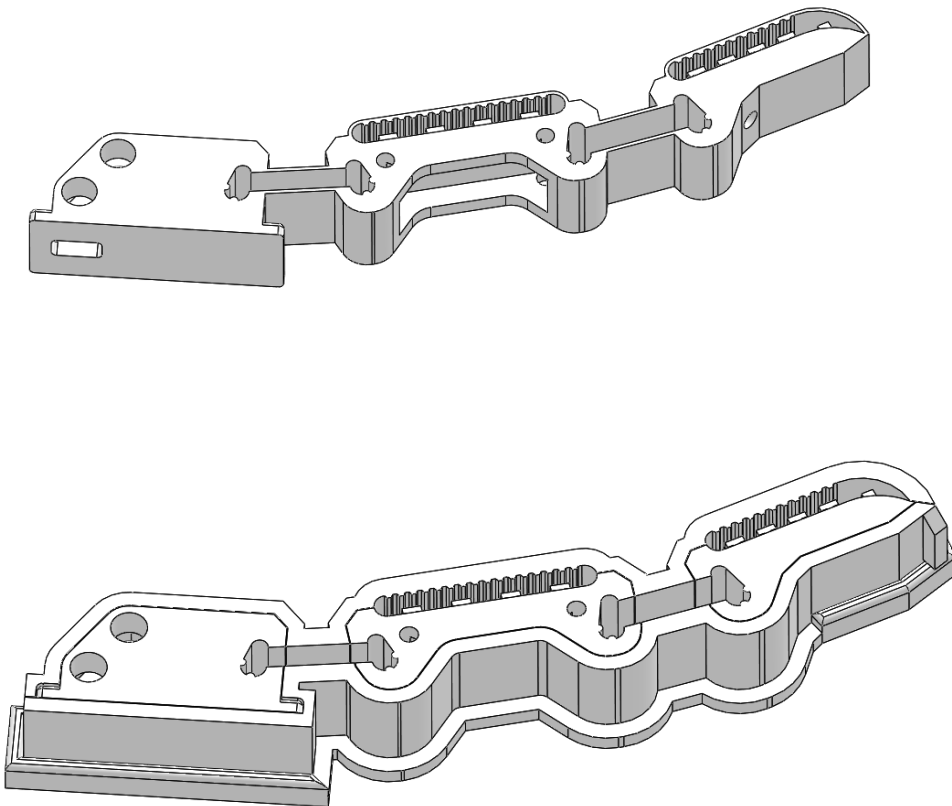
Vytaflex 30 urethane (1:1)



Go to page 3 for Pivot-Flexure finger sub-assembly

Go to page 5 for Pivot-Pivot finger sub-assembly

Refer to the *OpenHand Finger Guide* for more detail on casting these pads and flexures. No pins or additional elastic elements are needed for the joints in the Flexure-Flexure finger design.





Finger Sub-Assembly

Flexure-Flexure

Parts

Flexure-flexure finger from page 9 (x4)

4-40, L0.135" heat-set insert (x4)

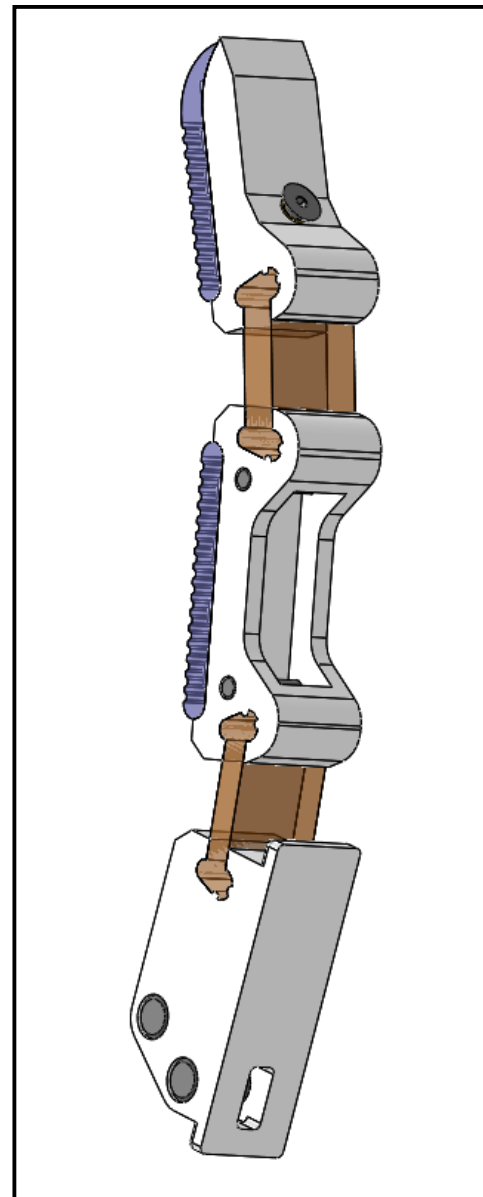
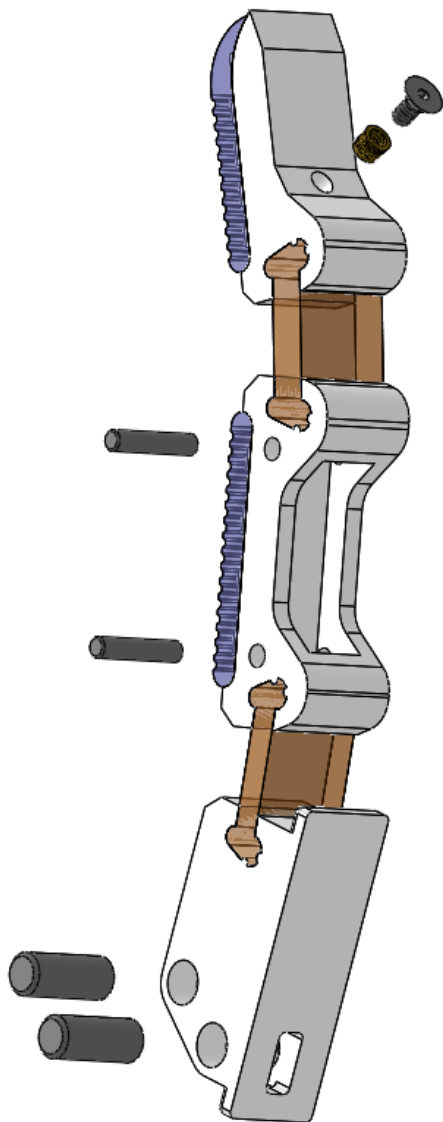
4-40, L1/4" countersunk screw (x4)

Ø1/8", L5/8" steel dowel pin (x8)

Ø1/4", L5/8" steel dowel pin (x8)



Press fit the 1/8" dowel pins for tendon-rerouting into the proximal link. Press fit the 1/4" dowel pins in the base of the fingers. If the pins do not press-fit easily, use a larger reamer to clean out the pin clearances or a vice. Use a soldering iron to install the heat-set insert into the distal link. The heat-set insert can be skipped in favor of using a nut for tendon termination.





Finger Sub-Assembly

Flexure-Flexure

Parts

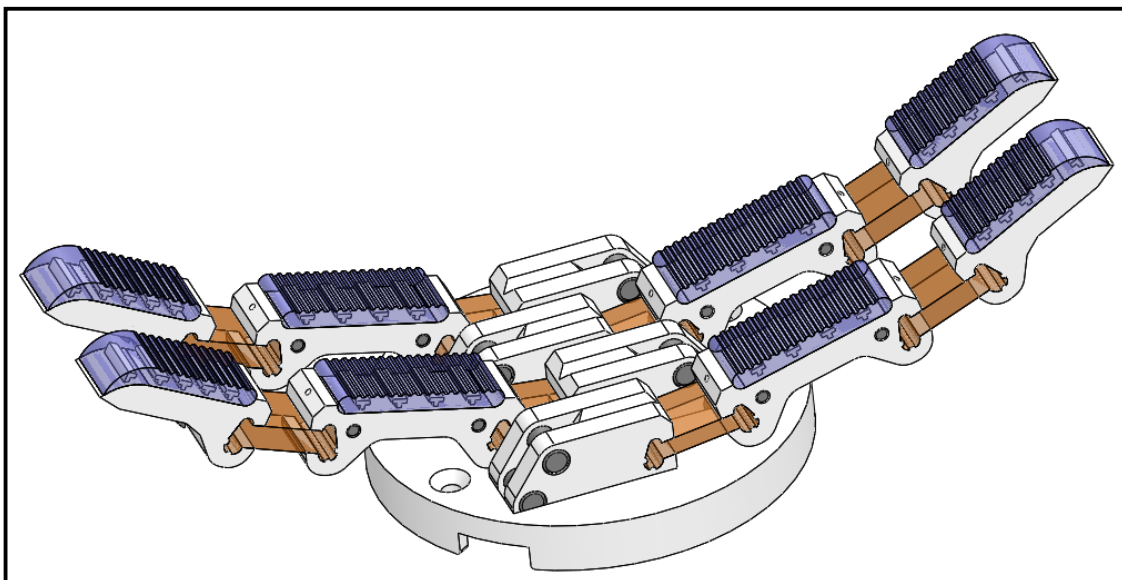
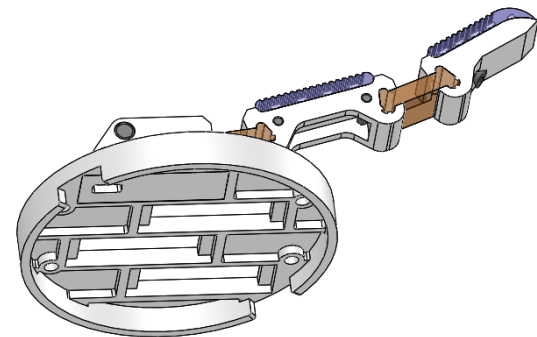
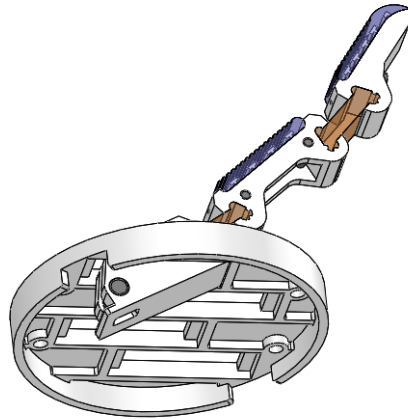
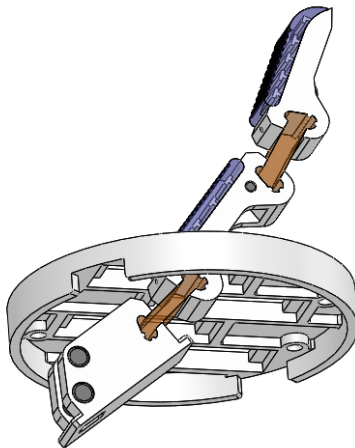
Flexure-flexure finger sub-assembly from previous page (x4)

a1_f_t.stl



The Flexure-Flexure fingers are simply inserted up through the top plate *a1_f_t.stl* and press-fit into place.


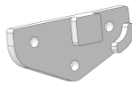




Note the positioning and orientation of the fingers. The Flexure-Flexure design uses a non-intuitive orientation of the fingers that may be confusing to some users.





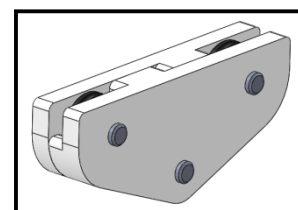
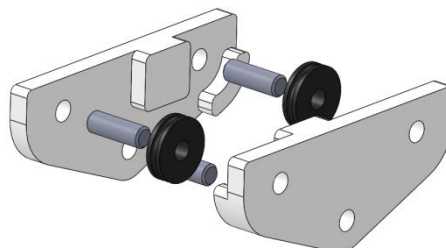
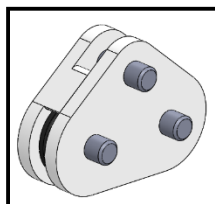
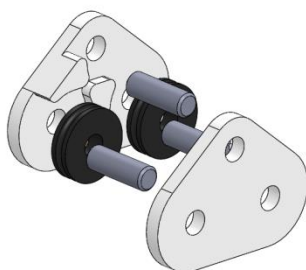
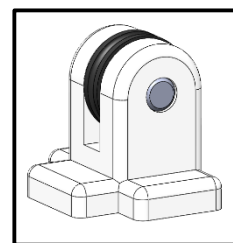
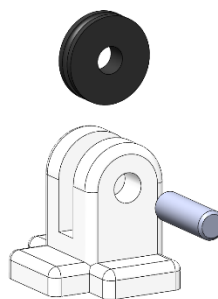
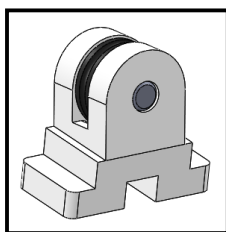
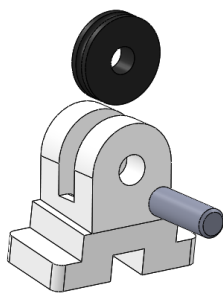
Actuator Sub-Assembly

Pulley Blocks

Parts	
b2_t.stl (x2)	
b3_t.stl (x4)	
b5_t.stl (x2)	
b6_t.stl (x1)	
∅1/8", L3/8" steel dowel pin (x12)	
∅3/8" nylon pulley (x9)	

Pulley blocks are assembled with press-fit 1/8" pins and nylon pulleys. Ensure that the nylon pulleys are free-spinning after assembly for all blocks.

It may be necessary to use a pair of pliers to press-fit all items together properly.





Final Assembly

Flexure-Flexure Top

Parts

top finger sub-assembly from page 11

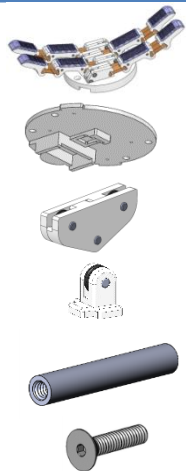
a2_t.stl

b3 sub-assembly from page 12 (x2)

b6 sub-assembly from page 12 (x1)

∅1/4", L2-1/2", 8-32 zinc-plated female standoff (x4)

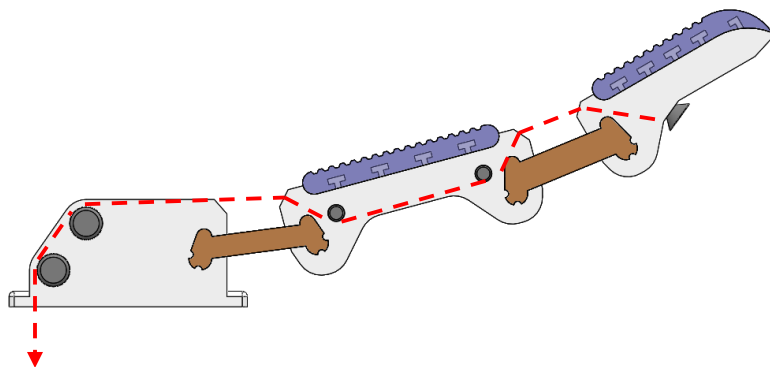
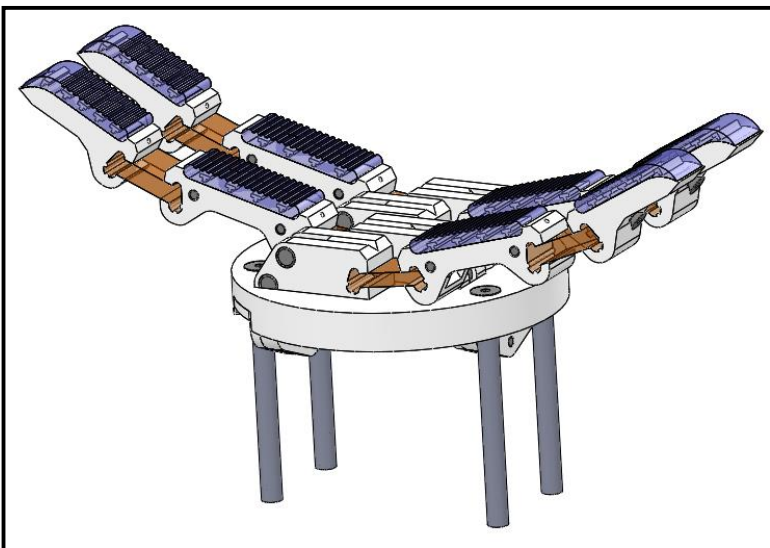
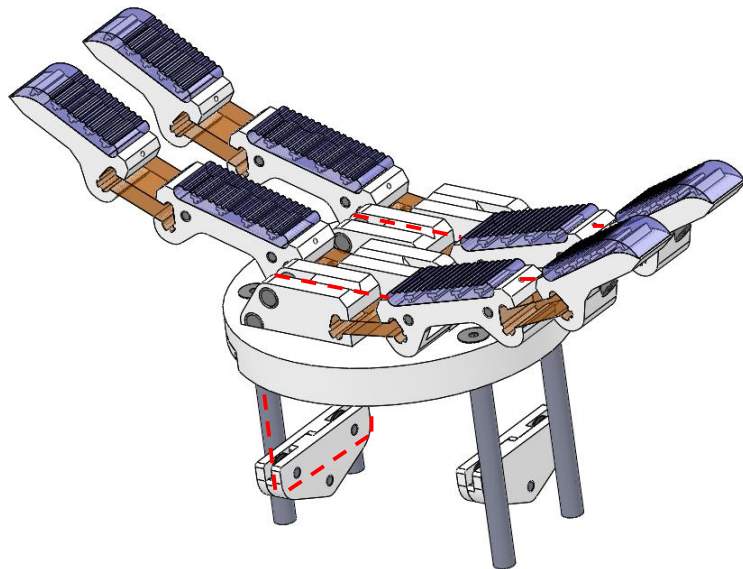
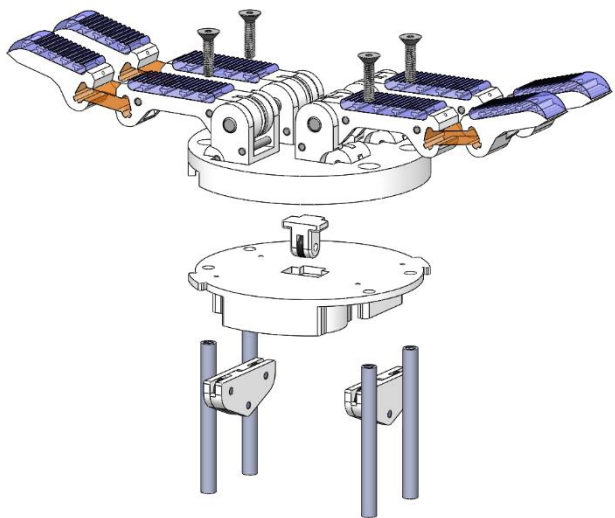
8-32, L3/4" countersunk bolt (x4)



For Pivot-base tops, go to page 14

Regardless of finger type, the top plate is attached to *a2_t.stl* and incorporate the b3 floating pulley block in the same way. The top two layers are sandwiched with 8-32 bolts and standoffs, and tendons are tied between the ends of finger pairs as shown such that the b3 pulley block is held taut against the bottom of *a2_t.stl*.

Note how the tendon should be routed in the diagram below.





Final Assembly

Pivot-Pivot or Pivot-Flexure Top

Parts

top finger sub-assembly from page 8

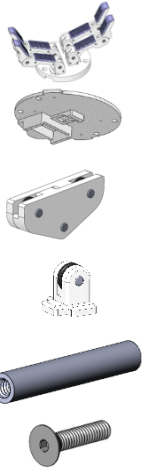
a2_t.stl

b3 sub-assembly from page 12 (x2)

b6 sub-assembly from page 12 (x1)

Ø1/4", L2-1/2", 8-32 zinc-plated female standoff (x4)

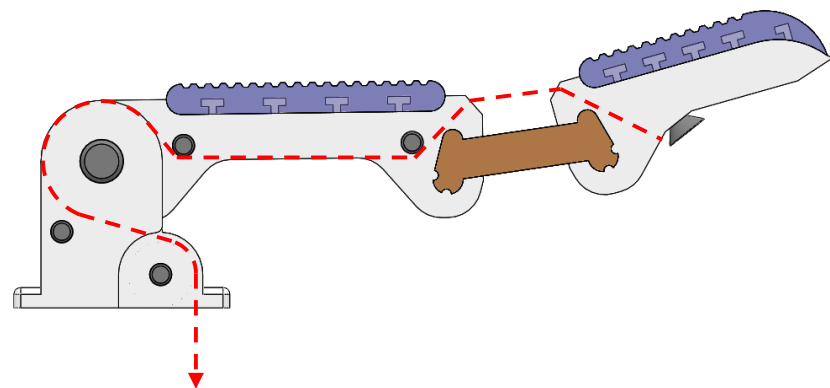
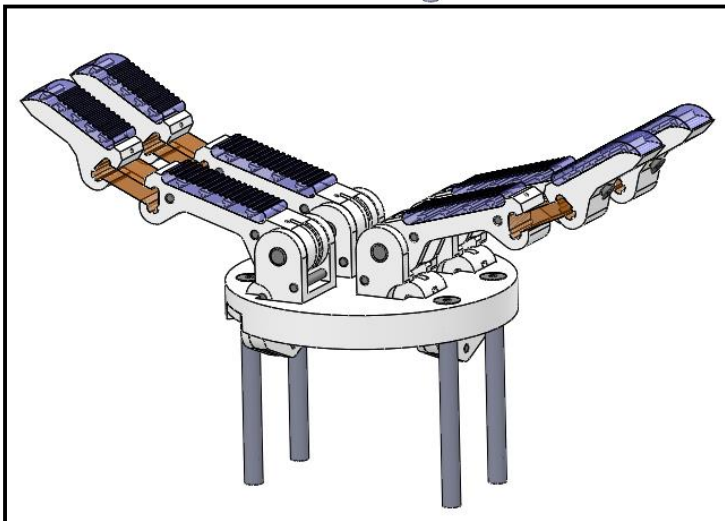
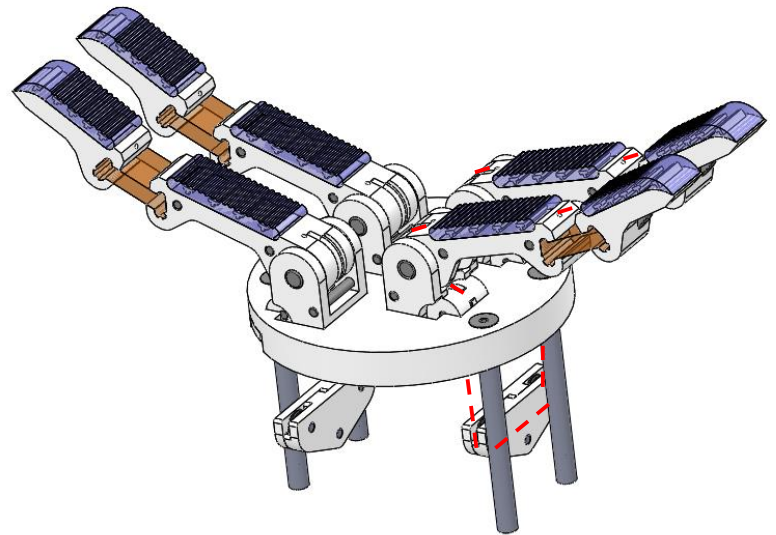
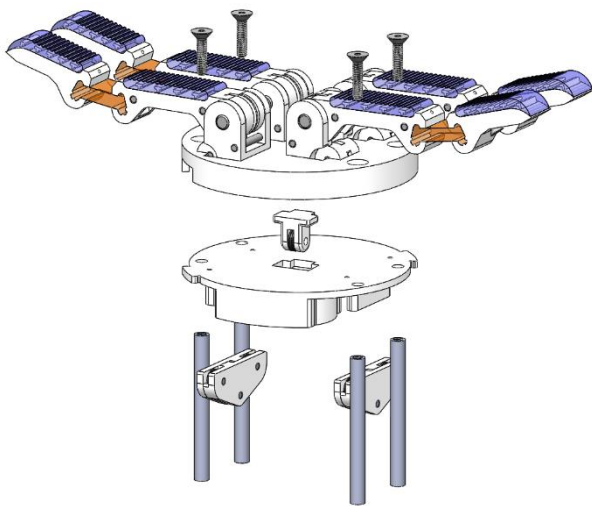
8-32, L3/4" countersunk bolt (x4)



For Pivot-base tops, go back to page 13

Regardless of finger type, the top plate is attached to *a2_t.stl* and incorporate the b3 floating pulley block in the same way. The top two layers are sandwiched with 8-32 bolts and standoffs, and tendons are tied between the ends of finger pairs as shown such that the b3 pulley block is held taut against the bottom of *a2_t.stl*.

Note how the tendon should be routed in the diagram below. It is different from the Flexure-Flexure model.





Final Assembly

Motor Insert

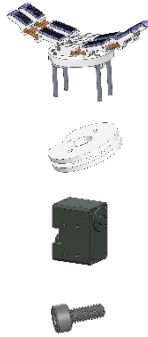
Parts

hand top sub-assembly from page 13 (FF) or page 14 (PF)

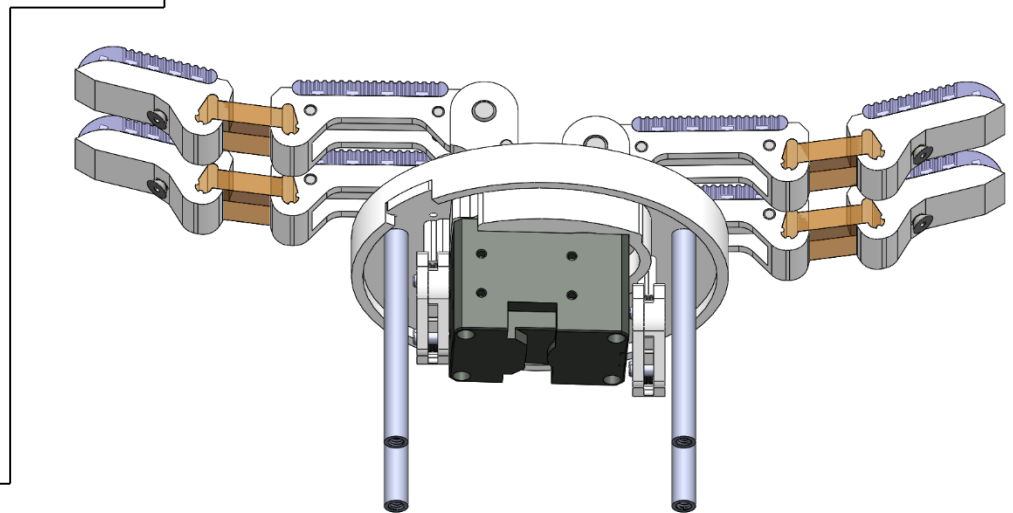
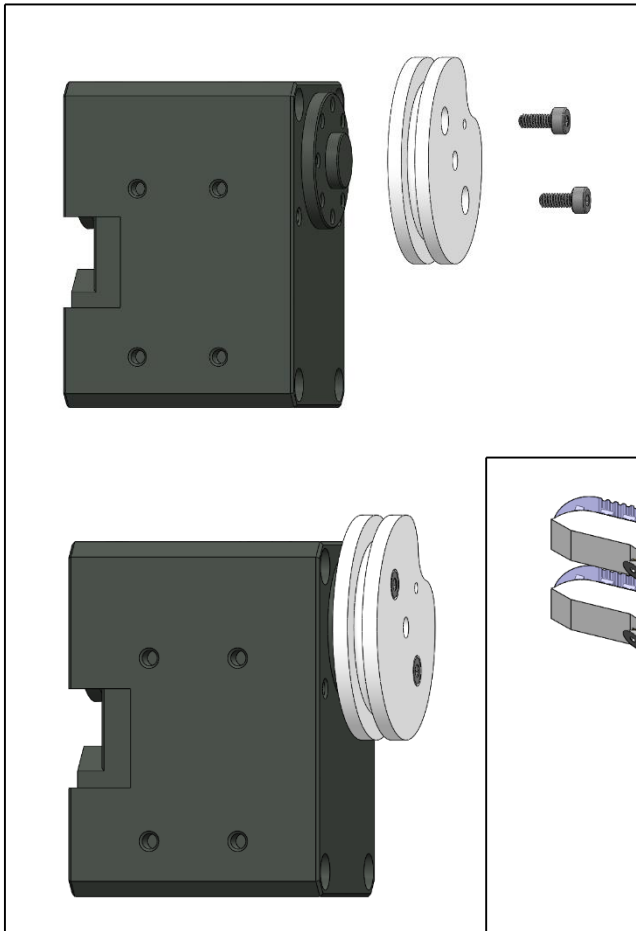
b1_t.stl

Dynamixel XM430 (x1)

M2, L5mm socket head screw (x2)



The motor horn pulley piece (*b1_t.stl*) is held into the motor by two M2, L5mm socket head screws. For easier installation, assemble the motor piece before inserting it into the hand top sub-assembly.





Final Assembly

Securing Main Transmission (1/2)

Parts

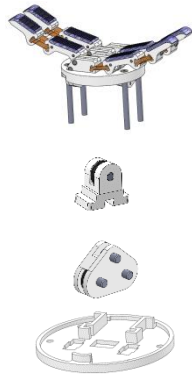
top finger assembly from page 15 or 16

b2 block from page 12

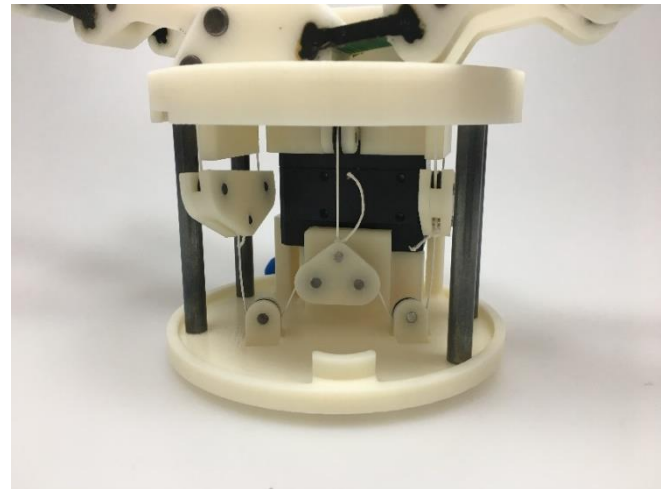
b5 block from page 12

a3_t.stl

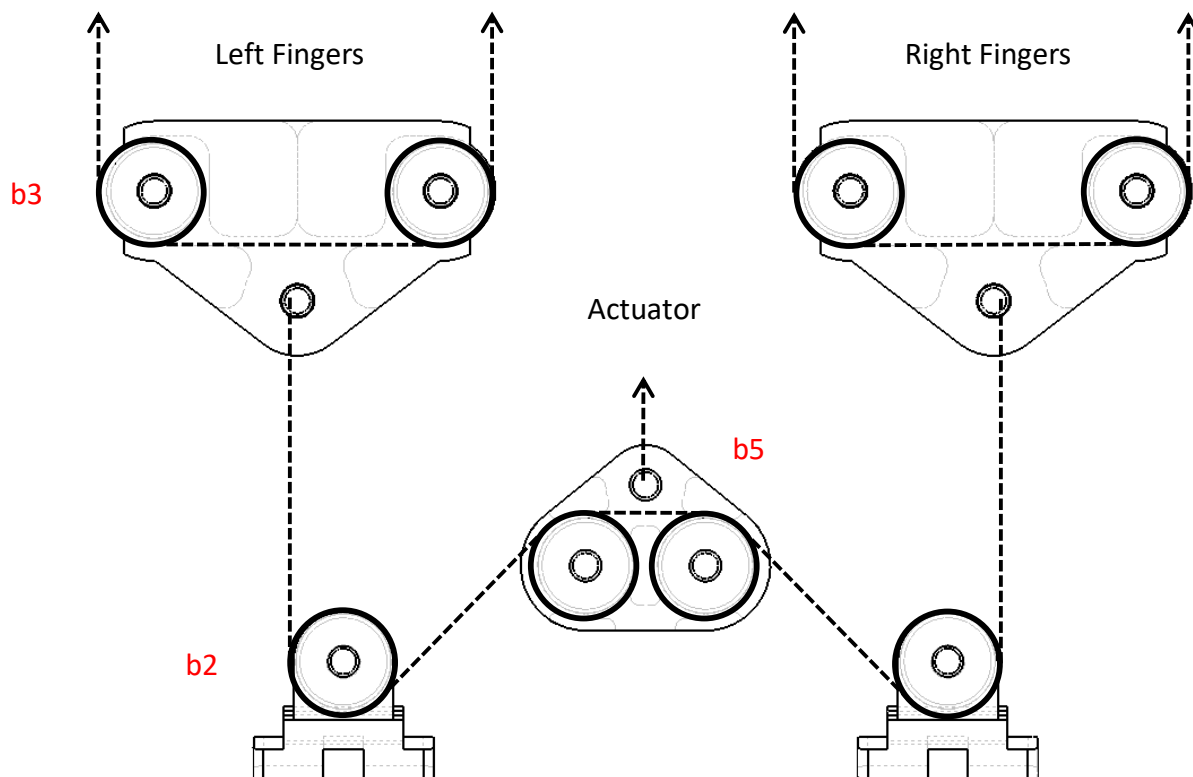
Spectra tendon line



This is probably the most difficult part of the build. Refer to the transmission diagram below for how the tendon should tie the b3 floating pulley blocks, through the b2 and b5 blocks. The XM430 motor will have to be removed to tie *b5_t.stl* to the pulley horn. This tendon runs through the upper pulley block, *b6_t.stl*.



Transmission Diagram



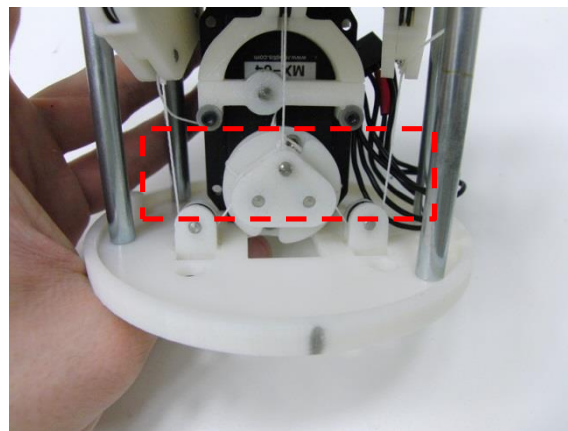
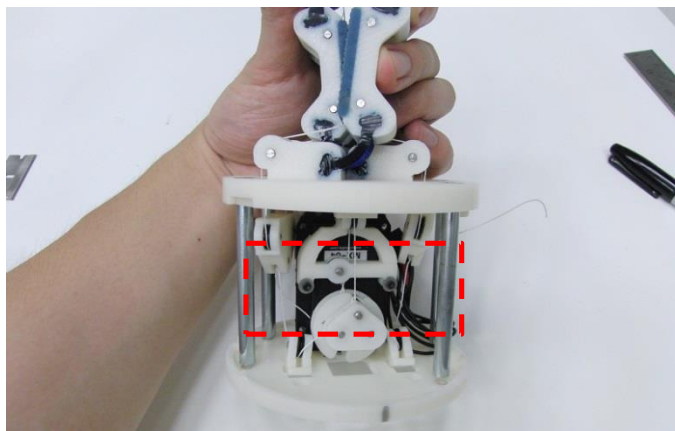
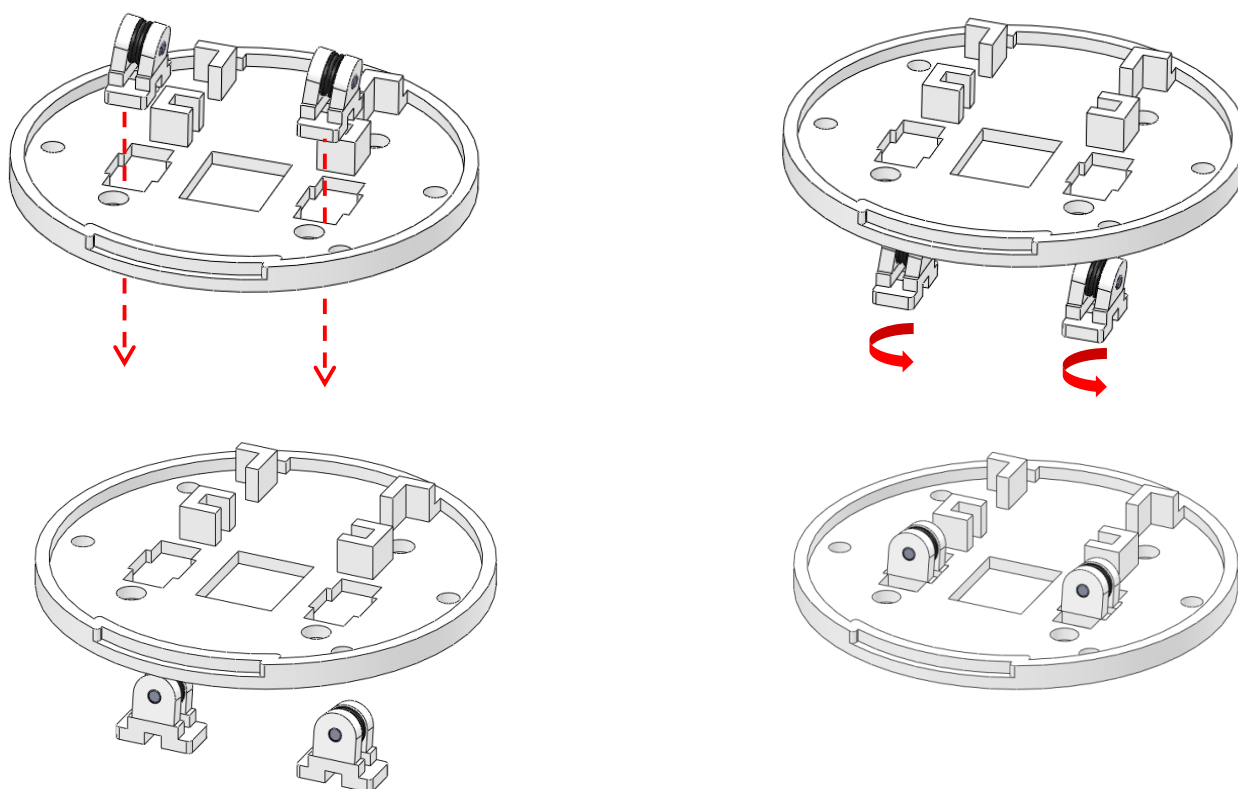


Final Assembly

Securing Main Transmission (2/2)

Note that the slots in *a3_t.stl* allow for the b2 pulley blocks to be pulled completely through. This can allow you to tie a set length of tendon between the floating b3 blocks before anchoring the b2 blocks to the bottom of the hand. To generate more slack, you can manually close the fingers as shown.

Example shown below is from Version 1.0 of the Model T, but these steps are identical.





Final Assembly

Bottom Plate

Parts

completed sub-assembly from previous page

a4_coupling_t.stl
- or -
a4_blank_t.stl

8-32, L3/4" countersunk bolt (x4)

