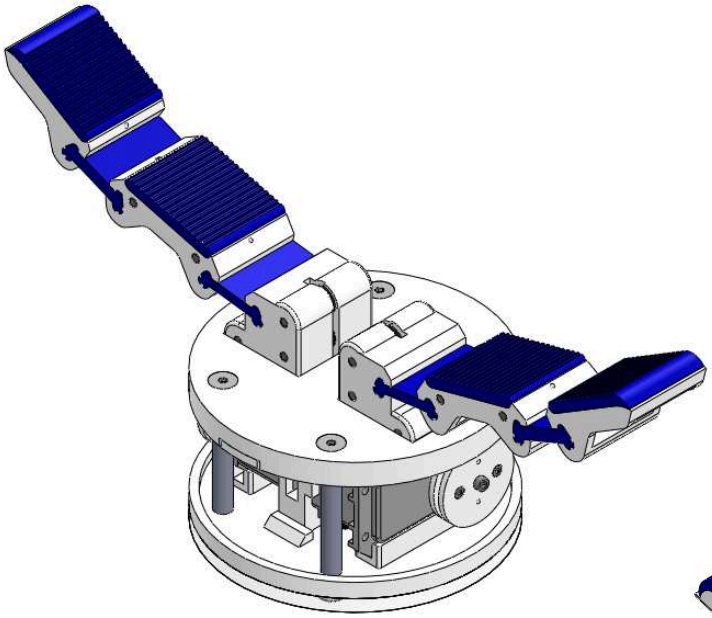
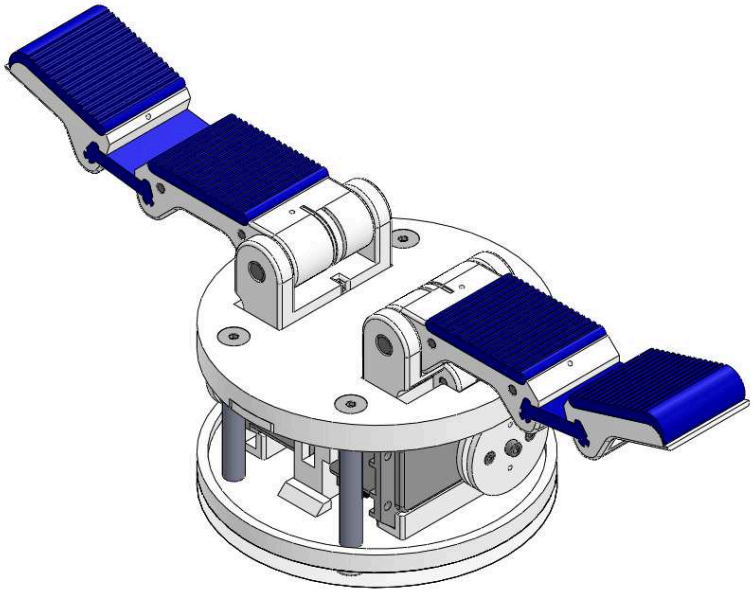
OpenHand

Model T42

Version 0.3





Assembly Instructions

Last updated: May 28, 2013

the GRAB LAB

Parts List (Flexure Base)

Part Name	Quantity	Usage	Vendor
a1.stl	1	Top Plate	3D Print
a2.stl	1	Top Keeper Plate	3D Print
a3.stl	1	Bottom Plate	3D Print
a4.stl	1	Bottom Keeper Plate	3D Print
b1.stl	1	Central Coupler	3D Print
b2.stl	2	Servo Pulley	3D Print
finger_flexure.stl	2	Finger Molds	3D Print
Robotis RX-28 Dynamixel	2	Actuator	Robotis [link]
Ø1/8”, L1-1/4” steel dowel pin (J1)	10	Support Pin	McMaster [98381A477]
Ø3/8”, Wd1/8” nylon pulley (P1)	6	Tendon Routing	McMaster [3434T31]
M2.5, L5mm bolt	2	Fastener	Provided w/ Dynamixel McMaster [92290A055]
M2, L5mm bolt	4	Fastener	McMaster [91290A012]
Socket Cap Screw 8-32, L3/4”	8	Fastener	McMaster [91253A197]
Ø1/4”, L1-1/2” zinc-plated female standoff (S1)	4	Support	McMaster [93330A482]
PMC-780 Urethane	1	Finger Joint Urethane	Smooth-On [link]
Vytaflex 30 Urethane	1	Finger Pad Urethane	Smooth-On [link]
Power Pro Spectra	1	Tendon	Amazon [link]

* optional

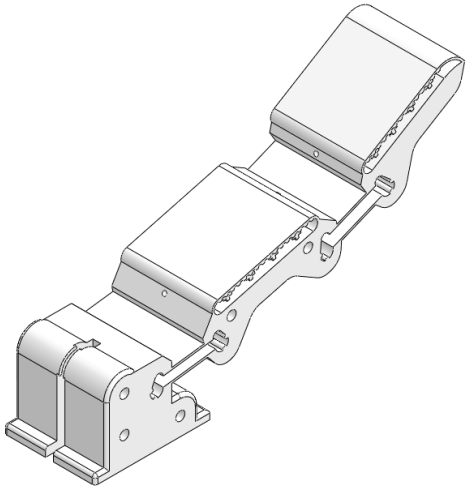
Parts List (Pivot Base)

Part Name	Quantity	Usage	Vendor
a1.stl	1	Top Plate	3D Print
a2.stl	1	Top Keeper Plate	3D Print
a3.stl	1	Bottom Plate	3D Print
a4.stl	1	Bottom Keeper Plate	3D Print
b1.stl	1	Central Coupler	3D Print
b2.stl	2	Servo Pulley	3D Print
c1.stl	2	Finger Pivot Base	3D Print
finger_pivot.stl	2	Finger Molds	3D Print
Robotis RX-28 Dynamixel	2	Actuator	Robotis [link]
Ø1/8”, L1-1/4” steel dowel pin (J1)	4	Support Pin	McMaster [98381A477]
Ø1/4”, L1-3/4” steel dowel pin (J2)	2	Joint Pin	McMaster [98381A548]
Ø1/8”, L5/8” steel dowel pin (J3)	6	Support Pin	McMaster [98381A477]
Ø3/8”, Wd1/8” nylon pulley (P1)	2	Tendon Routing	McMaster [3434T31]
Torsion Spring, Ø0.34”, 0.028” wire diameter, 180˚, left-hand wound	2	Joint Return Spring	McMaster [9271K605]
M2.5, L5mm bolt	2	Fastener	Provided w/ Dynamixel McMaster [92290A055]
M2, L5mm bolt	4	Fastener	McMaster [91290A012]
Socket Cap Screw 8-32, L3/4”	8	Fastener	McMaster [91253A197]
Ø1/4”, L1-1/2” zinc-plated female standoff (S1)	4	Support	McMaster [93330A482]
PMC-780 Urethane	1	Finger Joint Urethane	Smooth-On [link]
Vytaflex 30 Urethane	1	Finger Pad Urethane	Smooth-On [link]
Power Pro Spectra	1	Tendon	Amazon [link]

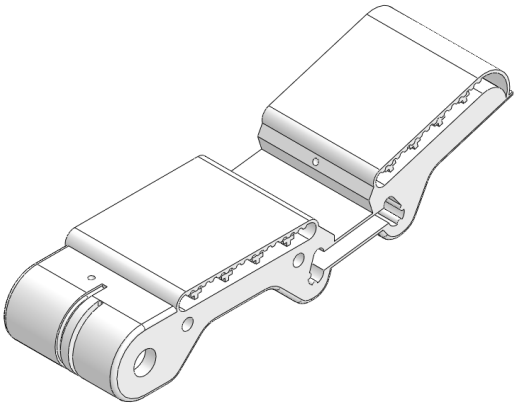
* optional

Part Preparation

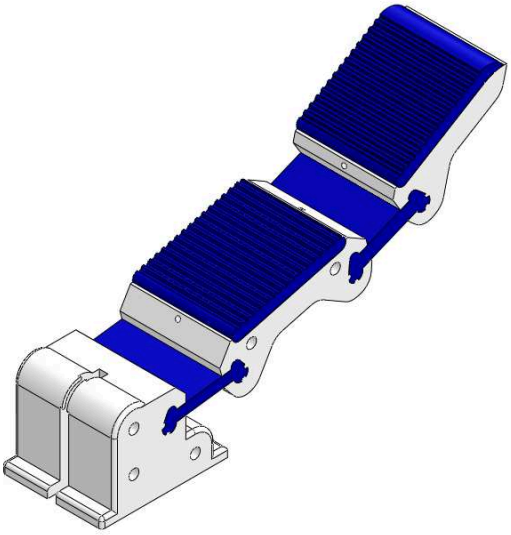
FINGER MOLDING

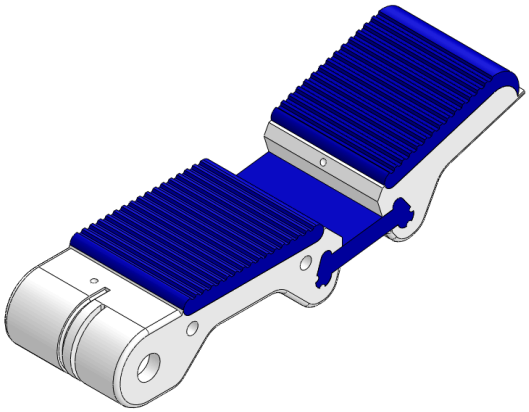


finger_flexure.stl



finger_pivot.stl

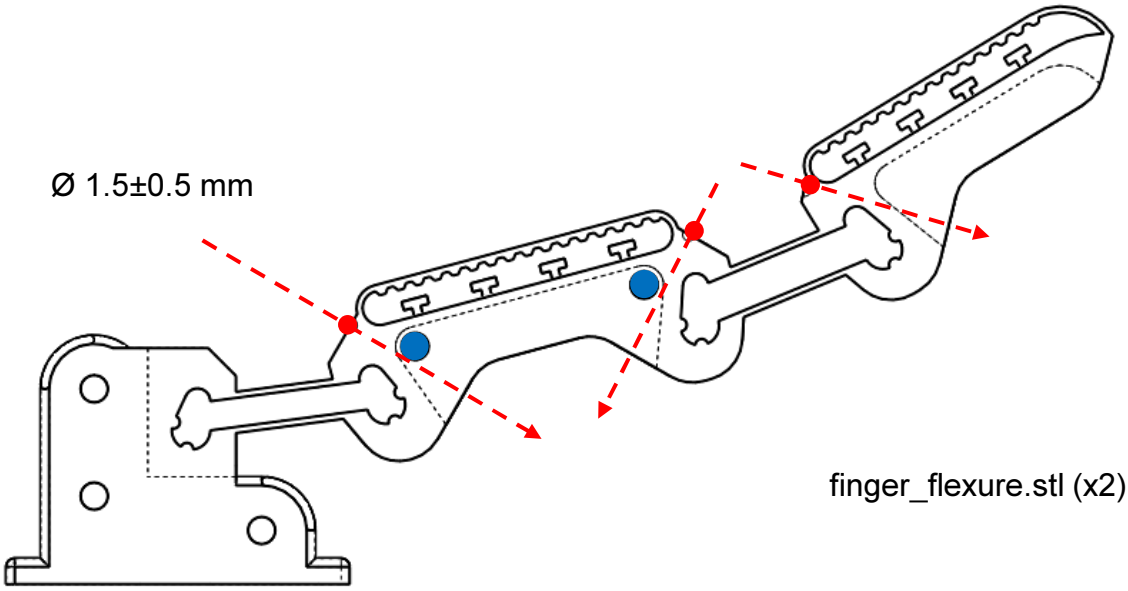


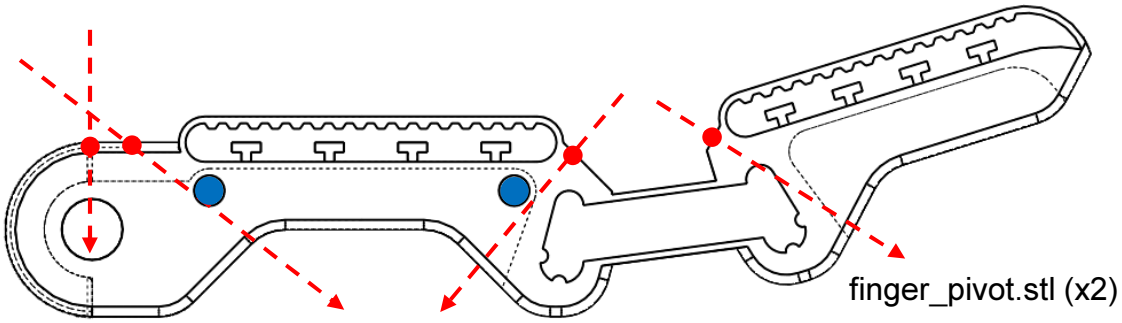


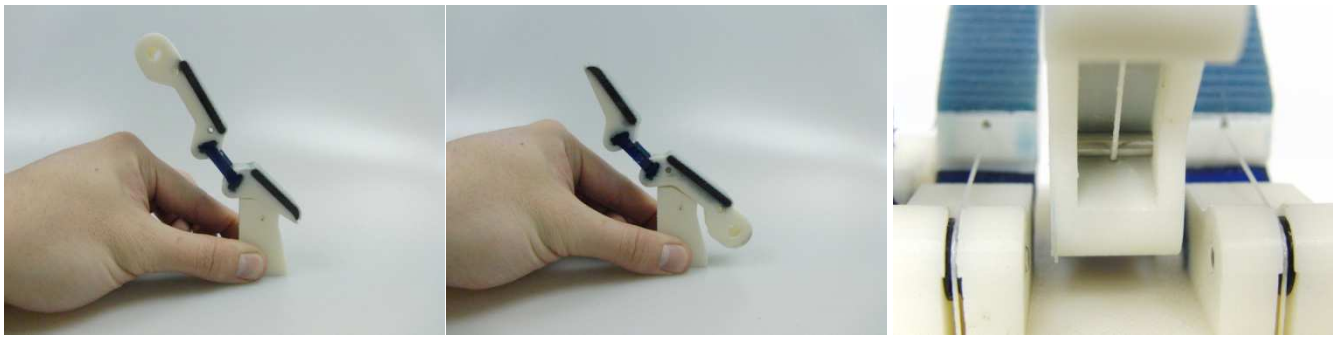
Consult DDM (Dieless Deposition Manufacturing) guide for further details on pouring/preparing the joints and pads for fingers

Part Preparation

TENDON ROUTING



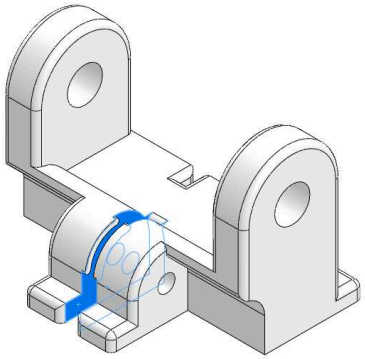




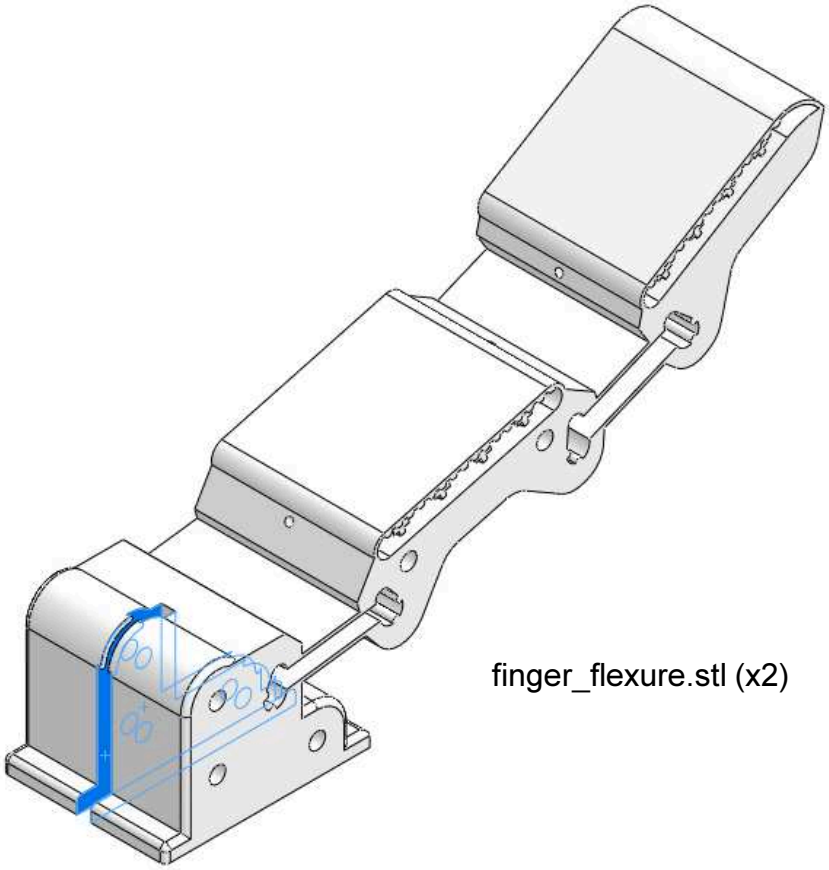
Drill tendon routing holes such that tendon will run tangent to inserted pin. Minimize contact between tendon and ABS but ensure that tendon runs freely. Use *helper_jig.stl* to aid in positioning. Hole should be drilled perpendicular to routing surface.

Part Preparation

SURFACE FILING/DEBURRING



c1.stl (x2)

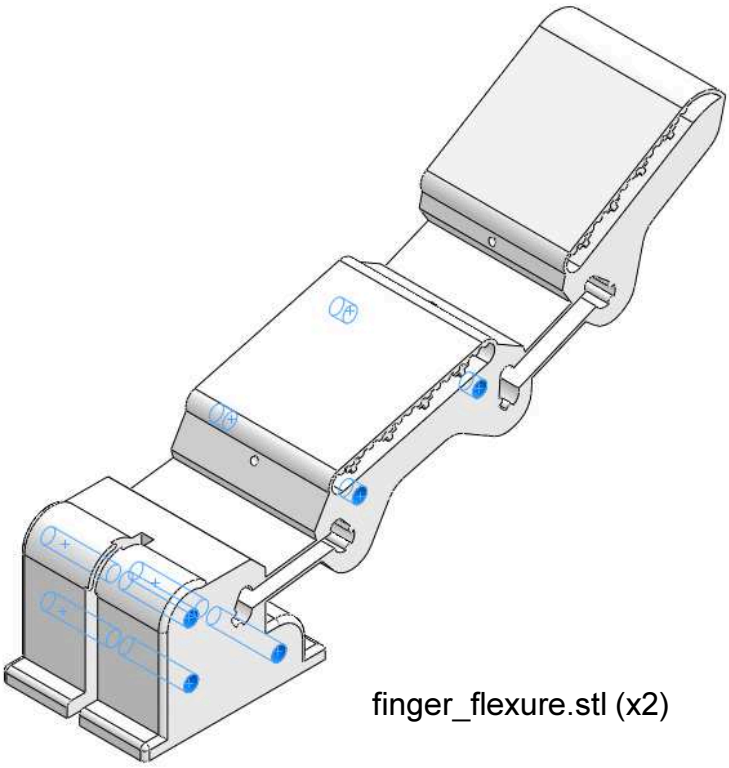


finger_flexure.stl (x2)

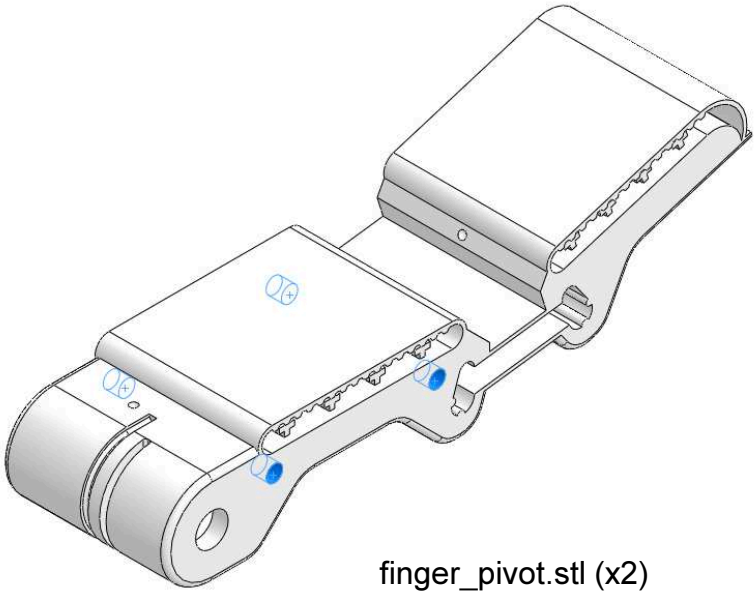
File down and deburr bearing surfaces as indicated above. Ensure that no support material remains, if applicable. Complementary piece (ie. pulley, finger) should slide in freely.

Part Preparation

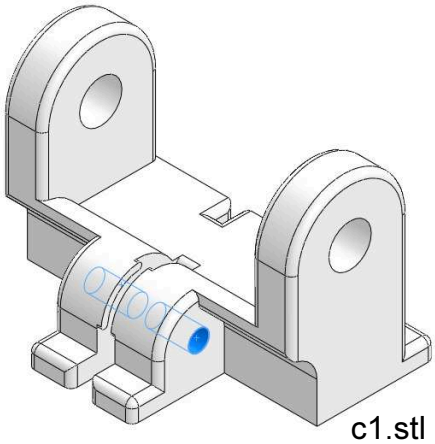
reaming (1/8" pin holes)



finger_flexure.stl (x2)



finger_pivot.stl (x2)

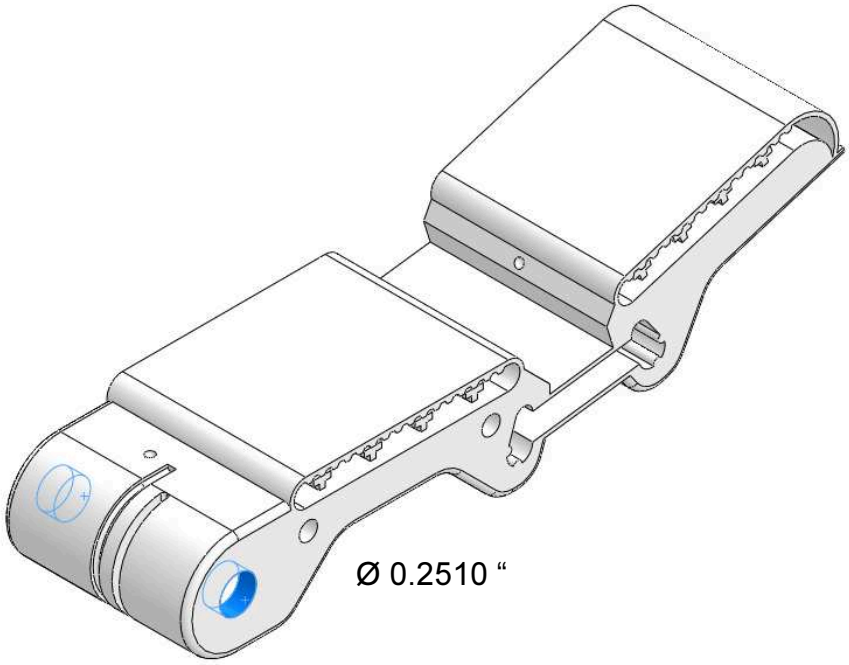


c1.stl (x2)

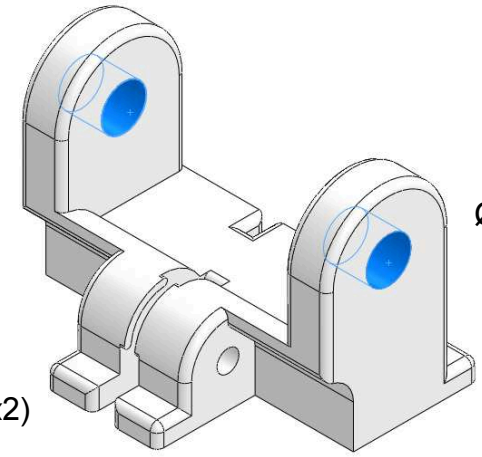
Use Ø0.1240" reamer to prepare pin holes as indicated above. This step can be skipped in lieu of precise 3D printer calibration and parameter selection, but manual reaming is the recommended approach.

Part Preparation

reaming (pivot bases)



finger_pivot.stl (x2)

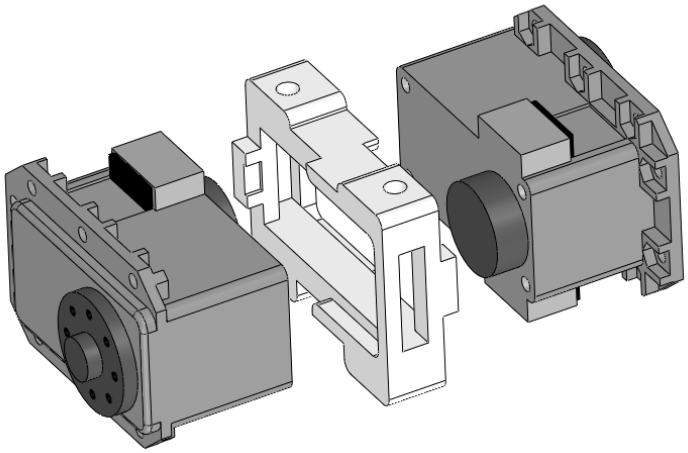


c1.stl (x2)

Use Ø0.2490” reamer to prepare pin holes on pivot bases *c1.stl*, and Ø0.2510” reamer to prepare pin holes on the corresponding fingers *finger_pivot.stl.* Finger should spin freely and loosely on a Ø0.25” steel pin

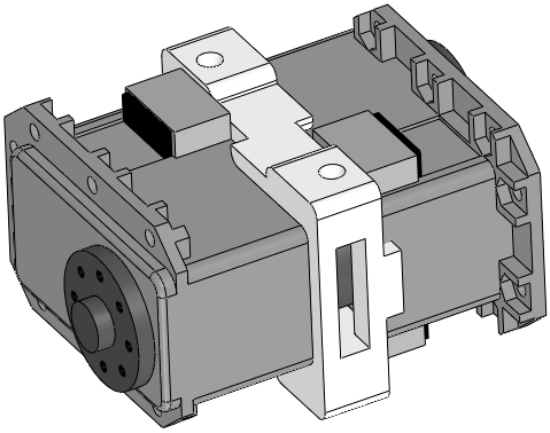
ASSEMBLY

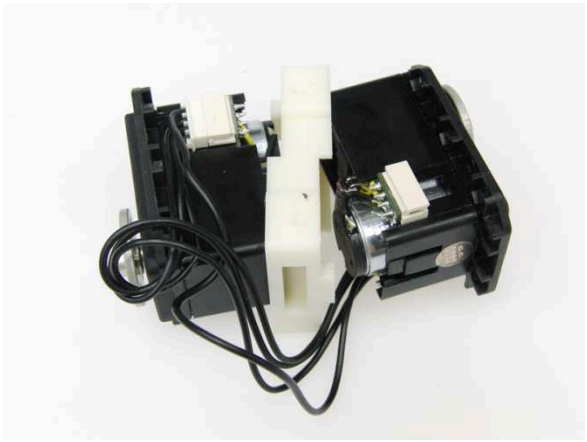
BLOCK_ACTUATOR



Parts:

- Dynamixel RX-28 (x2)
- Dynamixel cable
- b1.stl
- Sunon 12VDC fan

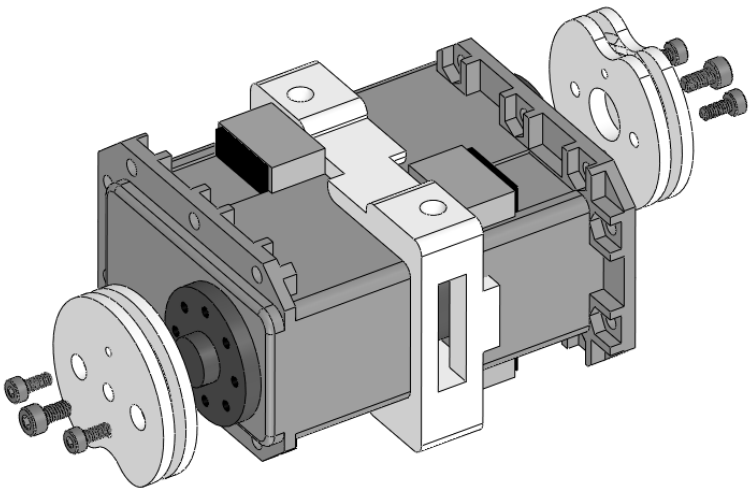




Remove back of Dynamixel RX-28's. The two Dynamixel servo's snap onto the coupler piece *b1.stl* as shown above. Connect the two Dynamixel servos in a daisy-chain configuration.

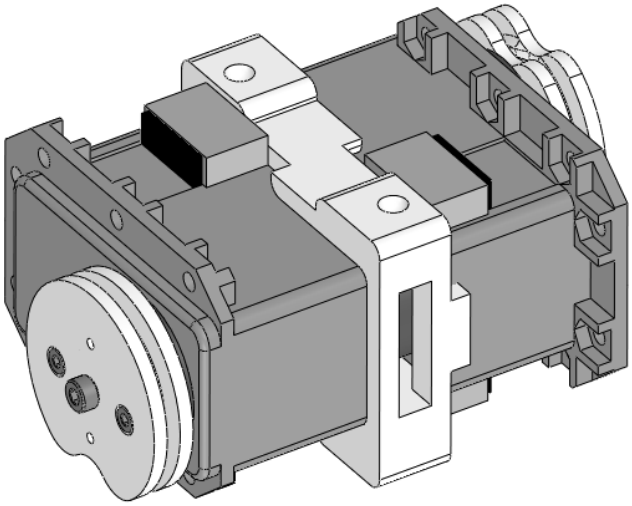
ASSEMBLY

BLOCK_ACTUATOR



Parts:

- Sub-assembly from step 6
- b2.stl (x2)
- M2.5, L5mm bolt (x2)
- M2, L5mm bolt (x4)

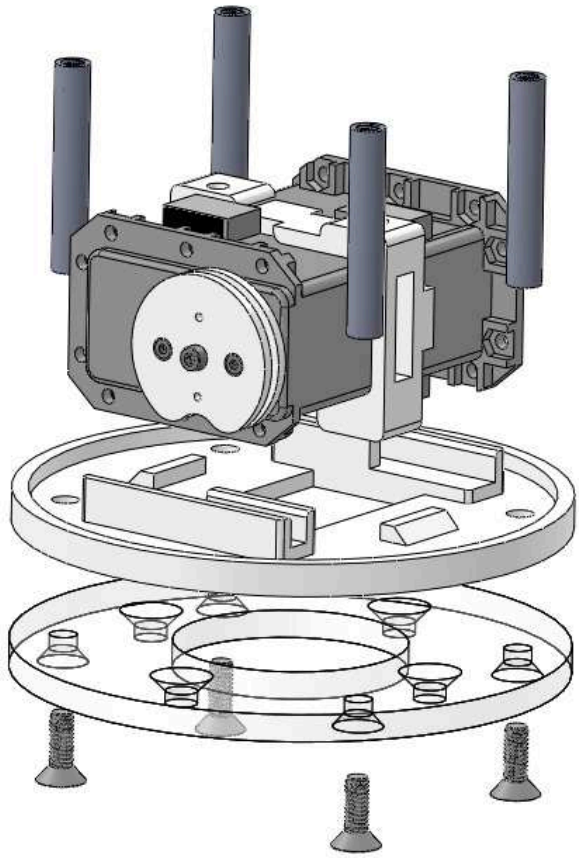


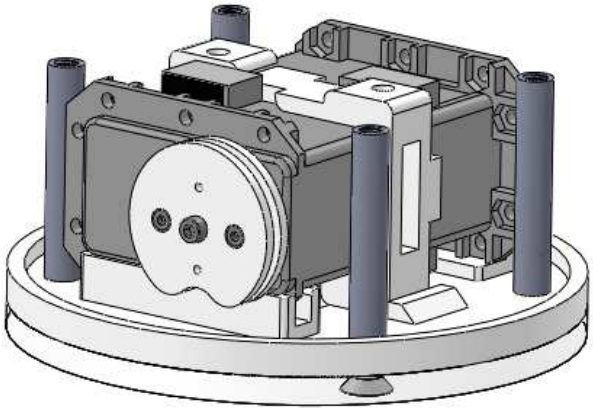
Assemble main drive pulleys onto actuator block sub-assembly as shown. Do not worry about zero-position of servo at this time.

(Optional): It may be beneficial to attach one end of the tendons to the pulleys at this point.

ASSEMBLY

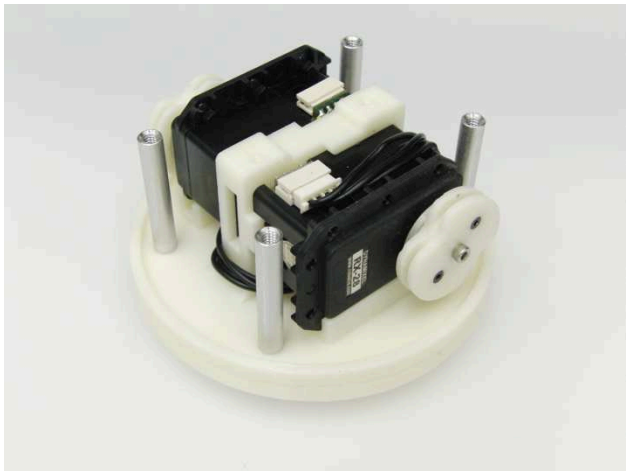
BLOCK_ACTUATOR





Parts:

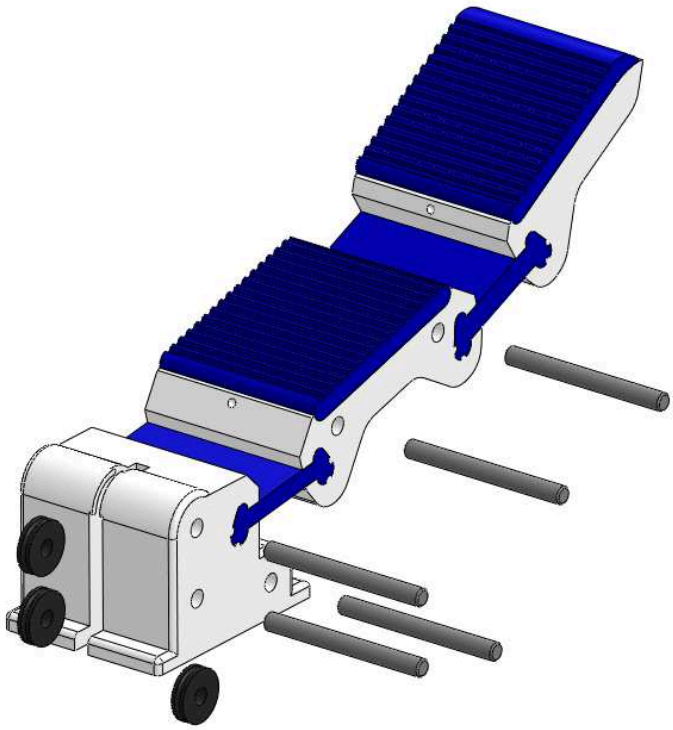
- Sub-assembly from step 7
- a3.stl
- a4.stl
- Ø1/4”, L1-1/2” standoffs S1 (x4)
- Socket Cap Screw 8-32, L3/4” (x4)



Assemble main drive pulleys onto actuator block sub-assembly as shown. Do not worry about zero-position of servo at this time.

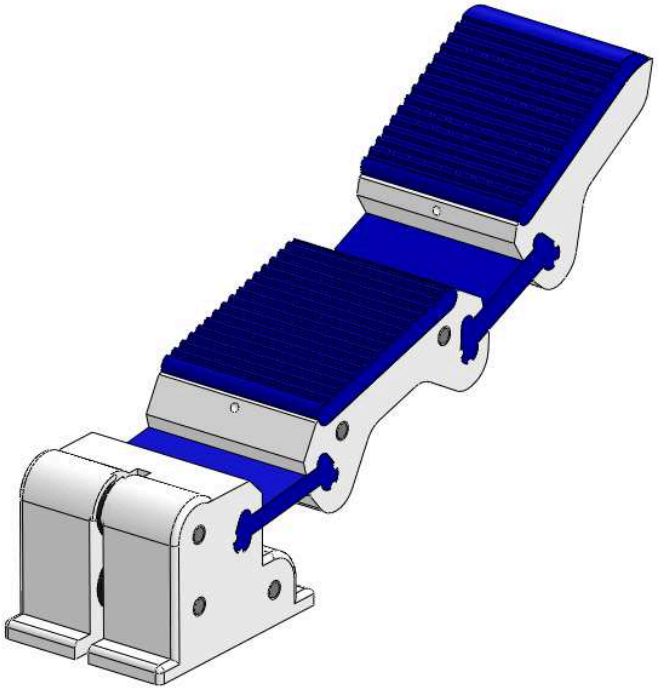
ASSEMBLY

FLEXURE-BASE FINGERS



Parts:

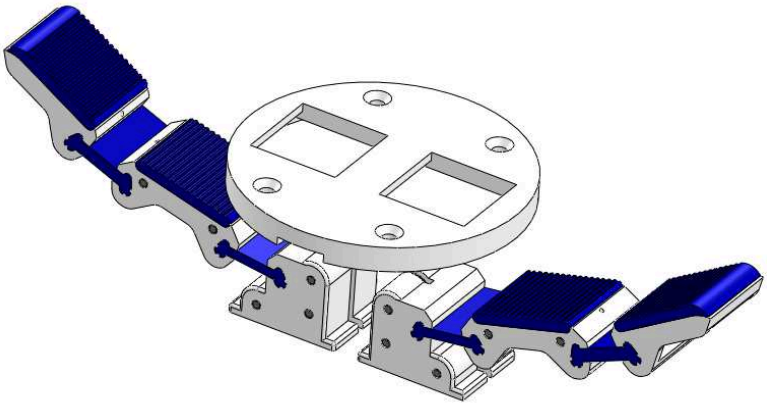
- finger_flexure.stl (x2)
- Pulley P1 (x6)
- L1-1/4” pin J1 (x10)



For pivot-base fingers, skip to step 11. Use a shim while press-fitting the pins to help ensure that nylon pulley spins freely at finger base

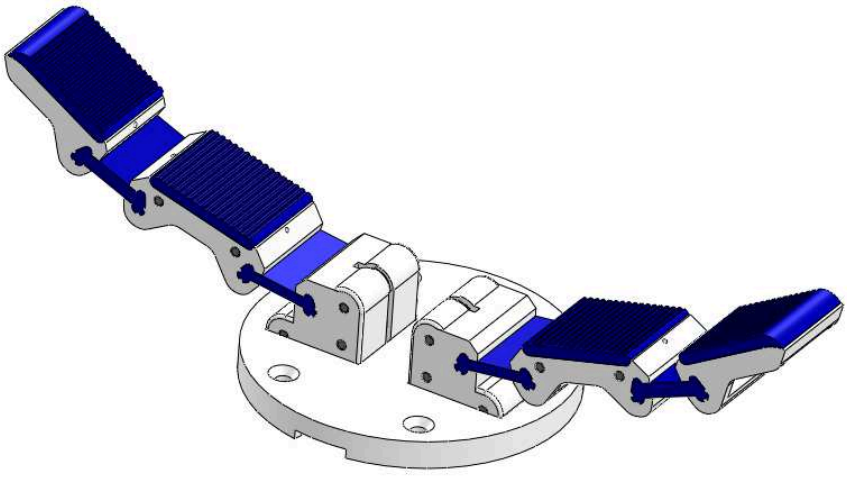
Assembly

FLEXURE-BASE FINGERS TOP



Parts:

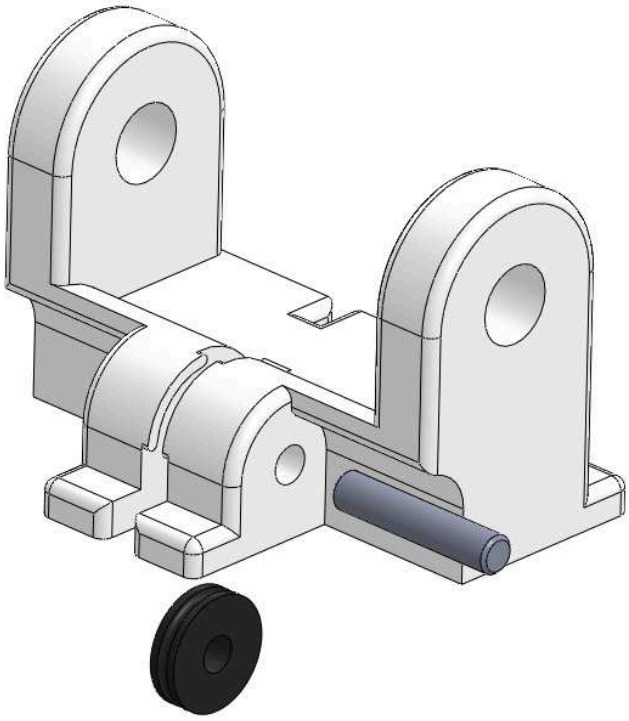
- Finger sub-assembly from step 9 (x2)
- a2.stl



Insert fingers into top plate from below as illustrated in the figures. Finger base should lie flush with plate *a2.stl*

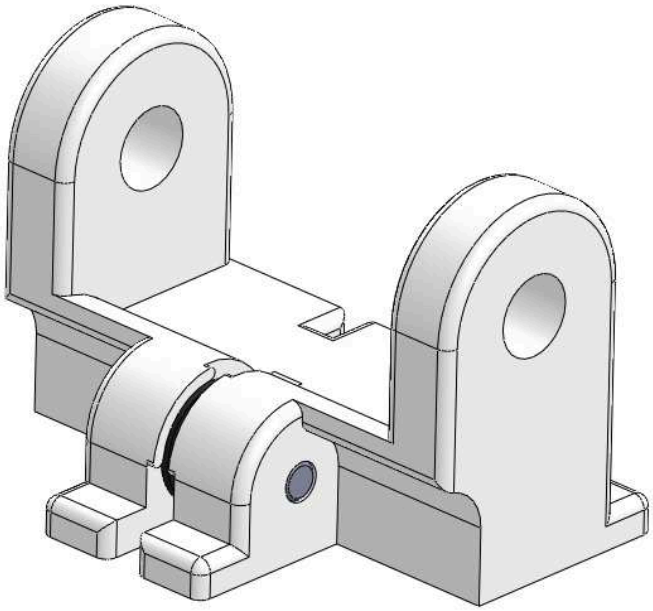
ASSEMBLY

PIVOT-BASE FINGERS



Parts:

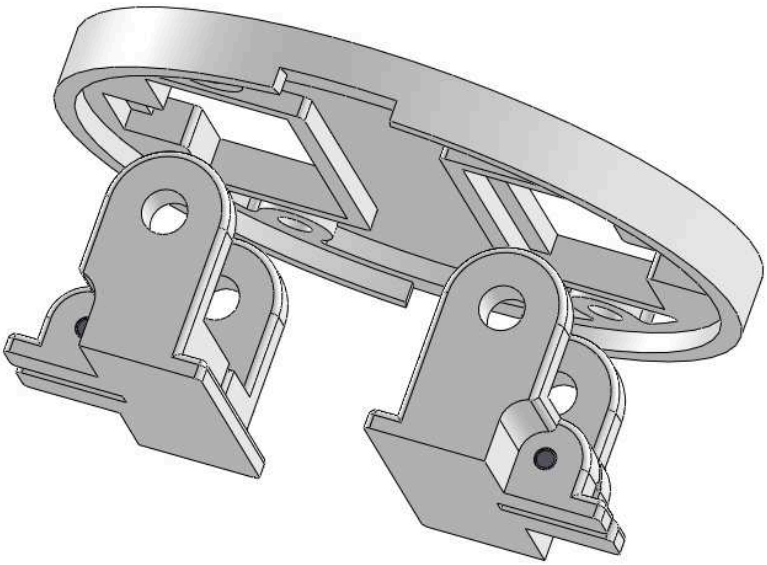
- c1.stl (x2)
- L5/8” pin J3 (x2)
- Pulley P1 (x2)



Assemble pivot base sub-assembly as shown. Use shim when press-fitting the pin and pulley to ensure that the pulley spins freely after assembly.

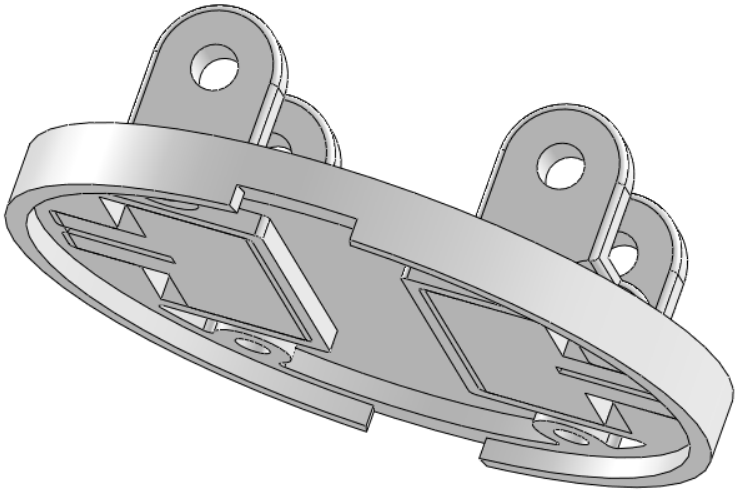
Assembly

PIVOT-BASE FINGERS TOP



Parts:

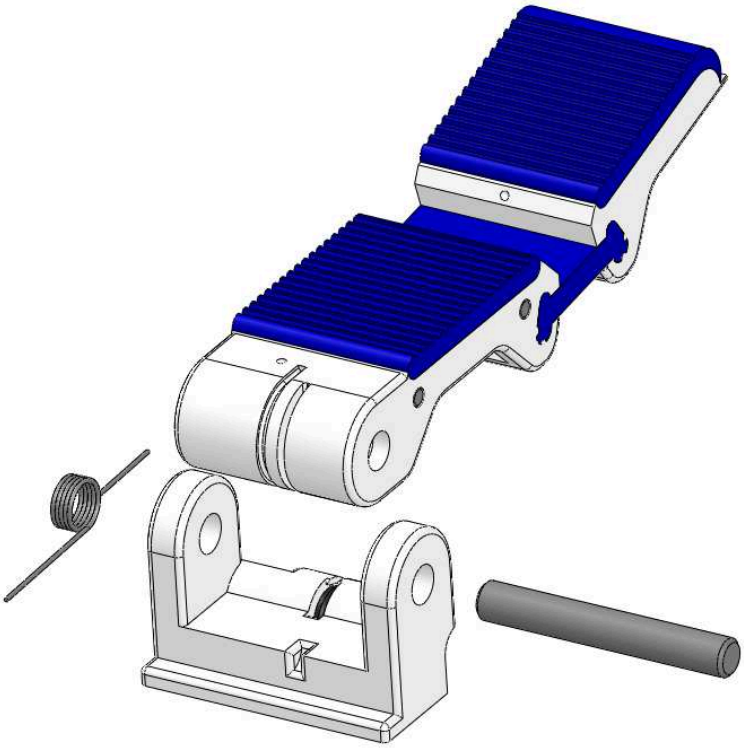
- Sub-assemblies from step 11 (x2)
- a2_pivot.stl



Assemble top pivot base plate as shown above. The finger pivot bases should fit flush with the top plate.

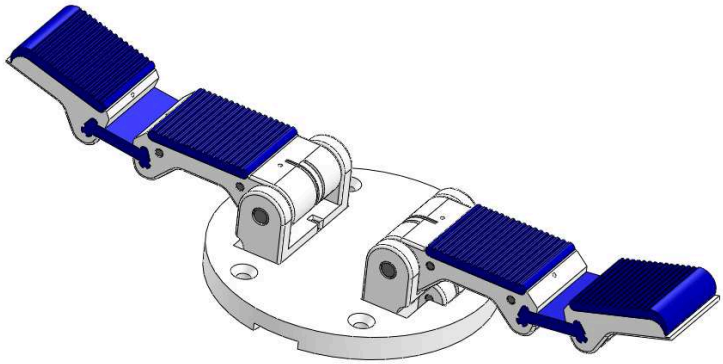
Assembly

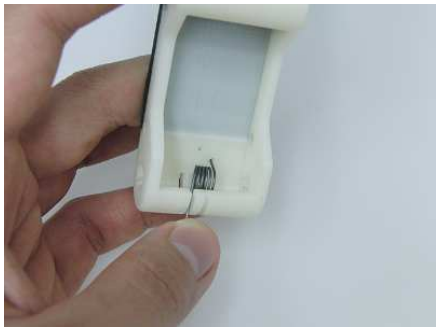
PIVOT-BASE FINGERS TOP

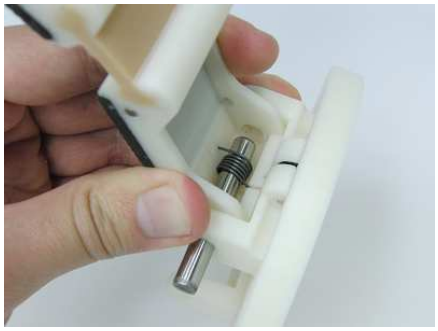


Parts:

- Sub-assemblies from step 11 (x2)
- a2_pivot.stl



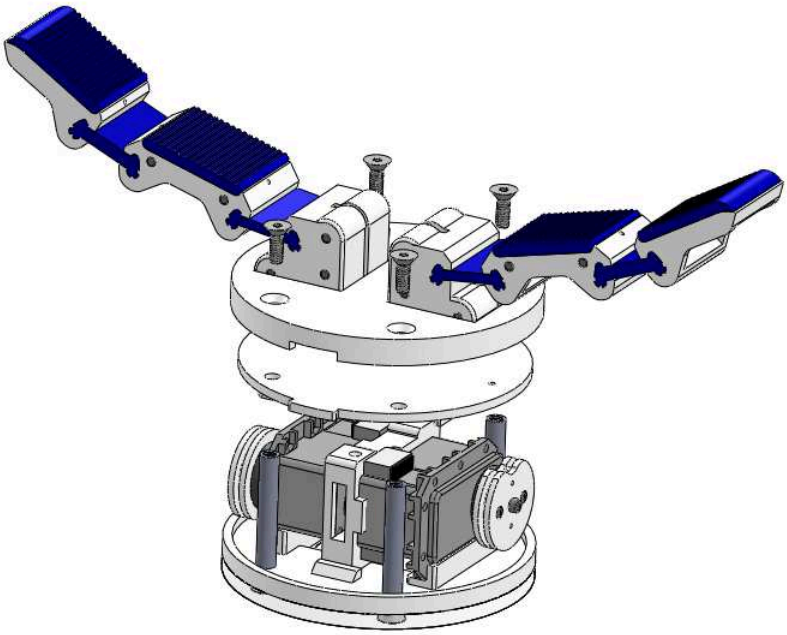




Assemble top pivot base plate as shown above. The finger pivot bases should fit flush with the top plate.

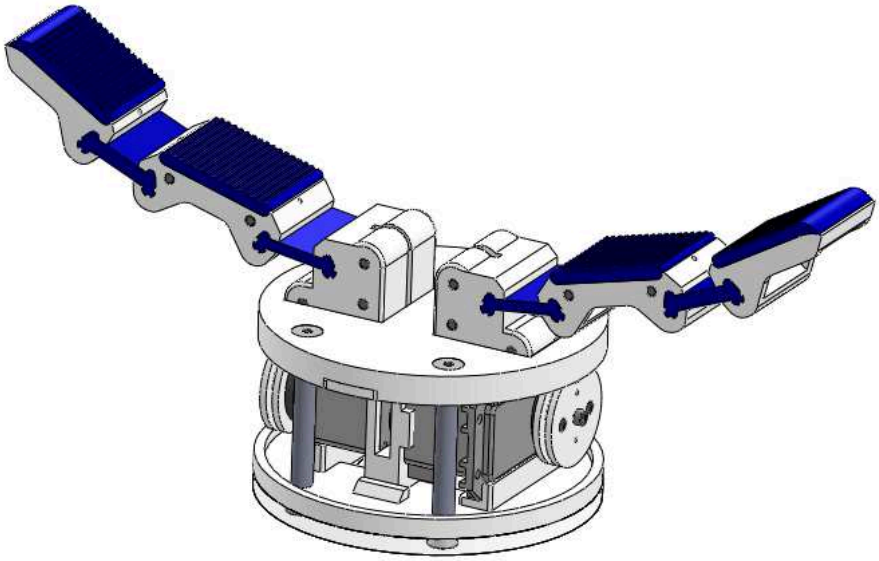
Assembly

FINAL ASSEMBLY – FLEXURE BASE



Parts:

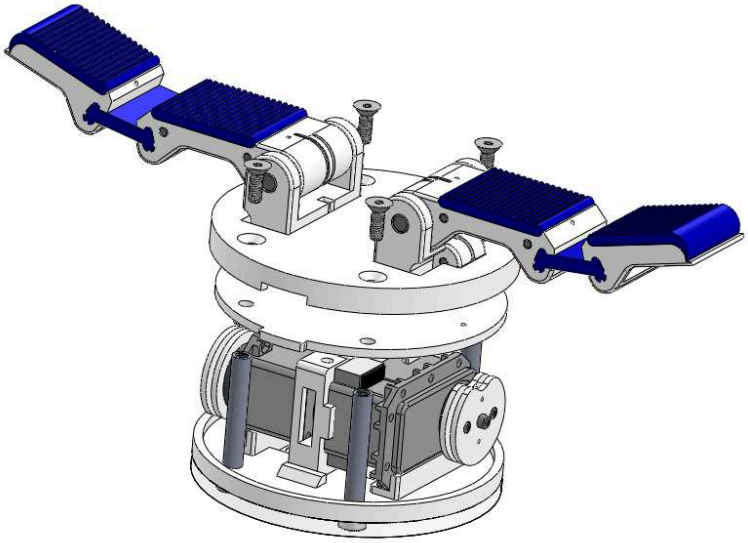
- Bottom base sub-assembly from step 8
- Top sub-assembly from step 10
- a1.stl



Use remaining socket screws to clamp the entire assembly together in place. The actuator block sub-assembly from step 8 should fit snugly

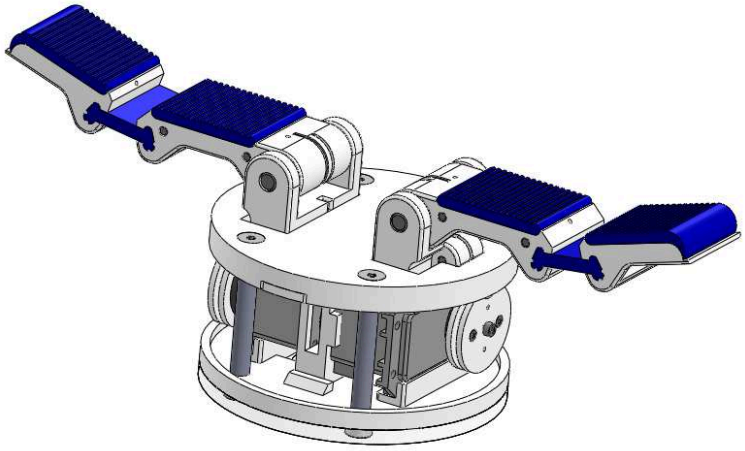
Assembly

Final Assembly – Pivot Base



Parts:

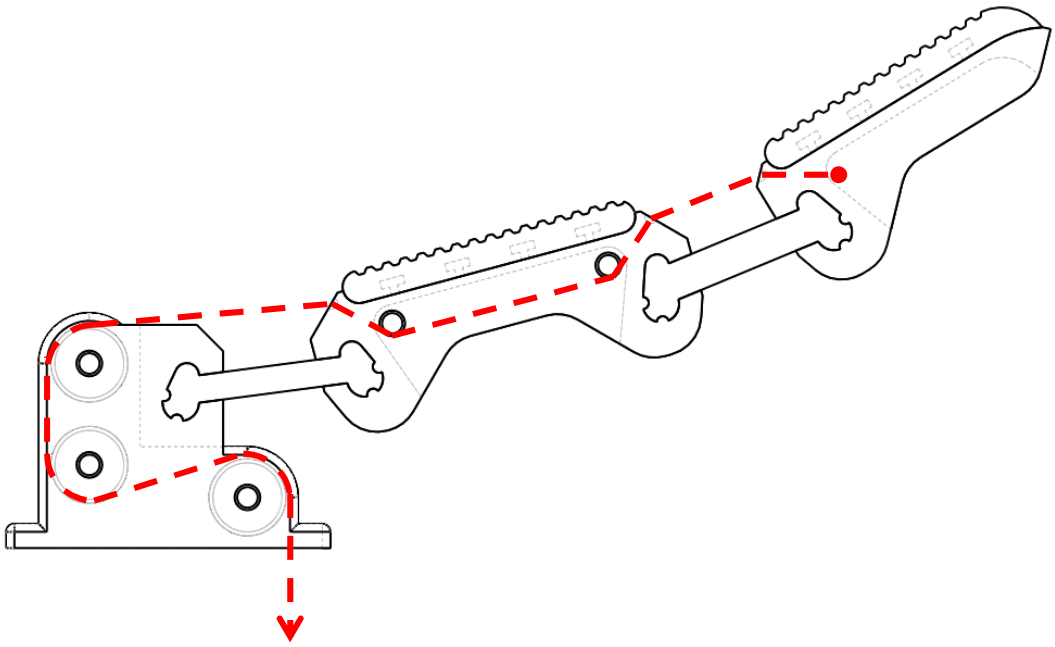
- Bottom base sub-assembly from step 8
- Top sub-assembly from step 13
- a1.stl



Use remaining socket screws to clamp the entire assembly together in place. The actuator block sub-assembly from step 8 should fit snugly

Tendon Routing

FLEXURE-BASE FINGERS

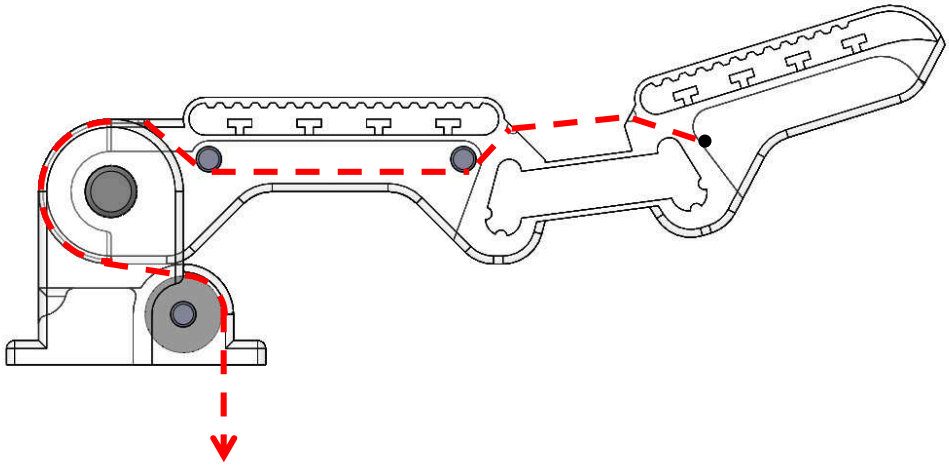


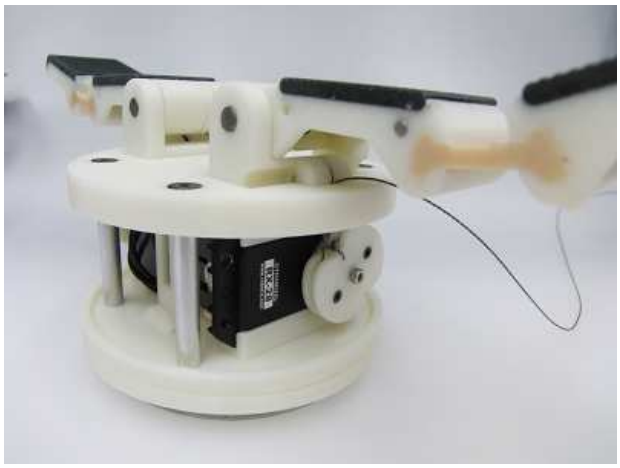
Tendons for flexure-based fingers run from the drive pulleys, through the top plate, across the 3 pulleys in the finger base, and through the finger routing ports, anchoring at the back of the fingertip, as shown above.

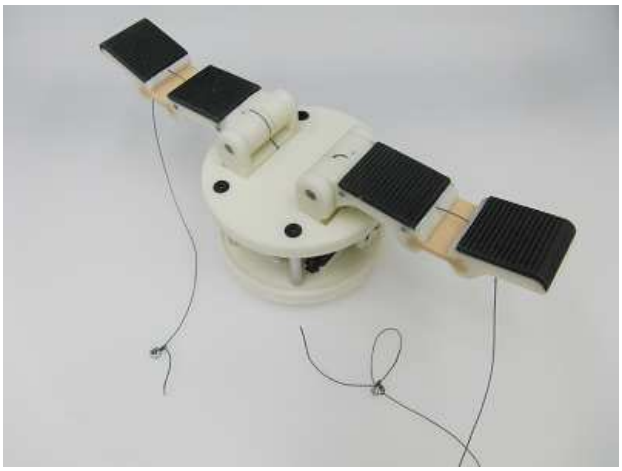
There should be enough tendon to leave slack after tying both ends.

Tendon Routing

PIVOT-BASE FINGERS





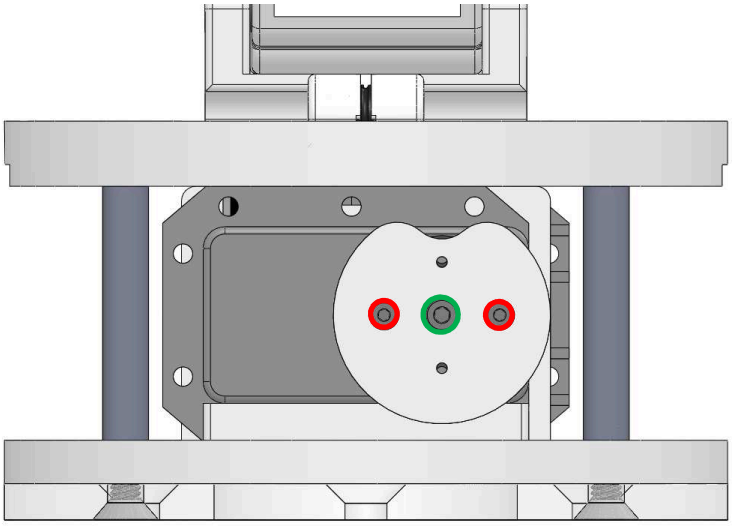


Tendons for flexure-based fingers run from the drive pulleys, through the top plate, across the pulley in the finger base, over the finger end, and through the finger routing ports, anchoring at the back of the fingertip, as shown above.

There should be enough tendon to leave slack after tying both ends.

Post-Assembly

SERVO ZERO-ING



1. Remove the M2 bolts from the servo pulley
2. Loosen, but do not remove, the central M2.5 bolt, such that the servo pulley can spin freely
3. Connect the Dynamixel and (in position mode) move it to its zero encoder position
4. By hand, turn the servo pulley until the tendon between the pulley and the main drive block is as taut as possible
5. Re-attach the M2 bolts and tighten the servo pulley
6. Repeat for other servo