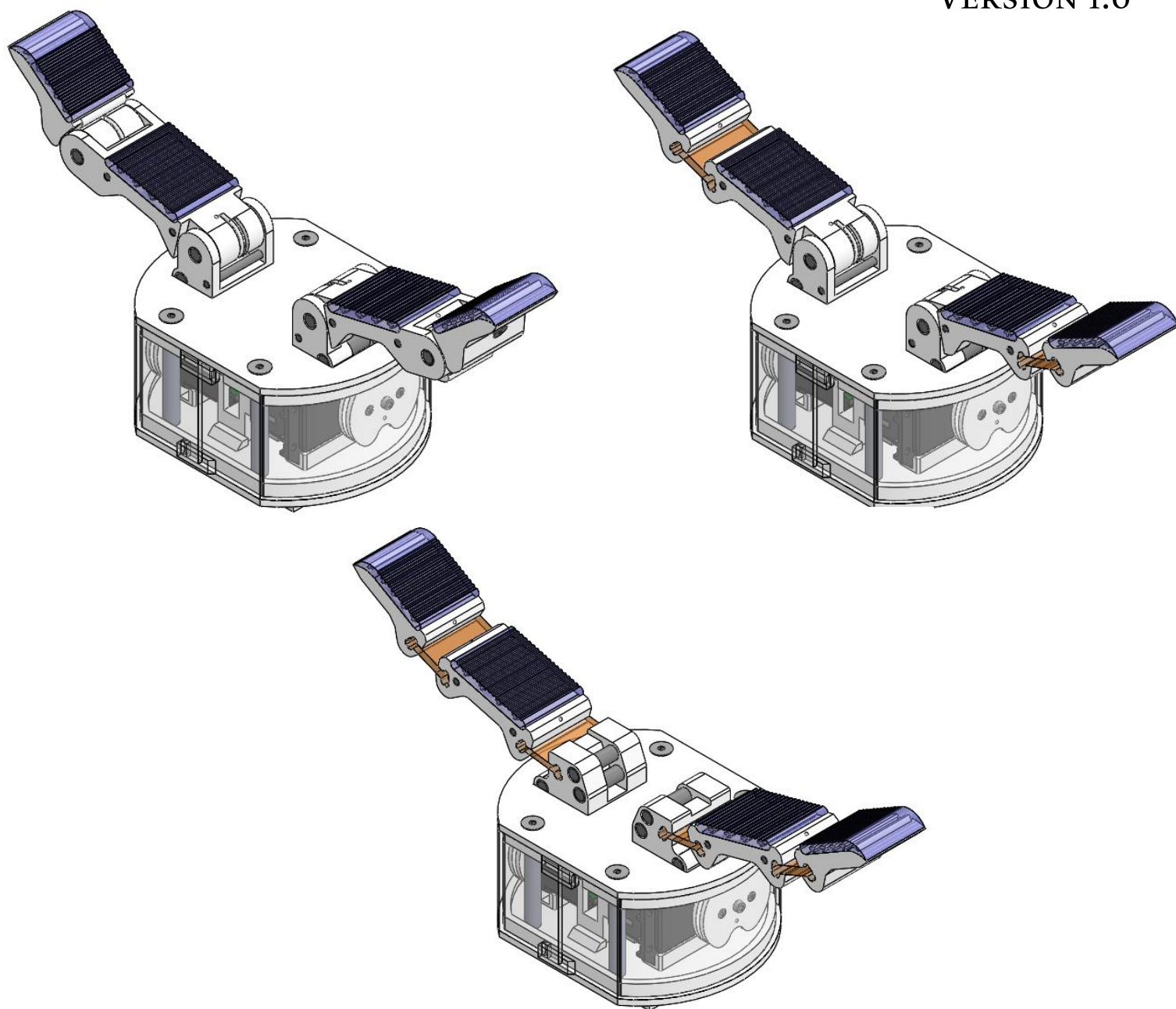OPENHAND

MODEL T42

VERSION 1.0

ASSEMBLY INSTRUCTIONS

LAST UPDATED: FEBRUARY 22, 2015

# 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", L1-1/2", 8-32 zinc-plated female standoff	4	Support	McMaster [93330A482]
Ø1/4", L1-1/4" steel dowel pin	6	Joint pin	McMaster [98381a544]
Ø1/8", L1-1/4" steel dowel pin	4	Routing pin	McMaster [98381A477]
8-32, L3/4" countersunk bolt	8	Support bolt	McMaster [92210A197]
M2.5, L8mm bolt	2	Center bolt for Dynamixel (included w/ Dynamixel)	McMaster [91292A012]
M2, L5mm bolt	4	Mounting bolts for Dynamixel	McMaster [91290A012]
4-40, L0.135" heat-set insert	4	Insert for bolt anchors	McMaster [93365A120]
4-40, L1/4" countersunk screw	4	Tendon/spring anchors	McMaster [91253A106]
Torsion spring, 0.340" OD, 0.028" wire diameter	2	Return spring, alternative to extension springs	McMaster [9271k605]
Extension spring, 0.188" OD, L3/4", 0.016" wire diameter	4	Return spring, alternative to torsion spring at proximal	McMaster [9654k955]
Dynamixel RX/MX-28, or RX24-F	2	Actuator, alternative to Power HD servo	Various [Link]
Power HD 1501 MG Servo	2	Actuator, alternative to Dynamixel	Various [Link]
Sunon DC 25x25x7mm Fan 5V	1	Cooling fan for Power HD servo	Various [259-1573-ND]
Sunon DC 25x25x10mm Fan 12V	1	Cooling fan for Dynamixel	Various [259-1570-ND]

* Note * There are certainly other combinations of fasteners that may work with these designs. We do not even claim that the parts list provided here is optimal for these designs. They are merely the components that we have used in past builds.
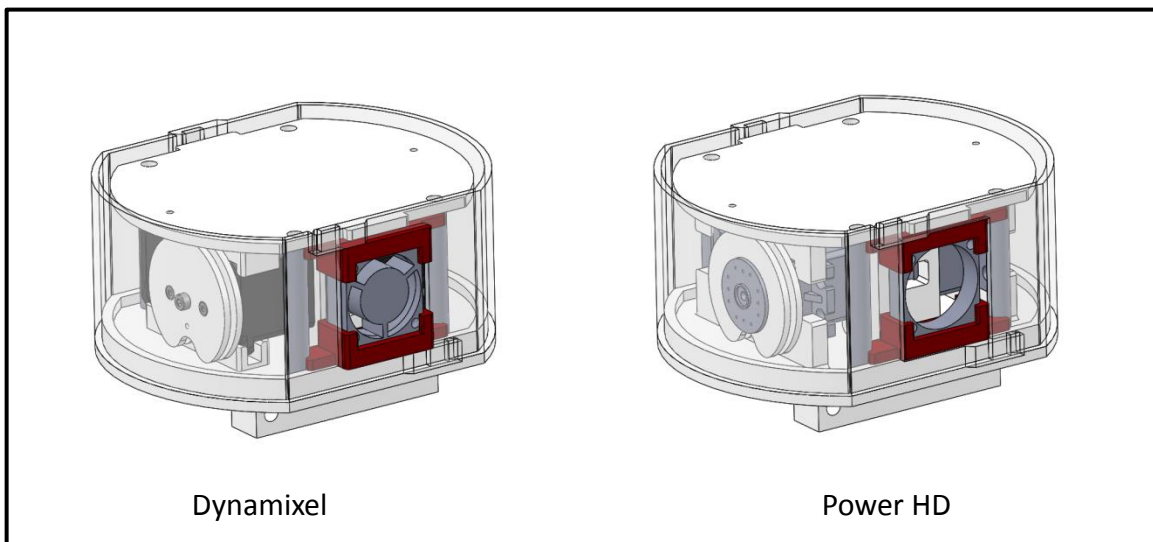
OVERVIEW

Finger Options

Flexure-Flexure   Pivot-Flexure   Pivot-Pivot

Actuator Base

Dynamixel   Power HD
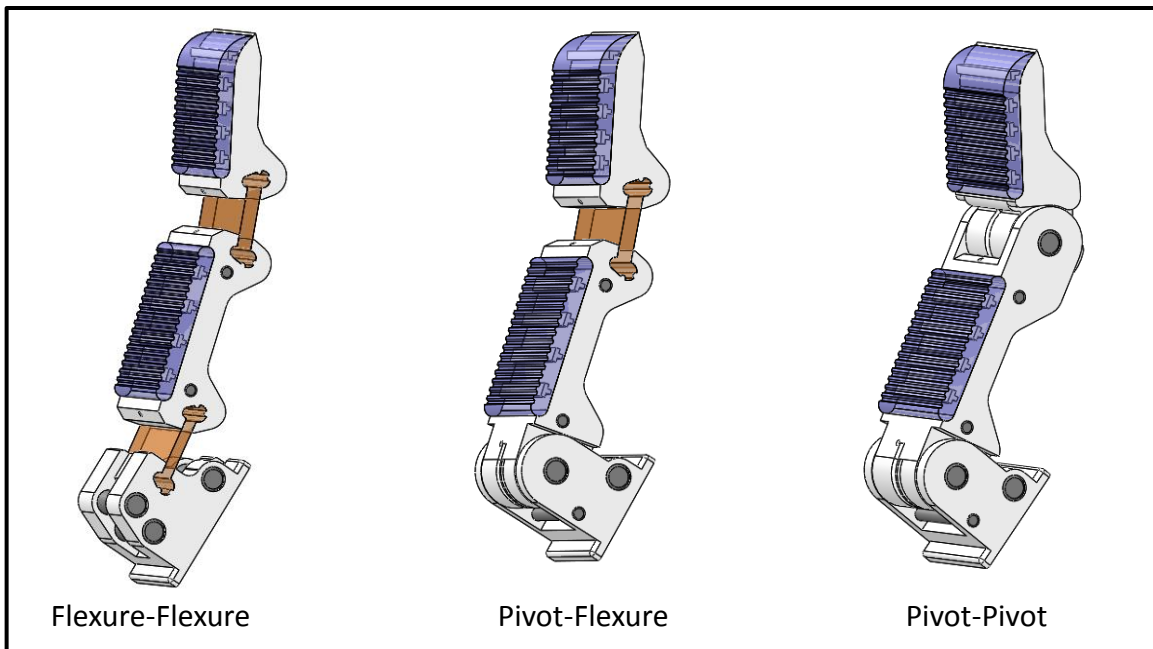
FINGER SUB-ASSEMBLY
FLEXURE–FLEXURE
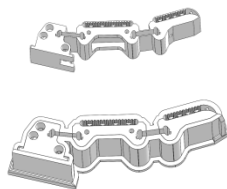
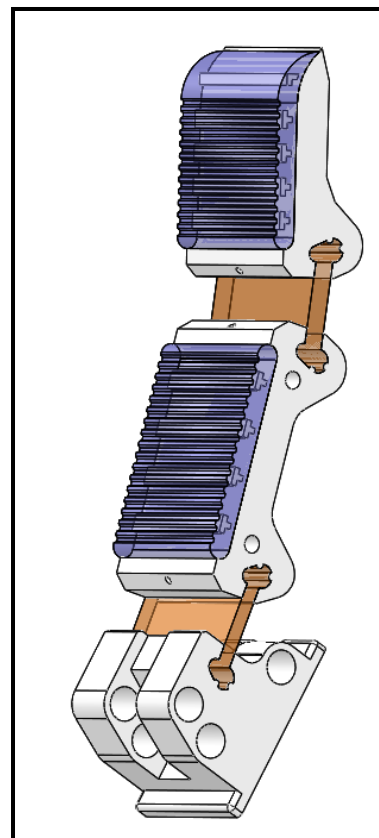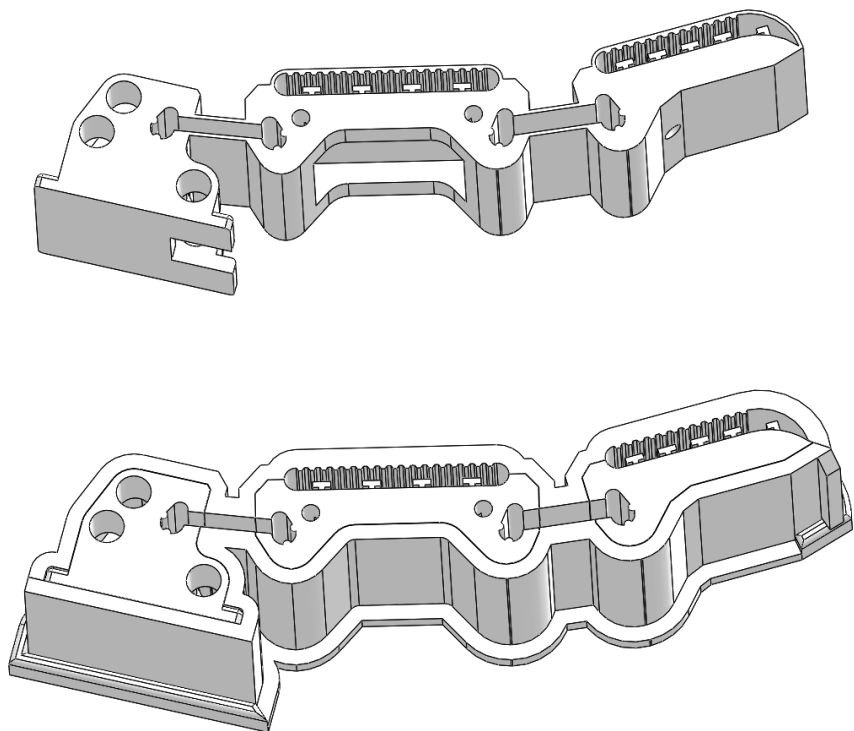| Parts |
|---|
| finger_ff_t42.stl
- or -
finger_ff_mold1_[A-C]_t42.stl
finger_ff_mold[2-4]_t42.stl

(x2) |
| PMC-780 urethane (2:1) |
| Vytaflex 30 urethane (1:1) |

Go to page 6 for Pivot-Flexure finger sub-assembly

Go to page 8 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 3 (x2)
4-40, L0.135" heat-set insert (x2)
4-40, L1/4" countersunk screw (x2)
Ø1/8", L1-1/4" steel dowel pin (x4)
Ø1/4", L1-1/4" steel dowel pin (x6)

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.
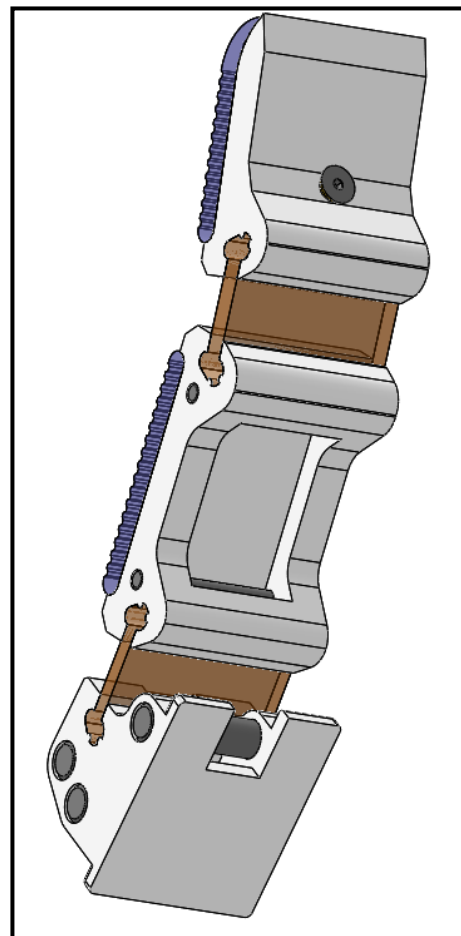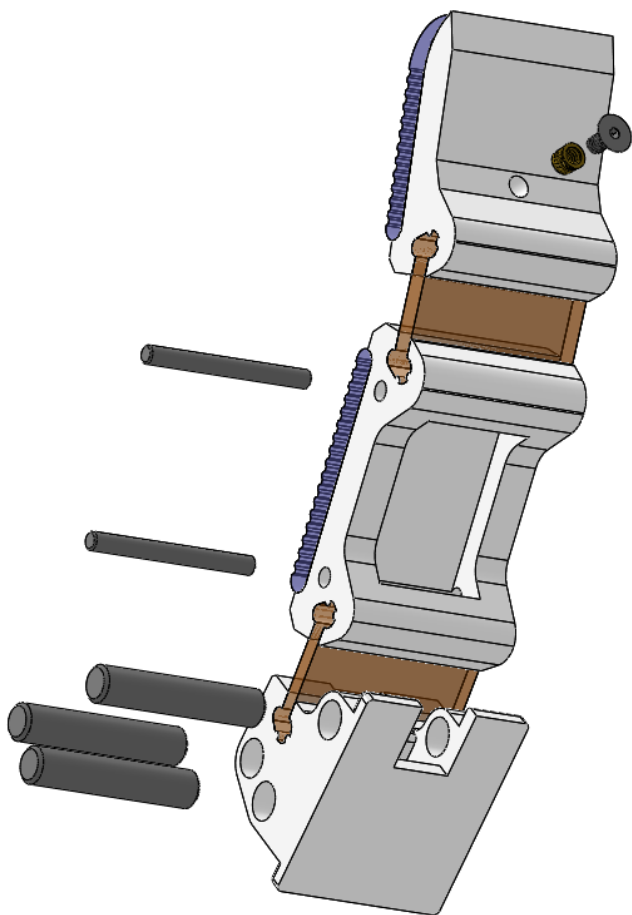
FINGER SUB-ASSEMBLY

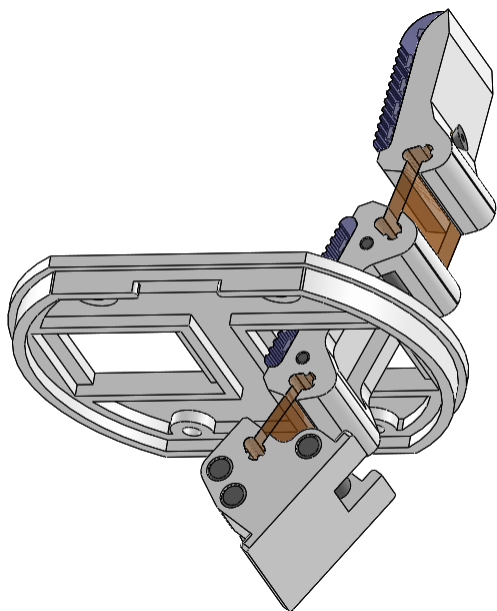## FLEXURE-FLEXURE

Parts
Flexure-flexure finger sub-assembly from page 4 (x2)
a1_f_t42.stl
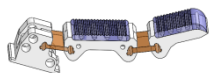
The Flexure-Flexure fingers are simply inserted up through the top plate *a1_f_t42.stl* and press-fit into place.
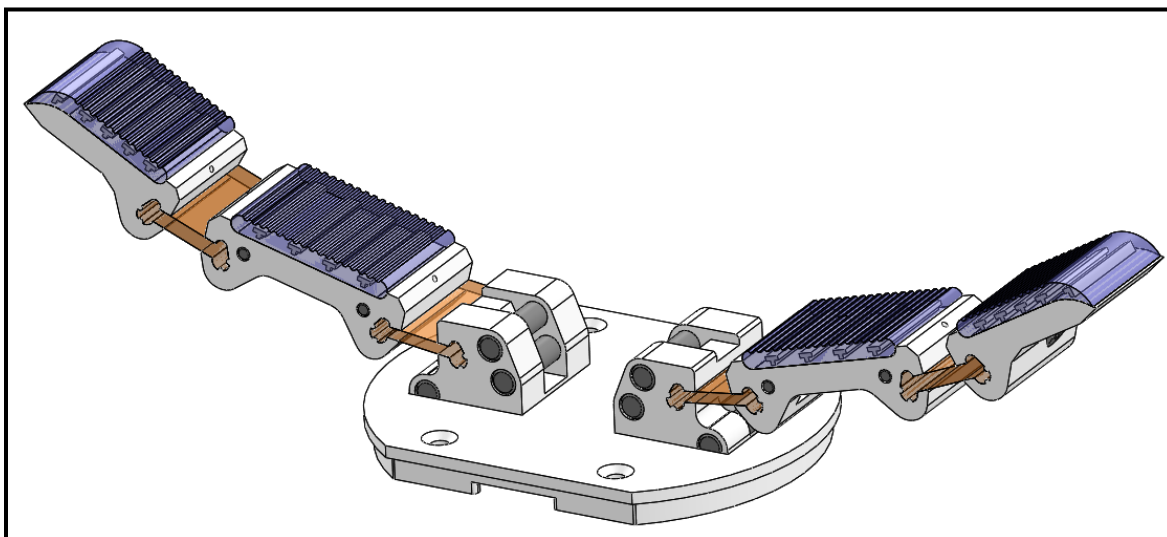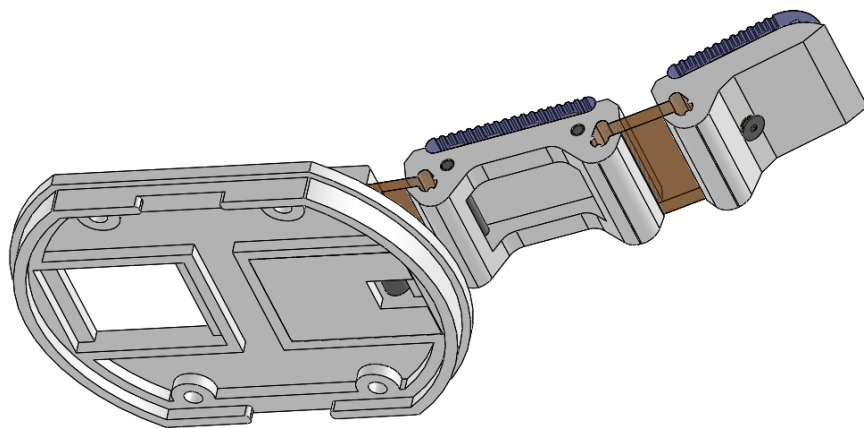
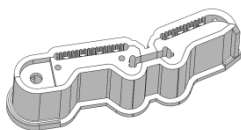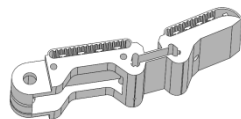# FINGER SUB-ASSEMBLY
PIVOT-FLEXURE

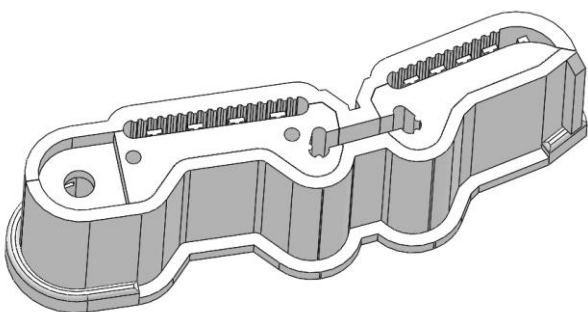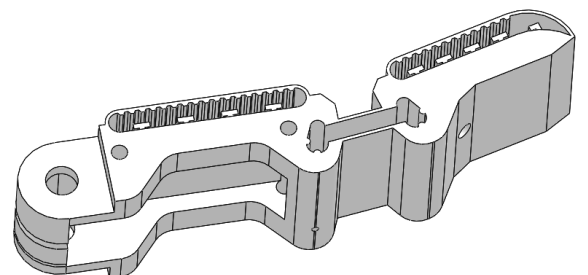| Parts |
|---|
| finger_pf_torsion_t42.stl
- or -
finger_pf_ext_t42.stl
- or -
finger_pf_torsion_mold1_A_t42.stl
finger_pf_mold1_B_t42.stl
finger_pf_mold[2-4]_t42.stl
- or -
finger_pf_ext_mold1_t42_m.stl
finger_pf_mold1_B_t42.stl
finger_pf_mold[2-4]_t42.stl   (x2) |
| PMC-780 (2:1) |
| Vytaflex 30 (1:1) |

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

Go to page 8 for Pivot-Pivot 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
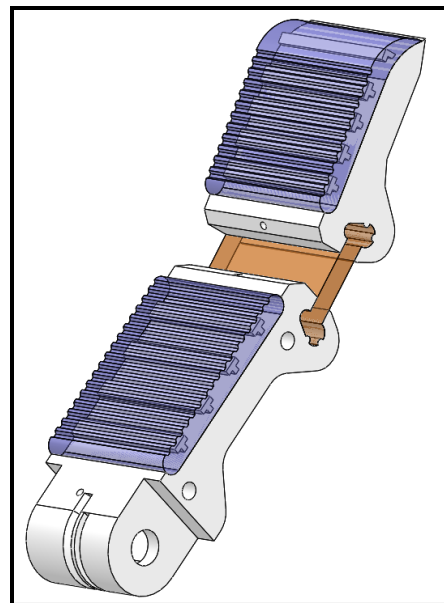
FINGER SUB-ASSEMBLY
PIVOT-FLEXURE

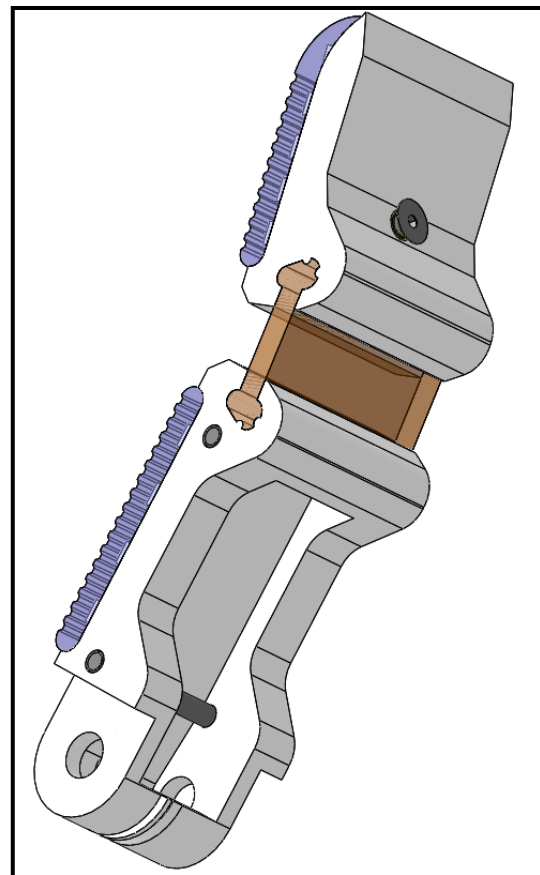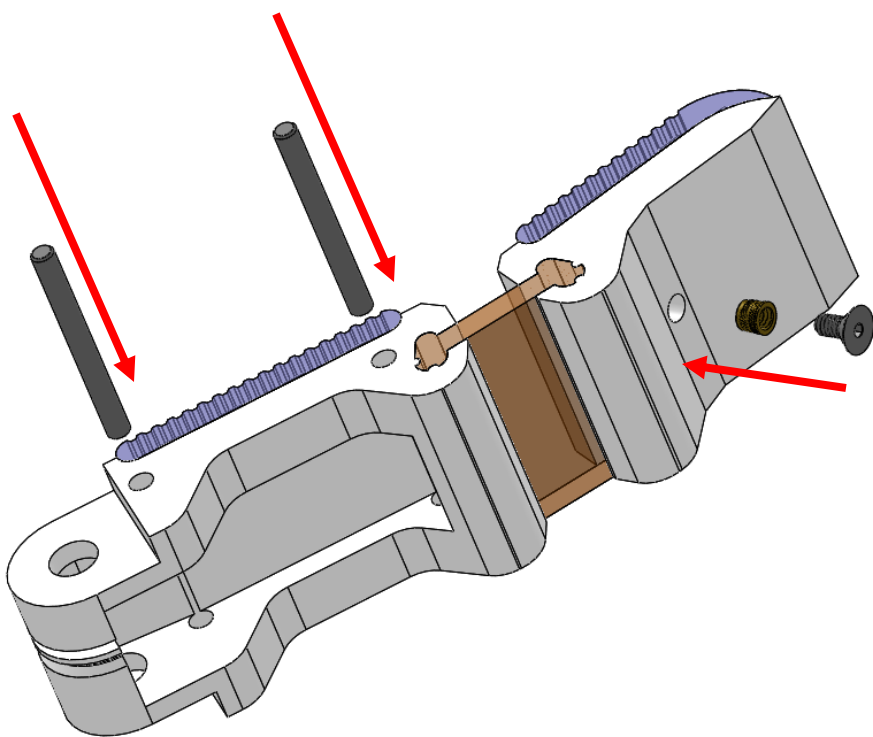| Parts |
| --- |
| Pivot-Flexure finger from page 6 (x2) |
| 4-40, L0.135" heat-set insert (x2) |
| 4-40, L1/4" countersunk screw (x2) |
| Ø1/8", L1-1/4" steel dowel pin (x4) |

Press fit the 1/8" dowel pins for tendon-rerouting into the proximal link. 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.
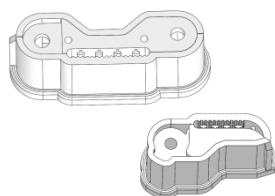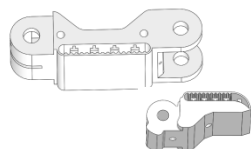
FOREFINGER SUB-ASSEMBLY

PIVOT-PIVOT

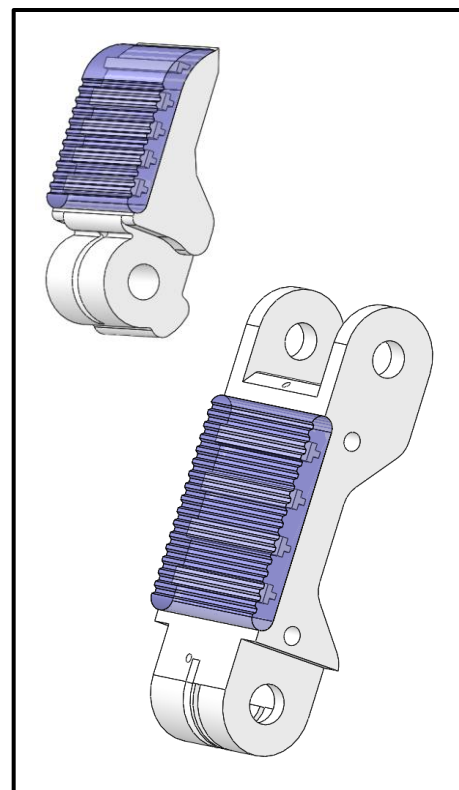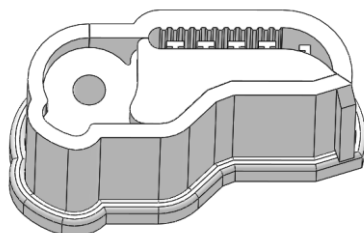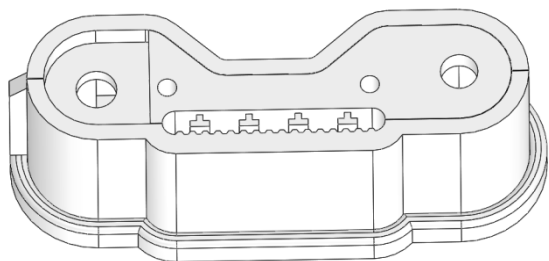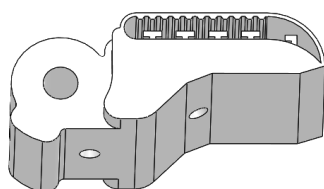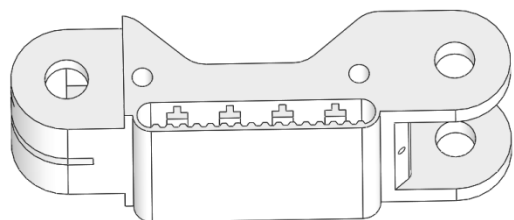| Parts |
|---|
| finger_pp_torsion_A_t42.stl
finger_pp_B_t42.stl
- or -
finger_pp_ext__A_t42.stl
finger_pp_B_t42.stl
- or -
finger_pp_torsion_mold1_A_t42.stl
finger_pp_mold[2-4]_A_t42.stl
finger_pp_mold1_B_t42.stl
finger_pp_mold[2-4]_B_t42.stl
- or -
finger_pp_torsion_mold1_A_t42.stl
finger_pp_mold[2-4]_A_t42.stl
finger_pp_mold1_B_t42.stl
finger_pp_mold[2-4]_B_t42.stl |
| Vytaflex 30 (1:1) |

Go back to page 3 for Flexure-Flexure finger sub-assembly
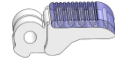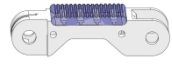
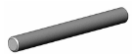**Go back to page 6 for Pivot-Flexure finger sub-assembly**

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
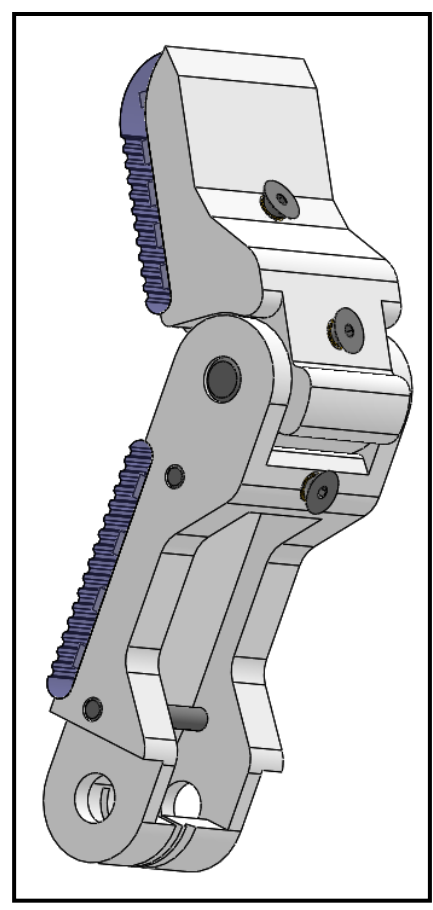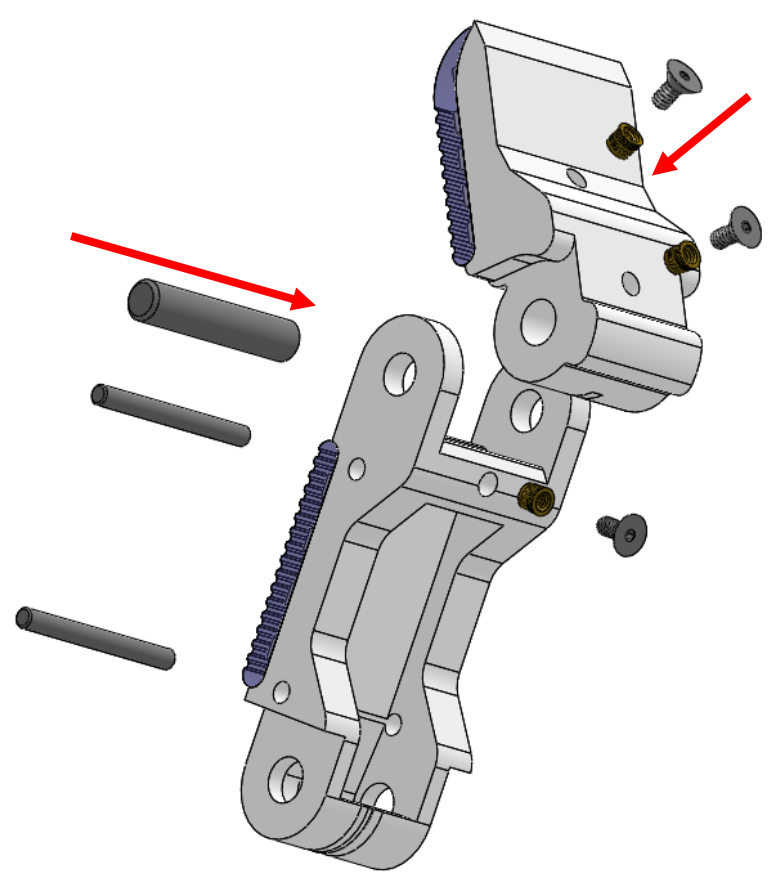
FOREFINGER SUB-ASSEMBLY

PIVOT-PIVOT

Parts
Pivot-Pivot finger distal link
Pivot-Pivot finger proximal link
4-40, L0.135" heat-set insert (x3)
4-40, L1/4" countersunk screw (x3)
Ø1/8", L1-1/4" steel dowel pin (x2)
Ø1/4", L1-1/4" steel dowel pin
Extension spring

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.
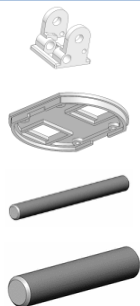
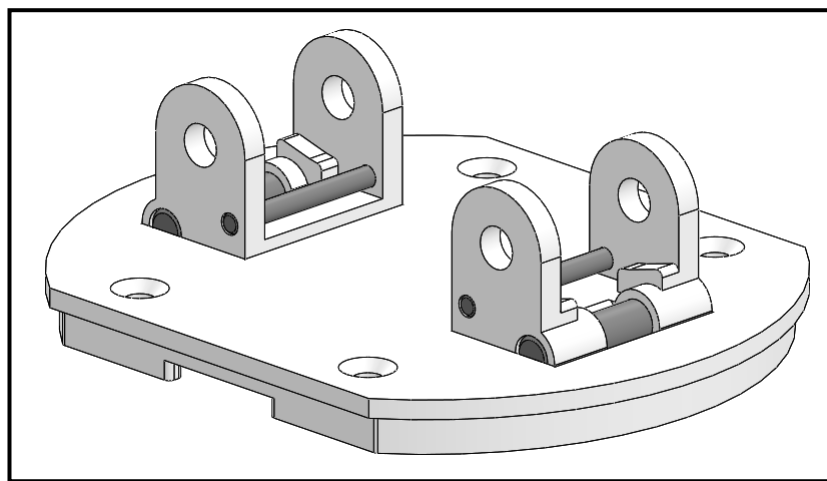# FINGER SUB-ASSEMBLY
PIVOT-FLEXURE OR PIVOT-PIVOT

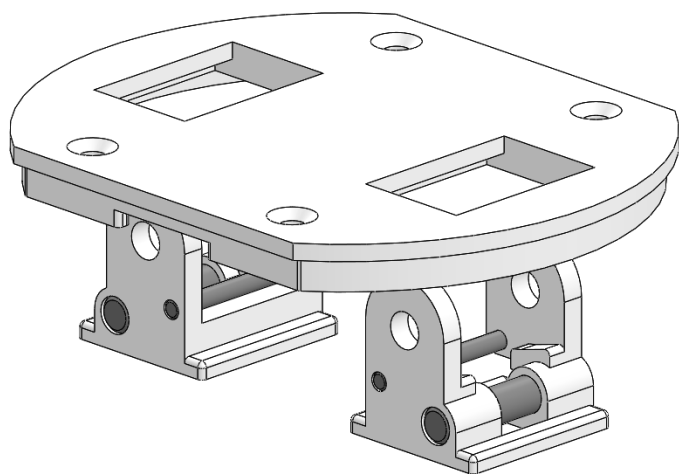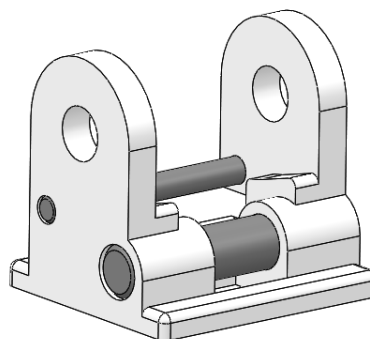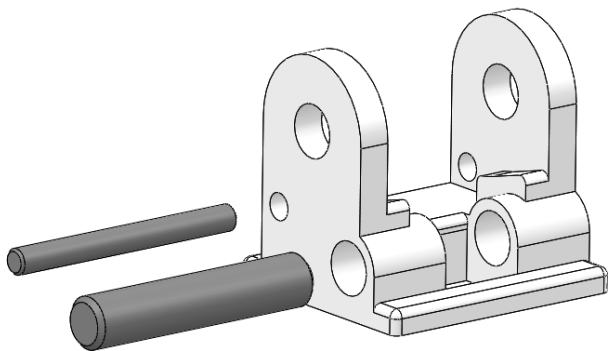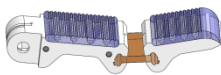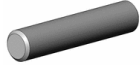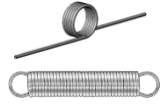| Parts |
|---|
| c1_t42.stl (x2) |
| a1_p_t42.stl |
| Ø1/8", L1-1/4" steel dowel pin (x2) |
| Ø1/4", L1-1/4" steel dowel pin |

Both the Pivot-Flexure and Pivot-Pivot fingers use the same base sub-assembly, incorporating *a1_p_t42.stl* and *c1_t42.stl*. These same parts are also used whether you're planning on using torsion or extension springs for the base joint.

FINGER SUB-ASSEMBLY
PIVOT-FLEXURE OR PIVOT-PIVOT

Parts
Top sub-assembly from page 10
Pivot-Flexure finger from page 7 (x2) - or - Pivot-Pivot finger from page 9 (x2)
Ø1/4", L1-1/4" steel dowel pin (x2)
Torsion spring - or - Extension spring (x2)
Spectra tendon line

Fingers with pivot bases at the proximal joint are assembled to the top base with a 1/4", press-fit dowel pin.

Torsion springs should be installed such that one stem rests on the 1/8" pin inserted into *c1_t42.stl*. An extension spring would be secured to this same pin via Spectra tendon and then anchored to the back of the proximal link. Consult the *OpenHand Finger Guide* for more details.
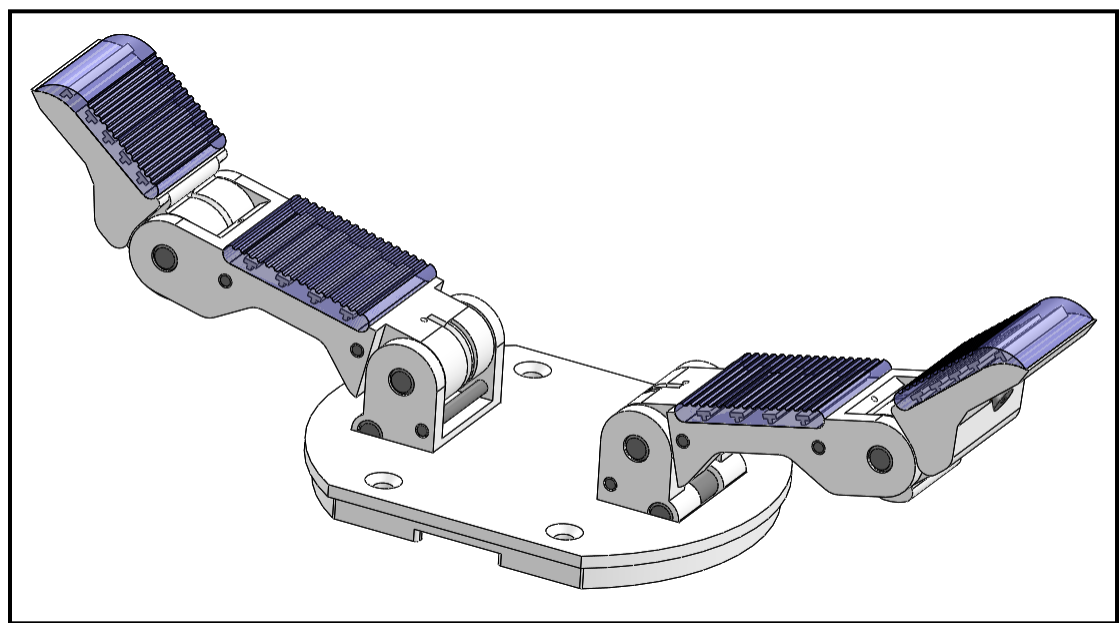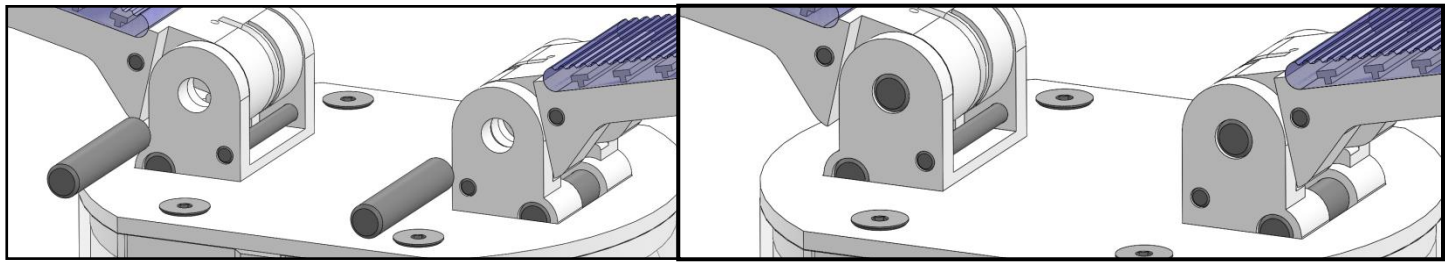
ACTUATOR SUB-ASSEMBLY

DYNAMIXEL

Parts
Dynamixel RX-28 or MX-28 or RX24-F (x2)
b1_dynamixel_t42.stl (x2)
b2_dynamixel_t42.stl
Spectra tendon line
M2.5, L8mm bolt (x2)
M2, L5mm bolt (x4)
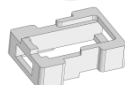
Go to page 14 for Power HD servo actuator sub-assembly

Either the RX-28 or MX-28 or RX24-F can be used as the Dynamixel actuator. Take the back off of the Dynamixel servos by unscrewing the 4 main bolts. Snap on piece *b2_dynamixel_t42.stl* as the servo's new back. The two Dynamixels will sit back to back.

Tie about a foot (~30cm) of tendon line to the servo pulley *b1_dynamixel_t42.stl* through the non-bolt hole. It's a good idea to wire the two Dynamixels together in a daisy-chain setup in this step.
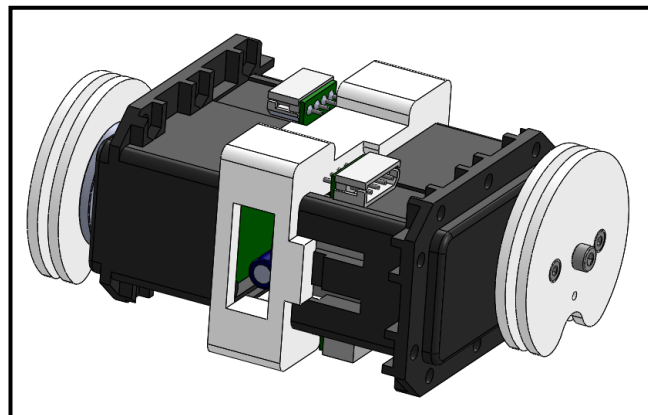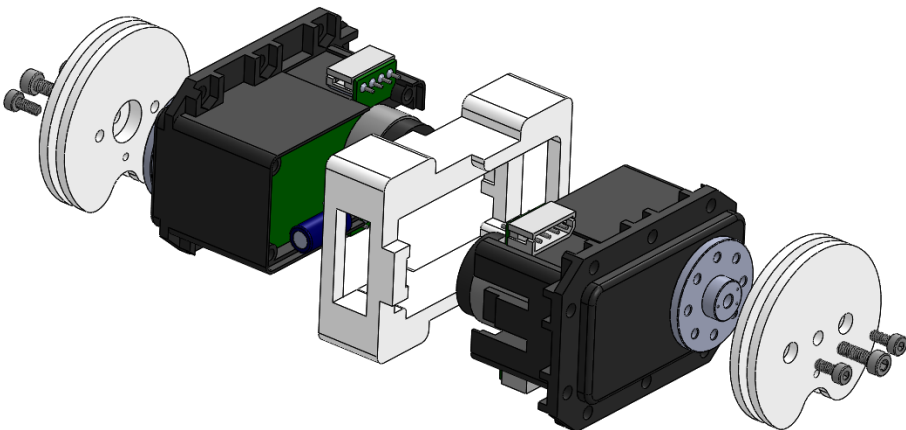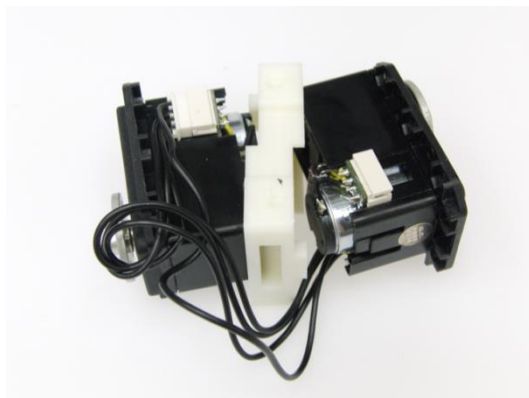
ACTUATOR SUB-ASSEMBLY
DYNAMIXEL

Parts
Dynamixel sub-assembly from page 12
a2_dynamixel_t42.stl
a3_dynamixel_t42.stl
a4_coupling_t42.stl - or - a4_blank_t42.stl
8-32, L3/4" countersunk bolt (x4)
Ø1/4", L1-1/2", 8-32 zinc-plated female standoff (x4)
d2_t42.stl (x2)
Sunon 25x25x10mm 12V fan

The final actuator sub-assembly is sandwiched together as shown. The Dynamixel sub-assembly should be oriented such that positive rotation (clockwise) of the servos will pull the tendon downwards.

The optional part *d2_t42.stl* is for implementations that incorporate a cooling fan. This tends to be a lot more helpful for Dynamixels than the Power HD servos.

This sub-assembly is essentially identical to that for the Model M2

13
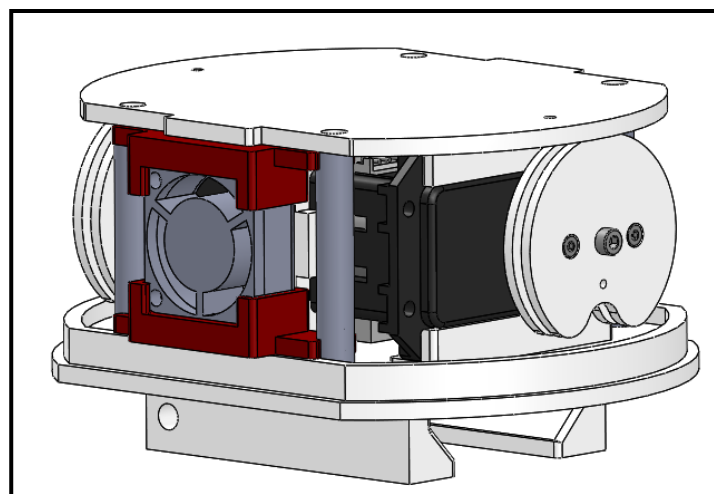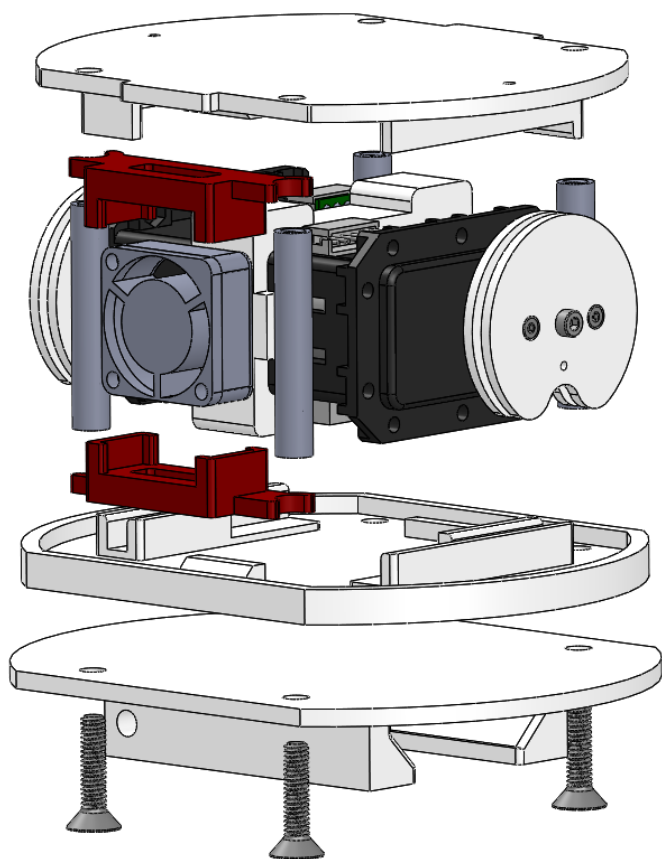
ACTUATOR SUB-ASSEMBLY
POWER HD SERVO

Parts
Power HD servo (or any other servo with same dimensions) (x2)
b1_power_t42.stl (x2)
b2_power_t42.stl
Spectra tendon line

Go back to page 12 for Dynamixel actuator sub-assembly

The Power HD servo is assembled into the actuator sub-assembly much like the Dynamixel is. The pulley part *b1_power_t42.stl* is assembled counter-intuitively. The part will sit between the servo body and the round servo horn that comes with the Power HD servo. You can choose to secure the printed pulley to the default servo horn however you like, but we chose to use the screws and bolt included with the servo.

Tie about a foot (~30cm) of tendon line to the servo pulley *b1_dynamixel_t42.stl* through the non-bolt hole.
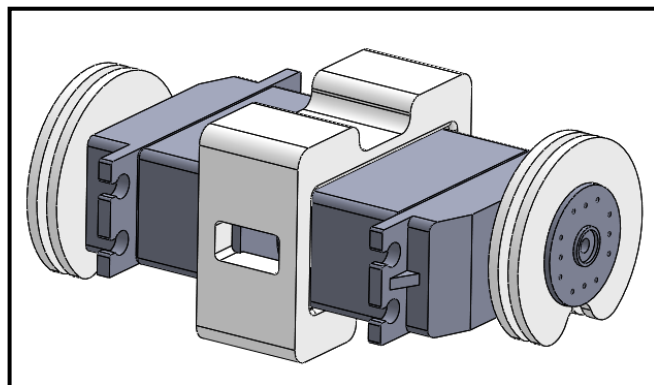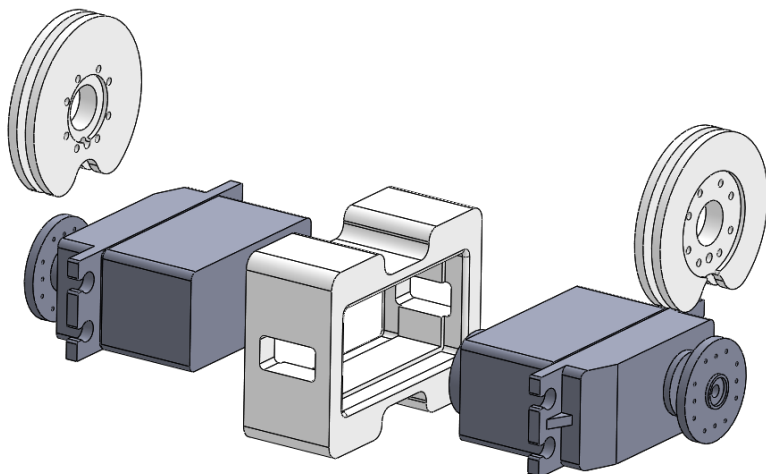
ACTUATOR SUB-ASSEMBLY
POWER HD SERVO

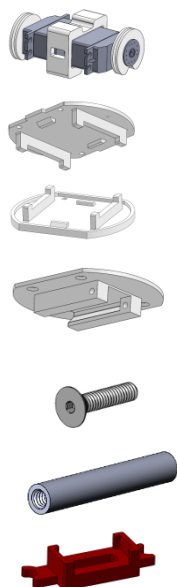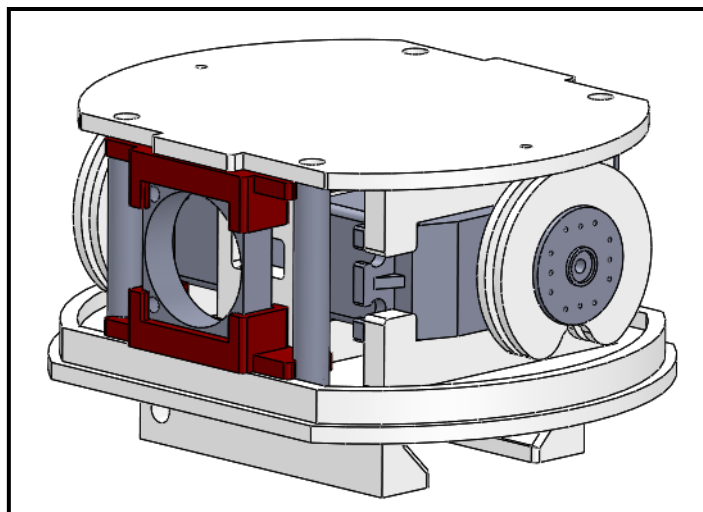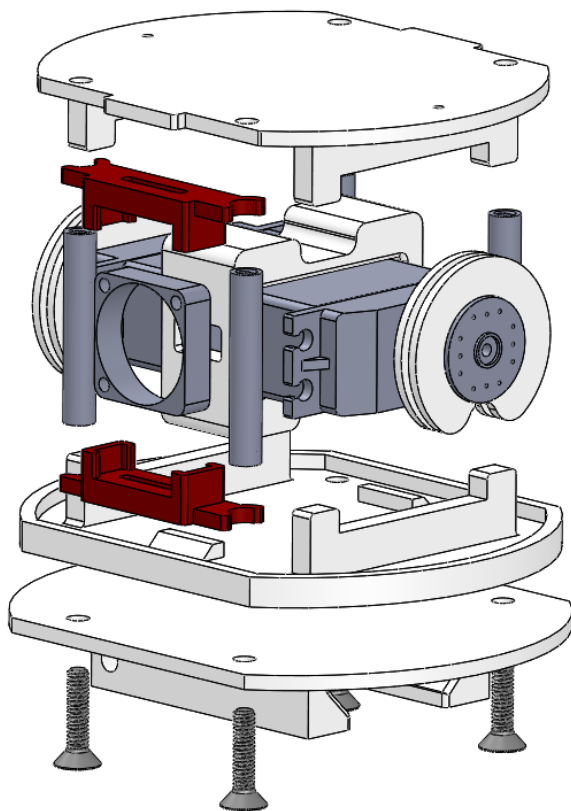| Parts |
|---|
| Power HD sub-assembly from page 14 |
| a2_power_t42.stl |
| a3_power_t42.stl |
| a4_coupling_t42.stl
- or -
a4_blank_t42.stl |
| 8-32, L3/4" countersunk bolt (x4) |
| Ø1/4", L1-1/2", 8-32 zinc-plated female standoff (x4) |
| d2_power_t42.stl (x2, optional) |
| Sunon 25x25x7mm 5V fan |

The final actuator sub-assembly is sandwiched together as shown. The Power HD sub-assembly should be oriented such that positive rotation (clockwise) of the servo will pull the tendon downwards.

The cooling fan isn't really necessary for the Power HD servos, but the design accommodates them as well with the fan mount part *d2_power_t42.stl*.

This sub-assembly is essentially identical to that for the Model M2

FINAL ASSEMBLY
HAND FRAME

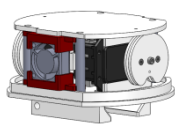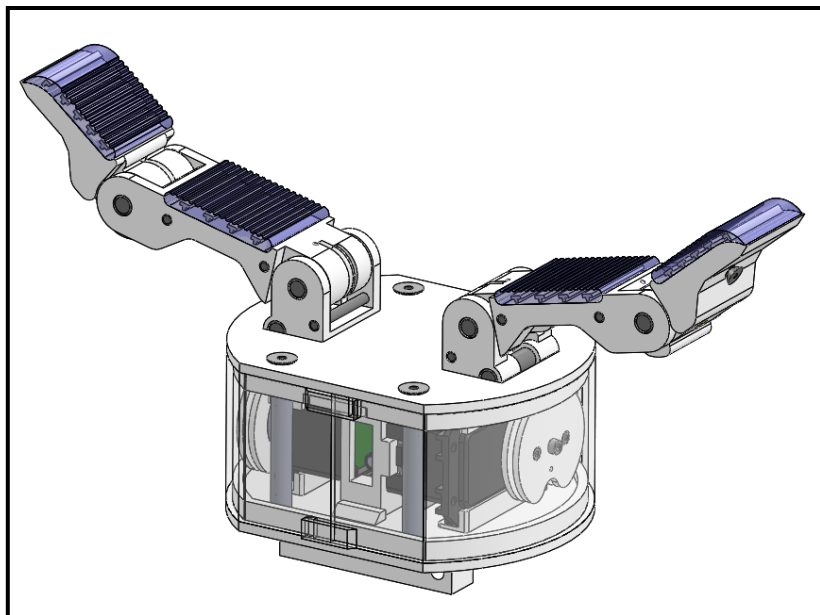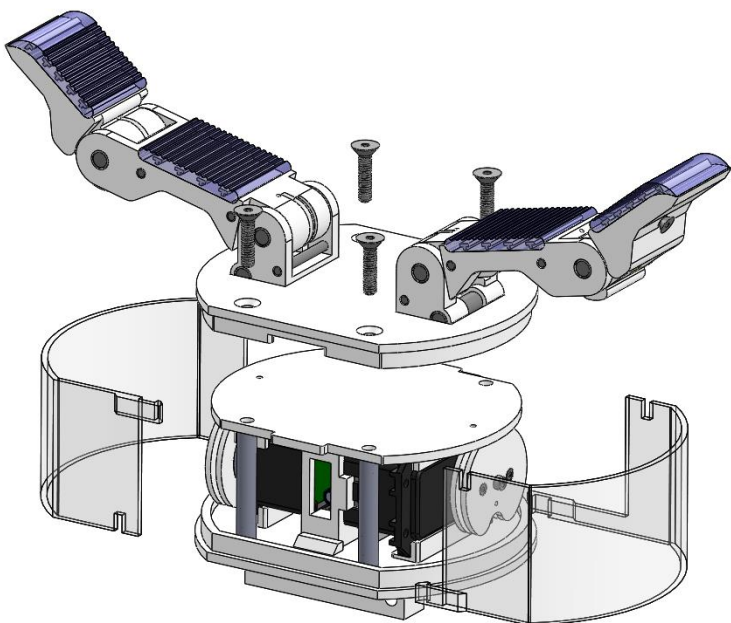| Parts |
|---|
| Actuator sub-assembly (Dynamixel) from page 13
- or -
Actuator sub-assembly (Power HD) from page 15 |
| Top flexure-base sub-assembly from page 5
- or -
Top pivot-base sub-assembly from page 11 |
| 8-32, L3/4" countersunk bolt (x4) |
| d1_m.stl
- or -
d1_fan_m.stl
                              (x2, optional) |

The top sub-assembly with topmost plate and the fingers are assembled onto the actuator sub-assembly in the same way, no matter which fingers are used. Use the 4 countersunk 8-32 bolts to sandwich and secure all the parts together.
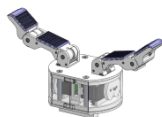
FINAL ASSEMBLY
TENDON ROUTING

Parts
Hand assembly
Spectra tendon line

The tendon is routed from the servo pulley through the tendon clearance in both *a2_dynamixel_t42.stl* or *a2_power_t42.stl*. The tendon is routed for each finger as shown below. The tendons will run over the 1/4" dowel pins.

The tendon can be terminated on the bolt at the back of the distal finger link or with a nut right after the tendon exits the back of the finger.

To zero the tendon line:
1. Anchor the tendon
2. Hook up the actuator and command it to its zero position
3. Unscrew the pulley until it can spin freely
4. Rotate the pulley until the tendon line is taut
5. Re-secure the drive pulley to the actuator