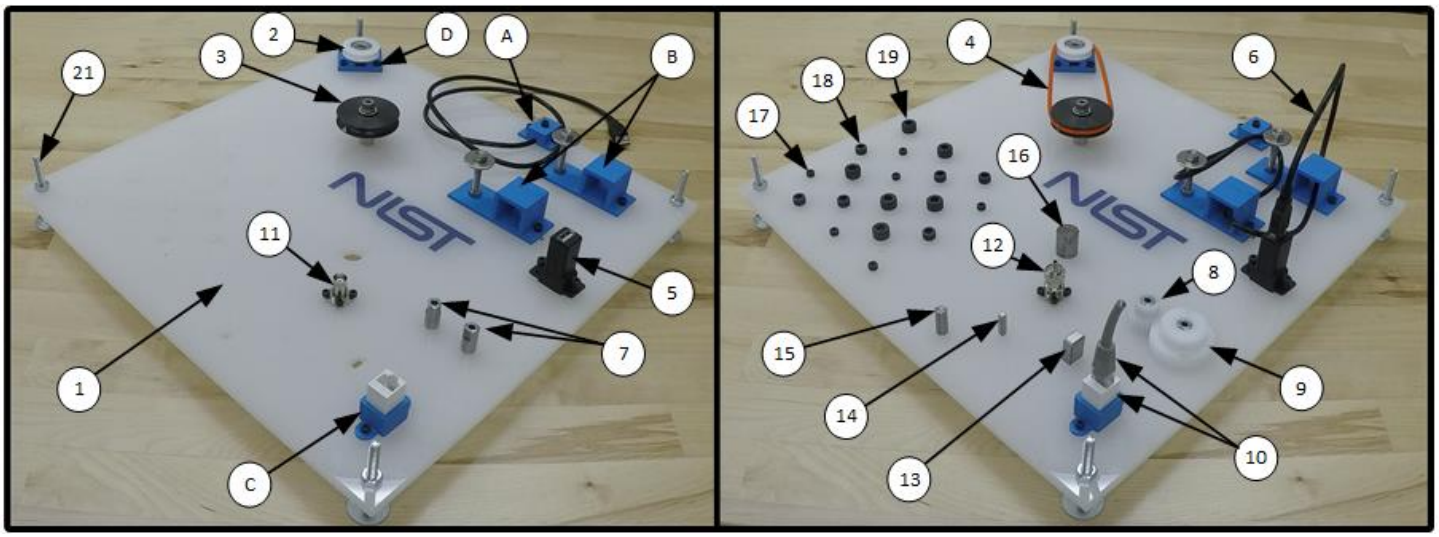
Instructions to Produce an IROS 2019 Manufacturing Track Practice Task Board

This document conveys fabrication instructions for assembling the practice task board for the Manufacturing Track of the IROS 2019 Grasping and Manipulation Competition. All major components are identified figures 1 and 2 below.



(a) Disassembled (b) Assembled

Figure 1. Identification of key components as labeled in the subsequent parts list and their locations on the task board.

Note: The orientation of the cable routing quadrant of the practice board is different from the orientation shown in the figure.

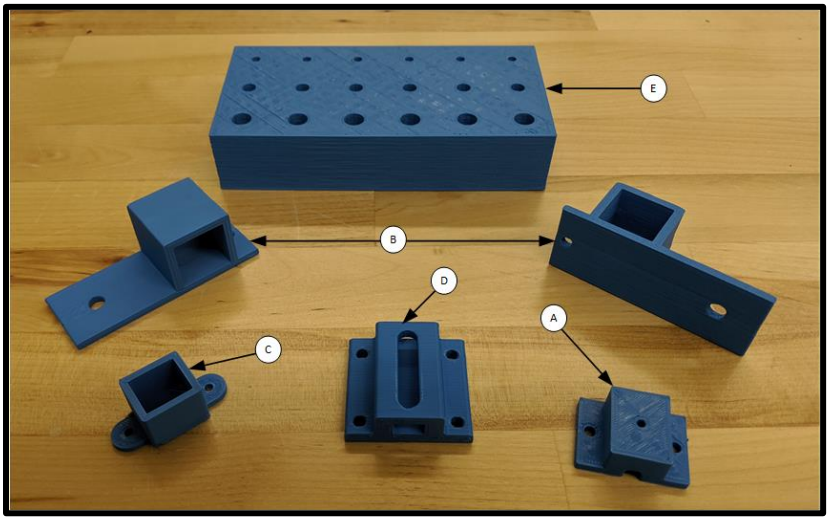


Figure 2. Identification components to be 3D printed.

Purchasing:

1) Majority of parts specified based on availability through MISUMI, an international distributor of components. Other vendors may supply the same parts. Note that this task board uses many parts from the three NIST Task boards found at https://www.nist.gov/el/intelligent-systems-division-73500/robotic-grasping-and-manipulation-assembly/assembly. If previously purchased, they can be used with the practice task board.
2) The laser-cut board can be produced and ordered here. Select "Add to Personal Factory". Log-in or if a first-time user of Ponoko, create a new user account. Select where you want the board manufactured (US or New Zealand) and follow check-out prompts.

Disclaimer: Certain commercial equipment, instruments, or materials are identified in this paper to foster understanding. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

Parts List- IROS 2019 Practice Task Board

(Example)

ID	Item	MISUMI Part Number	Unit Cost ($) (as of 9-9-2019)	Unit
1	Laser cut board (Ponoko)	N/A	74.40 + Ship	1
2	Round belt pulley with bearing (35 mm OD)	EUBHS35	17.59	1
3a	Round belt pulley (50 mm nominal dia.)	MBRF50-3-H10	17.67	1
3b	Shafts for round pulley (3a)	SFAD10-31-F20-B16-P8-N6	12.99	1
3c	Collar for round pulley/shaft (3a & 3b)	NCLC10-12-20	5.88	1
4	Polyurethane round belt (4mm dia. – 400 mm length)	MTB4-400	4.51	1
5	USB Female Connector	U09-AF-AF-B	6.63	1
6	USB Male Cable (4.8 mm dia)	U02-AM-BM-1	7.56	1
7	Gear Shafts	SPTR10-20-M6-SC12	16.33	2
8	Small Gear	GEABP1.0-20-10-B-10	13.60	1
9	Medium Gear	GEABP1.0-40-10-B-10	25.29	1
10	RJ45 Male and Female Connectors	ADT-EX-CRS5EK	14.77	1
11	BNC Female Connector	BNC-R	16.90	1
12	BNC Male Connector	BNCP-1.5A-K	14.03	1
13	Bar 12 mm x 8 mm x 300 mm	KET12	4.61	1
14	Bar 4 mm x 4 mm x 300 mm	KET4	1.82	1
15	Rod 8 mm	RGOCG8-50	4.70	1
16	Rod 16 mm	RGOCG16-50	7.88	1
17*	M4 Socket Cap Screw (20 mm length -pitch 0.7 mm)	F010410	2.03	14
18*	M6 Socket Cap Screw (20 mm length -pitch 1.0 mm)	F010610	2.03	8
19*	M8 Socket Cap Screw (20 mm length -pitch 1.25 mm)	F010810	1.96	6
20*	M3 Socket Cap Screw (20 mm length -pitch 0.5 mm)	F010310	1.87	8
21*	M6 Square Nut (10mm x 10mm x 5mm – pitch 1.0 mm)	NSQ-SUS-M6		1
22*	M6 Hex Head Screw (50 mm length – pitch 1.0 mm)	HXN-SUS-M6-50	0.48	2
23 *	M6 Socket Cap Screw (10 mm length – pitch 1.0 mm)	F010607	1.99	1
24*	M4 Socket Cap Screw (10 mm length -pitch 0.7 mm)	F010407	2.01	1
25*	M6 - Flat Washer (24mm OD)	WSX-SUS-M6X24-2	0.36	3
26*	M3 Hex Nut	HNT1-ST-M3	0.09	8
27*	M4 Hex Nut	HNT1-ST-M4	0.09	8
28*	M6 Hex Nut	HNT1-ST-M6	0.11	14
29*	M8 Hex Nut	HNT1-ST-M8	0.13	1
30*	M6 Leveling Mount	NFJN6-40	2.92	4

* Choice of supplier if specifications are met. Part numbers provided are associated with us.misumi-ec.com

Parts to 3D Print

ID	Part/Description	File Name	Unit
A	USB Cable Clamp	USB_Cable_Clamp.stl	1
B	Cable Routing Base	Cable_Routing_Base.stl	2
C	RJ45 Housing	RJ45_Housing.stl	1
D	Pulley Tensioner	Pulley_Tensioner.stl	1
E	Bolt Rack	Bolt_Rack.stl	1

Tools List

1) M4-0.7 tap
2) M6-1.0 tap
3) M8-1.25 tap
4) 6mm hex key
5) 5mm hex key
6) 3mm hex key
7) 10mm wrench
8) 5.5mm wrench

Assembly Instructions

Pegs and Holes:

1) Manually insert all four prismatic pegs in their corresponding holes, entering from topside of board. Some insertions may fail due to excess plastic at the "bottom" of the hole. This is an issue with the cutting laser beam not being perfectly perpendicular to the surface of the board. Use hand files to remove excess plastic at the bottom of the holes until pegs will smoothly insert. Do NOT remove plastic from the upper half of the hole as this will affect the leading hole tolerances.
2) Prismatic pegs will come in bar stock lengths of 300 mm. Cut to 50 mm segments.
3) Optional: per good design practices for assembly, chamfer one side of all pegs at 45 degrees and 0.1 times the largest cross-sectional side or diameter. E.g., 16 mm circular peg has 1.6 mm chamfer and 16 mm x 10 mm peg has 1.6 mm chamfer. Chamfering only one side of pegs allows for performance testing with and without the assistance of chamfers.

Bolts and Nuts:

1) Per bolt specifications in Figure 1, tap the corresponding holes intended for testing bolt threading. This includes six of each of the following: M4-0.7, M6-1.0, and M8-1.25 tapped holes.
2) Start the tapping process from the underside of the board through to the topside to ensure a clean finish and threads on the topside of the board.

Gears\Pulleys:

1) Insert two M6 bolts from underside of task board and tighten to two gear shafts (see below).

2) Attach shaft for round pulley as shown in Figure 1 and tighten to underside of task board using one M8 nut. Insert collar and round pulley on shaft and fasten using one M6 x 10 mm bolt and one M6 washer.

Connectors:

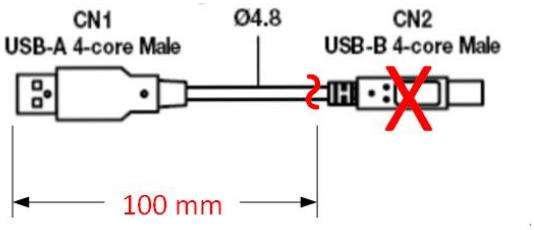
1) Tighten female BNC connector to board in location per figure 1 with four M3 x 20 mm bolts and four M3 nuts.

2) Tighten female USB connector to board in corresponding location as indicated by Figure 1 with two M3 x 20 mm bolts and two M3 nuts.

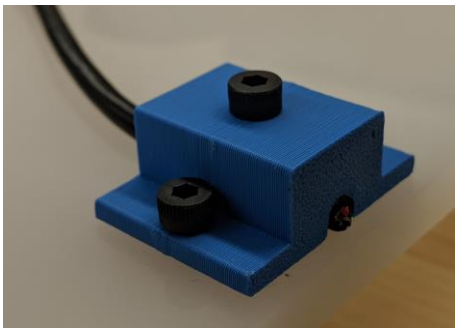
3) Tighten 3D printed RJ45 housing to board in corresponding location as shown in Figure 1 with two M3 x 20 bolts and two M3 nuts. Press female RJ45 connector into housing. If female connector with housing is loose, then a glue or epoxy may be used to fix connector to housing.

Cable routing components:

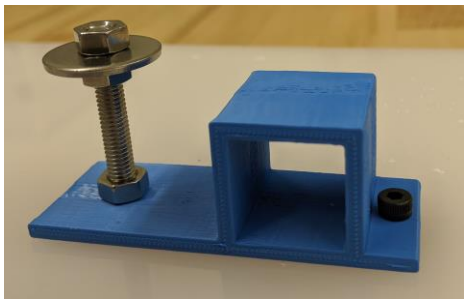
1) Cut USB cable as show to a length of 100 mm and discard the USB-B cable end.



2) Clamp cut end of cable to board using USB cable clamp as shown in Figure 1 with two M4 x 20 mm bolts and two M4 nuts. Tap the center hole on the usb cable clamp and tighten the M4 x 10 mm bolt to pinch the cable within the clamp.

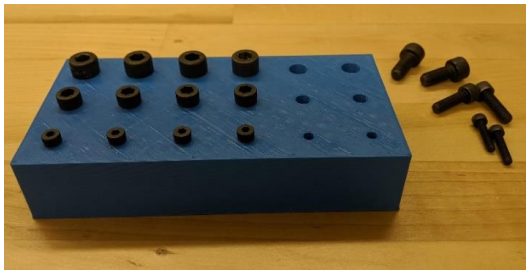


3) Attach the two cable routing bases. Each base is attached with one M4 x 20 mm bolt and associated M4 nut and one M6 x 50 mm bolt and associated nut. Additionally, attach two M6 nuts with one M6 washer in between to the top of the M6 x 50 mm bolt. The top nut should be flush with the bottom of the bolt.



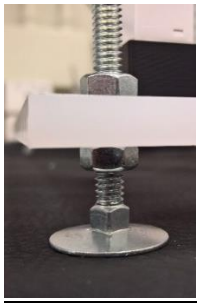
Bolt Rack:

This is an example bolt rack that supports the 18 fasteners to be assembled during the competition. If used, it may be useful to finish the holes using a drill bit in order to keep the threads from binding on the plastic surface. Otherwise, teams can develop their own bolt dispensing systems, whether it be a rack or automated feeder.



Standoffs:

1) Connect the threaded standoffs to the four corners of the board as shown in Figure 1 such that the distance from the underside of the board to the supporting surface is 20 mm.
2) There may be variation on how the standoff can connect to the board depending on the chosen standoff, itself. One method is shown below with a threaded standoff and two nuts that pin the plate.



Please contact Joe Falco (falco@nist.gov) with any questions regarding the production of this task board.