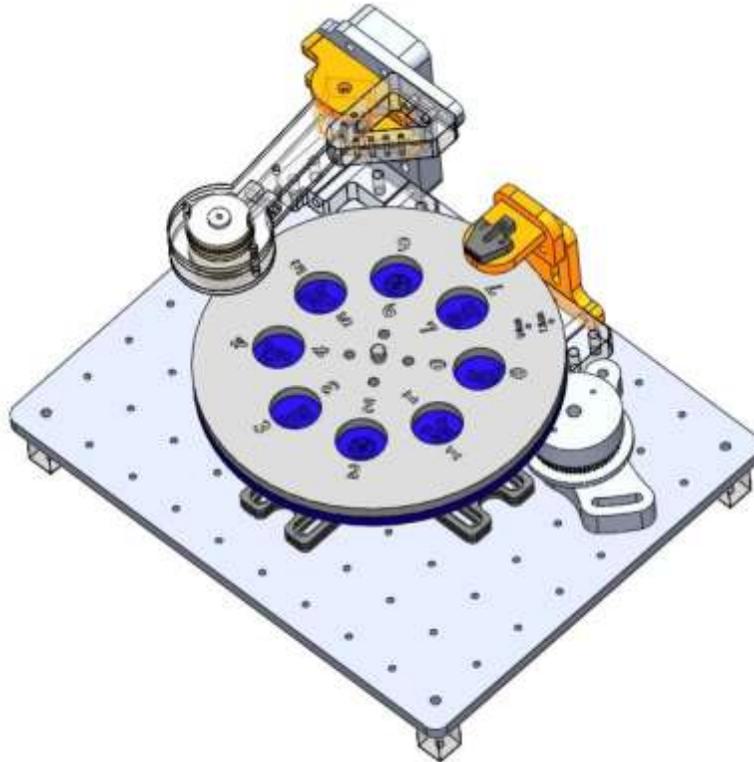


Fabrication and Assembly Instructions

MAE 156A Winter 2013



Overview

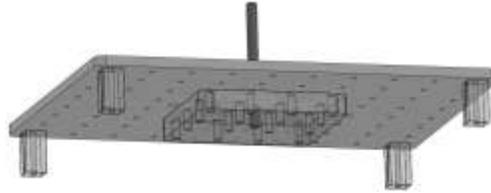
This guide is intended to help you smoothly get your robot operational. The first section deals with fabrication that you will need to use the Design Studio tools to complete. The second part helps walk you through the assembly procedure. Order of operations does matter in some cases, and when it does it will be highlighted in this guide. The guide will use pictures instead of text as much as possible.

Please also refer to the Bill of Materials for the robot when using this guide. Reference to part numbers will be used to speed up the discussion of how to assemble things.

You will need to have your robot constructed and wired prior to attending your second workshop session for driving a motor. You will take data using the hardware you put together! Your grade will be partially based upon the speed of your robot and well put together your assembly is, so take the time to do a good job!

Parts and Assemblies

Base Assembly

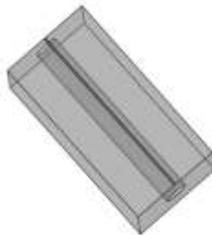


Bill of Materials						
Assembly:		Base Assembly				
#	Name	Description	Qty	Remarks	Mounting	Thickness
1.1	Base	8x10 Base	1			Quarter
1.2	Leg	Leg for system base	4			Half
1.3	Shaft Anchor	Shaft mounting location	1			Half
1.4	Turn Table Shaft	SS Shaft, Dia. 0.25", Length 3in.	1	COTS		

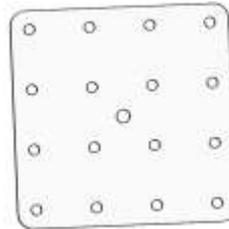
1.1 Base



1.2 Leg



1.3 Shaft Anchor



1.4 TT Shaft



Slider Bearing Assembly



Bill of Materials						
Assembly:		Slider Bearing				
#	Name	Description	Qty	Remarks		
2.1	Slider Plate Bottom	-	1		Requires glue	Eighth
2.2	Slider Plate Top	-	1		Requires glue	Eighth
2.3	Slider Bearing	Sliding surface - round	1		Requires glue	Quarter

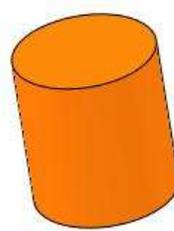
2.1 SP Bottom



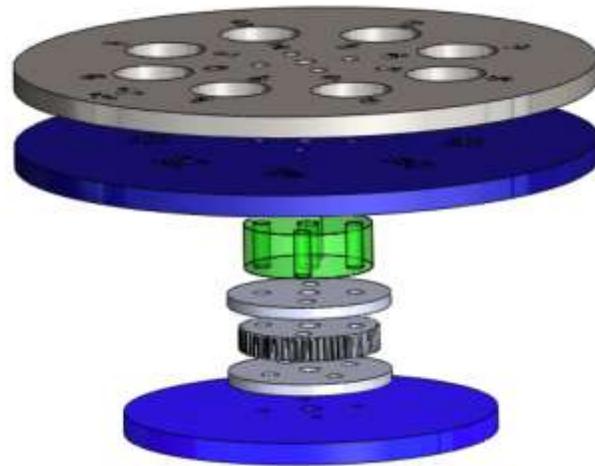
2.2 SP Top



2.3 Slider Bearing



Turn Table Assembly



Bill of Materials

Assembly:		Turn Table Assembly				
#	Name	Description	Qty	Remarks	Mounting	Thickness
3.1	TT Top Disc	Upper Disc with cargo cutouts	1			Quarter
3.2	TT Bottom Disc	Lower Disc on which cargo rests	1			Quarter
3.3	TT Pulley Flange	Keeps belt (7) on TT Pulley(3.4)	2			Eighth
3.4	TT Pulley	Pulley coupled to Potentometer Pulley(6.4)	1			Half
3.5	TT Bearing Flange	Bearing surface that rests on Slider Bearings(2)	1			Quarter

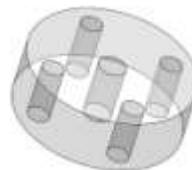
3.1 TT Top Disc



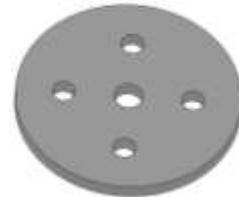
3.2 TT Bottom Disc



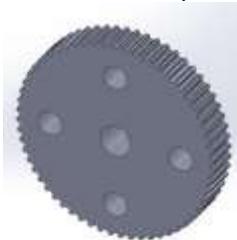
3.3 TT Spacer



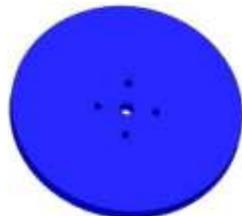
3.4 TT Pulley Flange



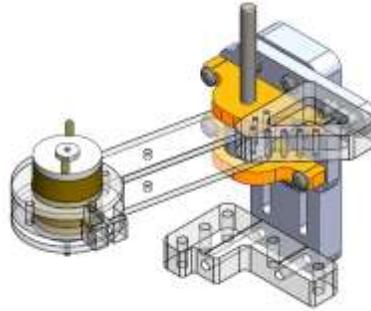
3.5 TT Pulley



3.6 TT Bearing Flange

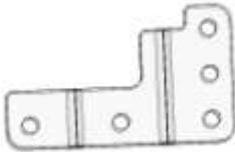


Motor Mount Assembly



Bill of Materials						
Assembly:		Motor Mount Assembly				
#	Name	Description	Qty	Remarks	Mounting	Thickness
4.1	MM Block	Motor Mount Assembly(4) base piece	1			Half
4.2	MM Bottom Vertical	Upright that supports MM Top Vertical (4.3)	1			Half
4.3	MM Top Vertical	Mounting point for MM Pivot Plate(4.4)	1			Quarter
4.4	MM Pivot Plate	Holds motor shaft - allows for motor plank motion	2		One press fit, one clearance	Quarter
4.5	MM Plank Spacer	Fits on MM shaft	1		clearance fit	Quarter
4.6	MM Base Plank	Eextension, face attachment	1			Eighth
4.7	MM Clamp Plank	Extension with clamp attachment	1			Eighth
4.8	MM Tension Extension	Mounting point for tension spring(8)	1			Half
4.9	MM Motor Clamp	Clamp for additional motor support	1			Half
4.10	MM Shaft	MM pivot for planks	1	COTS	Press fit	
4.11	High Speed Motor	Drive System	1	COTS		
4.12	Motor tensioning spring	Provides contact force for motor against turn table	1	COTS		

4.1 MM Block



4.2 MM Bottom Vertical



4.3 MM Top Vertical



4.4 MM Pivot Plate



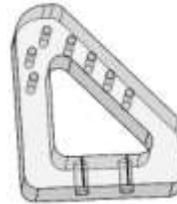
4.5 MM Plank Spacer



4.6 MM Clamp Plank



4.7 MM Tension Ext.



4.8 MM Motor Clamp



4.9 MM Shaft



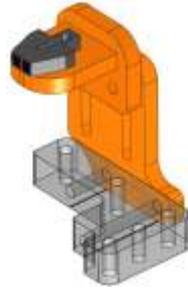
4.10 High Speed Motor



4.11 Tension Spring

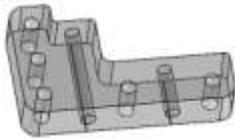


Photosensor Assembly



Bill of Materials						
Assembly:		Photosensor Assembly				
#	Name	Description	Qty	Remarks	Mounting	Thickness
5.1	PS Block	Photosensor Assembly(5) base piece	1			Half
5.2	PS Bottom Vertical	Upright that supports PS Top Vertical (5.3)	1			Quarter
5.3	PS Top Vertical	Support for PS Mount Extension (5.4)	1		Requires glue	Quarter
5.4	PS Mount Extension	Mounting location for photosensor	1		Requires glue	Quarter
5.5	Photosensor	Optical cargo sensing	1	COTS		

5.1 PS Block



5.2 PS Bottom Vertical



5.3 PS Top Vertical



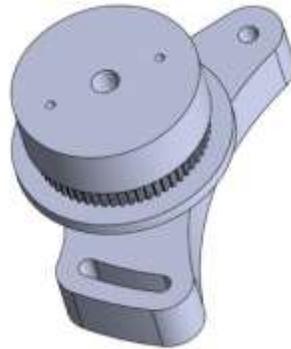
5.4 PS Mount Extension



5.5 Photosensor



Potentiometer Assembly



Bill of Materials						
Assembly:		Potentiometer Assembly				
#	Name	Description	Qty	Remarks	Mounting	Thickness
6.1	P Base	Base mounting block	1			Half
6.2	P Anchor Plate	Potentiometer panel mount plate	1			Eighth
6.3	P Pulley Flange	Keeps belt (7) on P Pulley(6.4)	2			Eighth
6.4	P Pulley	Pulley coupled toTurn Table Pulley(3.4)	1			Quarter
6.5	Pot Holder	Block with set screw to attach to Potentiometer	1			Half
6.6	Potentiometer	Digikey part number CT2158-ND	1	COTS		

6.1 P Base



6.2 P Bottom Flange



6.3 P Pulley



6.4 P Pot Holder



6.5 Potentiometer

Fabrication

Let's use some power tools!

Score Marks

Many of the parts have scoring marks from the laser (score level 3) that help indicate where to perform some of the fabrication procedures. When you get to the steps in this guide you will be instructed to use them to help align your cutting tools.

Base Assembly

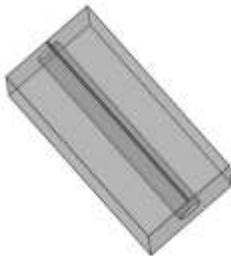
1.1 Base



Tap the indicated holes with an **8-32** tap.

Indicated holes have a circular score mark around them.

1.2 Leg



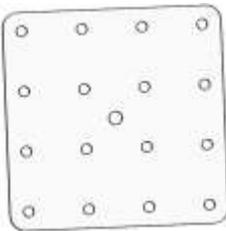
Use the drill press. Place part in vice with square face up and score mark facing towards you.

Drill an 8-32 tap hole through the length of the part. Use the score mark to help center the drill bit.

Acrylic melts if you drill too quickly, and it may help to drill twice, once with a small drill bit to make a starter hole, then followed by the 8-32 tap hole drill bit to complete.

Tap both ends (8-32 tap). One end will mount to 1.1, and one end you will use later.

1.3 Shaft Anchor



Use the drill press. **Do not use the vice**. Insert the **0.249 inch** reamer into the chuck. Align the reamer with the table positioning hand cranks so that when lowered it passes through one of the drill press platform's grooves (you must lower the reamer to verify this). You may have to go to the back of the press to lower the whole drilling assembly.

Switch the drill press to low speed **L** and gear **1** (look up). **It must rotate slowly!**

Holding the part with your hand to allow a free float, **Ream the center hole** with a **0.249 inch** reamer. Proceed slowly!

Caution: Verify the reamer is actually **0.249** inches – sometimes people put things back in the wrong place. A **0.251 inch hole will not work**. Look at the side of the reamer for a label that indicates its size.

Slider Bearing Assembly

No fabrication steps required!

Turn Table Assembly

3.1 TT Top Disc



Use the drill press. **Do not use the vice.** Insert the **0.251 inch** reamer.

Follow the reaming instructions for part 1.3, this time using the 0.251 inch reamer.

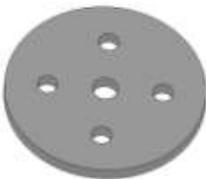
3.2 TT Bottom Disc



Use the drill press. **Do not use the vice.** Insert the **0.251 inch** reamer.

Follow the reaming instructions for part 1.3, this time using the 0.251 inch reamer.

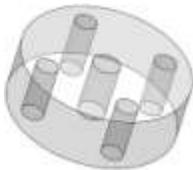
3.3 TT Pulley Flange



Use the drill press. **Do not use the vice.** Insert the **0.251 inch** reamer.

Follow the reaming instructions for part 1.3, this time using the 0.251 inch reamer.

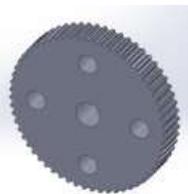
3.4 TT Spacer



Use the drill press. **Do not use the vice.** Insert the **0.251 inch** reamer.

Follow the reaming instructions for part 1.3, this time using the 0.251 inch reamer.

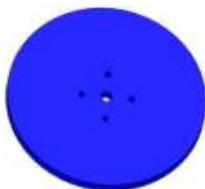
3.5 TT Pulley



Use the drill press. **Do not use the vice.** Insert the **0.251 inch** reamer.

Follow the reaming instructions for part 1.3, this time using the 0.251 inch reamer.

3.6 TT Bearing Flange



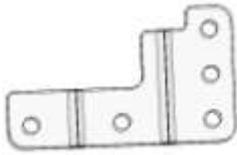
Use the drill press. **Do not use the vice.** Insert the **0.251 inch** reamer.

Follow the reaming instructions for part 1.3, this time using the 0.251 inch reamer.

Tap the four other holes with an **8-32** tap.

Motor Mount Assembly

4.1 MM Block



Use the drill press.

Drill two 8-32 clearance holes – one for each score mark

4.4 MM Pivot Plate



Use the drill press. Place part in vice with tab facing up. Place the part 4.3 such that the slot fits on the Pivot Plate tab. Use the part 4.3 clearance holes to align the 4-40 tap holes for the Pivot Plate.

Note: Drilling through the side of such thin acrylic puts the part at risk for failure. You must seek high precision with this part in particular!

Drill two 4-40 tap holes – one for each hole in the Top Vertical. Try to center the bit within the Pivot Plate material thickness so the holes are not close to either edge. Drilling through the holes in the Motor Mount Top Vertical will ensure the holes are aligned.

There are two MM Pivot Plates and they have different reaming instructions:

Plate 1:

Use the drill press. Do not use the vice. Insert the 0.249 inch reamer. Follow the reaming instructions for part 1.3 using the same sized reamer.

Plate 2:

Use the drill press. **Do not use the vice.** Insert the **0.251 inch** reamer. Follow the reaming instructions for part 1.3, this time using the 0.251 inch reamer.

4.8 MM Tension Ext.

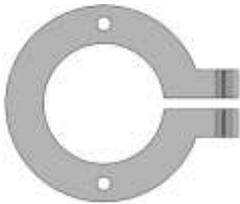


Use the drill press. Place part in vice with short flat surface facing up and score marks facing towards you as shown to the left.

Drill two 4-40 tapped holes – one for each score mark. Try to center the bit within the material thickness so the holes are not close to either edge.

Tap the all the holes using a **4-40** tap.

4.9 MM Motor Clamp



Use the drill press. Place the part in the vice with score marks vertical and facing towards you as shown to the left. When you place it in the vice, only reveal the top part of the score mark – make sure both ends are secure and won't flex when drill pressure is applied.

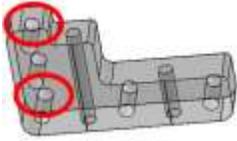
Drill a 4-40 tap hole through **both ends** of clamp – use the score mark to guide you. Try to center the bit within the material thickness so the holes are not close to either edge.

Drill a 4-40 clearance hole through only **one end** of clamp. Use the pilot hole from previous drill bit.

Tap the side opposite the clearance hole using a **4-40** tap.

Photosensor Assembly

5.1 PS Block



Use the drill press. Place part in vice with long edge facing up and score marks facing towards you.

Drill two 8-32 clearance holes – one for each score mark

Countersink the holes indicated to the left with an 82° countersink suitable for 8-32 flathead screws. Do not use drill press. *Countersink the side opposite to the score marks* (as shown).

Potentiometer Assembly

6.3 P Pulley Flange



Countersink with an 82° countersink suitable for 4-40 flathead screws. Screw does not have to be flush when placed in. Err on the side of being slightly under countersunk.

6.5 Pot Holder



Use the drill press. Place part in vice with long edge facing up and score marks facing towards you.

Drill a 6-32 tap hole – use score mark for alignment. Try not to drill right in the center of the thickness – offset your drill a bit to one side (as shown in figure). This will make it easier to set screw.

Tap the hole you drilled using a **6-32** tap.

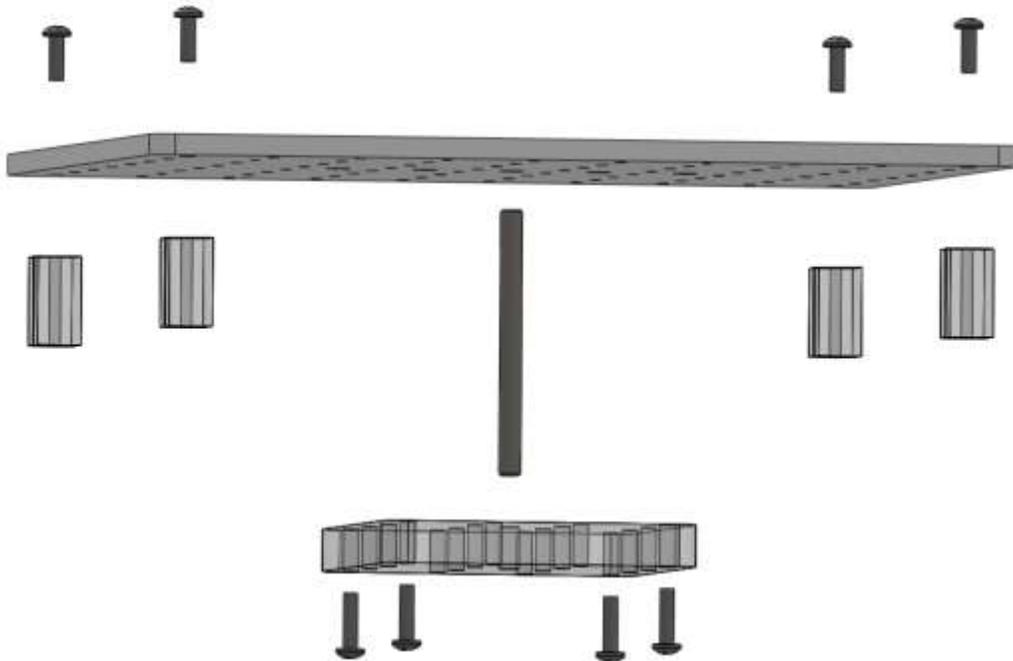
Tap the two side holes a **4-40** tap.

Assembly

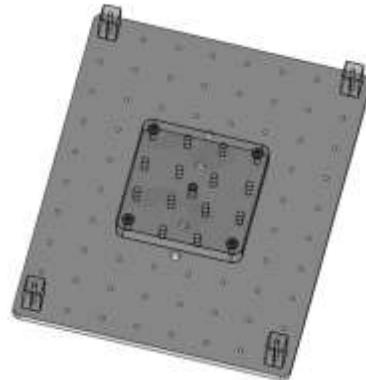
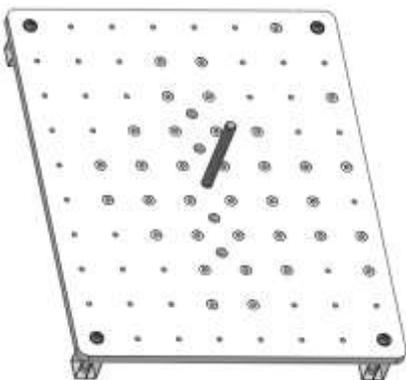
Putting it all together

Assembly of many components requires fasteners. The faster drawers do not have all possible lengths and you will have to cut a few bolts. When using the bolt cutter **ALWAYS insert the screw into the threaded side of the bolt cutter first**. The screw head and the threads on the bolt cutter should ALWAYS be on the same side!

Base Assembly



1. Screw on the four legs to the base. It is not shown, but washers and lock washers are recommended.
2. Press fit shaft into shaft anchor center hole.
3. *After you make the Turn Table Assembly*, bolt the Shaft Anchor on to the base. You need the shaft anchor with the shaft inserted to make the TT Assembly, so don't install it quite yet.



Slider Bearing Assembly

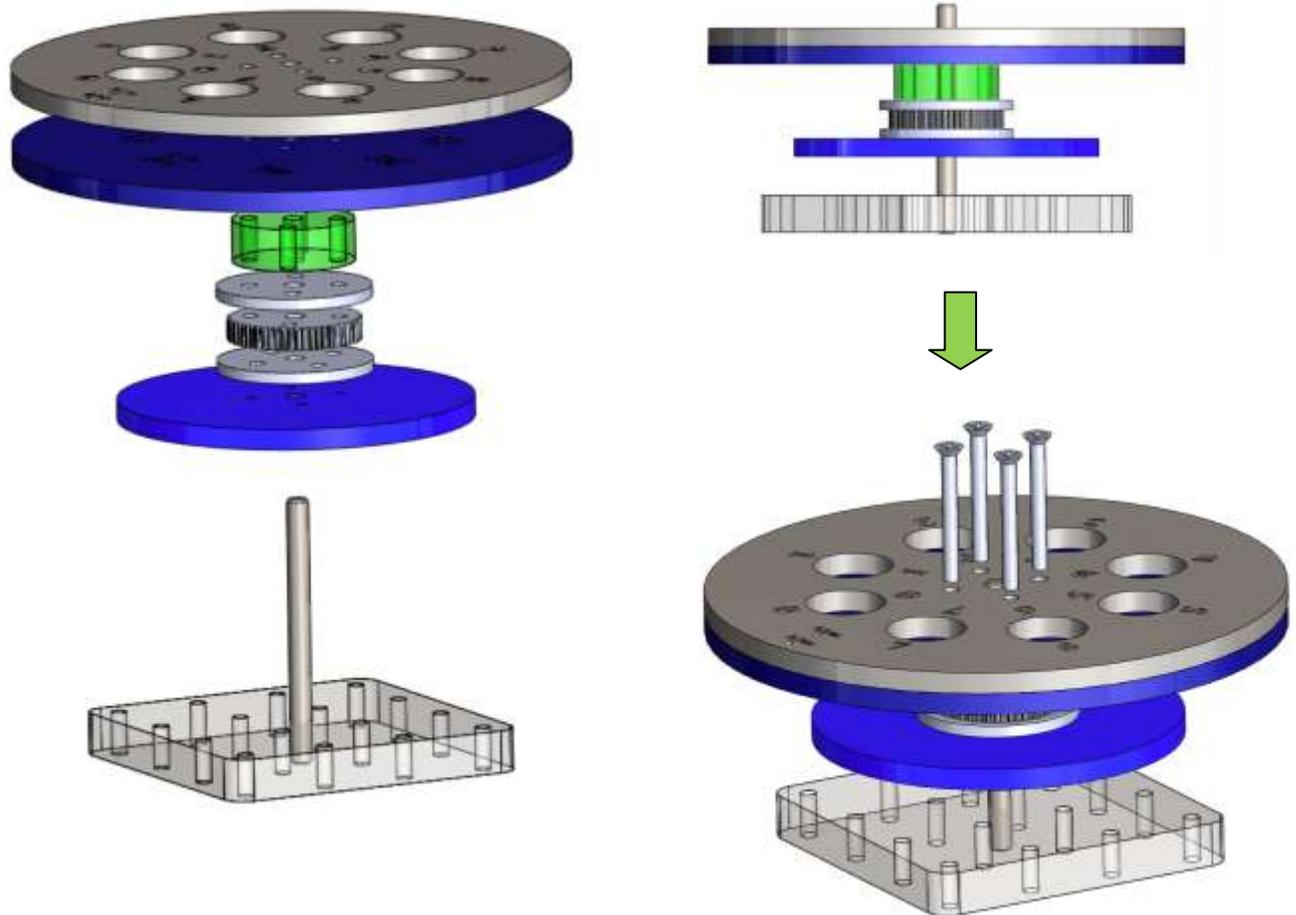


1. Apply acrylic solvent (which we all refer to as acrylic glue) liberally to the Slider bottom.
2. Place slider top on slider bottom, sandwiching the solvent – make sure you have them nicely aligned because their relative position will shortly be permanent.
3. Repeat for the other three slider bearings (you are making 4 total). Keep track of the order in which they are made for following steps.
4. When you are done the first one you made should be good enough for bearing insertion
5. Apply a small amount of solvent into the circular hole of the first slider you glued
6. Insert the slider bearing piece into the hole.
7. Repeat this step three times, trying to match the order in which the sliders were initially glued.



8. Bolt the final four assemblies to the base similar to the TA robot.

Turn Table Assembly



1. You will need to bolt cut four 8-32 screws so that when the assembly is screwed together, the bolts do not extend past the bearing flange. Do not cut them too short either because you want the threads to have good contact with the bearing flange.
2. Slide components onto shaft as shown – you need to complete the Base Assembly section first. If the parts don't fit ream them again with the **0.251 inch** reamer. Follow the reaming instructions from the fabrication of part 1.3.
3. You are using the shaft to align the Turn Table so that it rotates properly. Only install bolts after the components are properly slid onto shaft. Install the bolts somewhat loosely.
4. Slide turn table to the top of shaft so shaft is flush with TT Top Disc.
5. Tighten bolts. If you unscrew the bolts after the following procedures, you will need to redo this section and your turn table will have more slop in it.
6. Slide the turn table off of the shaft. If you can't get it off, loosen and tighten bolts and try again. You may have to pull hard - the centers are not totally aligned on the shaft when you tighten the bolts and it binds the parts to the shaft.
7. Using the **0.251 inch** reamer, ream the whole turn table assembly. This will enable the turn table to rotate. Follow the same reaming instructions as for part 1.3. If you need help with this ask a TA.
8. Once you are finished, put the Turn Table Assembly aside for the final assembly procedure.

Motor Mount Assembly

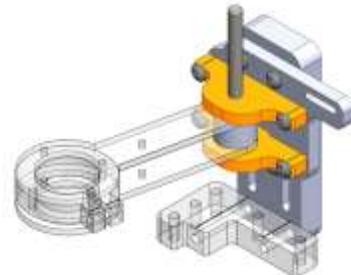
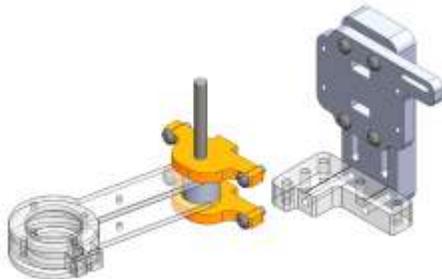


1. Put together assembly using 8-32 fasteners as shown to the left. (Also see TA robot)
2. Bolt onto base. You may have to do some bolt cutting for some of the bolts that are not the correct length.

3. Press fit small steel shaft into the MM Pivot Plate with a 0.249 inch ream (the 0.251 inch ream will not press fit). See MM Pivot Plate fabrication instructions for detail about reaming these parts.
4. Assemble the components as shown below in the figure in preparation to install onto mounting fixture in the picture above.



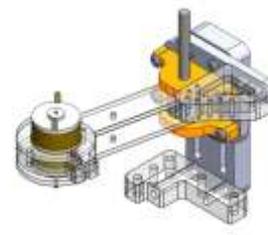
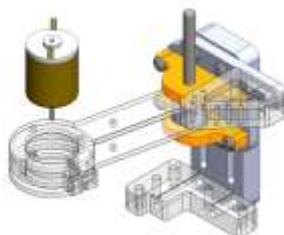
5. Using 4-40 screws with lock washers (see TA robot) install pivoting assembly onto the mounting fixture as shown below.



6. Illustration of how to install the MM Tension Extension. **Do not do this now.** Wait for the Final Assembly Instructions.



7. Finally, install the motor. **See wiring instructions at the end first!** Use a 4-40 screw to tighten the MM Motor Clamp.

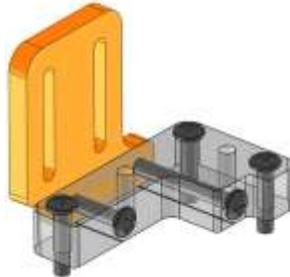


Photosensor Assembly

1. The first step is to glue the PS Top Vertical to the PS Mount Extension as show below. The slot fit will **not be perfect**. It is recommended that apply acrylic solvent (aka acrylic glue) to the contact area between the pieces and gently work the tab fit back and forth (second figure below). Dab glue (very small drop) in the seam as you work it back and forth (illustration below). If done right you will notice dissolved acrylic and it will look a bit sticky. This will form a strong bond.
2. Apply your last dabs/drops to help keep some of the sticky acrylic dissolved and push down as shown in the third figure. Wait about 2 minutes.



3. Bolt the assembly below together and to the base. The part above will be installed after the Turn Table and Potentiometer Assemblies are placed onto the base!



Potentiometer Assembly

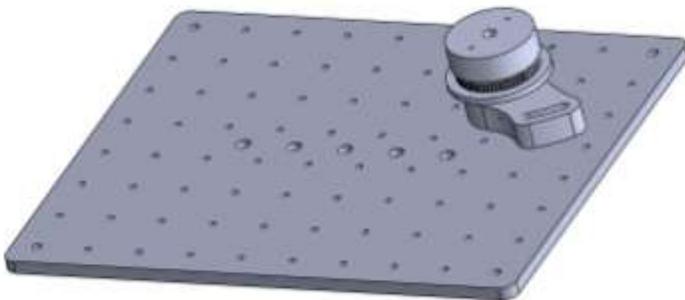
1. First assemble the potentiometer pulley subassembly, use the exploded view shown on the right.



2. Bolt the potentiometer base to the 8x10 turn table base in the position shown.



3. Set screw the potentiometer pulley subassembly to the potentiometer as shown below. Make sure the pulley is level/horizontal (you have to look from the side). Now you should have a pulley that doesn't have a tilt to its rotational axis. Ask a TA for help if you have trouble.



Final Assembly Instructions

There are a few things left to put in place.

1. If you have not yet installed the Shaft Anchor with press-fitted shaft onto the base, do so at this time (see Base Assembly instructions).

The following must be done in reverse to take the Turn Table Assembly off of the shaft:

2. Drop the potentiometer sub assembly into the potentiometer base. Put the timing belt onto the Turn Table Assembly (TT) pulley and then slide the TT onto the shaft. As you are doing so connect the timing belt to the potentiometer pulley. Then pull the potentiometer base away from the turntable, tightening the timing belt. Tighten the screws to secure the belt tension.
3. Complete the Photosensor assembly by bolting on the missing pieces (the ones you glued) onto the pieces installed onto the base. This must be installed after the TT, and must be removed to take off the TT.
4. Install the MM Tension Extension as shown in the Motor Mount Assembly section.
5. Install the tensioning spring between the MM Tension Extension and the MM Planks.

Wiring Instructions

You must wire three components for the Turn Table:

1. Potentiometer
 - a. Use red and black for the outer two terminal, and a blue signal wire for the wiper terminal in the middle.
2. Photosensor
 - a. See the online guide to wiring a photosensor.

The Potentiometer needs to be wired and installed in your Turn Table BEFORE YOU GO TO THE MOTOR DRIVING WORKSHOP. YOU WILL NOT BE ABLE TO FULLY PARTICIPATE IF YOU FORGET!!!

For the Photosensor, use the standard MAE 156 convention of red for +5, black for ground and blue for signal. If you need help ask Chris or the TAs.