

# Machine Shop

## Part 3 – Machine Tools

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# Safety Notice

- ▶ You must complete safety instruction before using tools and equipment in the Medical Device Center, ME Student Shop and CSE Workshops.
- ▶ All machinery can be dangerous. You must have a trained individual instruct you first when using unfamiliar equipment.
- ▶ Only authorized and trained individuals may operate CNC equipment.
- ▶ Code examples shown are for illustration purposes only, and are not meant for operation or programming actual equipment. They may be incomplete or contain errors.
- ▶ Always abide by shop safety instructions and never engage in horseplay.
- ▶ Remember to wear OSHA approved eye and ear protection in the shop, short sleeves, leather or steel toed shoes, and secure long hair, avoid loose clothing, and take off rings, watches and bracelets when using power equipment.
- ▶ These slides are part of the “Introductory Medical Device Prototyping” course at the University of Minnesota, and are not meant for any other purpose.

# Eye Protection & First Aid



- Always wear OSHA approved eye and ear protection.
- Familiarize yourself with the shop first aid kit, location of telephone, and emergency phone numbers.

# Tools of the Trade

- ▶ Safety
- ▶ Machine Tools
  - Drilling
  - Tapping
  - Sawing
  - Laser cutting
  - Waterjet cutting
  - Metal or plastic buffer
  - Belt sander & Grinder



# Drill Press



Floor Stand



Bench Top

# Drill Bits...



English fractional, letter and number set.



Reduced shank or "Deming" drill set.



Spotting/center drills.



Spade bit for wood.

Note lip ground flat.



Drill bits for Plexiglas and polycarbonate.

# *Drill Press Features...*



Drill, spindle & chuck.



Hand feed and depth adjustment.



Upper table height adjustment on column.



# Changing Spindle Speed



- Pulley and belt arrangement set the spindle speed.
- Material and drill diameter determine what spindle speed to use.
- Motor release handle loosens belts. Retighten when done.

# Leveling Upper Table



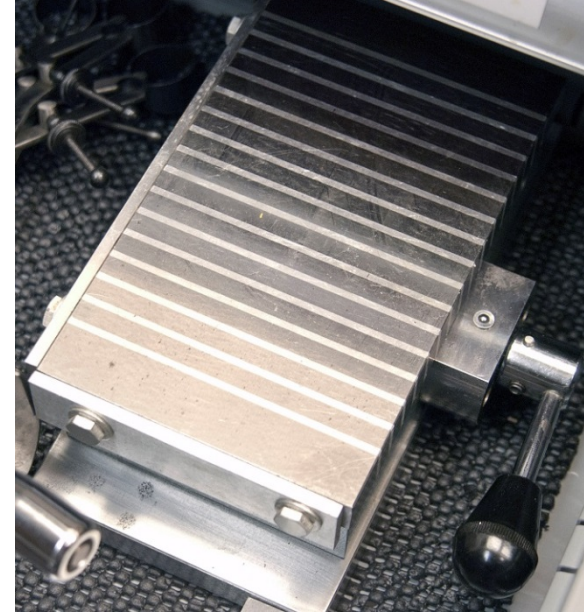
Check with a rod and square in two directions, and then adjust below if necessary. Alternatively use a digital level.



# *Drill Vise, Clamps & Magnetic Chuck...*



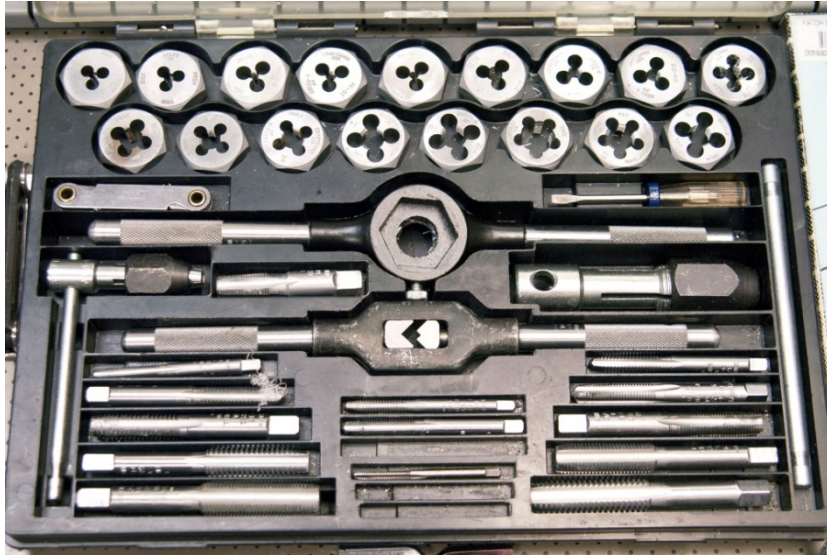
Table mount vise-grip clamps.



Switchable magnetic chuck.



# Tap & Die Set



- Taps, dies, thread gage, screwdriver, tap holders and die holders.
- Pick your bolt thread first, select the drill size, drill and tap.

## TAP DRILLS

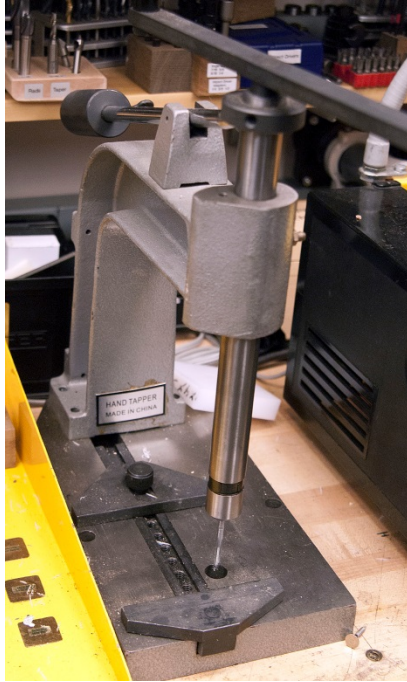
American Std. and Unified Form Threads Tap Drill Size is approximately 75% Thread						METRIC THREADS					
THREAD NOMINAL SIZE	Pitch Series	DRILL		THREAD NOMINAL SIZE	Pitch Series	DRILL		French and International Standard (D.I.N.)			
		SIZE	DECIMAL			SIZE	DECIMAL	TAP SIZE	STD.	DRILL STD. D.C.	
0-80	NF	3/64	.047	3/16-12	NC-UNC	3/64	.484	2.5-45	French	3/64	.0781
1-64	NC	53	.060	18	NF-UNF	3/64	.516	2.6-45	D.I.N.	#45	.082
72	NF	53	.060	5/16-11	NC-UNC	17/64	.531	3-50	D.I.N.	#39	.0995
2-56	NC	50	.070	18	NF-UNF	3/64	.578	.60	French	3/62	.0937
64	NF	50	.070	3/8-10	NC-UNC	17/64	.656	.75	Optional	#43	.089
3-48	NC	47	.079	16	NF-UNF	17/64	.688	3.5-60	French & D.I.N.	#33	.113
56	NF	45	.082	3/8-9	NC-UNC	9/64	.766	4-70	D.I.N.	#30	.1285
4-40	NC-UNC	43	.089	14	NF-UNF	13/64	.813	-.75	French	1/4	.125
48	NF	42	.094	1-8	NC-UNC	3/8	.875	4.5-75	French & D.I.N.	#26	.147
5-40	NC	38	.102	12	NF-UNF	59/64	.922	5-75	Optional	#19	.166
44	NF	37	.104	1 1/2-7	NC-UNC	49/64	.984	.80	D.I.N.	#19	.166
6-32	NC-UNC	36	.107	12	NF-UNF	13/64	1.047	.90	French	#20	.161
40	NF	33	.113	1 1/2-7	NC-UNC	17/64	1.109	1.00	Optional	5/32	.156
8-32	NC-UNC	29	.136	12	NF-UNF	17/64	1.172	5.5-75	Optional	3/16	.1875
36	NF	29	.136	1 3/8-6	NC-UNC	17/64	1.219	.90	French & D.I.N.	#14	.182
10-24	NC-UNC	25	.150	12	NF-UNF	17/64	1.297	6-1.00	French & D.I.N.	#9	.196
32	NF-UNF	21	.159	1 1/2-6	NC-UNC	17/64	1.344	1.25	Optional	3/16	.1875
12-24	NC	16	.177	2	4 1/2	NC-UNC	1 1/16	7-1.00	French & D.I.N.	1 1/16	.234
28	NF	14	.182	1 1/2-5	NC-UNC	17/64	1.563	1.25	Optional	#1	.228
1/4-20	NC-UNC	7	.201	2 1/2-4 1/2	NC-UNC	2 1/16	2.031	8-1.00	French	1	.277
28	NF-UNF	3	.213	2 1/2-4	NC-UNC	2 1/16	2.250	1.25	D.I.N.	1 1/16	.265
3/8-18	NC-UNC	F	.257	2 3/4-4	NC-UNC	2 3/16	2.500	9-1.00	French	3/16	.3125
24	NF-UNF	I	.272	3-4	NC-UNC	2 3/16	2.750	1.25	D.I.N.	3/16	.3125
3/8-16	NC-UNC	Q	.313	3 1/2-4	NC-UNC	3	3.000	10-1.00	Optional	3/16	.359
24	NF-UNF	Q	.332	3 1/2-4	NC-UNC	3 1/16	3.250	1.25	Optional	1 1/32	.3437
7/16-14	NC-UNC	U	.368	4-4	NC-UNC	3 3/16	3.500	1.50	French & D.I.N.	R	.339
20	NF-UNF	2 1/4	.391					11-1.50	D.I.N.	3/8	.375
1/2-13	NC-UNC	2 3/4	.422					12-1.25	Optional	3/8	.4375
20	NF-UNF	2 3/4	.453					1.50	French	1 1/32	.406
								1.75	D.I.N.	1 1/32	.406
								13-1.50	Optional	2 1/4	.453
								1.75	Optional	2 1/4	.453
								2.00	Optional	3/16	.4375
								14-1.25	Optional	3/16	.5156
								1.75	Optional	1/2	.500
								2.00	French & D.I.N.	1 1/32	.4687
								15-1.75	Optional	17/64	.531
								2.00	Optional	3/16	.5156
								16-2.00	French & D.I.N.	3/16	.5468
								17-2.00	Optional	1 1/32	.5937
								18-1.50	Optional	2 1/32	.656

DECIMAL EQUIVALENTS OF LETTER SIZE DRILLS					
Letter	Inches	Letter	Inches	Letter	Inches
A	0.234	J	0.277	S	0.348
B	0.238	K	0.281	T	0.358
C	0.242	L	0.290	U	0.368
D	0.246	M	0.295	V	0.377
E	0.250	N	0.302	W	0.386
F	0.257	O	0.316	X	0.397
G	0.261	P	0.323	Y	0.404
H	0.266	Q	0.332	Z	0.413
I	0.272	R	0.339		

Sold by SEARS, ROEBUCK AND CO., Chicago, IL 60684 U.S.A.

# *Tapping Machines...*



Manually operated tapping machine.



Reversible tapping attachment for drill press or mill.

# *Tapping...*



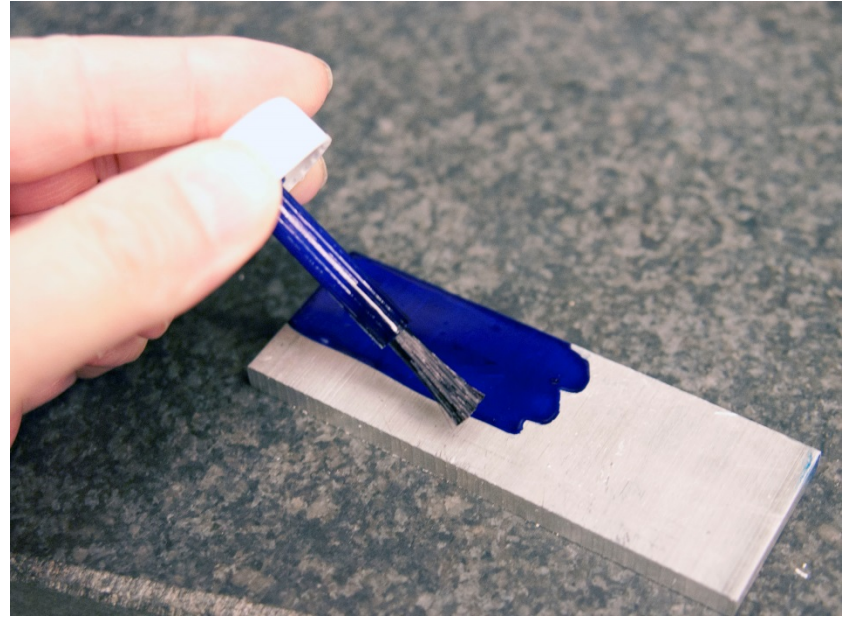
Taps & adaptors are based on screw sizes – either English or metric.



Work “loosely” clamped in place.

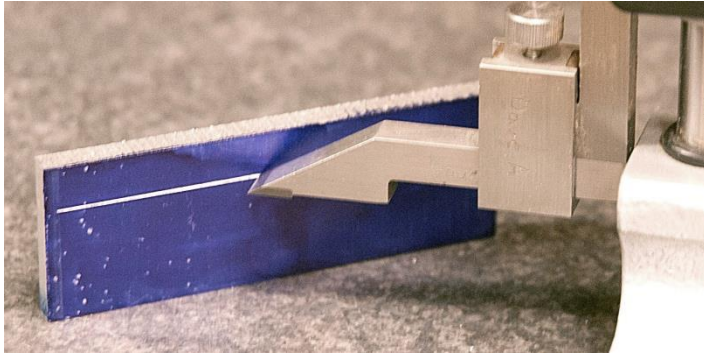


# *Layout Hole Pattern...*



Apply Dykem or equivalent over area holes are to be drilled. Polymers are tricky, as the Dykem may be hard to remove. Pre-test.

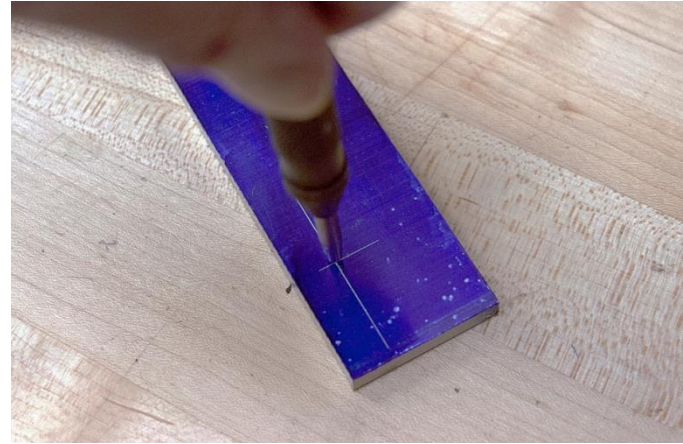
# Height Gage & Granite Surface...



Be sure to zero gage by leveling on granite surface before dialing desired height.



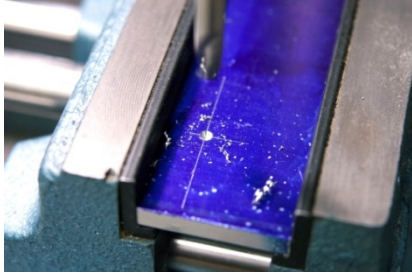
# *Spring-Loaded Center-Punch...*



Locate the center visually, align punch and push straight down.



# *Drilling a Pilot Hole for an 8-32 Tap...*



Make a small hole made with the spotting drill bit.



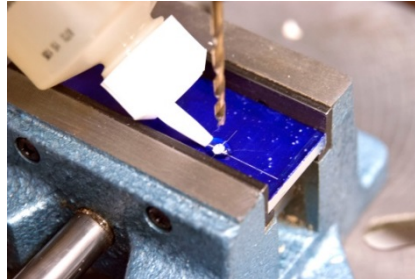
Clear away chips with a brush.



Select the #29 drill for an 8-32 tap (per the chart).



Replace spotting drill with #29 drill bit. Remove the key!



Place a drop of lubricant over the starter hole.



Drill - take short pecks - lifting drill every so often to release chips.

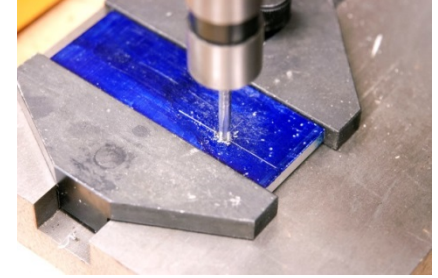
# *Tapping an 8-32 Hole...*



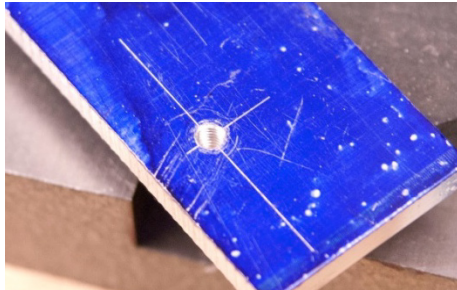
Select the 8-32 tap.



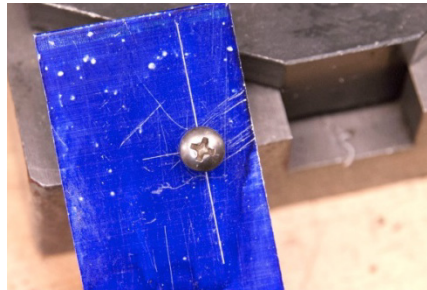
Place and tighten into #8 adaptor.



Rotate one turn CW/quarter turn CCW until well through the work.



Lift gently while rotating CCW to remove tap.



Test by screwing in an 8-32 bolt.



Clean with Dykem Cleaner.  
Wear a glove!

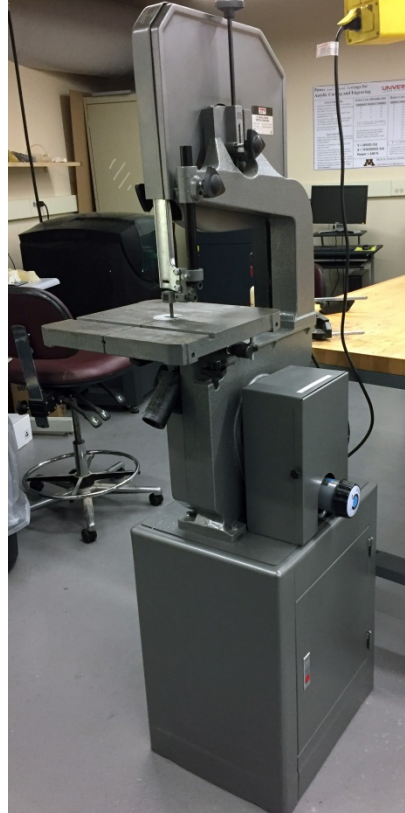
# Reaming Holes



- Come as chucking and hand operated reamers.
- There are both fractional and decimal diameters.
- Over and under sizes are also available.
- Use for bolt and shaft clearances and press fit nuts.



# Vertical Band Saw



# *Table Adjust and Fence...*



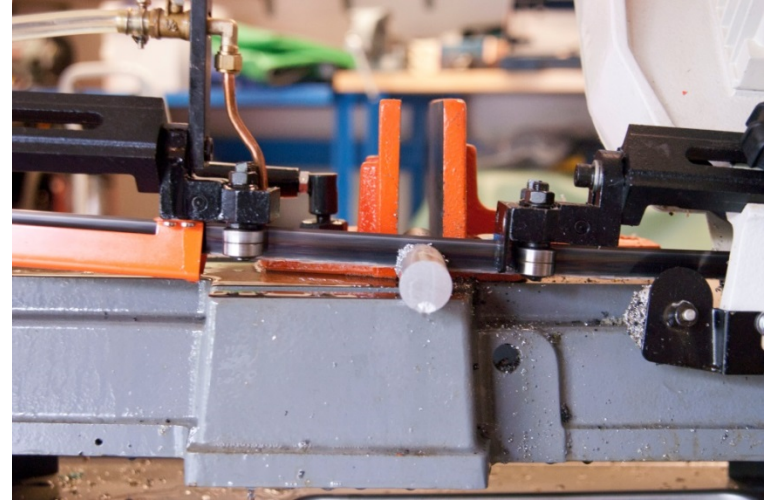


# Table Scroll Saw





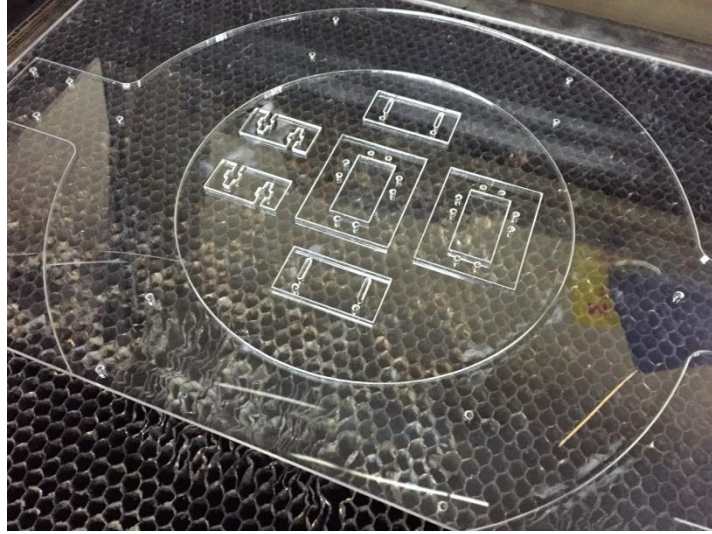
# Horizontal Band Saw



# Laser Cutting

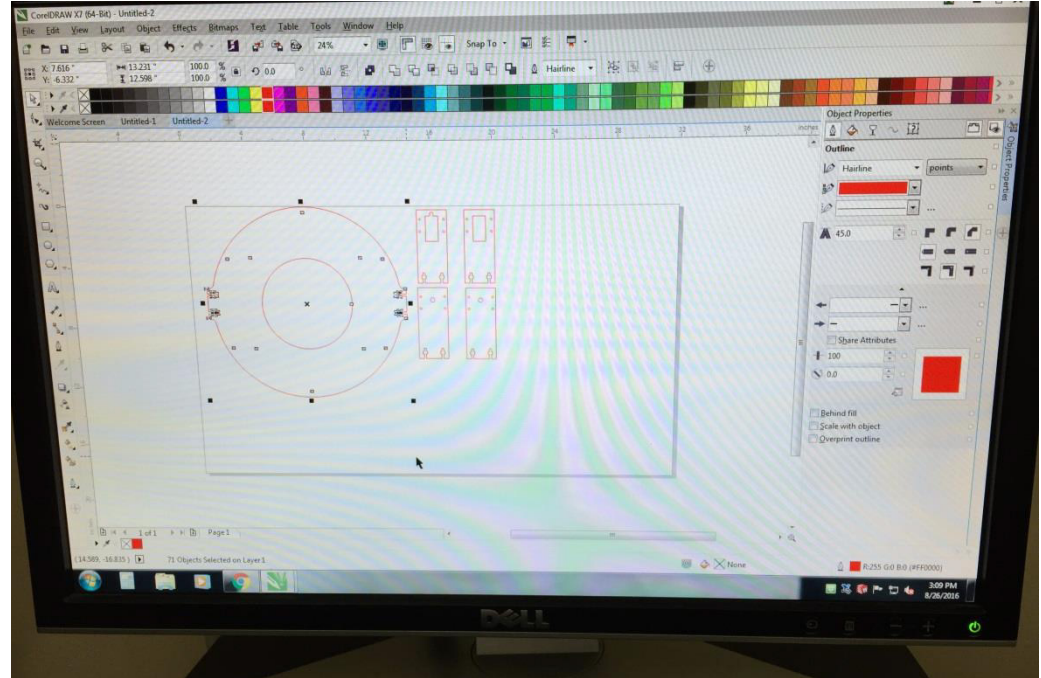
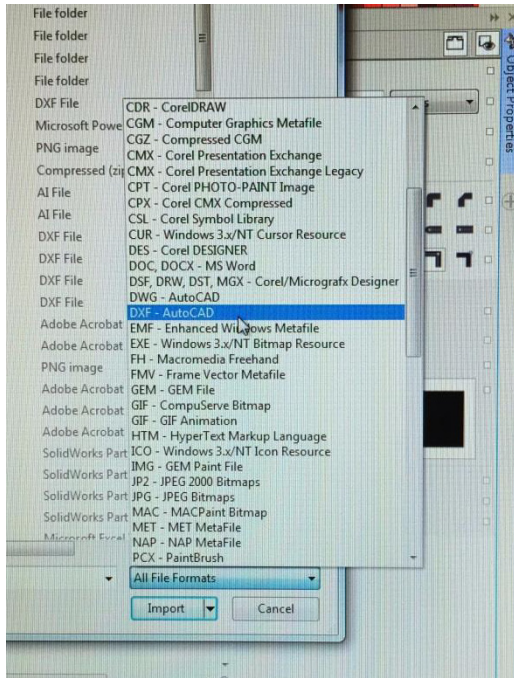


Acrylic and small thickness wood can be easily pattern cut. Either raster engraving or vector cutting can be performed. This is a supervised activity.



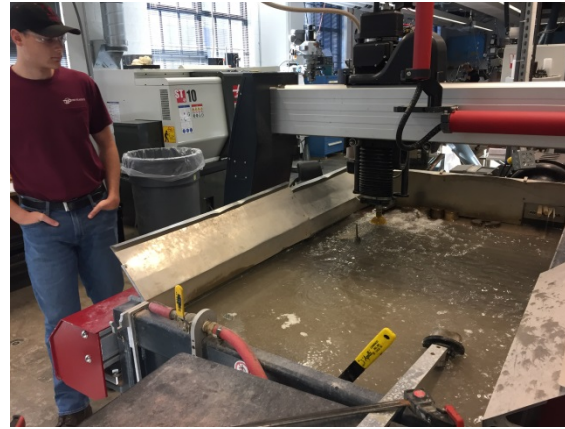


# Import File into CorelDRAW...



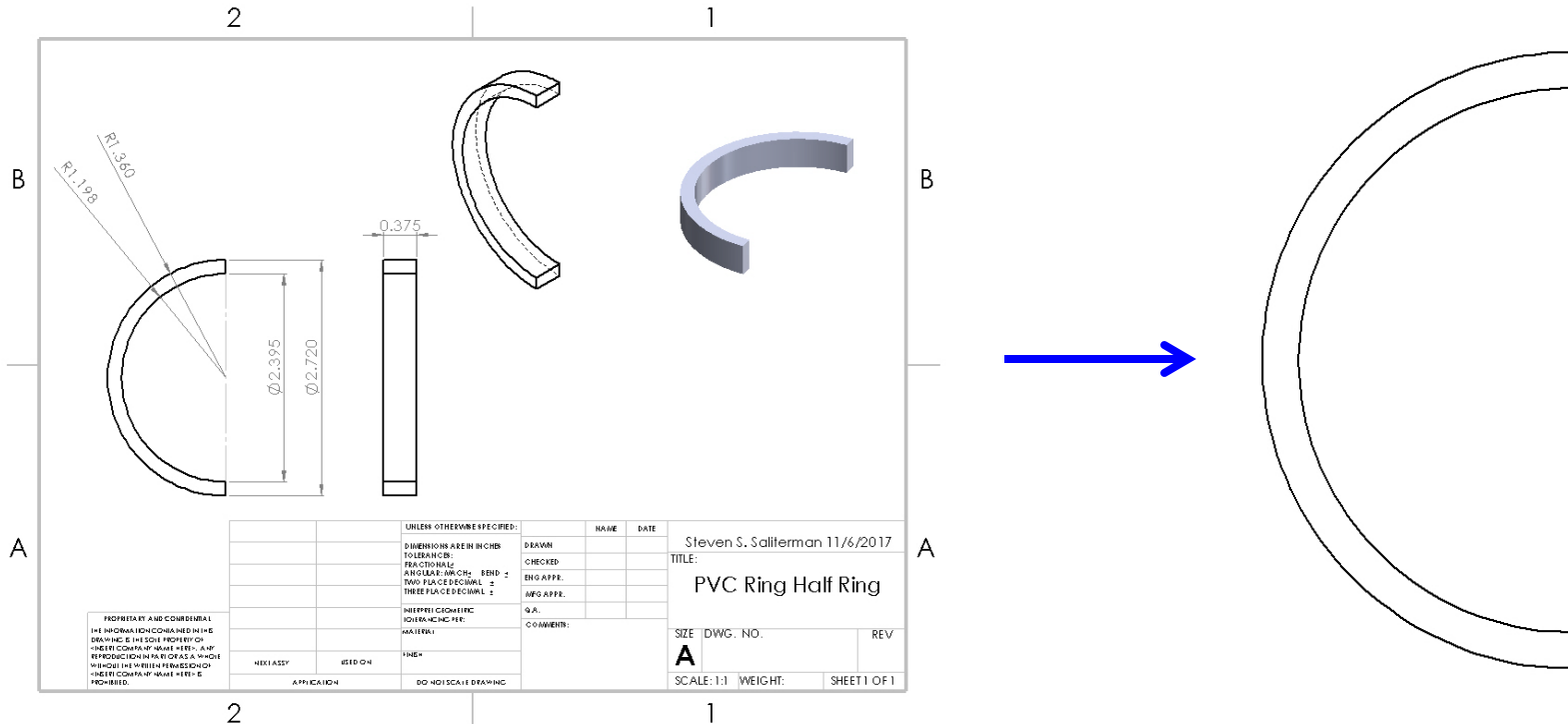
Draw in 2D with thin lines directly with CorelDRAW or e.g. SolidWorks. Save your file as .DXF and bring by thumb drive to the Laser Cutter in MDC or Anderson Labs in ME.

# Waterjet Cutting



You must receive instruction from the shop supervisor before using this equipment.

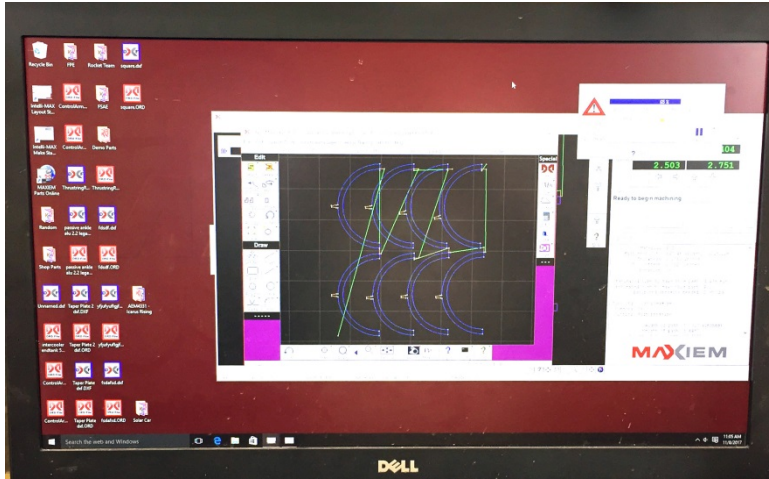
# Drawing Preparation...



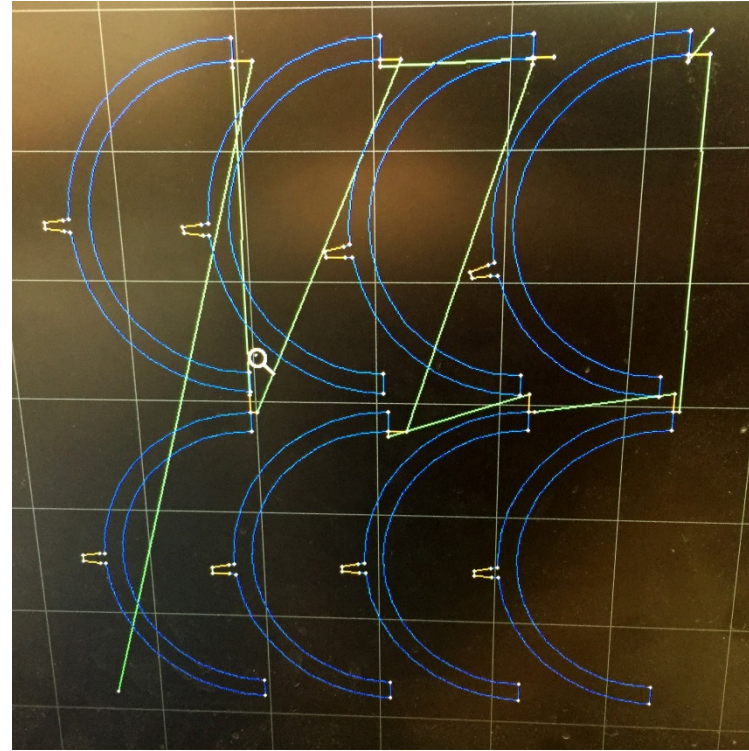
Convert your SolidWorks drawing to a .DFX file without formatting. There should only be a top view with no extraneous markings. (Similar to preparing a laser cutting file.)



# Maxiem Software...



Bring your .DFX file on a thumb drive to the ME Student Shop, and with assistance from the shop supervisor, open in MaxiEM. Here you will add tabs to stabilize the part and keep it from falling into the water bath. You can also make duplicates and inspect the tool path.

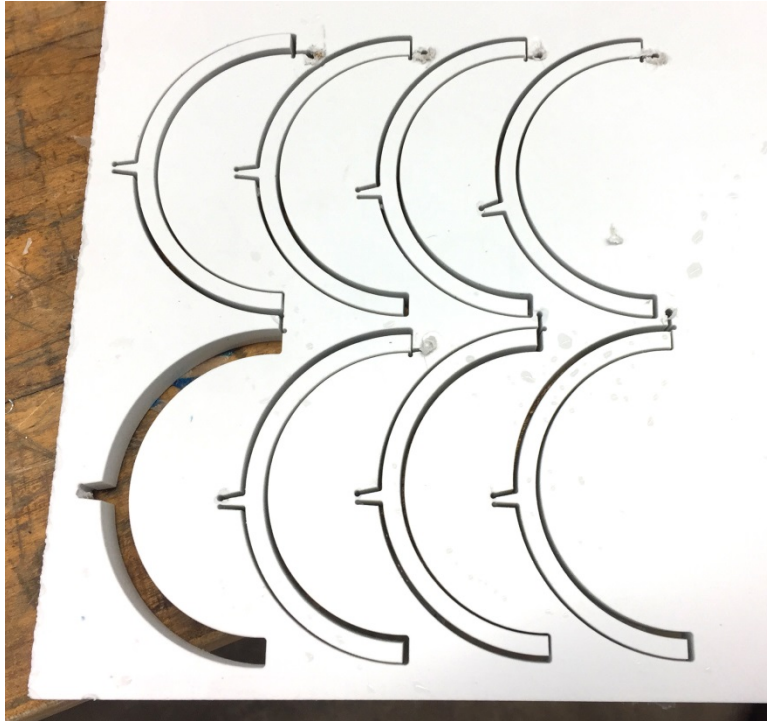




# *Positioned Workpiece and Cutting...*



# *Cut Stock & Example Part...*



# Metal or Plastic Buffer



- Have someone show you the correct technique first!
- Hold your work lower front part of the wheel.
- Learn to dress and apply polish to the wheels.
- Use the correct set of pads – metal vs plastic.



# Belt Sander & Grinder



Use only the front (down direction) portion of the disc sander and lower portion of belt sander.



# Summary

- ▶ Safety
- ▶ Machine Tools
  - Drilling
  - Tapping
  - Sawing
  - Laser cutting
  - Waterjet cutting
  - Metal or plastic buffer
  - Belt sander & Grinder