

# Machine Shop

## Part 2 – Hand 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.

# Safety Masks



Varied levels of protection for dust. Fumes, e.g. solvents and paints, require use of masks with replaceable cartridges specific for the chemical.

# Machine Shop Topics

- ▶ Facilities
- ▶ **Hand Tools**
- ▶ Machine Tools
- ▶ Mill
- ▶ Lathe

# Tools of the Trade

- ▶ Safety
- ▶ Hand tools
  - Basic tools
  - Electronic tools
  - Machinist tool chest
  - Other assembly tools
  - Sheet metal tools
  - Fasteners & adhesives

# Basic Tool

- ▶ Hammers and mallets
- ▶ Screwdrivers
- ▶ Wrenches
- ▶ Pliers



# Hammers...



Brass, ballpeen, standard, sledge, rock, drywall and framing hammers. Miscellaneous - tape measure & rollers.



# *Screwdrivers...*



Flat and Phillips



Miniature assembly.

# Wrenches...



Box wrenches.



English and metric, standard and deep socket wrenches; handles and stub box wrenches.



# *Adjustable Wrenches and Pliers...*



*Channel Lock* pliers, adjustable wrenches, slip-joint pliers and *Vise-Grip* pliers.



Electricians, long nose and needle nose pliers.

# *Allen Wrenches...*



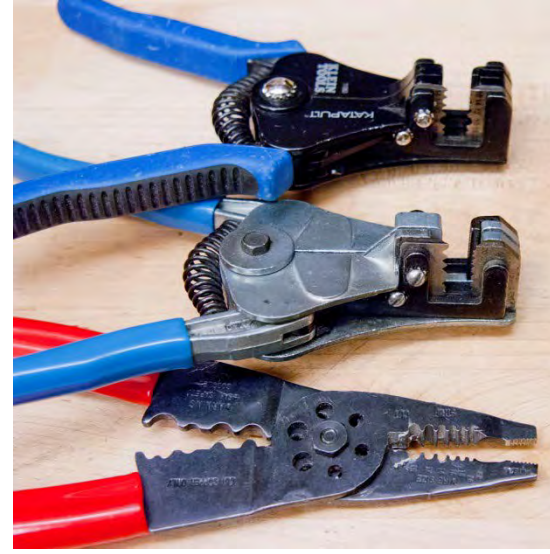
English and metric, used with hex socket cap fasteners.

# Electronic

- ▶ Wire strippers and wire cutters
- ▶ Special purpose screwdrivers
- ▶ Crimps
- ▶ Cable ties
- ▶ Soldering

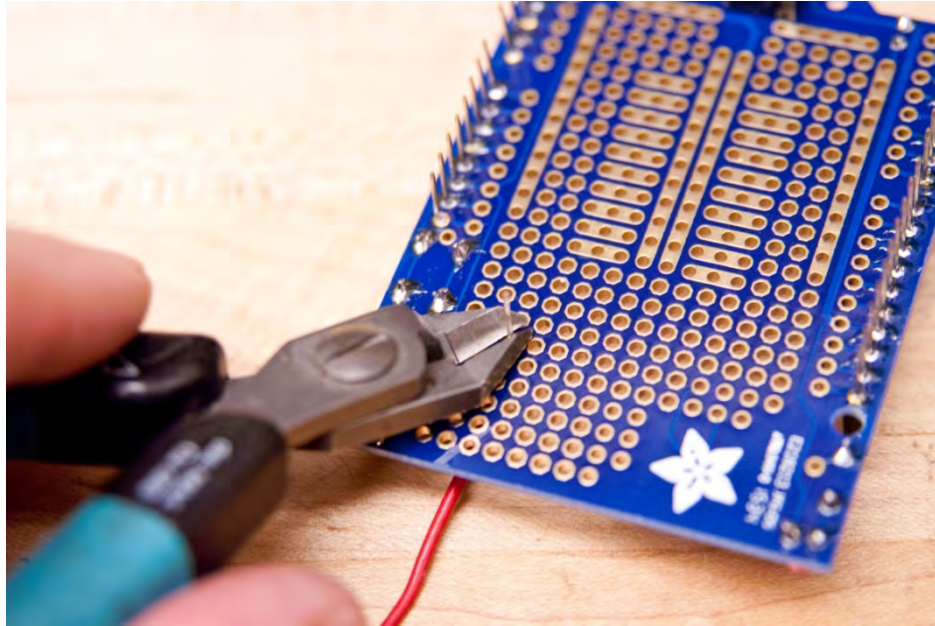


# *Wire Strippers...*

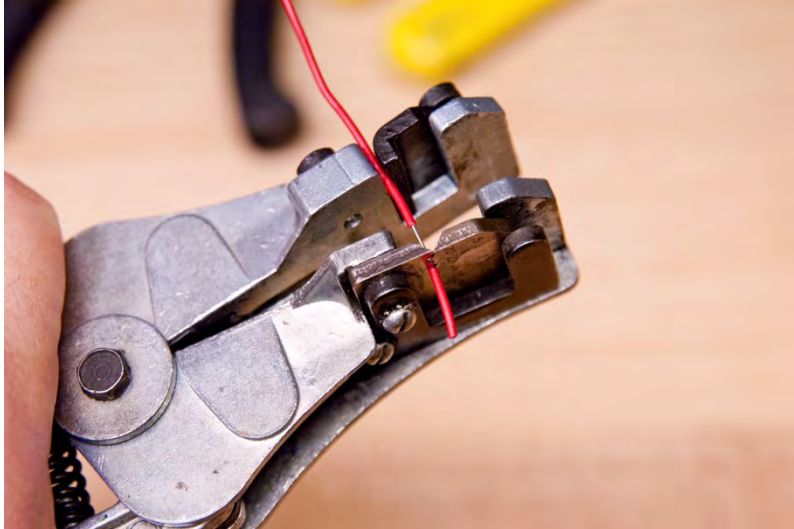


Wire strippers & cutters. These tools strip insulation or cut wire of various gages.





A flush wire cutter trims clean to the surface of a circuit board after soldering.



Technique for using multi-gage wire stripper. These style strippers do very little damage to the wire.

# *Special Purpose Screwdrivers...*



Non-magnetic screwdrivers



Electrostatic Dissipating (ESD) screwdrivers





Electricians screwdrivers.



“Gripper” for hard to reach assembly.

# *Crimps...*



- Terminal connector – fork, spade, hole and splice.
  - Red: 22–18 gage wire.
  - Blue: 16–14 gage wire.
  - Yellow: 10–12 gage wire.



Anderson *Power Pole Connectors* system. This maintains polarity and is recommended for all DC power supply connections.





Dupont barrel connectors and crimping tool.  
Used on all Arduino and similar boards.



Round pin crimps. Used for round gold pins found on RS232 connectors and other sub-D style connectors - male and female.

# *Cable Ties...*



Gun is used to “draw” the cable tie tight around the bundle.



Different sized cable ties. Black are usually UV resistant.



# *Soldering Tools...*



Various soldering irons, fan, hot air and holders.



Circuit board holder for soldering.



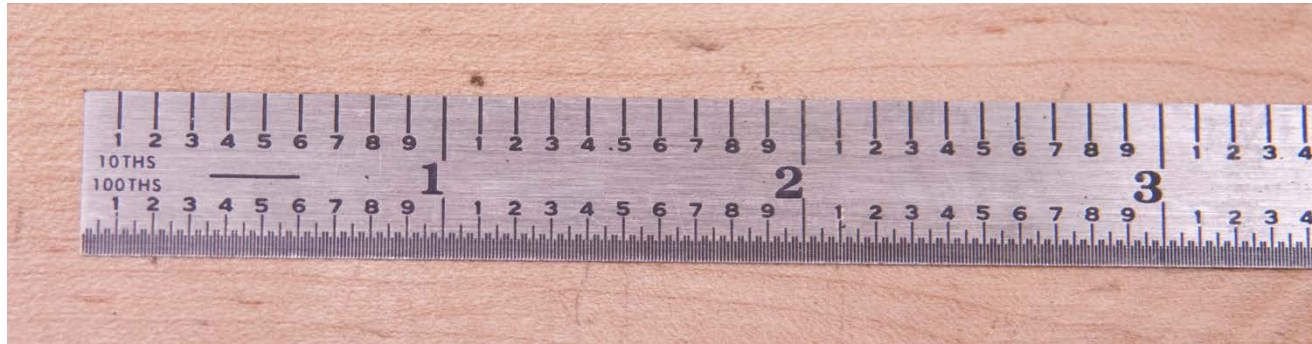
Solder, solder wick and sucker.

# Machinist Tool Chest

- ▶ Rulers
- ▶ Squares
- ▶ Calipers
- ▶ Micrometer
- ▶ Height gage
- ▶ Force gages
- ▶ Dial indicators
- ▶ Gage blocks
- ▶ Edge finders
- ▶ Screw, drill, & wire gages.



# *Ruler...*

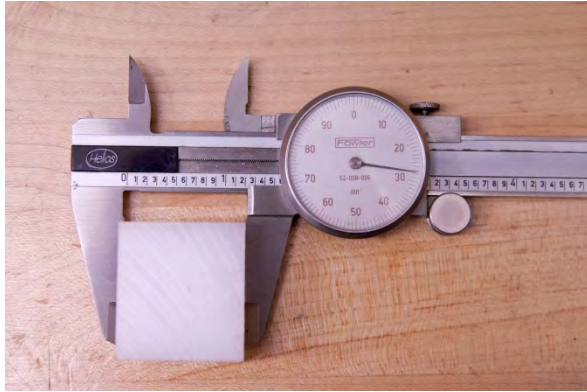


These come in lengths from 6" on up, and are marked in tenths and hundredths.

# *Machinist and Combination Squares...*



# Calipers...



Outside measurement to .001"



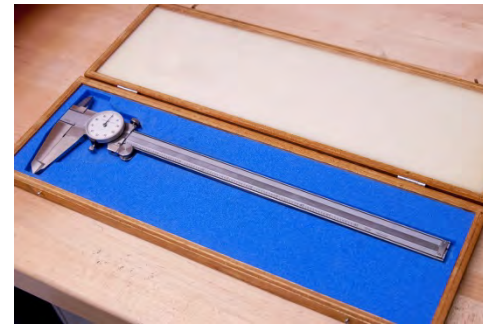
Inside measurement



Depth measurement



Digital caliper



12" long caliper



# Micrometers...



Digital micrometer to .00005"



Multiple size kit to .0001"

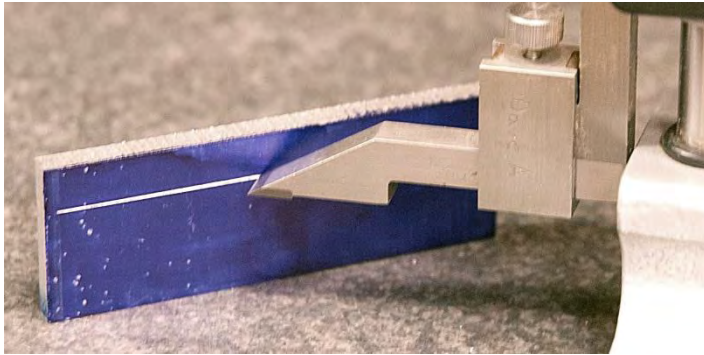
# *Inside Diameter...*



Telescoping gage set.



# Height Gage & Granite Surface...





# Force Gages...



$\pm 15$  gram



$\pm 50$  gram



← Calibration plate

Sensor pin

Durometer – *Shor*



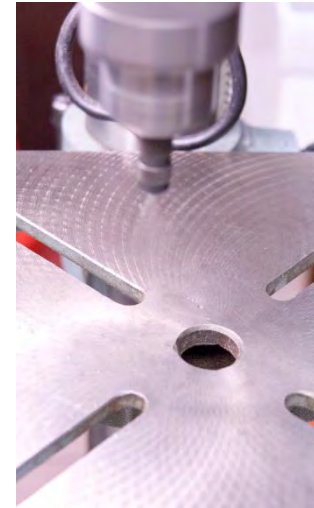
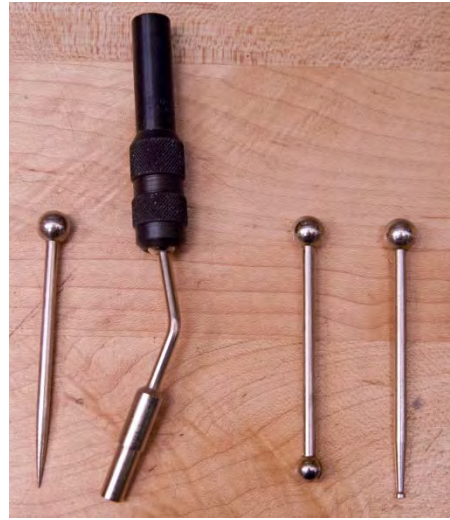
1–10 pounds







# *Center Finder – Wiggler...*



Used for mill and drill part alignment.



# Drill, Screw and Wire Guides...

TIME SAVER  
DRILL & WIRE GAUGE  
CHART  
FOR MACHINE SCREW TAPS.  
THE L.S. STARRETT CO.  
ATHOL, MASS., U. S. A.

TAP SIZE	TAP DRILL	DRILL	DECIMAL EQUIVALENTS
1	1.00	1.00	.60
2-56	50	44	.288
2-64	50	44	.288
3-48	47	39	.221
3-56	45	39	.221
4-36	44	33	.187
4-40	43	35	.187
4-48	42	33	.187
5-40	38	1/8	.125
5-44	37	1/8	.125
6-32	36	28	.109
6-40	33	28	.109
8-32	29	19	.301
8-36	29	19	.301
10-24	25	11	.139
10-32	21	11	.139
12-24	18	7/32	.187
12-28	14	7/32	.187
14-20	10	C	.187
14-24	7	C	.187
1/4-20	7	1/4	.187
1/4-28	3	1/4	.187

No. 185

FRACTIONAL SCREW CHECKER  
FOR SCREWS NO. 1 THRU 5/16

SIZE	N.C.	TAP	N.F.	TAP	N.S.	TAP	DIA.
1	64	72	53	53	53	53	.073
2	48	56	64	53	53	53	.086
3	43	48	51	50	50	50	.099
4	38	40	47	45	45	45	.112
5	30	32	39	37	37	37	.125
6	28	32	36	35	35	35	.138
8	23	28	32	36	40	35	.164
10	24	24	32	29	28	28	.190
12	24	24	28	32	32	32	.216
14	20	28	32	32	32	32	.250
16	18	24	32	32	32	32	.312

PEC TOOLS MADE IN U.S.A.

METRIC SCREW CHEK'R NO. 1  
REGAL-BELOIT CORP.  
P.O. Box 38  
South Beloit, Ill. 61080

mm DIAMETER			INCH DIA.	mm PITCH	
FIRST CHOICE	SECOND CHOICE	THIRD CHOICE		COARSE	FINE
2	2.1		.079	.4	.25
2.2			.087	.45	.25
2.3			.098	.45	.35
2.5	2.6		.118	.5	.35
3	3.1		.138	.6	.35
3.5	3.6	U. S. PAT. 2728145	.157	.7	.5
4	4.1	OTHER PAT. PEND.	.177	.75	.5
4.5	4.6		.197	.8	.5
5	5.1		.217	1.0	.5
5.5	5.6		.236	1.0	.75
6	6.1		.276	1.0	.75
7	7.1			1.0	1.0

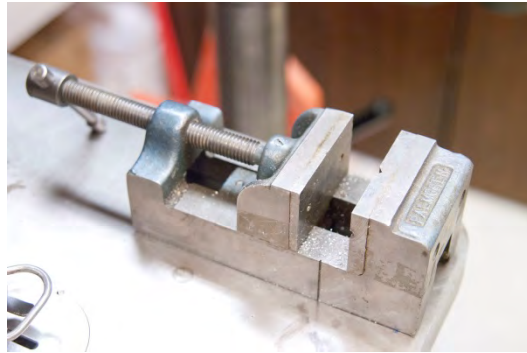
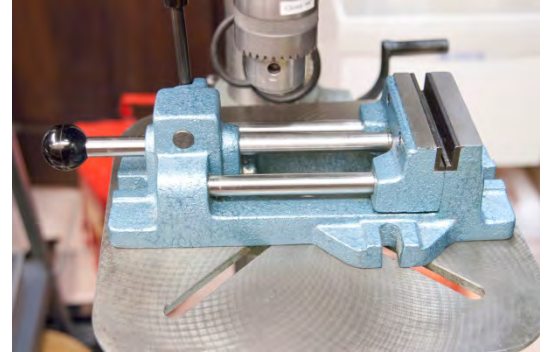
GENERAL No. 13

61	62	63	64	65	66	67	68	69	70
.039	.036	.037	.036	.035	.033	.032	.031	.0282	.028
.026	.025	.024	.0225	.021	.020	.018	.016	.0145	.0135
71	72	73	74	75	76	77	78	78	80

# Other Assembly Tools

- ▶ Holding work
- ▶ Drilling
- ▶ Sawing
- ▶ Filing
- ▶ Abrasives
- ▶ Tapping and threading
- ▶ Deburring
- ▶ Letter and number stamping
- ▶ Plastic Sheet Edge Scraper

# *Vises...*



Bench, wood working, drill press, small drill press and mill vises.



# Clamps...



Various clamps.



# *Hand Drilling...*



Rechargeable battery powered drill and drill bits.

# *Hand Sawing...*



Hacksaw



Scroll Saw

# *Filing...*



Rasp, square, round, semi-round, flat files, handle and cleaning brush.



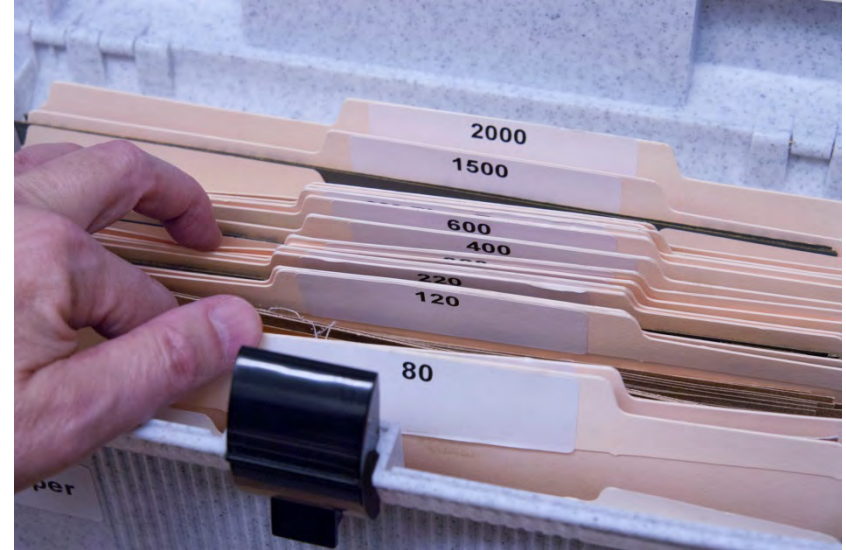
Miniature files.



# *Abrasive Paper (“Sandpaper”)*...

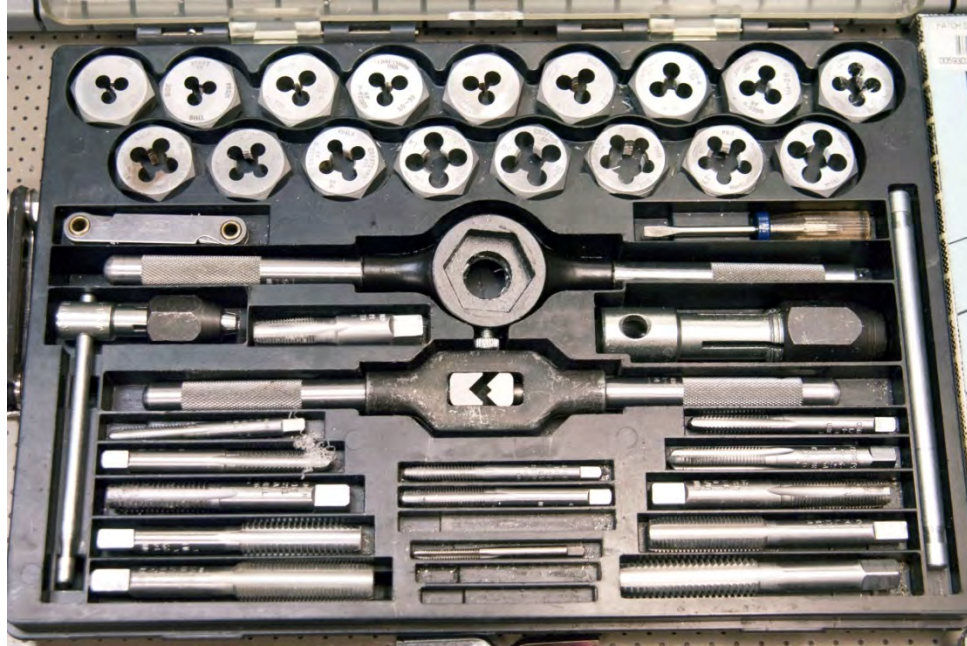


Sanding pads, belts, discs & profiles.



The lower the number of the abrasive paper the more course it is.

# *Tapping and Threading Set...*



Tap & die sets come in English and metric, and various size ranges.

# *Letter/Numbering Stamping Set...*



Aluminum part anodized black, stamped, and wiped with white paint.



# *Plastic Sheet Edge Scraper...*



Plexiglass edges are best cleaning by scraping.

# Sheet Metal

- ▶ Cutting
- ▶ Shearing with a machine.
- ▶ Bending with a break.
- ▶ Punching

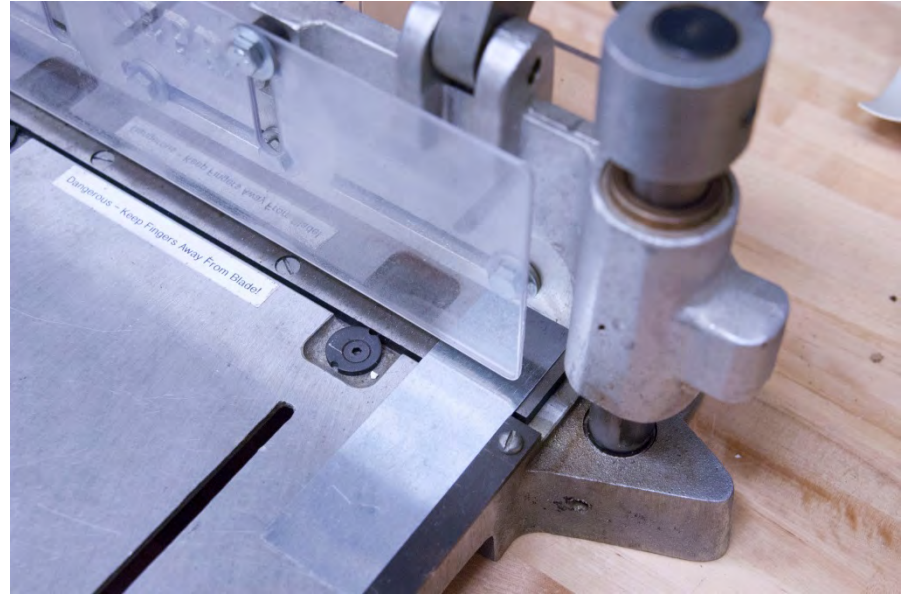
# *Hand Shears (“Tin Snips”)*...



Specific shears for mild or sharp, left or right hand cuts, or straight cuts.



# *Shearing Machine...*



Small (1 foot) shear. Align sheet to the right margin, hold plate down, and then pull lever down. Keep fingers away from cutting blade. Larger version may use a foot pedal.

# *Metal Break for Bending...*



Scribe layout first, cut or shear as needed, and then use a pan and box break to fold into shape.

# *Small Hole Punch...*



Whitney-Roper #5 Junior punch set.



# *Step Drills...*



Best way to make holes in sheet metal.  
Make sure work is secure, and advance slowly.

# Fasteners & Adhesives

- ▶ Nuts, bolts and springs.
- ▶ Press fit or melt-in (3D FDM) inserts
- ▶ Epoxy and UV curable adhesives.

# Nuts, Bolts and Spring...

10-24 Jam Nut	1/4" Flat Washer	#8 7/8" Phil Oval Head Screw	#10 1 1/2" Phil Pan Head Screw	10-24 1 3/4" Phil Oval Head Machine Screw	1/4-20 1 1/4" Phil Oval Head Machine Screw
#10 Finishing Washer	1/4" Large Flat Washer	#8 1" Phil Pan Head Screw	#10 1 1/4" Phil Oval Head Screw		
1/4" Finishing Washer	#6 3/4" Phil Pan Head Screw	#6 1/2" Phil Oval Head Screw	#8 1 1/8" Phil Oval Head Screw	1/4-20 Nut	1/4-20 1 1/8" Phil Flat Head Machine Screw
#8 1 1/4" Phil Pan Head Screw	#8 5/8" Phil Oval Head Screw	#10 1" Phil Pan Head Screw	#8 1 1/4" Phil Oval Head Screw		
#8 1 1/2" Phil Pan Head Screw	1-24 1 1/4" Phil Flat Head Machine Screw	#10 7/8" Phil Oval Head Screw	#10 3/4" Phil Flat Head Machine Screw	1/4-20 1 3/4" Phil Machine Screw	1/4-20 1 3/4" Phil Oval Head Machine Screw
1/4" Lock Washer	#10 Lock Washer	#8 3/4" Phil Pan Head Screw	#10 3/4" Phil Oval Head Machine Screw		






# *PEMS Inserts –Press Fit or Melt–In...*



The proper size hole is first drilled into the sheet, then the PEM insert is press-fit with an arbor press. Can also heat on a soldering iron tip, and then push into plastic.

# Epoxy & UV Curing Adhesives...



Hardman epoxy packages – single use. Mix together with stirring stick in a polyethylene cup. Clear version can be colored.



Fiber optic UV output allows direct placement of light.

# Summary

- ▶ Safety
- ▶ Hand tools
  - Basic tools
  - Electronic tools
  - Machinist tool chest
  - Other assembly tools
  - Sheet metal tools
  - Fasteners & adhesives