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.
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.
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...

+–15 gram  

+–50 gram  

1–10 pounds

Durometer – Shor
Dial Indicators...

Ideal for measuring runout or quality inspection.

Traveling indicator instead of a DRO
Edge Finders...

Top – Laser center and edge finder.
Right – Different spring-loaded edge-finders.
Center Finder – Wiggler...

Used for mill and drill part alignment.

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Drill, Screw and Wire Guides...
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.
Tap & die sets come in English and metric, and various size ranges.
Aluminum part anodized black, stamped, and wiped with white paint.
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.
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...
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.
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