

Georgia Tech

College of Architecture



Design Shop Manual

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Introduction

The use of the College of Architecture Design Shop is a privilege and shall be treated as such. Anyone misusing equipment or not abiding by shop policies will be denied access immediately. We strive to operate a safe environment for the students and faculty to explore materials and how these materials can be safely and effectively used. The student is ultimately responsible for his or her safety by knowing the correct procedures for using the machines located within the shop. This Shop Manual gives basic knowledge of how and when to use those machines. However, not all procedures can be covered in a manual, and asking for help from the shop staff is always recommended.

Virtually all power tool accidents are preventable. Yet accidents continue to happen to novices and experienced operators alike. There are three major reasons for accidents.

- *Inattention through repetition* - This occurs often in production shops where the user becomes hurried, or complacent during repetitive actions. Slow down and think. If making repetitive cuts, pause and refocus frequently.
- *Unexpected events* - The tools in the COA Design Shop are powerful, and can quickly overcome the user. The most common occurrence is Kickback on the Table Saw. Be aware of the hazards. This accident group also includes falls, clothing being pulled in, and other general safety precautions.
- *Inexperience or Overconfidence* – Users should respect the tool, but never fear them. Inexperience leads to fear and not reacting to dangerous situations. Overconfidence leads to an attitude that “nothing will happen to me”.

Facility Access

The College of Architecture Design Shop is located in the Old Architecture Building, ground floor, Room 4. The Design Shop is only to be used by qualified students and faculty of the College of Architecture who:

- Are enrolled and have completed the Basic Orientation Session.
- Have been approved by the Shop Director as competent in the safe use of the equipment (Example: Faculty/Staff)

Sophomore Students within the Industrial Design & Architecture programs will attend a mandatory Basic Shop Orientation. Sophomore Instructors are responsible for scheduling their class during the offered times in Early Fall. Before attendance, the **Shop Manual** must be read thoroughly. After completion of the Orientation Session a Shop Test will be administered. Completion of this test and the signing of the Shop Waiver will allow the student to gain Buzzcard access and the use of Level 1 and 2 machines. Level 3 machines will be taught and certified during Advanced Sessions on an as reserved basis with the Instructor and Shop Director.

Classes requiring the use of the shop areas by more than 12 students must notify the Shop two weeks in advance. The Instructor must also notify the Shop Director of project requirements, intended materials, etc. This policy ensures students will have access, staffing, and the proper equipment / knowledge available. Classes must continue to follow shop guidelines including :

Limits in part size (No cutting of small parts. No large projects allowed.).

Maximum occupancy of no more than 12 in the Main Shop.

Limitations of materials within the College of Architecture.

The Instructor is required to be present when additional staff is not available.

Emergency Situations – Notify Campus Police by using the Red Emergency phone located near the Main Shop entrance next to roll door. This phone dials direct 894-2500. Faculty and Staff call 4-2500, Inform police of employee status.

Shop Rules and Guidelines

All persons that use the shop must complete the basic orientation, test, and sign the Shop Release. Only certified persons are allowed to be in the main shop area. (No Guests in Main Shop).

Guests in Prototype lab must follow shop rules.

Eye protection must be worn when using any power equipment. Students are also responsible for wearing eye protection when not in Main Shop area. Eyewear is available in shop office, however it is recommended for students to have their own. Students are responsible for wearing dust masks and hearing protection when needed.

All accidents, injuries, and machine damage must be reported immediately to the Shop Director.

No more than 12 Students in Main Shop at one time. Large classes using the shop at the same time should be scheduled, and an instructor shall be supplied to assist with overload.

Clean after shop/machine use. If large groups are using the shop, they will be in charge of cleaning during and after each day.

Storage of large materials & projects in either of the shop rooms is allowed only by the Director's approval.

Materials & projects left over 24 hours without a permission slip signed by staff will be removed.

Shop will be cleaned after each semester, and all items will be removed.

No Personal projects allowed.

Shop Hours are posted on doors and are subject to change.

General Safety

Do not enter shop while tired or under the influence of any medications causing drowsiness.

Alcohol & Drugs are prohibited on the Ga. Tech campus

(www.catalog.gatech.edu/genregulations/alcohol.php)

Eye protection must be worn – Respirators are recommended.

Long hair must be tied back, and remove jewelry.

Beware of loose clothing – Sleeves, coats, shirt tails, etc. No open toed shoes

No Gloves may be worn while operating machinery.

No horseplay, running, yelling, or sudden movements toward persons at machines.

Turn machines off before leaving - when possible, wait for machine to stop.

Beware of machines that are still running while unattended.

Never use equipment without a thorough understanding of its operation and your safety.

Never make adjustments or repairs to machines. Notify Shop Director if repairs are needed.

Report damage of machinery – Failure to do so could result in injury.

Never use Vise Grips on any machine or tool in the shop.

Be aware of finger and hand location at all times.

Avoid awkward operations, and use push sticks when necessary.

No Headphones allowed. Listen to the machinery – motor slowing, bit/blade smoking, bearings squeeling, . . . These can be indications of dangerous situations.

Never distract someone while they are using a machine. Talking, & sudden movements can distract long enough for in accident to occur.

Never lose focus while using a machine. Keep your mind on what you are doing.

Cleanup after yourself. A clean work area minimizes accidents.

Tools are for use while in shop. Anyone removing tools or abusing tools by incorrect use will lose privileges at Director's discretion.

Anyone purposely damaging property will lose privileges – Painting property, Nailing tables, etc.

No Plaster or Cement in main shop. Do not wash hands or equipment in sinks after using plaster or cement type products.

No pressure treated or painted lumber used on machinery.

Spraypaints and solvents in Spray booth only.

First Aid

Burns

- For minor burns do the following:

Cool the Burn – Hold under cold running water for at least 5 minutes.

Do Not use ice. Do Not apply ointments.

Cover the burn with sterile gauze – Do not use fluffy cotton. Wrap gauze loosely, avoid placing pressure on wound.

Take an over the counter pain reliever.

Watch for signs of infection, Do not puncture blisters.

Cuts

- For minor cuts do the following:

Stop the Bleeding – Minor cuts should stop on their own. Apply gentle pressure with a clean cloth. If blood spurts or continues to flow, seek medical help.

Clean the wound – Rinse wound with clean water. Soap may be used to clean area around wound, but not the actual wound.

Apply an Antibiotic – For minor cuts, a thin layer of Neosporin may be applied.

Cover the wound – Bandages keep wound clean, and bacteria out.

- For deep cuts:

Apply Pressure to the area with a clean cloth. Call for Campus Police using the Red Phone located in the Prototype Lab. A call box is also located in the stairwell.

Fainting

- Just before fainting a person may feel lightheaded, dizzy, see spots, or have nausea. Do the following:

Catch the person before he or she falls. Best done by placing arms under person's Armpits, and lowering to ground.

Have the person lie down with head below the level of the heart.

Turn victim's head to the side, so tongue does not fall back into the throat.

Loosen any tight clothing.

Apply moist towels to face and neck.

Keep person warm if environment is cold.

Do Not slap the person to try and wake.

Do Not give the person anything to eat or drink until they are fully conscious.

First Aid Kits are located near the doors in the shop. One large kit can be found in the main shop, the other large kit at the entrance to prototype lab.

Machine and Tool Listing

Prototype Lab

Level 1 Workroom – open 24/7

- Spray Booth
- Down Draft Sanding Tables
- Scroll Saws
- Hand tools for checkout

Main Shop

Level 2 Machines –Hours posted

- SSC Panel Saw
- 12” Hitachi Sliding Miter Saw, 10” Hitachi chop saw
- 2 - 14” Powermatic Band saws
- 20” Powermatic Band saw
- 24” Laguna Band saw
- Oliver 36” Scroll Saw
- 2 Powermatic Belt/Disk Sanders, Powermatic 6x108 edge Sander
- Grizzly Spindle Sander
- 3 Powermatic Drill Presses
- Router Table
- 2 – Z-Corp 3D printers
- 2 – Dimension FDM 3D printers

Level 3 Machines – Must attend advanced sessions before use

- 10” SawStop Table Saw
- 12” SCM Sliding Table Saw
- 20” SCM Surface Planer, 13” DeWalt Planer
- 12” helical Powermatic Jointer
- 2 Powermatic 20” Wood Lathes, 1 Powermatic lathe w/ copy attachment
- Dyna 2800 CNC Mill
- Dyna 3000 CNC Lathe

Metal Shop

Level 2 Machines

- 36” Jet Shear
- 24” & 48” Finger Brakes
- Metal Roll
- 90 degree Brake
- Pipe/Rod Bending Form
- Grinders/Sanders
- Abrasive Chop Box
- Di-Acro Punch Press

Level 3 Machines – Must ask for assistance / May require advanced session

- Kalamazoo Cold Cut Saw
- DoAll Vertical Bandsaw
- Logan Metal Lathe
- Horizontal Bandsaw
- Bridgeport 9x48 Knee Mill
- Spot Welder, Arc Welder, MIG Welder
- CNC Plasma cutter (appointment only)

Also Available are a wide range of Hand and Portable tools to be used while in shop.

Basic Layout Tools

Squares:

Engineers: All Steel construction and highly accurate.

Try Square: Short square for general woodworking.

Combination Square: 3 Heads available.

- 90 and 45 degree head.
- Protractor head - use to mark any angle.
- Center Finder - Find center of squares and circles.

Sliding Bevel: Not a square, but useful to mark and transfer angles.

Measuring:

Tape: Flexible steel tape, General purpose marking. Easy to carry.

Engineers Scale : Rigid steel ruler. Useful to make exact measurements. Markings usually in 10th and 100ths

Steel Rule : Common in 2-4 foot lengths. Often have markings in 1/16ths.

Dividers: Useful for transferring dimensions from a scale or drawing to a part.
Can also be used to scribe circles..

Outside Calipers: Useful to transfer dimensions from or to a part.
Commonly used with Lathe, and general layout.

Dial Calipers: Use for taking exact measurements. Reads to the thousandths or .001

Marking Gage:

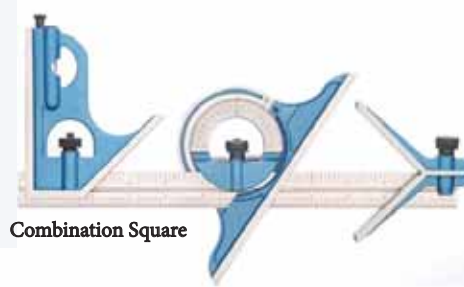
Used to scribe lines on wood. Commonly used to scribe lines for cutting joints.



Engineer's Square



Try Square



Combination Square



Tape Measure



Sliding Bevel



Engineer's Scale



Dividers



Outside Caliper



Dial Caliper



Marking Gage

Files, Rasps, Surforms

Files:

Used to remove and smooth materials. Wood, Plastics, Metals.

Bastard files remove the most material of the file group. They leave

a rough cut, and will need further cleanup. These files feel rough to the touch.

Second Cut files are best for metals and plastics, sometimes wood. Coarse to the touch.

Mill files or Smooth cut have a smoother feel, and are good for plastics and metals. These leave a cleaner cut.

Common File shapes include: Round, Half round, Square, Triangular, and Flat.

Needle Files, are small files that are used for detail work, these should be used for metals and plastics. They come in various shapes as well.

Clean files and rasps by using the file card. Never return a clogged file.

Files can be used on plaster, but **MUST** be cleaned immediately after.

Same with bondo, **DO NOT** allow bondo to cure in files, clean often while using.

Rasps:

Used to quickly remove material. Can be used on plastics, best on wood, and foam.

Rasps come in various shapes, ones for detail work are called rifflers.

4-in-1 is most versatile with a file - rasp combination. Half round and flat.

Surforms:

Used for removing large amounts of material, similar to rasps.

Best used in wood and foam. These tools have small blades that cut material.



File Types



File Cards are used to clean



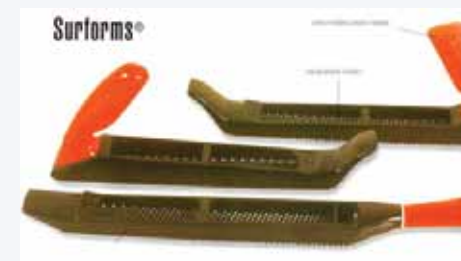
Needle Files



Rasps



Rifflers



Nailing

Always use correct hammer for task at hand.

Never use the side of a hammer for striking.

When hammering joints where damage could occur, use a scrap block to strike against.

Claw Hammer: *Safety Glasses*

Sometimes nothing can beat an original. Use for nailing and pulling nails.

Nail Set

Used with a hammer to lightly tap a finishing nail below the surface. Hole is then filled with putty.

Air Nailers: *Safety Glasses*

Nails are loaded into magazines and fired with the assistance of air pressure.

Know how gun operates before using. Some have safety triggers, others allow for a rapid firing for production.

Nails are available in the office.

Crown Staple Guns also available.

Sometimes these guns lack the control of where, and how deep you drive the nail.

Nose of gun must be able to lie flat on surface to be nailed, if not, nail will not penetrate.

Ask for assistance

Rubber Mallet: *Safety Glasses*

Used for hammering items without causing damage. Finessing parts into place,

Do not use to drive nails.

Carver's Mallet: *Safety Glasses*

Used when tapping chisels, and gouges. Steel hammers will damage chisels.

Ball Peen Hammer: *Safety Glasses*

Used to hammer cold chisels and punches.

Useful to shape unhardened metal.



Claw Hammer



Nail Gun



Nail Set



Rubber Mallet



Carver's Mallet



Ball Peen Hammers

Hand Saws

Coping Saw: *Safety Glasses*

Used to cut curves in thin stock. Named after its use in coping mouldings.
Blades available in office. Can be used in similar manner as the scroll saw.
Can be used to cut wood and plastics. Blade can be rotated to allow easier access.

Hacksaw: *Safety Glasses*

Used to cut metals. Clamp workpieces in vise when possible.
Thin sheetmetal should be clamped between pieces of wood.
Blades available for use.

Handsaw: *Safety Glasses*

3 types

Ripsaw - For cutting with Grain. Teeth are set 90 degrees to blade.
Crosscut - Teeth set 75-80 degrees to blade, and used for crosscuts.
Panel Saw - Similar to crosscut, but has shorter length.

Backsaws: *Safety Glasses*

Called backsaw because of the additional strength added along top of blade.
Types of Backsaws include: Dovetail, Gent's, & Tenon
Differences are length and the number of teeth per inch (TPI). More teeth=finer cut
These saws are for wood only, and commonly used in furniture joinery.

Flush Trim Saw: *Safety Glasses*

Saw is used for fine cutting, specifically made to cut off dowel pins flush that have been driven to cover screw holes.



Coping saw



Hacksaw



Hand saw



Tenon saw



Flush cutting saw

Cutting tools

Chisels: *Safety Glasses*

Used to trim and shape wood. Usually in sets ranging from 1/8 " to 2"
Use for trimming pockets, dovetails, smoothing small surfaces.
Never used to cut metal, to pry with, or as a screw driver.
All tools should be sharpened by the Shop Director.

Gouges: *Safety Glasses*

Used similar to chisels. Mainly used in carving. Curved section or "sweep" allows a gouge to cut concave surfaces. Useful in removing material quickly on carvings.

Planes:

Used for planing and smoothing wood. The Block plane is useful for small parts, and endgrain. Smoothing plane is for smaller work and is an all around general use plane. The Jack plane is used to smooth large surfaces

Spokeshave:

Used to form irregular shaped objects. Commonly used in shaping carved table legs.

Hand Punch:

Used to punch small holes in rubber, plastic, and thin gauge sheet metal.

Hollow Punch: *Safety Glasses*

Used for punching small holes in rubber and gasket type materials.

Cold Chisels: *Safety Glasses*

Steel chisels for metal. Uses include cutting rivets, rusted nuts/bolts, and cleaning welds.

Aviation Snips:

Use to cut thin sheetmetal ONLY. Yellow is for straight cuts. Red for Left curves, and Green for Right curves.

Chisels



Gouges



Block plane



Smoothing Plane



Jack Plane



Hollow Punch



Hand Punch



Cold Chisels



Aviation Snips



Clamps

Bar Clamp:

Threaded handle tightens against work.
When loose, handle head can be slid freely along length of bar.
Slide head against workpiece to be clamped, tighten handle.



Bar Clamp

Pipe Clamp:

Best for clamping edge to edge joints (doors, tabletops).
Clamps use standard black pipe, so pipe lengths can be added.



Pipe Clamp

Parallel Clamp/Screw Clamp:

Wooden clamps can be used to apply even pressure along jaw length.
Can also be tightened to allow point pressure at ends.



Parallel Clamp

C or G Clamp :

Most versatile - Can be used to clamp workpieces to a surface or to each other.
Vary in size from 1" +.



C Clamp



Spring Clamp

Spring Clamp:

Light clamping.
Good for quick setups and use as a third hand.



Vise Grip Clamp

Vise Grip Clamps:

Different styles available.
Quickly clamp items to a table, or to a drill press table.



Corner Clamp

90 degree Corner Clamp.:

Use to clamp a mitered corner while gluing and nailing.

Quick Clamp:

One hand operated.
Simple finger release.



Quick Clamp

Glues

* Glues not provided to students.

Polyurethane Glue - \$1.17 oz.

Gorilla Glue - Bonds many materials and is waterproof.
20 min work time, 1-4 hour cure time.
Joints must be tight for proper strength.
Best for wood, not a general purpose glue.
Water is used to aid curing process.
Can be messy. Glue foams. Do not get glue on skin - stains
Flexible to withstand climate extremes.



Cyanocrylates - \$5.00 oz.

Super Glues - Quick set
0-1 minute cure time
General purpose for hard to glue materials.
Not easily primed and painted over - tends to gas out.



Epoxies - \$1.25 oz.

Good general purpose project glues.
Good for dissimilar materials.
Available in many formulas for specific materials.
Available in various time sets, 90 second to 90 minutes+.
5 minute epoxy is best all around glue - \$4-5
Available in a two part tube allowing equal dispensing.
Books for mixing on are available in office.



Yellow Wood Glue - \$.36 oz.

Polyvinyl Acetate (PVA)
Best for wood to wood applications.
Approx. 30 minute clamp time
Relatively inexpensive.
Quite strong once set, Bonds with wood fibers.
Joint must be a tight fit. Clean with water.



White Glue - \$.24 oz.

Good cheap glue for paper, light woods.
60 minute minimum clamp time.
Cleans with water.



Hot Melt - \$.53 oz.

Good project glue.
0-15 sec set time.
Good for Cardboard, Foam Core.
Heat will melt some materials.
Best to let harden for clean up.



Contact Cement - \$.25 oz.

High bond.
Bonds laminates, veneers.
Follow directions.
No clamp time.
Cure time 15 minutes - 3 hours.



Bondo -

Not a Glue, but useful in filling larger imperfections in models.
Two part system, with a strong odor.
Must be mixed in the spray booth or outdoors.
Respirator, and protective gloves should be worn.
Shape before a hard cure is achieved, clean rasps, remove all waste including filings from building after use. Fans may be needed for cross ventilation when shaping.
Once in Priming stage, begin filling small imperfections with spot putty.



Sandpaper

Basics:

Move sandpaper with the grain.

Non grain materials - use small circular motion.

Start with coarse grits and work down.

Painted models - Sand to 220 then prime. Add spot putty if needed, sand with 220 then prime again. Now move to 320 and prime. Check, then paint.

Grit:

40-60	Coarse
80-100	Medium Coarse
120-150	Medium
180-220	Fine
240+	Very Fine

Types:

Glass paper - Quartz granules on paper backing.
Cheap, wears quickly, leaves rough finish.

Aluminum Oxide - Cuts faster and lasts longer than glass or garnet.
Use for Metal and Wood.
Available in Paper, Waterproof, and Cloth backing.

Silicon Carbide - "Wet or Dry" Paper
Suited for sanding Plywood, Hardwood, Soft Metals, and Plastic.
Can be used to smooth glass edges.
Fast cutting, heavier grits can be brittle and wear quickly.
Water - Gives fine sanding to paint or varnish between coats. The slurry prevents dust and keeps paper from clogging.

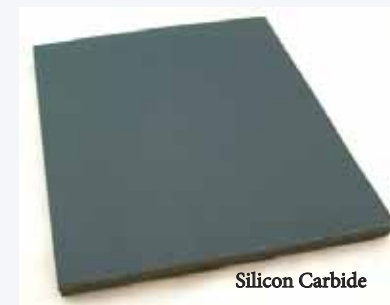
Garnet - Natural crushed rock - and is best for wood.
Available with cloth backing.
Useful for smoothing Hardwoods and fine finishing work.

Steelwool - Used for fine sanding, and polishing.
Available from coarse to very fine(5-0000).
Not for surfaces where fragments could imbed and rust.
Can be used to sand complicated shapes, metal castings, mouldings.

ScotchBrite - Similar to steelwool with varying degrees from coarse to fine.



Aluminum Oxide



Silicon Carbide



Garnet



Scotch Brite

Sanders - Belt, Palm, Air

Belt Sander: *Safety Glasses, Dust Masks*

Removes stock quickly, but not always accurate.

Sanding should be done on downdraft tables with Vacuum on.

Use appropriate belt size and grit. Ask for assistance.

Make sure sander is on its side and turned off before plugging into outlet.

Watch belt tracking during use. Do not allow belt to wander off or into sander housing.

Allow sander to lightly remove stock, do not force tool.

* Belts available in shop

Palm Sanders: *Safety Glasses, Dust Masks*

Two types are available - Electric, and Pneumatic.

Sanders are good for light sanding, and are easy to control.

Sand only on downdraft tables with vacuum system running.

Sheet sand paper can be cut and inserted into the sander. Ask for assistance.

Sander has a quick orbiting action causing sander to vibrate.

* Students provide standard sheets of paper.

Random Orbit Sander: *Safety Glasses, Dust Masks*

More aggressive than pad sander. These sanders rotate making them good for heavier sanding over larger surfaces.

Pads easily removable, usually a hook and loop type.

Follow the guidelines of Palm Sanders.

* Students provide pads.



Grinding Tools -

Bench Grinder: *Safety Glasses, or Face Shield*

Use for shaping smaller metal stock, Rod, Tube, Flats, etc.
Do not sharpen tools here.
Keep workpiece flat on support rest.
Buffing wheels for polishing metals, and plastics.
Rouge compounds must be applied to buffing wheels.
Hold piece firmly. Do not allow piece to pull under wheel.
Wire wheels useful to remove rust, clean and brush finish metals.



Bench Grinder

4" Hand Grinder: *Face Shield, Hearing Protection*

Use for shaping larger metal pieces, and grinding corners.
Grind welds.



4" Hand Grinder

Air Die Grinders: *Safety Glasses*

Use with burs to grind metals and plastics.
Use with rotary rasps to carve wood.
Ask for assistance choosing correct bit type.



Die Grinder



Angle Die Grinder

Dremel Tool: *Safety Glasses*

Use with burs and stones for grinding metals, woods, and plastics.
Stones should be used for metal only.
Burs and sanding drum for wood and plastic.



Stone Set



Burs for metal and plastic



Rotary rasps

3" Metal Cut Off Saw: *Face Shield*

Use for cutting bolts and similar stock when not able to cut with chop box.
Available by appointment.



Dremel Rotary Tool



3" Cut Off Saw

Sabre saw & Scroll saw

Sabre Saw: *Safety glasses*

Names vary - some call this a jig saw.

Useful for cutting internal and external curves.

Use appropriate blade for material.

Cut should be supported - Be aware of where the table lies beneath your part as you cut.

Do not cut into tables.

Check blade size. As it reciprocates, is it long enough to cut through your part.

Mostly used to cut through 1/4"-1" material.

Ask for help with blade change and selection.

Typical blade choices. Finer teeth for thin hard material - plastics, metal.

Heavy teeth for thicker wood type products.

Often times you may choose blade from a trial and error basis.

Scroll Saw/Jigsaw: *Safety glasses*

Use to cut small parts, curved parts, and interior holes.

Some materials, thin plastics especially, will require a hold down clamp to keep part from lifting as you cut. Due to theft, this part is in the Director's office.

Blade Installation: (Dewalt Saws)

Release tension using top lever arm.

Unscrew T-screws to remove old blade or prep for new blade.

Insert blade into lower chuck (teeth pointing down) and tighten T-screw.

(If cutting Hole in part - Insert blade through hole drilled in part.)

(Also if cutting thin materials - you should insert the hold down clamp)

Insert blade into upper chuck, tighten T-screw.

Tension blade using lever arm.

Select proper speed, slow to keep plastics from melting.

Oliver Scroll Saw: *Safety glasses*

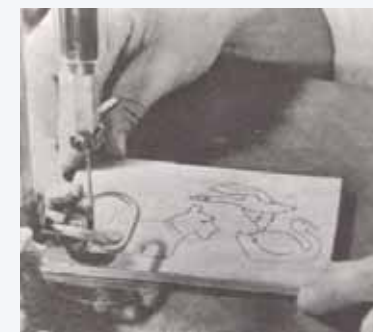
Useful for thicker materials.

Wood and MDF only.

Ask for assistance



Sabre Saw



Detail of intricate cuts possible with Scroll saw



Scroll Saw



Oliver Scroll Saw

Drill Press & Hand Drill

Drill Press: *Safety Glasses*

Loosen table lock to adjust height of table - Gold machine must be lifted manually, Grey has turn crank.

Always position hole in table directly beneath bit, Always place scrap between table and part to be drilled - Do Not drill into table.

Make sure the part to be drilled is clamped properly before drilling. Thin sheet acrylic and metals must be clamped.

Small parts can be clamped in a vise (Do Not drill into vise!)

Table Clamp can be used in presses with a slotted table.

On deep cuts, back out often to clear chips from hole and to clear bit.

-Select the correct bit and fasten securely in chuck.

-Does the bit clear hole in table, and do you have a board beneath?

-Remove key from chuck before starting machine.

-Select appropriate speed and watch as you feed into material. If tool smokes, reduce speed and feed rate, also bit may be dull. Check chart for correct speed and for tool selection.

Drill only Wood, Plastics, Mild Steel, and Aluminum. If any questions - ASK.

Drill bits are designed to drill holes and should never be used to “mill”. In other words, do not attempt to cut with the side of the bit

Twist Drills are the only bits in the shop you are allowed to cut metal with.

Hand Drill: *Safety Glasses*

Cordless drills are available in office, and can be used for many applications in the shop.

Most of these drills have a Keyless type chuck. When rotated, chuck can easily be tightened by hand.

When drilling, you should back out often to reduce build up of chips in the bit's flutes. Not

following this simple procedure when drilling will cause unnecessary heat, and force build up that will ruin bits. Especially in plastics, slow speed and backing out are a must.

Care should also be used when drilling with small bits. A slight movement of the drill or not clearing build up can quickly break these bits.

Pre-Drill holes for screws to eliminate splitting of workpiece.

Never force the drill - apply enough pressure to keep the bit cutting smoothly.



Floor Model Drill Press



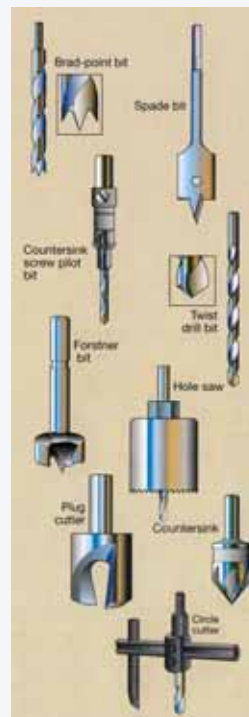
Cordless Hand Drill



Drill Press Vise



Drill Press Table Clamp



Brad-point bit - Central point and 2 raised spurs keep bit drilling straight. Leaves a clean hole - Ideal for drilling holes for dowels. WOOD ONLY.

Spade Bit - Used to drill large holes in WOOD ONLY. Leaves a flat bottom hole with a center point. Can be used to recess a bolt and washer. Drill recess, then drill smaller through hole for bolt.

Countersink with Pilot - Drills a clearance hole and countersink at same time. WOOD ONLY

Twist Drill Bit - Use for drilling WOOD, METAL, PLASTICS.

Forstner Bit - Use to drill flat bottomed holes. Commonly used in Euro-style door hinges where hinge sits in drilled pocket..

Hole Saw - Used to cut large holes in WOOD and PLASTICS. Must use the installed center drill to stabilize saw.

Plug Cutter - Used to cut plugs that can be hammered into a hole to cover a screw fastener. Allows user to match material and grain of workpiece.

Countersink - Forms a conical recess for the heads of flat screws and bolts. Best in WOOD and PLASTICS. Works best when workpiece is clamped on drill press. Countersinks are available with varying cut angles.

Circle Cutter - Used to cut large through holes in thin WOOD and PLASTICS. High speed steel cutter actually scrapes away material.

Sanders - Stationery

Belt / Disk Combination Sander: *Safety Glasses, Dust Masks*

Belt:

Used commonly to sand edge grain.

Removes stock quickly, but not always accurate.

Parts should be held firmly against fence, with light pressure being applied to belt.

When free sanding, Do Not point material against belt direction. This will cause material to catch and be thrown.

Watch belt tracking during use - Do not allow belt to wander off rollers. Notify attendant if this occurs.

Disk:

Use to sand small flats and exterior curves on Wood, and Plastic.

A machine for Metal is available in metal lab.

Know direction of rotation and sand only on the downward side of rotation.

Often times different grits will be on the two machines. Choose best for your application.

Be aware when sanding plastics. Plastics melt and can pull themselves into the sander causing harm to you and the workpiece. Use light pressure, and back plastic piece away often to inspect.

1" Belt:

Use to sand small parts. Belt can access small interior cut outs other sanders can not.

Large Edge Belt:

Use for edge sanding of longer parts.

Parts should be kept against fence at right edge of table. Use light pressure.

Not for small pieces.

Oscillating Spindle Sander: *Safety Glasses, Dust Masks*

Primarily used for edges and irregular curves.

Different Diameter spindles are available. Ask for assistance with spindle change.

Sand workpiece against rotation of spindle. Sand Right to Left.

Care should be taken not to sand interior holes.

1" spindle in an 8" hole OK, but hold tightly and do not allow part to catch and spin.

1" spindle in a 1 1/4" hole will most likely catch and violently spin part.



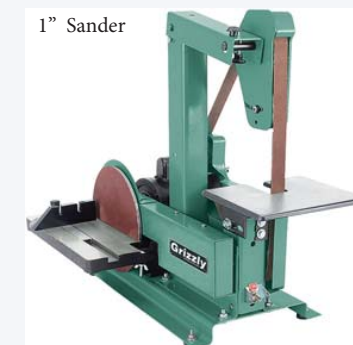
Belt/Disk Sander



Spindle Sander



Disk Sander



1" Sander



Large Edge Belt Sander

Panel saw & Circular saw

Panel Saw: *Safety glasses*

Use this saw to quickly cut down sheet material. This machine is simply a circular saw on guide rails.

To use:

Slide sheet of material into machine.

Allow material to rest against the horizontal rails.

Slide material to the desired dimension located on the saw.

Turn on Vacuum.

Pull knob on saw to turn machine on and slowly pull saw through material.

Push knob in to stop saw. Wait for saw blade to stop, then retract saw and remove pieces.

Do not cut tall narrow pieces on this saw.

Circular Saw: *Safety glasses*

Use to cut large sheet.

The user guides the saw along a straight line either freehand, or with the aid of clamping a straight edge to the workpiece.

Before starting - be sure the power cord is out of the blade path and is long enough to complete the cut. Also verify you will not be cutting into table.

Use both hands to guide the saw - clamp workpiece.

Never hold workpiece in hand or across leg when sawing.

Avoid cutting small pieces that can not be properly supported.

Set blade depth no more than 1/4" below workpiece.



Panel Saw



Circular Saw

Band Saws

Safety Glasses must be worn.

Check Stock - Is it free of knots and nails?

Adjust bar so that upper guide is about 1/4"-1/2" above work piece.

(If too high, blade is exposed, and blade will not have proper support)

Never allow anyone to stand to the right or behind saw.

(In case blade breaks) Always stand in front of saw.

Cut just outside of your line, 1/16" and clean up on sander or with sanding block.

Avoid backing out of a cut - this can pull blade off wheels.

Never have fingers, hands, in line with the blade.

Fingers should NEVER be closer than 3" to the blade. (Plan your cuts)

Use caution as blade nears exiting the piece - if any unnecessary force is being applied -

the blade can "jump" as it exits workpiece. (Use caution when cutting circles - this

"jump" could quickly put fingers into the blade.

Always use bandsaw push block.

Never try to pick pieces out of the table slot while saw is running.

Get help when cutting long pieces.

Do not cut tall thin pieces on a bandsaw.

Do not make adjustments while saw is running (Table tilt, Guide height, Opening of Doors).

Never force part through blade, cut only as fast as saw allows.

Never attempt to cut radii that are too small for blade.

Never cut overhanging, or spherical parts that do not lie flat on table surface. Parts can quickly twist, spin, or grab and pull fingers into blade.

Never make adjustments to any machine without approval.

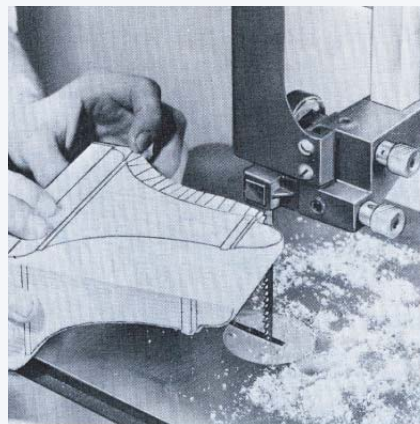
(Guide height and Table Tilt OK)

Understand which blades are best, and know their limitations.

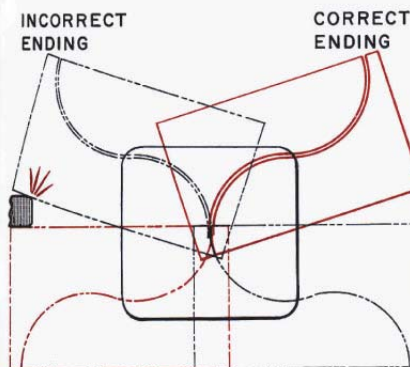
Many teeth per inch (tpi) good for thin stock.

Narrow blades better for tight curves.

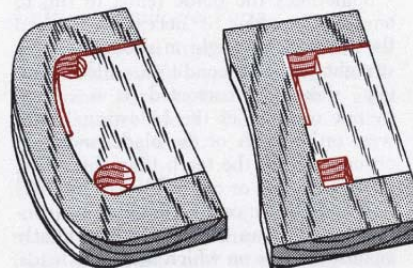
Don't operate saw with tools, debris, or loose objects on the table.



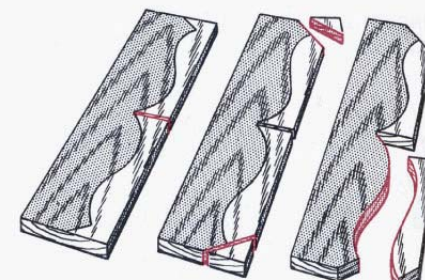
Never cut overhanging, or spherical parts that do not touch table !!!!



28-14. Notice that the correct beginning for this cut is with the stock to the left of the blade.



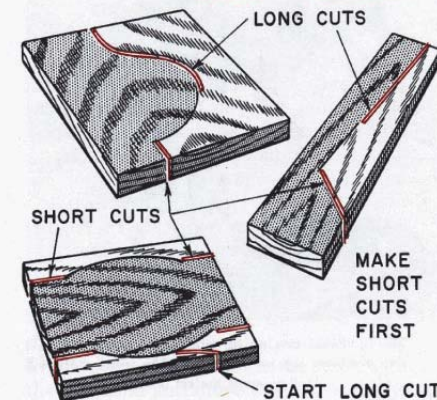
Drill Holes to relieve tight radii.



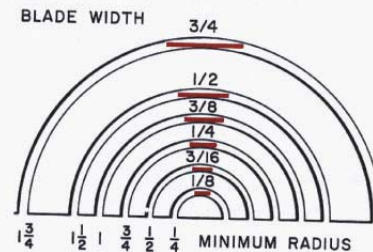
FIRST CUT SECOND CUT THIRD CUT

28-18. Combination curves should be broken up into a series of smaller, simple cuts.

Unit 28 • Band Saw



28-15. If you make short cuts first, little backing out is necessary. Note that when the long cut is completed the waste piece will fall away.



28-7. This chart shows how to select the correct width of blade. For example, a 1/2" blade cannot cut a circle smaller than 3" in diameter.

Sliding Compound & Miter Saws

Miter Saw: *Safety Glasses, Hearing Protection*

Open vacuum line before starting saw.
ONLY crosscuts, no rip cuts are allowed.

Maximum thickness = 3 3/4 inches (due to motor height).

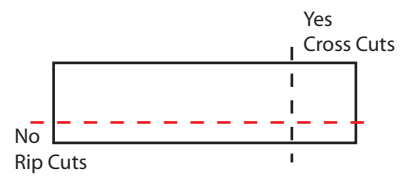
Remove debris, tools, and loose objects from table before starting.

Material should be flat and straight.

Hold material firmly against fence, keeping fingers **AT LEAST 8"** from blade path.

Hold material, pull trigger, lower saw into cut.

When cut is complete, release trigger and wait for blade to stop before lifting saw.



Miter Saw

Sliding Compound Miter Saw

Sliding Compound Miter Saw: *Safety Glasses, Hearing Protection*

Cut Wood and Wood Composites - if in question - ASK

Material should be flat and straight.

Hold or clamp material firmly against fence.

Keep Hands and Fingers **AT LEAST 8"** from blade path.

Wide pieces (see diagram)

Pull saw out beyond workpiece (1.)

Press safety and squeeze trigger.

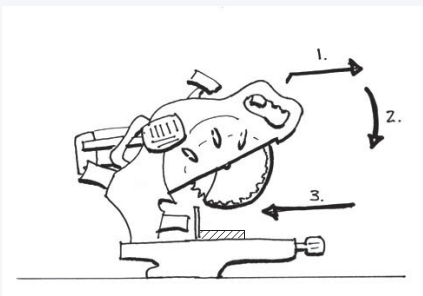
Once saw has reached speed, lower blade into work (2.)

and push saw through slowly(3).

Release trigger, and allow the blade to stop before lifting and removing work piece.



Proper holding and cross cutting.



Saw use for cutting wide pieces.

Narrow pieces

May not need to pull saw out, User can bring saw to speed and chop directly into piece.

Follow same rules above.

Metal Chop Box: *Face Shield, Hearing Protection*

Used for quickly cutting ferrous metal rod, tube, and small flats to length. **NO ALUMINUM**
 Inspect cutting wheel for damage before use. Allow wheel to run in lower position for 30 seconds before using.

Sparks could cause fire - be aware of surrounding that could cause injury/fire.

Clamp part, and when starting saw - wait for it to reach peak speed before cutting.

Cut part, and carefully remove pieces. Parts will be **HOT**.

ASK for assistance.



NEVER make rip cuts.



Metal Chop Box

Routers

Hand Router: *Safety Glasses, Hearing Protection, and Dust Mask*

Mainly used to add decorative edges to boards. Can be used to cut slots, mortises, dados, grooves, rabbets, rounds, and dovetails.

Use proper bit for your application.

Make sure bit is properly secured and inspect bit for damage - chipped, missing bearing, dull, etc.

Use caution when plugging router into outlet. (Router could still be in "on" position).

Work piece should be supported or clamped to a work surface.

Use straight edges or patterns when necessary.

Know where cord is.

For larger bits, deep cuts, or harder materials, make several light passes instead of one heavy one. (1/8" - 1/4") If not, the bit will overheat and dull.

Cut direction should be from left to right. Counter clockwise for outside diameters, and clockwise for inside holes or diameters.

If cutting 4 sides - cut end grain sides first, followed by other two sides. This will minimize chip out.

Use only bits intended for use with a router.

Router Table: *Safety Glasses, Hearing Protection, and Dust Mask*

Also available is a router table. Useful to cut rabbets and dados.

Fence is clamped to the table and workpiece is run through the router.

Ask for help.



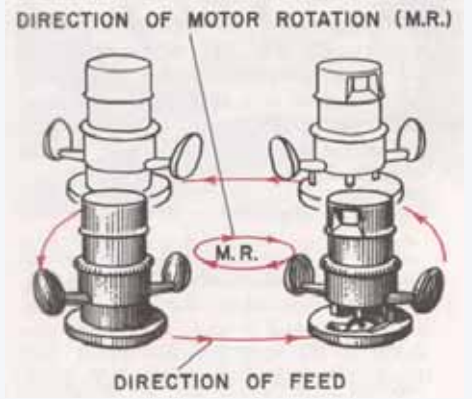
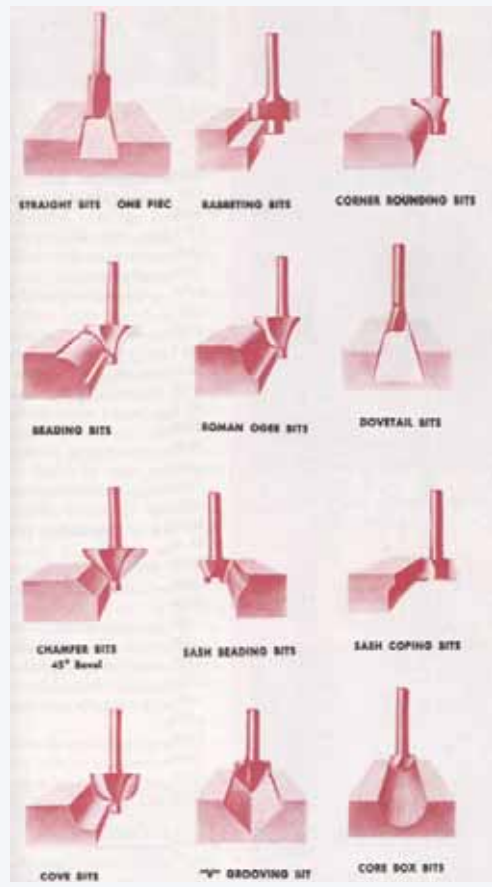
Handheld router



Straightedge for cutting dado

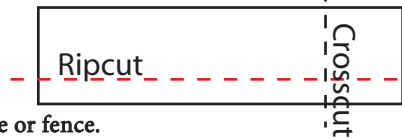


Router user - Hearing Protection



Left to right feed direction.

Table Saws - This is a Level 3 Machine



Safety Glasses must be worn.

Seek Approval before using the Table Saw.

Never attempt Freehand cuts without use of guide or fence.

Keep the saw table free of tools, or debris.

Never clear scraps with fingers.

When cutting narrow pieces, less than 6", Use a Push Stick.

Adjust blade so that it clears stock by approx. 1/4 inch.

Material to be cut must be flat and straight on two adjacent sides.

Pieces must be clear of Knots, Dirt, Metal (nails, staples)

Push material completely through the saw. **DO NOT** let go of part between Fence and Blade until past the back of blade.

Do not reach over the saw blade.

Never stack parts when using the fence.

Rip cuts should be made using the fence, while cross cuts should be made without the fence and only with the miter gage or sled.

The shop is equipped with two table saws:

Saw Stop - Black - This saw has all guards in place and should be used for Rip Cuts and crosscuts with the miter gage.

This saw also has other safety features, and care must be taken not to cut conductive materials. ie. metals, wet wood, mirrored plastics. Ask for Help.

SCM - White - This saw is used for cutting large sheets. Ask.

Kickback

Several causes and types, but all refer to the same basic principle :

- The workpiece is driven back unexpectedly by the blade.

Causes:

- If Blade is too low, workpiece can ride above blade and be thrown back.

- Relieving tension within a piece of wood, thus causing the blade to bind.

- Allowing workpiece to drift into rear of blade, blade throws piece back.

Stop Saw



SCM saw



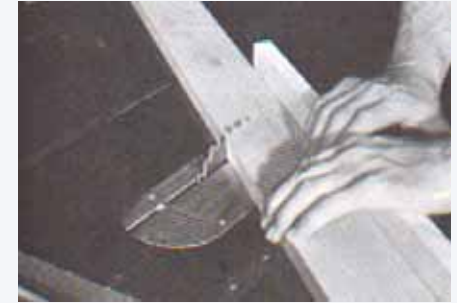
Table Saws - Crosscuts

Miter Gage: *Safety Glasses*

- Before using, clean table slots, and verify the gage slides easily.
- Never use fence as a stop. A stop block may be used to cut repetitive lengths. See pic.
- When cutting angles with miter gage, the closed position should be used. See pic.
- Material should lay flat on the saw, and rest flat against the miter gage.
- Line up cut - Back material and gage away from blade before starting saw.
- Hold material firmly against gage and push through blade with a steady speed.
- Let waste piece fall away.
- Retract miter gage and work piece. Turn off saw.
- Remove pieces once blade stops.



Standard cut-off with miter gage.



Mitered cut with gage in a "closed position". User could easily use chop box instead.

Crosscutting with Sled: *Safety Glasses*

- Clean table slots, and verify sled slides smoothly.
- Never use fence with sled.
- Layout cutline on material and hold secure against rear of sled.
- Adjust blade to correct height.
- Back sled away so workpiece does not touch blade.
- Start saw.
- Hands should be holding material down while pushing sled.
- Know that blade exits sled - Be aware of hand location.
- Once cut is complete : Retract sled, turn off saw, and remove pieces when blade stops.
 - or Turn off saw, wait for blade to stop, then retract sled.



By clamping a stop block to the fence you can make repetitive cuts. This method allows part to fall away and not become lodged and KICKBACK. It would be easier to use other machines.



NEVER attempt a crosscut using the fence. Part will Definitely kickback causing injury.



Crosscutting with the sled.

Table Saws - Ripping

Ripping: *Safety Glasses*

Verify material will pass safety features without interference.

Adjust fence to cut dimension - Lifting fence knob releases cam lock - push down to lock in place.

Guards should be kept in place.

Turn on Saw.

Place material flat on table surface, and tight against fence.

With steady, even pressure push part through keeping force angled toward fence.

For thin rips - Use right hand to push, left hand to hold against fence.

As you feed material - maintain this force of the part against fence.

For best cuts, do not pause, but do not force part through saw.

As end of piece clears front of table - reach for push stick if needed. Always keeping a hand on the part. Have push stick ready, or in hand.

Left hand is retracted for small rips, or simply supports larger material as it passes blade.

Always push part pass blade. Never leave part floating between fence and blade.

Fingers should never be near the blade.

Always ask for assistance.

Comments:

Initially, the left hand aids in keeping part against fence.

As part is pushed through with right, left hand never passes blade, and eventually is no longer pushing on the part. As part nears blade, the right hand has control of the part against fence, and continues pushing beyond the blade.

At this point the left hand either stays back and is not used at all, or if material to the left is large enough, the left hand is supporting the piece from splitting out, but not pushing.

Thin Rips



Part is held securely on table and against the fence.



Left hand aids in keeping part against fence.



Right hand pushes part through.



Once part clears table, a Push Stick is used to push pass blade.



Left hand never pushes part, it supports part against fence.



Continue to push part through, maintaining force against fence.



Always clear parts between blade and fence.

Wide Rips



Part held to table. Both hands are applying force toward corner of part.



Both hands are applying force toward top right of part.



Left hand approaching point where it is no longer needed.



Part is being pushed with right hand. Keeping part against fence.



Left hand supports material so it does not pull cut piece into blade.



Cut complete. Part between fence and blade must be cleared past blade.

Vacu-former

What is it?

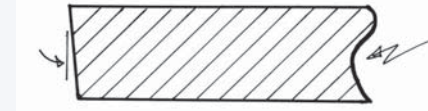
- Vacuforming is an industrial process in which multiple thin walled parts can be produced.
- Process in which you heat a thermoplastic to it's forming temperature, stretch it over a part, and with use of vacuum pull plastic tight against the part.
- Elements needed: Mold box, mold, frame for holding plastic, heat, & vacuum.
- Time is involved to create master tool. Time is needed to experiment & create a good "useable part". Vacu-forming is **not** quick and easy.

Formable Parts

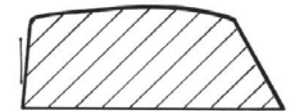
- Parts must be free of undercuts
- Sides must be drafted
- Do not paint or prime master tool.
- Verify holes are drilled in master tool as needed.
- Two types of molds - positive or negative. Positive molds are more common and material is pulled around the part. A negative mold has a cavity carved and the material is pulled into this cavity.
- Sign Foam molds will leave a slight texture on parts. Clear parts will haze slightly.

Machine Basics

- You will need a box (platen) that is a few inches larger than your part in all directions.
- The frame will need to be adjusted a few inches larger than the box.
- The frame is easily adjusted with a 7/16" wrench. Only remove the top nut and washer.
- The box will need to be taped down to the vacu-form table.
- Material will need to be cut so it fits into the frame.
- Your part needs to sit flat on the box and be lifted slightly by sliding pennies beneath.
- Helpful to have a friend to help. Often times they will be needed to operate the controls while you are controlling any leaks around box.
- Plan on making several parts. Typically several pulls before a good part, also parts can break when cutting.
- Flashing/skirt around final part will need to be removed.
- Plan ahead. Help will not be given during busy times and nights/weekends.
- You must have a tutorial before using machine.z



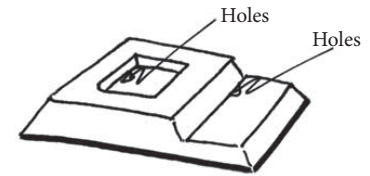
Here the arrows point to undercuts. Undercuts are not possible.



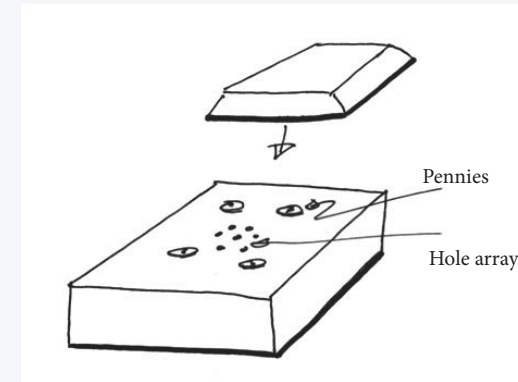
This part shows good draft. Parts should have an additional 2 degrees of draft for every 2 inches in height.



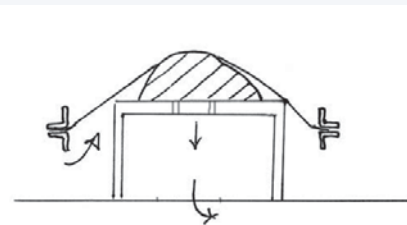
This part only needs an airgap below it to be successful.



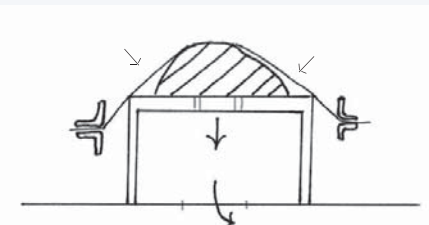
Here we need the airgap below, as well as holes drilled in the "valleys".



An airgap around the part's perimeter is achieved by lifting with pennies or hardware cloth. .



The arrows show vacuum. Here the frame is set too large and the plastic is not "kissing off" on our box. The gap to the left will keep the part from pulling.

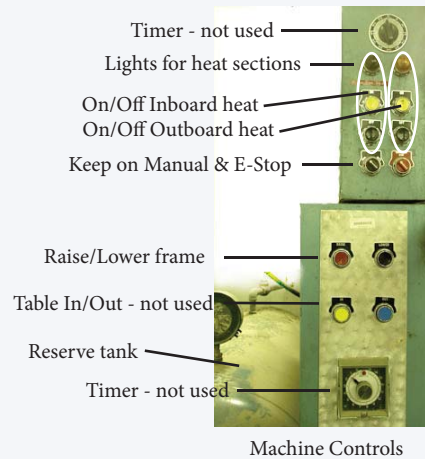


In this image we are "kissing off" and will get maximum vacuum to the part .

Vacu-former - continued

Machine Use

- Control panel to the left of the machine controls most of the operations. First you will have to turn the vacuum on at the breaker panel behind the machine. Next, verify the valve from the reserve tank is closed. The vacuum shuts off once it has pulled a vacuum on the reserve tank.
- Make sure box is taped to the bed, also adjust frame as needed. The small black frame floats within the larger frame and can be removed if necessary for adjustments. Remove only the top nut that secures the frame rail (7/16" wrench). The lower nut secures the threaded stud and aligns the frame for assembly.
- On the smaller black frame there are four cross rails that contain the adjustable studs. When assembling, the two hinged rails should be toward the back, and the shorter rails should be on top. This allows the frame to open for loading.
- Once the frame is installed and lowers around box, it is time to load plastic. Plastic sheets must be cut large enough to lock into frame. Lift frame above box and load plastic. Next you will need to lock the two frames using clamps provided.
- After material has been loaded, lift rack to its highest position. Load part onto box, and lift part slightly using pennies or hardware cloth. Once positioned, the heating elements can be turned on. If your frame is smaller than 43"x48", then only the inboard heat is needed. If frame is larger than this (up to 48"x72") then you will need both inboard and outboard heat. You will also need to remove the small frame and use only the large frame for these pulls.
- As the material heats you will watch for plasticity in the corners. To control temperature the frame should be lowered. With a broom handle check the corners, if you touch any portion that will become your part, it may leave a mark. Continue to monitor until material is ready, at this point shut off the heating elements and prepare for forming.
- Press the lower button until the frame stops on the table, then immediately open the vacuum valve. Allow the vacuum to run until part has cooled. Return valve to closed (horizontal) position. Lift frame, remove plastic (careful it will be hot), then you may have to force mold out depending on geometry.
- When done - ALWAYS turn off vacuum pump at breaker.



Breaker panel to turn on Vacuum pump. Lower left breaker marked with tape. Panel located behind machine.



Vacuum Pump is beneath breaker panel. Verify clean oil is in top reservoir. If not "do not use". Notify staff.



Reserve tank valve. Shown closed, push down to open.



Adjust frame to fit correct box size.



Close up of adjustable frame. Never remove threaded stud and nut. These are for alignment.



Lift frame and tape box to table. An airtight seal is needed.



3 clamps needed. 2 on small frame, one on larger frame.