LAU
School of Architecture and Design

FABRICATION & DIGITAL LAB
USER HANDBOOK

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INDEX

FABRICATION & DIGITAL LAB

Byblos-Architecture Level 1 Beirut-OG 103A
Room 105 – 106 - 108

Supervisor:
Shaker G. Azzi (Byblos & Beirut) shaker.azzi@lau.edu.lb

Lab Personnel:
Issam Abboud: Senior Fabrication Lab Supervisor, issam.abboud@lau.edu.lb (Beirut)
Paul El-Haddad: Lead Fabrication Lab Technician (Beirut)
Elias Bou Malhab: Fabrication Lab Technician (Byblos)

Operating Hours:
- Regular hours: 8:00-4:30. Access to the Fabrication Lab may be limited during scheduled classes.
- Students wishing to use the shop after hours must check in with the area supervisor before 4:30.
- The twelve students limit will be applied at any point that crowding becomes a hazard.
- The Fabrication Lab may be used on weekends only with permission from the Chair of the Department of Architecture and Interior Design.

Contacts:

3D Fabrication Lab: Byblos – Ext: 2370- 2389 / Beirut – Ext: 1155-1095

Labs E-mail: fablab@lau.edu.lb

Workshop: http://sard.lau.edu.lb/student-resources/workshop.php

Laser: http://sard.lau.edu.lb/student-resources/laser-lab.php

Member of: Society of Academic Workshops (SAWS), USA
edu_shops@yahoogroups.com
https://www.facebook.com/3Dfablab

EMERGENCY CALLS

University Nurse: Byblos Ext: 2179 / Beirut Ext: 1132
Security: Byblos Ext: 2105 - 2146 - 2163 / Beirut Ext: 1100
HR Office: Byblos Ext: 2156 - 2174 / Beirut Ext: 1735
Red Cross: 140
Operations: Byblos Ext: 2119 - 2246 / Beirut Ext: 1010

LAB OVERVIEW

This Lab is designed for the students to build design projects. After becoming familiar with the basic techniques, students will begin working on individual projects using various power machines and tools.

Through the experience and knowledge gained in the orientation sessions, students will begin to develop an appreciation of 3D design, craftsmanship, safe work habits, pride in their individual work, integrity and proper work ethic. They will gain an understanding of how to use the tools, machines, woods and devices properly and safely.

LAB WORKSHOP OBJECTIVES

1. To provide each student with information concerning wood, metal and other materials and their characteristics
2. To provide each student with an opportunity to develop skills in safe care and use of hand tools for design projects
3. To provide each student with an opportunity to learn the importance of integrity, craftsmanship, work habits and ethics in the shop
4. To provide each student with an opportunity to work with different kinds of woods, metal, Plexiglas, abrasives, glues, hardware and finishes

After completing the orientation sessions, students will be able to:

1. Develop problem-solving skills related to materials and processes.
2. Develop the necessary skills which will enable him/her to communicate and express design ideas in an understandable, efficient and accurate manner.
3. Thoughtfully plan the work by developing a pictorial view, materials list, cutting list, estimating cost and a plan of procedure list.
4. Develop the ability to read a drawing and be able to construct it in the shop.
5. Use the correct tools and machines in order to prevent personal injury as well as preventive damage to the equipment.
6. Develop the ability to identify hand tools, machines, softwoods, hardwoods, plywood, portable tools, wood joints and metal products.
7. Develop proper attitudes toward work and daily relationships with others.
8. Develop the ability to construct various wood and metal joints and 3D forms assigned by the instructors.
9. Demonstrate the proper way to apply various design problems.
10. Develop the ability and skill to fasten materials together using various adhesives, hardware and techniques.
11. Develop the ability to be on time and keep busy in a safe manner in the shop.

SHOP ORIENTATION PROGRAM

Shop Supervisor's Guidelines

To use the shop, each student must take a six-hour orientation. During this orientation, each student will learn the basics of shop safety and will be introduced to the shop's tools, machines and their proper and safe use.

The metal, wood and model shops provide valuable resources in support of the design process, from general feasibility of manufacturing to the challenges of translating concepts into tangible objects. However, the proper and safe use of the Fabrication Lab is conditioned by the primary security against dangers to one's self as well as others. This is highly emphasized during the orientation session and throughout the use of the workshop.

Each orientation is limited to 12 students per session.

A. Machine Shop Safety

What students should learn:

1. Use of personal protective equipment specific to machine operation
2. Understand and avoid injuries associated with machines
3. Types and operating principles of machine guards
4. Proper use of hand tools to avoid injuries when working on machinery

B. Precision Measuring Instruments

What students should learn:

1. Purpose and language of measurement
2. Scale instruments and accessories
3. Vernier caliper, micrometers, protractors, divider

C. Bench Work

1. Introduction to bench work and all tools and instruments: wrenches, hammers, pliers, screwdrivers, punches, drills, saws, chisels, snips, finishing and grinding tools, files, scrapers and abrasives
2. Treaded fasteners, bolts, screws, studs, thread systems, hole preparation for threaded fasteners, rivets, keys and pins
3. Fitting practice, tolerance, clearance and fit

D. Fundamentals of Machine Technology

1. Introduction to Machine Shop
2. Basic power tools, drill presses, metal lathe, electric welding, cutting metals, folding and forging metals
3. Power saws (wood, metal, plexiglas) routers, grooving machine, wood turning lathe

3D Fabrication Lab Users Requirements

1. Enroll in Shop Techniques course for Foundation students
2. Read the Safety Manual
3. Watch the Safety Video
4. Complete and pass the Safety Quiz
5. Complete a walkthrough of the Lab Facilities with Lab personnel
6. Sign a User Safety Agreement

Visitors

The shop is not an appropriate place for visitors. People who do not have any official reason to be in the shop should stay out, unless specifically invited by the supervisor.

Shop Occupancy Limits

In order to maintain a safe work environment, strict user limits are enforced. Therefore all users should always schedule their shop related projects with the shop supervisor. The following are capacity limits:

- 0 to 12 students*: Requires one shop personnel.
- 13 to 20 students*: Requires two shop personnel.
- 21 to 25 students*: Requires three shop personnel.

* These are only guidelines; the supervisor may restrict access at his discretion. More than 26 students are not allowed in the shop at any one time. The shop supervisor may waive this limit if prior arrangements have been made.

ATTENTION: Knowledge and understanding of rules and procedures are your responsibility. The Fabrication Lab supervisor holds all rights to change and/or modify at any time or for any specific situation. Rules and procedures are strictly enforced.

GENERAL SAFETY RULES & GUIDELINES

To prevent personal injury or machine damage in the Fabrication Lab, students should make sure that they are familiar with and know how to operate the equipment correctly. If a student does not, he/she should ask the area supervisor or other Fabrication Lab personnel.

How Do Accidents Happen?

Accidents are caused by inattention, taking chances, horseplay, bad judgment, fatigue, uncooperativeness, improper clothing, defective tools and so on.

How Do We Help Avoid Accidents?

By strictly following the safety rules provided in the following pages and any additional instructions that the area supervisor might have. Please read over this manual carefully and follow the rules described. If you have any questions about the operation of any machine or tool, ask the area supervisor for instructions.

LIST OF SAFETY RULES

1. Safety glasses, cover goggles or face shields are required when in any 3D Lab area, whether working or not.
2. Shoes must be worn in any Fabrication Lab area. No one wearing sandals will be allowed to enter any Fabrication Lab area. The minimum footwear must cover the entire foot.
3. Do not operate any item of equipment unless you are familiar with its operation and have been authorized to operate it. If you have any questions regarding the use of equipment, ask the area supervisor.
4. No work may be performed using power tools unless at least two people are in the shop area and can see each other.
5. Avoid excessive use of compressed air to blow dirt or chips from machinery to avoid scattering chips. Never use compressed air guns to clean clothing, hair, or aim at another person.
6. Machines must be shut off when cleaning, repairing, or oiling.
7. Do not wear ties, loose clothing, jewelry, gloves, etc. around moving or rotating machinery. Long hair must be tied back or covered to keep it away from moving machinery. Hand protection in the form of suitable gloves should be used for handling hot objects, glass or sharp-edged items.

8. Wear appropriates clothing for the jobs, that is do not wear short-sleeve shirts or short pants when welding.
9. Do not work in the Fabrication Lab if tired or in a hurry.
10. Never indulge in horseplay in the Fabrication Lab areas.
11. All machines must be operated with all required guards and shields in place. In case of power failure/cut-off, the emergency lights provide the necessary light level to help you remove your hands off the machine and/or exit the Lab. Wait for the power to be restored before working on the machine again.
12. A brush, hook or special tool is preferred for removal of chips, shavings, etc. from the work area. Never use your hands.
13. Keep fingers clear of the point of operation of machines by using special tools or devices, such as push sticks, hooks, pliers and so on. Never use a rag near moving machinery.
14. A hard hammer should not be used to strike a hardened tool or any machine part. Use a soft-faced hammer.
15. Practice cleanliness and orderliness in the Fabrication Lab areas.
16. Keep the floor around machines clean, dry and free from trip hazards. Do not allow chips to accumulate.
17. Think through the entire job before starting.
18. Before starting a machine, always check it for correct setup and always check to see if the machine is clear by operating it manually, if possible.
19. Do not drink alcoholic beverages before or during work in the machine Fabrication Lab area. Do not bring food or snacks.
20. Don’t rush or take chances.
21. If you have not worked with a particular material before, ask the Fabrication Lab personnel before cutting any unusual material.
22. Heavy sanding and painting should only be done in well-ventilated areas, preferably on the patio.
23. Follow all appropriate precautions when working with solvents, paints, adhesives or other chemicals. Use appropriate protective equipment.
24. Check the power cords and plugs on portable tools before using them.
25. Always store oily rags in an approved metal container.

IN CASE OF EMERGENCY

1. In case of injury, report it to the Fabrication Lab personnel. The campus emergency phone numbers are:

   Emergency Calls:

   University Nurse: Byblos Ext: 2179 / Beirut Ext: 1132
   Security: Byblos Ext: 2105 - 2146 - 2163 / Beirut Ext: 1100
   HR Office: Byblos Ext: 2156 - 2174 / Beirut Ext: 1735
   Red Cross: 140
   Operations: Byblos Ext: 2119 - 2246 / Beirut Ext: 1010

2. Do not attempt to remove foreign objects from the eye or body. If chemicals get in the eye(s), wash eye(s) for 15 minutes in an open flow of water before proceeding for medical treatment.

3. **Fire Procedures:**

   Step 1 - Remain calm: Do not shout "FIRE".

   Step 2 - Rescue: Rescue personnel or students who are in immediate danger (this step is usually performed simultaneously with Step 3, Alarm).

   Step 3 - Alarm: Sound the alarm and call 2020 to inform Operations about the exact location of the fire, no matter how small the fire appears to be.

   Step 4 - Contain: Close doors and windows to isolate fire and smoke from the rest of the building.

   Step 5 - Extinguish: You may fight the fire if you have been trained to do so, your exit is assured and the alarm has been given.

   Step 6 - Evacuate: Evacuate the building using the nearest exit; do not use elevators. Do not re-enter the building until the alarm has been silenced and you are told that it is safe to re-enter.

UNDERSTANDING POWER TOOLS

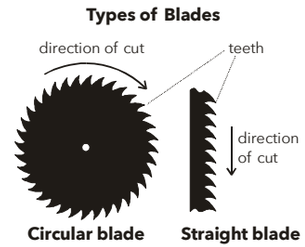
Obviously, the most dangerous parts of power tools are the moving parts. All of the machinery in this Fabrication Lab are powered by electric motors and the radial forces produced by spinning shafts, pulleys, blades and belts can be particularly dangerous. This danger arises from two effects of spinning parts:

1. **outward forces**: wood and debris can become violent projectiles when thrown by spinning blades.
2. **inward forces:** loose clothing, jewelry, hair and fingers can be grabbed, wound up, pulled in and mangled by any spinning machinery.

Always be aware of the danger of these radial forces. Always wear eye protection, never stand in line with circular blades and always maintain a safe distance from spinning parts when the tool is operating.

Understanding how saw blades cut will help you cut efficiently, accurately and safely. There are two basic types of saw blades: the circular blade and the straight (or band) blade. The blade cuts the wood with a series of sharp teeth along the cutting edge. Each tooth acts like a chisel that plows into the wood to make the cut and these teeth are angled toward the direction that they rotate or slide. This is the direction that the force of the blade is exerted. The teeth point in the direction in which the saw will push the wood if allowed, or will throw debris.

As one tooth cuts into the wood, it makes a path for the following tooth. As long as the cut is made properly, each individual tooth is required to remove only a small amount of wood. No significant friction should ever occur between the side of the blade and the wood. If the blade and/or the wood is twisted or becomes misaligned, the side of the blade will foul out against the wood and create friction.



This will cause one of three things to happen:

1. the blade will heat up and dull or break,
2. the blade will stall out and kickback, or
3. the blade will throw the wood. If the blade begins to bind, ease off the cut and try to correct the alignment. If the blade stalls out, hold the wood in place (or the saw in some cases) and turn off the motor.

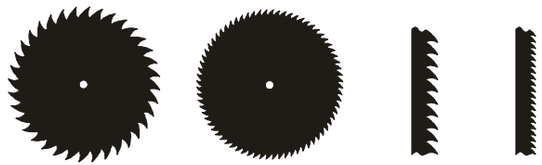
As you will not have time to react in the third possibility, preventive measures are critical. If the blade throws the wood, it will either throw it away from the machine, in which case you must not be in line with the blade, or it will pull the wood away from you toward the blade. In such a case, you do not want your hand too close as it will be pulled in after it. Wood that is irregularly shaped, warped, or split parallel to the cut will be prone to move as it is cut, creating a dangerous situation. Cutting through knots is also hazardous, as they are dense and brittle. When cut, knots can fragment unpredictably, creating debris that can become violent projectiles. When cutting, a slow steady feed should be used. If excessive force is required, the blade is then dull or not appropriate for the material being cut. Forcing a cut will overheat the blade and create the potential for it to bind in the wood.

The thickness of the blade, including any side-to-side offset of the teeth, is called "the blade's set" and determines the width of the slot or groove cut into the wood. This groove is known as a kerf, and generally measures between 1/16 and 1/8 inch. This groove is waste material, and must be taken into account for when marking a board for cutting.

Every blade is designed to cut a specific kind of material and to make specific kinds of cuts. Using a blade to cut the wrong kind of material can result in damage to the blade and injury to the operator. Circular blades can only be used to make straight cuts. Never try to cut a curved cut with a circular blade. Straight or band blades can cut both straight and curved cuts. Blades designed to cut wood generally have larger teeth, and blades for metals and plastics have small teeth. Never try to cut metal with a wood cutting saw, and cut plastics only under direct supervision. Never cut wood that might contain nails or other foreign materials. Metal will instantly dull a wood cutting blade and potentially create hazardous debris.

The size of the teeth also determines the thickness of wood that can be cut with a blade. Blades with large teeth are used to cut thick wood; those with small teeth cut thin wood.

Size and Number of Teeth



The size and number of teeth determine the appropriate thickness of wood that can be cut. The large teeth cut thick wood, and the small teeth cut thin wood.

Generally, it is not advisable to cut wood that is thinner than the space between a blade's teeth. This is true because the larger teeth tend to splinter and grab the thin wood instead of cutting it cleanly. The blades with small teeth can overheat and warp when cutting thick wood, so care must be taken when doing so. The size of the teeth of a blade is described in terms of the number of teeth, either as the number of teeth per blade in the case of circular blades, or teeth per inch in the case of straight blades.

Width of Blade

The width of the straight blade determines the radius of the curve that can be cut. The narrow blades can cut tight curves, whereas the wide blades can cut only wide curves or straight lines.

Another characteristic important to straight blades is the width of the blade. It determines the kinds of curves that can be cut with it. The narrower the blade, the tighter the curve possible. Wide blades can only make straight or gently curving cuts, whereas a very narrow blade can make very tight curves with a small radius. If the blade binds up during a curved cut, then the blade is too wide to make the turn. Trying to force a blade to curve too tightly will wear out the blade and the blade guides very quickly, potentially breaking the blade.

The grain of the wood will also affect the cut. Wood cuts more cleanly along the grain than across the grain. Crosscuts often result in the splintering and tear-out of the wood fibers along the trailing edge of the cut. As the blade's teeth emerge from the wood, they tear the fibers rather than cut them off cleanly. Softwoods and veneers are most susceptible to tear-out. Blades with fine teeth cause less tear-out than coarse teeth. This tear-out can be minimized by making the cut slowly, especially as the blade cuts through the wood. Having a sacrificial board on the underside of the cut also helps, or tape the area to be cut beforehand. If practical, cut outside the mark and sand down to the mark. Most importantly, use sharp, well-maintained blades appropriate for the material.

Listen to the sound of the machine as it cuts, and be aware of any changes in pitch as the cut progresses. You will usually hear the motor begin to strain if the blade begins to bind, even before you see or feel it. If you hear the machine having trouble, ease off and re-correct, or stop the cut. Try to identify the problem before proceeding.

Pay attention to the results of the cut. Watch for undue tear-out, splintering, or especially scorch marks on the cut surfaces. Scorch marks mean that friction is producing enough heat to burn the wood. These marks indicate that the blade is fouling out, the blade is dull, or the blade is not appropriate for the material. Be aware that woods with heavy resins can gum the blades and cause excessive friction. If the cut ever begins to smoke, stop the cut immediately and correct the cause before proceeding.

MARK-UP AND LAYOUT

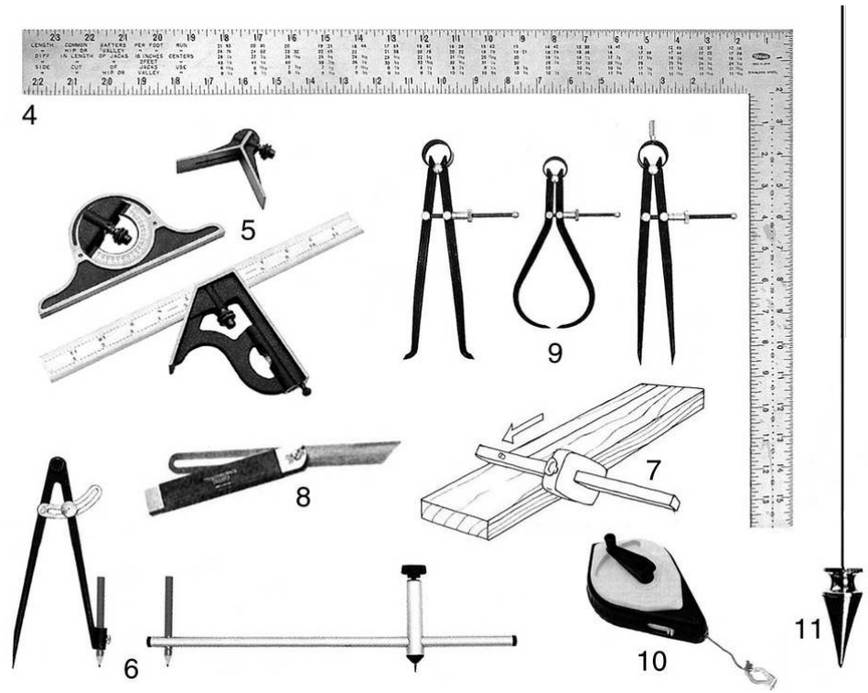
A. Accuracy: "Measure twice and cut once." When unsure, cut a little long and physically check fit.

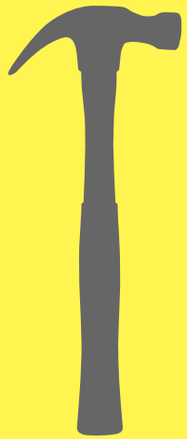
B. When measuring for cuts, remember that blades have thickness and will turn a portion of the wood into sawdust.

C. Cut on one side (waste side) of pencil mark.

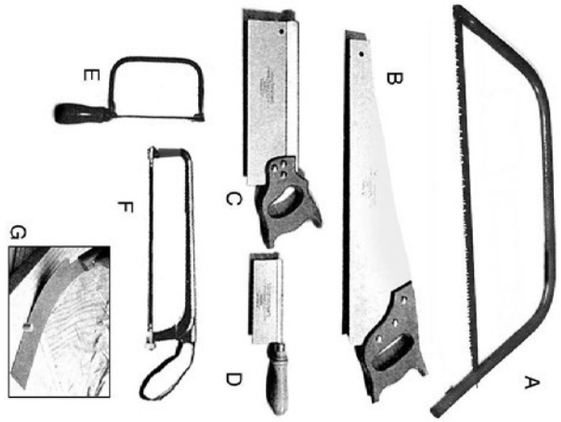
D. Tools for layout:

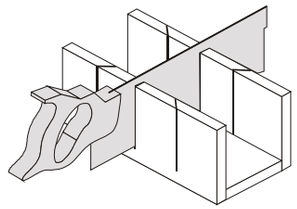
1. **Pencil:** *(not shown)*
2. **Scribe:** (not shown) any kind of sharp, pointed metal marking tool. Because a pencil mark is not as thin as a scratch or knife cut, a scribe mark is more precise.
3. **Tape measure:** *(not shown)*
4. **Square:** L-shaped, right-angle metal straight edge
5. **Combination Square:** an adjustable 90° and 45° angle gauge with a ruler on one side and an offset that can be set against the edge of a board for accuracy on the other
6. **Compasses:** tool marking a circle around a center point
7. **Marking gauge:** an adjustable scribe that slides along the edge of a board to mark a set distance from that edge
8. **Bevel:** an adjustable gauge for transferring variable angles
9. **Calipers:** two prong measuring devices similar to a compass *(from left to right: inside calipers, outside calipers, dividers)*
10. **Chalk line:** a chalk impregnated string on a reel for snapping straight lines
11. **Plumb bob:** a pointed weight on a string used for determining true vertical
12. **Level:** *(not shown)* a rigid straightedge with bubble gauges for determining true vertical and true horizontal





HAND TOOLS





Miter Box: a box or jig that guides the back saw when making miter cuts

HAND SAWS

Few tools are as useful or as often overlooked or misused as the handsaw. When used correctly, the handsaw is a quick and efficient way to accomplish precise cuts. When misused, the handsaw is tiresome and sloppy. The handsaw should be used any time a power tool would be difficult or dangerous to use.

Correct Use of a Handsaw

A hand tool must be sharp to be useful. A dull saw will quickly tire the user after very little progress. If a saw is dull, either replace the blade (if possible), or inform a Fabrication Lab monitor.

You will also find sawing much easier when the saw is held correctly. The work should be secured at a comfortable height with the saw, your wrist, elbow and shoulder in line. The saw should be held at a 45°-60° angle to the wood for general cutting, and level for precise cutting with your elbow bent. You will want to stand so that you can look down at the saw on edge and in line with the cut. The saw should appear to be just a thin line, and you should be able to see both sides of the saw with only a slight movement of your head. When you make a stroke, you should be able to keep the saw's cutting edge level without seesawing the end up and down. The motion should be smooth, steady and comfortable. If not, reposition the work or your body. Remember to cut on the waste side of your mark. Hold the saw with a relaxed but secure grip, with your index finger pointing forward. This finger will help provide lateral control.

To start a cut, begin with a few short strokes, steadying the saw with the thumb of your free hand. Be careful that you don't let the blade hop off the work and cut your hand. After a groove is started, continue sawing with long steady strokes. Long, even strokes are more efficient, producing a faster cutting action and better control. A short, jerky motion will wear out both you and the saw. You must not tense up your hand, arm or body, especially as you begin to fatigue. You should concentrate on using only those muscles needed for steady control. Use just enough force to maintain contact with the wood. If you tense up or force the cut, you will upset the saw's balance, resulting in a crooked and uneven cut. A well-tuned saw will want to cut straight: let it. Concentrate on keeping the saw straight in line and level, not on cutting fast. Cutting through hard parts, such as knots, will require slower - not faster - strokes. Support the waste end until the cut is complete. Letting it fall off by itself will cause the work to split. Also, do not twist the saw to knock the waste piece away, as this will damage the saw's teeth.

Kinds of Saws

Each kind of saw is designed for a specific task. Using the wrong saw for any task means wasted effort and poor accuracy.

A. **Bow Saw:** a large, double-action toothed band blade is held in tension like a bowstring. It is used for cutting limbs and rough lumber.

B. **Rip, Crosscut, or Panel Saw** (General-purpose saws)**:** the teeth configuration determines whether the saw is appropriate for ripping, crosscutting, or sawing panels.

C. **Back Saw:** a straight wide blade stiffened along the top edge for accuracy and that cuts on the push or "back" stroke. It is used for cutting miters (often with a miter box), tendons, and dovetails.

D. **Gent Saw:** a smaller version of the back saw used for very precise work.

E. **Coping Saw:** a saw with a narrow, thin blade (cuts on the pull stroke) held in tension by a deep C-shaped arm. It is used for cutting intricate curves. The blade can be inserted through a hole in the piece to make a trapped cut.

F. **Hack Saw:** a saw with a fine-toothed band saw blade held in tension. It is used for cutting metals and some plastics. The blade cuts on the push stroke.

G. **Flush-Cut Saw:** an extra thin, flexible blade that cuts on the pull stroke. It is used to cut wooden dowels and pins flush without marking the surface. It is also useful for various detail cuts.

HAMMERS

A hammer is a very basic tool for any carpenter. Hammers are made in various qualities. There are two shapes of claws on hammers. The straight claw hammer is better for prying or pulling wood apart. The claw wedges, like a chisel, in between two boards to loosen them. This straight claw hammer is preferred by framing carpenters and is usually a heavier weight (450g – 900g). The curved claw hammer is better for pulling nails. This curved claw hammer is preferred by finish carpenters and is usually lighter weight (370g – 450g).

Hammer Safety

1. Use the proper size and type of hammer for the job.
2. Never throw a tool.
3. Check the head to see that it is securely fastened to the handle.

Most Common Hazards

1. Smashing thumbs and fingers
2. Fumbling and dropping
3. Being hit on the head during the back swing

CHISELS

A wood chisel is used to cut mortises into wood for hardware and other items. It is made of a steel blade heat treated throughout so it can be sharpened throughout its entire length. Chisel sizes are determined by the width of the blade. Blades are available in 1/8" to 1", and in 1/4" increments from 1" to 2".
A chisel is made to either cut by hand or cut by holding the chisel and striking it with a hammer or mallet. Either way, the beveled side should be turned down. This enables you to prevent the chisel from cutting too deep by rocking it back on the bevel. This raises the cutting edge.

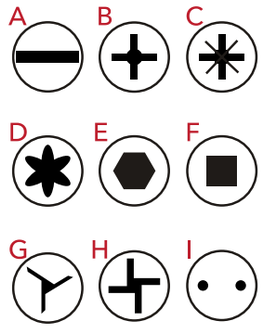
Chisel Safety

1. Keep chisels sharp. A sharp tool is less dangerous than a dull one, because less pressure needs to be used.
2. Drive wood chisels outward, away from your body.
3. Never put your hand in front of the cutting edge.
4. Remove nails or screws from the wood before you use a chisel on it.
5. Never use a wood chisel as a pry or wedge. The steel is hard and brittle and may break.
6. Always carry a chisel with the sharp end down.
7. Never carry sharp tools with points sticking up.

SCREWDRIVERS

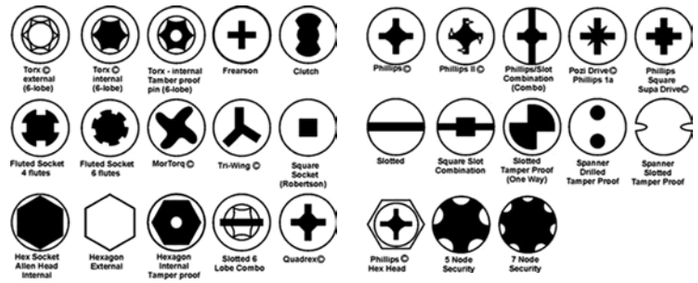
When selecting a screwdriver, remember the tip should fit snugly in the slot and be almost the full width of the screw head. Most hardware is supplied with Phillips screws. To drive these screws, it takes more downward pressure to keep the tip in the slots. The Phillips screwdriver is very much like the standard screwdriver. The difference is that the tip is shaped like an "x" so it will fit into slots in Phillips screws.

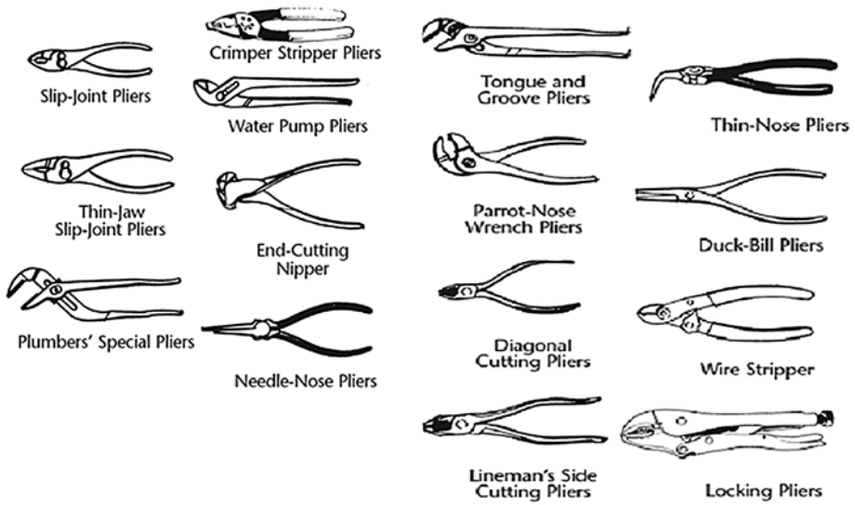
A. Flat Head (or Slotted or Straight Head)
B. Phillips
C. Pozidrive (or Crosspoint)
D. Torx
E. Hex (or Allen)
F. Robertson (most common)
G. Tri-Wing
H. Torq-Set
I. Spanner



Screwdriver Safety

1. Use a screwdriver only for its intended use, not as a punch, wedge or pry bar.
2. Do not use a screwdriver with a broken handle, bent blade or a dull twisted tip.
3. Keep your hands away from the work after the screw is started.
4. Never hold an object in the hand and press a screwdriver into it.





PLIERS

Pliers are a hand tool used to hold objects firmly, for bending, or physical compression. Generally, pliers consist of a pair of metal first-class levers joined at a fulcrum positioned closer to one end of the levers, creating short jaws on one side of the fulcrum, and longer handles on the other side.

This arrangement creates a mechanical advantage, allowing the force of the hand's grip to be amplified and focused on an object with precision. The jaws can also be used to manipulate objects too small or unwieldy to be manipulated with the fingers.

BLOCK PLANE

When using the block plane, check to see that the blade is adjusted to the proper depth. Also, secure your work to keep it from moving around. Keep a firm grip on the plane and apply pressure downward and forward. This plane is mostly used to plane small pieces of wood and end grain such as fitting the ends of molding. Its small size makes it easy to control accurately.

How to Use a Block Plane:

1. First rest the palm of the hand to be used on the upper-most part of the plane.
2. Grasp the sides of the plane between the thumb and second finger with the index.
3. Finger resting in the hollow of the finger rest at the front of the plane.
4. Pressure should be applied down and forward at the beginning of the stroke.
5. Maintain uniform pressure throughout the stroke.

NOTE: Always plane with the grain. If the grain is irregular, it may be necessary to change the direction of planning to suit the run of the grain. If cross or curly grain is to be cut, be sure that the plane edge is very sharp and set for a fine cut. When any plane is not temporarily in use, set it on its side to protect the blade.

POWER DRILLS

The principle danger of power drill is the loss of control by the operator and the danger of loose material being twisted up onto the bit. Remember, the bit is spinning, creating the hazards of radial forces.

These examples are just a few of the many bits available. It is important to note which bits are appropriate for what materials. In general, wood cutting bits can be used only to cut wood, whereas metal cutting bits can cut both metal and wood.

A. **Countersink:** for creating an enlarged hole with an angled bottom to allow screw heads to set below the surface

B. **Combination Bit:** a flat tapered bit with a shoulder for drilling and countersinking holes for wood screws

C. **Forstner Bit:** a very precise bit for cutting large holes over ½ inch

D. **Masonry Bit:** a bit for drilling holes into masonry or cement

A. **Bullet Point Bit:** a woodcutting bit with a "bullet" point that reduces point drift and cuts a hole with a flat bottom (also called a Brad-point bit)

B. **Reduced Shank Twist Bit:** a large twin-fluted bit with a smaller shaft

C. **Twist Bit:** a twin fluted bit with a beveled point appropriate for general drilling in wood or metal

D. **Spade Bit:** a flat, inexpensive bit for boring large holes over ½ inch wide. It is not accurate and tends to tear-out the beginning and ends of cuts.

E. **Auger:** drills large deep holes with a brace or slow speed hand drill. The threaded point screws into the wood and pulls the bit deeper. IT CANNOT BE USED IN THE DRILL PRESS.

F. **Fly Cutter:** an adjustable hole saw. It cannot be used with a hand drill, and can only be used in the drill press.

G. **Hole Saws:** for sawing large holes (1 to 3 inches) through wood no thicker than twice its length (3½ inches max)

HAND-HELD POWER TOOLS

ROUTER

OFF LIMITS WITHOUT SPECIFIC PERMISSION, TRAINING, AND SUPERVISION

1. **Configuration:** essentially a smaller, hand held, inverted version of the wood shaper
2. **Action:**
   a. The router is used to cut slots and dados, and to mould the edges of boards.
   b. The wood is secured and the router is moved by hand.
3. **Adjustments:**
   a. Interchangeable cutters (bits) for different cuts and profiles
   b. Bit depth
   c. Various guides, jigs, templates, straight edges, and accessories for specific procedures
4. **Safety:** Do not use without specific permission, specific training, and direct supervision.

Router Bits:

Router bits are essentially a smaller version of the wood shaper cutters. They come in a variety of shapes and profiles, each suited for a particular kind of cut. There are two types of router bits: (1) plunge and (2) bearing. Plunge bits are used to cut in the center area of a board, whereas a bearing bit cuts around the edges.

A few examples of router bits are:

Plunge bits:

A. Straight: cuts square slots or dados

B. Round nose: cuts rounded slots

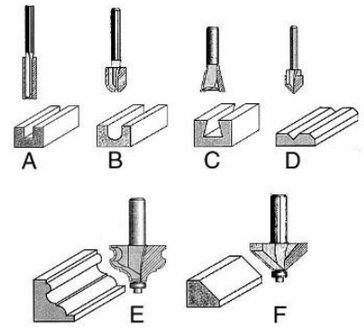
C. Dovetail: cuts dovetail slots

D. V-groove: cuts V-shaped grooves

Bearing bits:

E. Molding: cuts a molding profile

F. Chamfer: cuts a sloped corner



CIRCULAR HAND SAW

USE ONLY UNDER DIRECT SUPERVISION

1. **Configuration:** hand held circular blade
2. **Cutting Action:** wood is held in place while blade is moved
3. **Adjustments:**
   a. Blade can be raised or lowered for cut depth.
   b. Blade tilts for bevel cuts 0/45°.
4. **Cuts:**
   a. Straight cuts
   b. Rips-cuts and crosscuts on stock too large to fit on table saw, radial arm saw, or miter saw
5. **Safety:**
   a. USE ONLY UNDER DIRECT SUPERVISION OF SHOP PERSONNEL
   b. Set blade depth so that the teeth emerge completely from underside of cut.
   c. Keep the blade aligned along straight path. Make sure you don't bind the blade.
   d. Never cut "blind." Always ascertain that underside of cut is clear of obstructions.
   e. Do not cut into tabletop or supports.
   f. Make sure both sides of the cut are supported even after the cut is made.
   g. Do not cut electrical cord.
   h. Allow blade to stop spinning before placing saw down after cut is finished. Take extreme care when making bevel cuts, as the angle between the blade and foot can bind the blade easily.
   i. Always hold saw with both hands.
   j. Secure small and/or thin work with clamps. The wood must not be allowed to move during the cut.

JIGSAW

1. **Configuration:** hand held, with a short stout blade extending from bottom (foot)
2. **Cutting Action:** the blade reciprocates up and down, cutting on the up stroke.
3. **Adjustment:** varies with model
   a. Trigger can be locked on.
   b. Speed can be adjusted.
   c. Single action or orbiting blade
   d. The foot tilts on some models.
4. **Cuts:** straight or curved cuts in moderately thin wood (up to length of blade)
5. **Safety:**
   a. Do not cut “blind”. Do not cut without ascertaining backside of cut is clear of obstructions.
   b. Do not cut into tabletop or support.
   c. Do not cut electrical cord.
   d. Keep electrical cord free of snags.
   e. Make sure blade extends completely through material throughout stroke.
   f. Secure material before cutting. Small and/or thin material may flex or vibrate causing loss of control.

RECIPROCATING SAW

1. **Configuration:** hand held, with a stout blade extending from end
2. **Cutting Action:** the blade reciprocates in and out, cutting on the in stroke
3. **Adjustment:**
   a. The shoe is both hinged and removable.
   b. The blade can be reversed.
   c. Variable speed
4. **Cuts:** freehand rough cuts (up to length of blade)
5. **Safety:**
   a. Do not cut “blind”. Do not cut without ascertaining backside of cut is clear of obstructions.
   b. Do not cut into tabletop or support.
   c. Do not cut electrical cord.
   d. Keep electrical cord free of snags.
   e. Make sure blade extends completely through material and beyond shoe throughout stroke.
   f. Secure material before cutting. Small and/or thin material may flex or vibrate causing loss of control.
   g. Use both hands to hold the saw.

DREMEL

A dremel is a small, all-purpose shaping device for very detailed work. It is similar in configuration to a router without a guide base, and can be utilized for shaping, sanding, grinding and much more.

Dremel bits:

A – E. High speed rotary cutters: for general purpose shaping of wood, metal, or plastics

F – H. Tungsten carbide cutters: longer lasting cutters

I. Wire brush: for cleaning corrosion and rust on metals

J – M. Grinding points: for grinding metal

N. Cutting disks and Mandrel

Safety: Wear Eye Protection!

HAND DRILL

1. **Configuration:** hand held drill
2. **Cutting Action:**
   a. Work is secured and drill moved by hand.
   b. It can be used to drive screw with special bits.
3. **Adjustment:** varies with model
   a. Trigger can be locked on.
   b. Speed can be adjusted.
   c. Direction can be reversed.
4. **Safety:**
   a. Do not drill “blind”. Do not drill without ascertaining backside of work is clear of obstructions.
   b. Do not drill into tabletop or support.
   c. Do not abuse electrical cord.
   d. Keep electrical cord free of snags.
   e. Use both hands on drill. If the bit binds up, the drill will try to wrench itself violently from your grip, so be prepared.

HAND SANDERS

All of the same precautions taken with the large stationary sanders also apply to the smaller hand sanders, especially the hand belt sander. The finishing and random orbit sanders, however, produce far less force and are, thus, generally safer. Always wear a dust mask when sanding, especially when there is not a dust collector on the machine.

NEVER SAND WOOD PAINTED WITH LEAD-BASED PAINT IN THE FABRICATION LAB.

Special hazardous materials precautions must be taken with the dust produced from sanding lead-based paint. If you cannot determine with absolute certainty that a paint is not lead-based, treat it as if it were. All hand sanders are equipped with trigger locks that lock the sander in the on position. Make sure the lock is off before plugging in the sander. Some hand sanders are equipped with dust collecting bags. Always check these bags before and after use, and empty any dust inside.

Hand Belt Sander:

1. **Configuration:** small, hand held belt
2. **Action:** belt rotates around two pulleys; sander is moved while wood is held stationary.
3. **Safety:**
   a. Use both hands to hold the sander firmly. Always be able to hold against the direction of belt rotation.
   b. Secure the wood. The sander will try to throw loose wood.
   c. Never approach from attacking angle. Do not tear the belt on sharp corners.

   d. Be aware of belt tracking and tension. Shut off machine and alert shop personnel if belt tracks wrong, especially if sparks are created.
   e. Do not use if belt is loose or torn. Alert shop personnel.
   f. Keep hands away from abrasive surfaces, especially near intake gaps.
   g. Do not sand electrical cord, loose clothing and/or cloth in the sanding area.
   h. Keep electrical cord free of snags.

Finishing Sanders:

1. **Configurations:** small, hand held vibrating pad sander
   a. Half Sheet Finish Sander: uses a half sheet of sandpaper
   b. Quarter Sheet Palm Sander: uses a quarter sheet of sandpaper
   c. Palm Sander: round pad
2. **Action:** sanding pad vibrates in a randomly changing circular motion

CORDLESS DRILL

It is similar to the hand drill, but battery powered and used primarily for driving screws. Cordless drills are often equipped with a clutch that slips when the screw is seated, preventing the head from being broken off or stripped out. Phillips head and square head screws work best.

A. Phillips Bit
B. Slotted Bit
C. Square Recess
D. Socket Hex Head
E. Star
F. Star Insert
G. POZIDRIV
H. Hand Drive Adapter for socket wrenches

STATIONARY POWER TOOLS

CIRCULAR SAWS

Special care must be taken with tools that cut with a circular blade. These blades cut with tremendous forces, and the radial motion of the blades can both throw wood and debris outward and pull fingers and loose clothing inward. The wood being cut must be held securely at all times. If allowed, the blade will try to move the wood violently rather than cutting it.

- **Never cut freehand with mounted circular saws.**
- **Never place hands closer than 6" to a moving blade.**

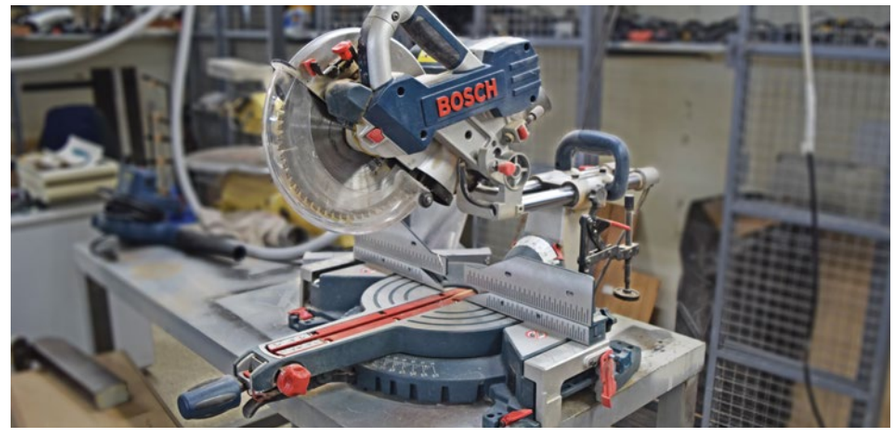
TABLE SAW

COMPLETELY OFF LIMITS TO STUDENTS

1. **Configuration:** circular blade mounted into table
2. **Cutting Action:** wood is moved across tabletop either against fence or pushed with miter gauge: NEVER CUT FREEHAND.
3. **Adjustments:**
   a. Blade can be raised and lowered
   b. Blade can be tilted to the right 0/45° for bevel cuts
4. **Cuts:**
   a. Straight cuts and Rip cuts (along board's length) with fence
   b. Cross-cuts on panels with panel attachment
   c. Cross-cuts and miter cuts on short boards with miter gauge
   d. Dado and mill work with fence
5. **Safety: STRICTLY OFF LIMITS**

MITER SAW COMPOUND MITER SAW (CHOP SAW)

1. **Configuration:** Circular blade mounted on single action arm
2. **Cutting Action:**
   a. Blade swings down in chopping motion
   b. Wood is held in place while blade is moved
3. **Adjustments:**
   a. Compound Miter Saw blade swivels for miter cuts
   b. Compound Miter Saw blade tilts for bevel cuts
4. **Cuts:**
   a. Crosscut and miters in long narrow boards
   b. Compound Miter Saw cuts compound miters in long narrow boards
5. **Safety:**
   a. Firmly fix wood against table and fence: never cut freehand.
   b. Hold wood with left hand, cut with saw in right hand.
   c. Slow steady feed: DO NOT TRY TO CUT TOO QUICKLY.
   d. Always check for square.
   e. Tilted blade bevel cuts are most prone to binding and thus most dangerous.
   f. Always return saw to its full start position after the cut.
   g. Never “gang cut.” Never cut more than one piece at a time.



SLIDING COMPOUND MITER SAW

1. **Configuration:** circular blade mounted on a double action arm
2. **Cutting Action:**
   a. Slides forward above wood
   b. Swings down in chopping motion
   c. Slides back on rails, cutting on the push stroke
   d. Rail assembly can be locked so that saw can only chop like a standard miter saw
   e. Wood is held in place while blade is moved
3. **Adjustments:**
   a. Blade assembly swivels for miter cuts 45/0\45°
   b. Blade assembly tilts for bevel cuts 0\45°
4. **Cuts:** straight cuts. Compound crosscuts and miter cuts in long boards
5. **Safety:**
   a. Firmly fix wood against table and fence: never cut freehand.
   b. Hold wood with left hand, cut with saw in right hand.
   c. Slow steady feed: DO NOT TRY TO CUT TOO QUICKLY.
   d. Always check for square.
   e. Tilted blade bevel cuts are most prone to binding and so most dangerous.
   f. Always return saw to its full start position after the cut.
   g. Never “gang cut.” Never cut more than one piece at a time.

BAND SAWS AND OTHER SAWS

Although straight blade saws, such as the band saw, are somewhat safer than circular saws, misuse can still result in serious bodily injury. Band saws are generally more versatile than circular saws, and they are able to make many of the same kinds of cuts as well as others.

Unlike circular saws, cuts on band saws can be made free hand (without fence or miter gauge) as long as the pieces are given adequate and stable support throughout the cut. This means that curved cuts can be made as well as straight. However, the band saw does not cut as precisely as a circular saw and cannot cut dados and rabbets.

LARGE BAND SAW

1. **Configuration:** long, continuous band blade looped around large upper and lower wheels
2. **Cutting Action:** wood is moved on table into blade
3. **Adjustments:** table top tilts for beveled cuts 0-45°
4. **Cuts:**
   a. Straight cuts and wide curves
   b. Versatile: rip-cuts, crosscuts, miters, re-saws, and long radius curves in medium size boards and panels
   c. It cuts any size piece of wood that will fit through throat and on table.
   d. Surves are cut freehand.
   e. Rip-cuts are cut with fence.
   f. Crosscuts and miters are cut with miter gauge.
5. **Safety:**
   a. Wood must flat against table and stable. Never cut round or unstable wood without secondary support (such as a jig). The downward force of the blade will twist round or unstable stock as it cuts, causing the blade to bind, kink, and break.
   b. Set guard ¼" above wood.
   c. Never force a curved cut tighter than allowed by the blade width.
   d. Watch your fingers, especially at the end of the cut.
   e. Never back out of long cuts with the machine running. Backward pressure can cause the blade to jump its guides, hang up, and break.
   f. Plan your cuts before you begin cutting. Make sure the wood will clear the throat throughout the cut. Make release cuts before cutting long curves.

14" BAND SAW

1. **Configuration:** long, continuous band blade looped around large upper and lower wheels
2. **Cutting Action:** wood is moved on table into blade
3. **Adjustments:** table top tilts for beveled cuts 0-45°
4. **Cuts:** straight cuts and wide curves
    a. Versatile: rip-cuts, crosscuts, miters, and long radius curves
    b. Curves and rip-cuts are cut freehand.
    c. Cuts any size piece of wood that will fit through throat and on table
    d. Crosscuts and miters are cut with miter gauge.
5. **Safety:**
    a. Set guard 1/8" above wood.
    b. Same as Large Band Saw
    c. Watch your fingers.

SCROLL SAW

1. **Configuration:** a short thin blade held through the table by a long arm
2. **Cutting Action:** the blade reciprocates up and down, cutting on the down stroke.
3. **Adjustments**
    a. The table tilts for bevel cuts.
    b. The blade can be easily removed and inserted through a hole in the wood to allow trapped cuts.
4. **Cuts:** intricate and delicate curves in flat, thin wood
5. **Safety:**
    a. Watch your fingers.
    b. Make sure blade has teeth pointing down.
    c. Make sure tension is adjusted properly on the blade.
    d. Do not push too hard on the wood. You want only enough pressure to maintain good contact on the down stroke, not the up stroke.

SANDERS

The large stationary sanders are used primarily for shaping and coarse sanding. These sanders remove material very quickly and must be used very carefully. Deep gouges can be quickly cut into the wood surface, and edges can easily be sanded crooked. Always hold the piece securely, and sand with light, even pressure, moving the piece constantly. Use the tables and guides whenever a straight or beveled edge is required and use of such aids is possible. Trying to sand too quickly will result in poor accuracy and sloppy work.

The primary danger of power sanders is that the users underestimate their hazard because there are no blades. They can, however, be just as dangerous as saws.

The hazards of power sanders include:

- **radial forces of the spinning parts**
- **abrading power or sanding surfaces**
- **fine particles of dust created**

Power sanders have been known to pull out hair by the roots and tear flesh away to the knuckles. Wood dust can be extremely flammable, and the dust created from sanding lead-based paints and other materials can pose long term health risks to both the operator and others in the area.

- NEVER LEAVE SANDERS RUNNING UNATTENDED.
- ALWAYS MAINTAIN SECURE FOOTING AROUND THE SANDER.
- NEVER WEAR GLOVES, LOOSE CLOTHING, JEWELRY, NECKTIES, OR LONG LOOSE HAIR NEAR SANDERS.
- NEVER LEAN OVER OR REACH UNDER RUNNING SANDERS.
- NEVER POWER SAND METALS, including nails, screws, or other fasteners in the wood. Sparks can ignite air borne sawdust. Countersink fasteners below wood surface before sanding.
- NEVER POWER SAND PAINTED WOOD OR OTHER MATERIALS IN THE DESIGN SHOP.
- ALWAYS RUN DUST COLLECTOR WHEN SANDING.

BELT/DISK SANDER

1. **Configuration:** combination belt and disk sander
2. **Action:** rough sands and shapes
3. **Adjustments:**
   a. Belt swivels from horizontal to vertical.
   b. DO NOT CHANGE WITHOUT PERMISSION OF SHOP PERSONNEL.
   c. Tables tilt 0-45°.
   d. Miter gauge can be used.
4. **Safety:** (also see above)
   a. Hold wood firmly, always to be able to hold against the direction of sander.
   b. Never approach from attacking angle.
   c. Be aware of belt tracking and tension. Shut off machine and alert shop personnel if belt tracks wrong, especially if sparks are created.
   d. Do not use if belt or disk is loose or torn. Alert shop personnel.
   e. Keep hands away from abrasive surfaces, especially near intake gaps.
   f. Use tables to support material when sanding against a vertical belt or disk.
   g. Hold wood securely. Loose wood will be thrown violently.
   h. Do not stand in line without feed of belt.
   i. Do not let others stand in line of the out feed.
   j. Never sand pieces too small to hold safely.
   k. Never use gloves or a rag to hold material.
   l. Use sanding disk on down side, not upside.
   m. Sand with the grain whenever possible.
   n. Keep work moving. Do not over sand in one place.

HOLLOW CHISEL MORTISE

1. **Configuration:** hollow square chisel with a drill bit in the center built in a press
2. **Cutting Action:** bores a squared hole
3. **Adjustments:**
   a. Uses different sizes of chisels from 1/4" – 1"
   b. Head can tilt at an angle
4. **Safety:**
   a. Secure wood in vise.
   b. Use the proper chisel/ bit combination.
   c. Tighten bit and remove chuck.
   d. Do not over work chisel and bit.
   e. Do not mortise your hand.

FLOOR DRILL PRESS

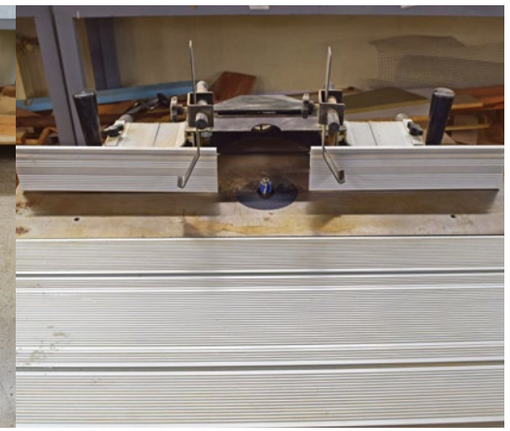
1. **Configuration:** overhead drill mounted above adjustable table
2. **Cutting Action:**
   a. Drill bit is mounted in a chuck, which travels up and down on the quill
   b. Drills holes perpendicular to table
3. **Adjustments:**
   a. Variable speed (change with drill on only)
   b. Table elevation
   c. Quill can be locked
   d. Depth stop for setting hole depth
4. **Safety:**
   a. Use only bits appropriate for the material.
   b. Make sure that the bit is tight and straight in chuck.
   c. Remove key from chuck before turning on.
   d. Secure wood, clamping it whenever possible.
   e. Do not drill into metal table.
   f. Place a scrap of wood under work to avoid tear-out.
   g. Check drill speed: faster for soft materials or small bits, slower for hard material or large bits. Adjust speed only with drill on.
   h. Never use auger bits in the drill press.
   i. Avoid awkward hand positions in which a sudden slip would cause hand to go into the cutting tool.
   j. Hold work in left hand and operate drill with right hand.
   k. Never wear gloves, neckties, jewelry, loose clothing or long loose hair.

SHAPING

Besides the general cutting and sanding tools, there are many other tools used for specialized shaping, such as jointing edges, planning surfaces and cutting molding. For the most part, these power-shaping tools are some variation of a cutter blade (composed of knives or blades mounted on a spindle or shaft) and a guide surface or surfaces.

Such tools include the jointer, the planer, the wood shaper, and the router. With the lathe, the wood is spun on spindles and the cutting instruments (the chisels or turning knives) are held stationary. Hand shaping is performed with a variety of chisels, knives, rasps and files, as well as small all-purpose devices such as the Dremel and rotary cutter.

The safety procedures for the shaping tools are essentially the same as those for the circular saws. Keep in mind, however, that the knives on the shaper cutters are generally much larger than the teeth of the saw blades and there for are more prone to grab loose clothing and throw large splinters.



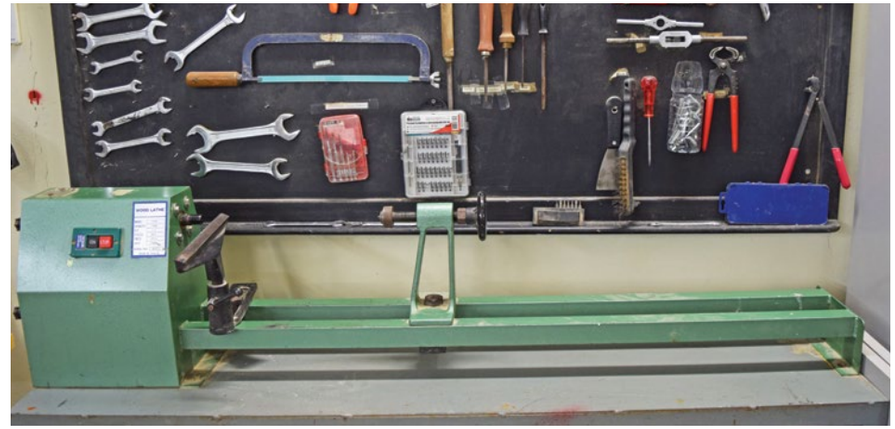
JOINTER

1. **Configuration:** a series of short knives mounted on a horizontal spindle set into a long flat table equipped with a fence
2. **Action:**
   a. The jointer is used to true the edges of boards that makes them very straight at a constant angle to the face.
   b. The wood is pushed on the table along the fence and into the spinning knives.
3. **Adjustments:**
   a. Blade elevation
   b. Out-feed table height
   c. Fence can be tilted for beveled edge
4. **Safety:**
   a. You must have had proper instructions on how to use the jointer.
   b. Shop personnel must supervise you when using it.
   c. Use push blocks and push sticks to feed wood through cutters.
   d. Be aware of where your fingers and hands are placed when using the jointer.
   e. Keep in feed and out feed table clean and clear of debris.

THICKNESS PLANER

OFF LIMITS WITHOUT SPECIFIC PERMISSION, TRAINING, AND SUPERVISION

1. **Configuration:** a series of 15-inch knives mounted on a horizontal spindle set above a short table and equipped with self-feeding rollers
2. **Action:**
   a. Planer is used make the faces of a board flat and parallel
   b. The wood is fed between the spinning roller/knife assembly and the table
3. **Adjustments:** Table or blade elevation for thickness
4. **Safety:**
   a. You must have had proper instructions on how to use the thickness planer.
   b. Shop personnel must supervise you when using it.
   c. Wood must be free of all dirt or any metal and paint.
   d. You must wear face shields, dust mask, and ear protection when using the machine.
   e. Remove only a maximum 1/16" at a time.



WOOD LATHE

OFF LIMITS WITHOUT SPECIFIC PERMISSION, TRAINING, AND SUPERVISION

1. **Configuration:** two spindles equipped with a parallel tool rest
2. **Action:**
   a. The lathe is used to "turn" or cut rectangular pieces into cylindrical forms.
   b. The wood is mounted between the spindles and spun, while turning chisels are used to cut the cylindrical profiles.
3. **Adjustments:**
   a. Spindles accommodate various lengths
   b. Variable speed
   c. Adjustable tool rest
   d. Variety of chisels
4. **Safety:** Do not use without specific permission, training, and direct supervision.

WOOD SHAPER/ROUTER TABLE

OFF LIMITS WITHOUT SPECIFIC PERMISSION, TRAINING, AND SUPERVISION

1. **Configuration:**
   a. A series of short knives mounted on a vertical spindle set into a short flat table equipped with a fence and miter gauge
   b. Or a Router mounted upside-down in a table with a fence
2. **Action:**
   a. The shaper or router is used to “mold” the edges of boards, that is shape them into specific molding profiles.
   b. The wood is pushed on the table along the fence or with the miter gauge and into the spinning knives.
3. **Adjustments:**
   a. Interchangeable cutters for different profiles
   b. Blade elevation
   c. Fence settings
4. **Safety:** Do not use without specific permission, training, and direct supervision.

SAFETY RULES

LATHE SAFETY RULES

1. Make sure that the chuck, drive plate, or, faceplate is securely tightened onto the lathe spindle.
2. When removing the chuck, drive plate, or faceplate do not use machine power.
3. When installing the chuck, drive plate, or faceplate do not use machine power.
4. Move the tool bit to a safe distance from the chuck when inserting or removing work.
5. Don't run the machine faster than the proper cutting speed.
6. In setting up the tool holder place it to the left side of the compound slide to prevent the compound slide from running into the chuck or spindle attachments.
7. Always clamp the toolkit as short as possible in the tool-holder to prevent it from breaking or chattering.

8. Always make sure that the toolkit is sharp and it has the proper clearance. Ask for assistance making adjustments.
9. If any filing is done on work revolving in the lathe, file left-handed to prevent slipping into the chuck. Never use a file without a handle.
10. If work is turned between centers, make sure that proper adjustment is made between centers and that the tailstock is locked in place.
11. If work is being turned between centers and expands due to heat generated from cutting, readjust centers to avoid excessive friction.
12. Do not grasp or touch chips or turnings with your fingers, but get rid of them using a blunt instrument. It is safer to turn off the lathe before clearing chips than to leave it running.
13. Set the toolkit on centerline of work to prevent work from climbing over tool or cutting above center and dragging.
14. Don't cut work completely through when turning between centers.
15. Remove chuck key from chuck immediately after using.
16. Turn chuck or faceplate through by hand before turning on the power to be sure there is no binding or clearance problem.
17. Stop the machine before taking measurements.
18. Before cleaning the lathe remove tools from the tool post and tailstock.

MILLING MACHINE SAFETY RULES

1. Work must be clamped securely in a vise and vise clamped tightly to the table or work must be clamped securely to the table.
2. Do not take climb-milling cuts on the shop's mills unless instructed to do so.
3. Make sure cutter is rotating in the proper direction before cutting material.
4. Before running machine the spindle should be rotated by hand to make sure it is clear for cutting.
5. Make sure the power is off before changing cutters.
6. Always use the proper cutting fluid for the material being cut.
7. Never run the machine faster than the correct cutting speed.
8. Make sure that the machine is fully stopped before taking any measurements.
9. Always use cutters which are sharp and in good condition.
10. Don't place anything on the milling machine table such as wrenches, hammers, or tools.
11. Always stay at the machine while it is running.
12. Don't take too heavy a cut or use too rapid a feed.
13. Remove the collet-tightening wrench immediately after using it.
14. If at all feasible, rig a guard or shield to prevent chips from hitting other people.
15. Use the milling machine spindle brake to stop the spindle after the power has been turned off.
16. Before cleaning the mill, remove cutting tools from the spindle to avoid cutting yourself.

WELDING SAFETY RULES

Shop staff approval is required before using any welding equipment.

1. Welders, assistants and anyone else in the welding area shall wear glasses or shields of recommended shades during welding operations.
2. A screen shall be erected around the welding area to protect other personnel in the shop from injury.
3. Inspect all welding equipment to be used, prior to each use, for possible damage.
4. Avoid handling oxygen bottles with greasy hands, gloves or rags. Fatal explosions have resulted from this cause.
5. Always strap tanks to a welding cart or a fixed object. Never allow a gas cylinder to be free standing. Replace the safety cap on all cylinders when not in use.
6. When arc welding, make sure work and/or worktable is properly grounded.
7. Do not arc weld in a wet area.
8. Be alert to possible fire hazards. Move the object to be welded to a safe location, or, remove all flammable materials from the work area.

9. Never weld in the same area where degreasing or other cleaning operations is performed.
10. Keep suitable fire extinguishing equipment nearby and know how to operate it.
11. Shut off the cylinder valves when the job is completed, release pressure from the regulators by opening the torch valves momentarily and back out regulator adjusting valves. Never leave the torch unattended with pressure in the hoses.
12. Utilize all protective equipment and clothing. Do not arc weld with any part of the body uncovered, the arc light is actinic light (excessive ultraviolet) and will cause burns similar to severe sunburn.
13. Never weld inside drums or enclosed spaces without adequate ventilation, or the use of airline respirators or self-contained breathing apparatus.
14. Check the ventilation system before starting to weld and periodically thereafter to insure adequate performance. Welding fumes should not be allowed to get into the rest of the shop working areas.
15. Never cut or weld any container that has held explosive or flammable materials. Use prescribed methods for cleaning or flooding.
16. Never use wrenches or tools except those provided or approved by the gas cylinder manufacturer to open valves. Never use a hammer to open or close valves.
17. Abide by any other safety measures required for each particular type of welding.
18. Allow for proper ventilation when brazing or soldering. The fluxes are acidic and toxic.
19. Do not weld on painted galvanized or greasy, oily metals. Not only can the fumes be toxic, but the welds will not be satisfactory and will fail in use.

SPOT WELDING (RSW)

Spot welding is a process in which contacting metal surfaces are joined by the heat obtained from resistance to electric current flow. Work-pieces are held together under pressure exerted by electrodes. Typically the sheets are in the 0.5-3 mm thickness range. The process uses two shaped copper alloy electrodes to concentrate welding current into a small “spot” and to simultaneously clamp the sheets together. Forcing a large current through the spot will melt the metal and form the weld. The attractive feature of spot welding is a lot of energy can be delivered to the spot in a very short time (approximately ten milliseconds). That permits the welding to occur without excessive heating to the rest of the sheet.

The amount of heat (energy) delivered to the spot is determined by the resistance between the electrodes and the amperage and duration of the current. The amount of energy is chosen to match the sheet’s material properties, its thickness, and type of electrodes. Applying too little energy won’t melt the metal or will make a poor weld. Applying too much energy will melt too much metal, eject molten material, and make a hole rather than a weld. Another attractive feature of spot welding is the energy delivered to the spot can be controlled to produce reliable welds.

Projection welding is a modification of spot welding. In this process, the weld is localized by means of raised sections, or projections, on one or both of the work pieces to be joined. Heat is concentrated at the projections, which permits the welding of heavier sections or the closer spacing of welds. The projections can also serve as a means of positioning the work pieces. Projection welding is often used to weld studs, nuts, and other screw machine parts to metal plate. It’s also frequently used to join crossed wires and bars. This is another high-production process, and multiple projection welds can be arranged by suitable designing and jigging.

Spot Welding Safety Rules

Shop staff approval is required before using any welding equipment.

Proper eye protection, such as welding goggles and face shields, are needed to prevent eye damage called “arc eye” as well as damage from debris. It is recommended to use lens shade #6 or darker for cutting to prevent the retina of your eye being “flashed” or burned.

PLASMA CUTTING

Plasma cutting is a process that is used to cut steel and other metals of different thicknesses (or sometimes other materials) using a plasma torch. In this process, an inert gas (in some units, compressed air) is blown at high speed out of a nozzle; at the same time, an electrical arc is formed through that gas from the nozzle to the surface being cut, turning some of that gas to plasma. The plasma is sufficiently hot to melt the metal being cut and moves sufficiently fast to blow molten metal away from the cut.

Plasma Cutting Safety Rules

Fabrication Lab staff approval is required before using any welding equipment.

Proper eye protection, such as welding goggles and face shields, are needed to prevent eye damage called “arc eye” as well as damage from debris. It is recommended to use lens shade #6 or darker for cutting to prevent the retina of your eye being “flashed” or burned.

BENCH SHEAR

Also known as a lever shear, a bench shear is a bench mounted shear with a compound mechanism to increase the mechanical advantage. It is usually used for cutting rough shapes out of medium sized pieces of sheet metal, but cannot do delicate work. For the small shear, it mostly designed for a wide field of applications.

A bench shear is light in weight and has easy efficient operation, yet is very sturdy in construction. The cutting blades fitted are carefully and accurately ground to give easy, clean quick cuts, and free of burrs. These special features help the operators save a great deal of their energy, but some shearing machine can cut sheet bar and flat bar up to 10mm. It is electrically welded together to make it a sturdy stable unit capable to withstand highest stresses due to heavy duty usage.

The footplates are reinforced with bracing angles so that they give firm stability to the shear. The machine is provided with section knives with sliding blades which can be adjusted by hand to make 90° cuts on angels and T-sections of different sizes as well as with openings for cutting round and square bars.

POWER TOOL SAFETY SYMBOLS

Your power tool and its Owner's Manual may contain "WARNING ICONS" (a picture symbol intended to alert you to, and/or instruct you how to avoid, a potentially hazardous condition). Understanding and heeding these symbols will help you operate your tool better and safer. Shown here are some of the symbols you may see.

PROHIBITION

DANGER: indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING: indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION: indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION: used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

WEAR EYE PROTECTION.

READ AND UNDERSTAND INSTRUCTION MANUAL.

SUPPORT AND CLAMP WORK.

HOLD SAW WITH BOTH HANDS.

KEEP HANDS AWAY FROM BLADE.

GLUE

DIFFERENT TYPES AND USES OF ADHESIVES

This section will deal with the various types of glue available to modelers, explaining their characteristics, advantages and disadvantages.

Remember, that many glues give off toxic fumes or are flammable.

Today, there are numerous types to choose from which reflects in part the fact that high quality scale models may be made from a variety of materials - traditional styrene plastic, polyurethane resin, various metals, rubber and soft vinyl. Getting the right glue for the right job is very important, so modelers need to know what is available. The huge variety of glues from so many manufacturers means that you should always pay attention to the instructions on the particular product you are using.

Types of Glue

- Polystyrene cement
- Cyano acetate ('super glue')
- Epoxy Resin
- Clear 'canopy' glue
- Gloss varnish
- Clear rubber/silicone cement
- PVA adhesive
- White glue/woodworkers glue

POLYSTYRENE CEMENT

The fumes from polystyrene cement are toxic. Use only in a well ventilated area. Polystyrene cement dissolves plastic. Use minimum amounts only and do not use it in an enclosed space on a model where it will take a long time to dry.

Polystyrene (poly) cement is only suitable for rigid polystyrene plastic which is the type used for injection molded kits. It works by dissolving the surface of the plastic which then re-hardens. If a bead of poly cement is put between two pieces of plastic, then both faces of the plastic dissolve and meld together so that when they harden they have formed a solid joint. In effect, the two pieces have been welded together, so a very good bond is formed that is as strong as plastic.

The drying time will vary mainly depending on how much is applied and the viscosity (thickness) of the glue. Note that even when a bond has formed the plastic may not have fully re-hardened so should be treated with care for a time. The major disadvantage of poly cement is that if too much is used, then it will completely dissolve through the material being glued and damage it. Also, if any glue is dropped or smeared on the surface of the model it will damage any surface detail. For this reason, it does have to be used with care and the minimum amount should be used. Furthermore, glue should not be placed into holes and cavities that are not exposed to the air, because it will not be able to dry and will slowly dissolve the surrounding plastic.

Poly cement comes in three types according to how viscous it is:

1. Traditional thick polystyrene cement
2. Liquid cement looks like water
3. Ultra fast cement

CYANO ACETATE ADHESIVE ('SUPERGLUE')

Be aware that it bonds human skin almost instantly and will cause permanent damage to the eyes. The fumes from cyano glues will make clear plastic parts cloudy. Do not use for windscreens and cockpit canopies and so on. Special glues are available for this purpose.

When this glue was introduced, it was advertised as instantly bonding almost anything to anything else and indeed it is very versatile. The only substances that resist it seem to be certain soft plastics. As such, it is very good for bonding hard plastics, resin and metals to each other, which makes it very useful on multi-media kits. However, it not easy to use and should perhaps be avoided by novices and children. It can be unforgiving, with the thin formulas curing in one or two seconds and often seeming to stick fingers to the kit much better than it sticks kit parts together.

Like poly cement, it comes in three viscocities from ultra-thin to thick (also known as gap-filling superglue):

1. Thick (Gap-filling) Cyano
2. Medium Cyano
3. Ultra-thin Cyano

The advantage of the ultra-thin superglue is that parts can be assembled 'dry' and, then, the adhesive allowed to run along the edges where it is sucked in by capillary action. It bonds very fast, sometimes in only one or two seconds.

EPOXY RESINS

At the top is the traditional form of epoxy adhesive in two separate tubes of hardener and adhesive. At the bottom is a twin barreled dispenser that makes measuring out exactly the same amounts of both parts much easier.

These adhesives consist of two parts: the hardener and adhesive. These need to be thoroughly mixed before application. Sometimes they come in separate tubes, and sometimes they come in a double syringe. The latter is the easiest to use because it is simple to get equal parts of hardener and adhesive which is important for the strength of the bond.

Epoxy glues are great when a really strong bond is needed, especially between two different materials. Because it has to be mixed (and you will usually mix far more than you need) and it tends to be messy, it is not the primary glue of choice for modelers.

Clear 'Canopy' glues is specifically designed for gluing clear parts. Sticking clear plastic parts presents problems. The fumes given off by polystyrene cements and even cyano glues can make the clear parts become foggy. It is very difficult to use epoxy resin glues on clear parts without smearing the glue on the parts.

GLOSS VARNISH

The buckles on the yellow straps are held in place with gloss varnish. It may be surprising to find gloss varnish in a list of adhesives because, clearly, it is not intended to be used as a glue at all. However, gloss varnish is surprisingly useful for holding very small parts, such a photo etch buckles in place.

Using a small paintbrush wet with gloss varnish is also a useful way to hold tiny parts and put them into the correct position.

CLEAR RUBBER AND SILICONE CEMENTS

This is an example of universal clear glue. It should be noted that it comes in a wide range of applicators and packages. There is a wide range of tube glues mainly intended for domestic use that are often branded as 'All Purpose' or 'Universal' glues. They generally dry clear and remain rubbery.

These are not suitable for general modeling use because they are difficult to apply in small amounts, can be stringy, and generally do not produce a bond as strong as any of the adhesives mentioned above. These glues only work well when there is a large surface area. However, they can be handy for special work.

Small drops can temporarily hold parts in place when doing a dry run and the glue can be pulled away later.

PVA GLUE

PVA glue is has many uses so comes in a wide variety of containers and sizes. This 5 liter tin is aimed at the construction industry. This is a thin water based white glue that dries rubbery. It has wide range of commercial and domestic uses. It is ideal for sticking paper and card and safe for use. It can be found in building suppliers (where it is sold by the gallon) and in art shops.

The uses for PVA adhesive are the same as for clear glue in the previous section. The difference is that it is thinner and water based, so is more suitable for situations where it can be brushed on a large area. The bond will not be as strong as with clear glues. When dry it can be peeled off most surfaces.

WHITE GLUE / WOODWORKERS GLUE

This looks very much like PVA glue, being white and water-based but it is more viscous. It has limited use for most modeling applications, but is very good at bonding.

JOINING PARTS TOGETHER - BASIC PRINCIPLES

1. Clean up parts.

If you have not already done so, this is the last chance to check and clean up the parts you are about to glue. Remove any seam lines, sink holes, ejector pin marks and flash. If you want to enhance any details this is probably the best time to do it, because once it is on the model it will be more difficult to make alterations to the part. If you have pre-painted the part then make sure that the area that is to be glued is free of paint to ensure a good bond.

2. Always do a dry run.

It is always best to do a dress rehearsal of fixing the parts in place before applying any glue. Even if you are fixing several parts which appear all the same check that each one fits first. This can seem to be tiresome for parts that are repeated such as fitting the wheels on a tank. However, just because the first nine wheels fit on their axles perfectly, it does not mean that the tenth will.

3. Check the parts fit well.

This is the last chance to identify any changes that will improve the fit of the parts and reduce any gaps. It also identifies whether the parts will need to be clamped or held together while the glue sets, so that the appropriate clamps, rubber bands, masking tape etc. can be at the ready.

4. Identify where to apply the glue.

You will see where the parts meet and, therefore, where glue needs to be applied and whether one or both parts need to have glue applied. Depending on how well the parts fit, your choice of type and viscosity of glue may change.

How much glue to use and where to apply it is critical, but it is normally best to err on the side of too little glue. When putting a bead of glue along an edge to be glued hold the glue dispenser at a 45° angle and put the bead on the interior corner of the edge so that it is unlikely to ooze out of the seam.

5. Work out how to hold the parts.

If the parts are small, or they need to be placed into awkward places, you need to work out beforehand where you will hold them and how you will maneuver them bearing in mind that one or both parts will have glue on them that will prevent them being touched in places.

6. Choose your glue.

There is no one glue that is appropriate in all places. When gluing two styrene parts, then either poly cement, cyano or epoxy glues can be used. When gluing resin or metal parts then poly cement cannot be used, but that still leaves epoxy cement and thin, medium or thick cyano.

Your choice of glue will depend on the size of the parts, how well they fit, how long you need to work with the part to get it in the right position, how strong the bond needs to be and whether or not it matters that any excess glue is visible.

7. Make sure that you have the necessary supports.

The two halves fit very badly and had to be held tightly together with rubber bands and masking tape whilst the glue sets.

The dry run will identify whether the bond is instantly self-supporting or whether it needs to be held in place while the glue sets. Depending on how you intend to support the bond, do the following:

- Check you have the right number and size of rubber bands.
- Check you have the right size clamps and they are unscrewed.
- Cut sufficient strips of masking tape of the right length and width.

SAFETY RULES FOR WORKING WITH SOLVENTS AND RESINS

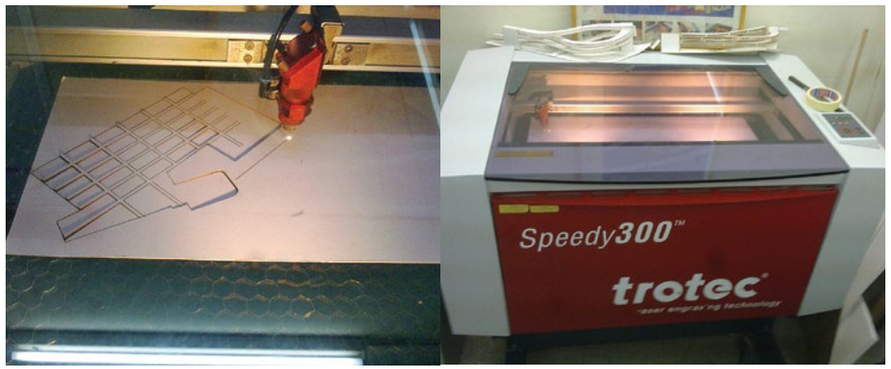
1. Avoid skin contact. Wear latex gloves.
2. Work in a fume hood if possible. Respirators are available when necessary.
3. Avoid using solvents around hot metal surfaces and flames.
4. Do not smoke or light flames in areas where solvents are used and stored.
5. Report and clean up any spills immediately.
6. Do not work with solvents in confined, unventilated areas.
7. Do not drink alcoholic beverages or take medications containing alcohol before or during working with solvents.
8. Report any ill effects and skin disorders to the area supervisor.
9. Develop and maintain good personal hygiene habits. Remove protective equipment and wash thoroughly after contact with solvents.
10. Fumes from paints, solvents, adhesives, and the abrasive cut-off saw used on the patio can drift into the shop. Work with staff to minimize these problems.
11. Mix resins in small batches.

FLAMMABLES

Store all flammable material in the Flammable Storage Cabinets.
This includes: paint, paint thinner, spray paint, acetone, wood finish and so on.

SAFETY RULES FOR HEAVY SANDING OF WOOD AND FOAM

1. Sand in a well-ventilated area, away from other machines.
2. Use a vacuum or a dust collector to collect dust while sanding to prevent the dispersal over a large area.
3. A dust mask may be worn if desired.
4. Safety glasses must be worn.



GENERAL LASER CUTTING GUIDELINES AND POLICY

1. The use of the laser cutters is restricted to the academic work of SArD students only. You may not use itfor personal projects, work for professional firms or for academic work outside of LAU.
2. Students may not operate the laser cutters, only trained personnel may operate these machine. Any student who attempts to operate these machines will lose laser cutting privileges for the remainder of the semester.
3. In order to budget time efficiently and reduce errors and re-cuts, students must be present while their files are being cut in order to answer any questions that may arise, or to be advised of any remedial CAD work that may be required.
4. The laser operators cannot correct or draw your files for you. You may not use the computers in the laser room to correct or draw your files.
5. All work must be completed within your scheduled time slot. Corrupt files, unsuitable materials, experimentation, etc. all count against your time.
6. Only materials posted on the “Laser Suitable Materials” handout may be cut on the lasers. Students must supply all materials. SArD does not supply any materials.
7. Students must remove all cut-off, waste and garbage from the laser room and clean up after themselves when finished.
8. Come prepared to your appointment.

9. You may not bring work to the laser cutters until you have read and understood all notices and guidelines posted in the laser rooms.
10. Students are required to maintain a high level of respect for the laser operators. Disrespect will result in immediate suspension of laser cutter privileges.

Laser Scheduling

You must e-mail: fablab@lau,edu.lb, arch.laserlab@lau.edu.lb or schedule an appointment in person:
Byblos Fabrication Lab at ARC 108, Ext 2778
Beirut Laser Lab at OG 103B, Ext. 1095

Permissible Number of Time Slots

Students may initially reserve up to two 30-minute time slots per week (one hour in total per week). Furthermore, if there are open time slots during any scheduled day, students may reserve in advance for one additional time slot on that given day. All other unused time slots are available on a first-come first-serve walk-in basis, regardless how much laser cutting a student may have already done or scheduled in that week.

Example: On Saturday, you reserved for a half-hour slot for Tuesday and another half-hour slot for Wednesday. On Thursday morning, you noticed that there was a half-hour slot open that afternoon, so you signed up for it. On Friday, you came to the laser room at 1:00 and noticed that no one was cutting, so you asked the operator to cut some files for you.

Weekly Schedule Activation

Reservation times will become available at 8:00 AM on each day.

Important Notes

You must reserve under your own name only. You may not reserve using any other person’s name or under anyone else’s slot. When you are caught trying to reserve for someone else or under a name other than your own, all of your timeslots will be deleted. Stacking cutting for buildings is not allowed unless the scale of the model is less than 1/500.
Show up promptly for your scheduled time. If you are more than five minutes late, you will forfeit your time to the first available student.
Cancel your appointment online or by phone call if you no longer need it.

Three incidences of failure to show up for your scheduled time in one semester will result in suspension of your laser cutting privileges for the remainder of the semester.

The Fab Lab supervisor will resolve all scheduling conflicts. Do not approach the laser operators or faculty members to resolve conflicts. Students are reminded that disrespect to the laser operator will result in an indefinite suspension of laser cutting privileges.

AutoCAD Guidelines

Please read the "Working with the AutoCAD Laser Cutter File" for complete information.
All parts to be cut in AutoCAD must be drawn in the red layer.
All parts to be light cut in AutoCAD must be drawn in the blue layer.
All parts to be engraved in AutoCAD must be drawn in the white layer.

Drawing

Draw everything on AutoCAD. **Files drawn in other programs that are then imported or pasted into AutoCAD will cause problems.**
Use only the 3 standard "index" colors: red, dark blue and white.
For smoother cuts, all continuous line segments should be joined using the PEDIT/JOIN command.

All line widths should remain at "0.00" or default thickness. Line Thickness settings for all layers are accessible in the "Layer Properties Manager" window. If you want scored lines to be thicker, do multiple .004" offsets. If this is unacceptable, the laser system is capable of engraving virtually any thickness line. However, this involves raster engraving rather than vector scoring and requires considerably more time.

Before Your Appointment

- Erase all stray lines.
- Remove all overlapping and duplicate lines. The laser will double cut overlapping lines with very negative results. Use the OVERKILL command.
- When importing files from RHINO, please refer to the "If you Must draw in Rhino" sheet posted in the laser room.
- In AutoCad, it is possible to have multiple cut templates in a single file. Please ensure that any file you bring strictly follows the Laser Cutting Template format, is well organized and is ready to cut.

- Delete all unnecessary information from your file.

About the Laser

The laser's TROTEC 25 watts in Byblos 70cmx40cm is approximately .001 centered on the drawn line.
The laser's TROTEC 60 watts in Beirut 100cmx60cm is approximately .001 centered on the drawn line.

This will cause the parts that are cut to be slightly smaller than what is drawn. This fact is normally insignificant, but if it is critical to your work, please make a note of it.

The rule of thumb for spacing between discrete parts is to allow at least half of the thickness of the material between relatively parallel cuts, particularly on acrylics.

Laser Suitable Materials

Cutting and Etching
- Acrylic
- Wood (*Consult laser room charts for species-specific thicknesses*)
- Paper
- Leather
- Mylar
- Matte Board
- MDF (3mm small quantities thick only)

Etching Only
- Glass
- Stone
- Anodized Metals
- Corian

Banned Materials
- Rubber (All Forms)
- Casting Resins
- Polypropylene
- Polycarbonate
- Any material in the chloride/chlorine family (e.g. PVC-polyvinylchloride)
- Felt
- FoamCore
- Polystyrene

LASER SIZE and SCALE for Byblos Laser cutter dimensions 70cmx40cm

Scale	PRINT	Rectangle (cm)
1/50	20=1	35x20
1/100	10=1	70x40
1/200	5=1	140x80
1/250	4=1	175x100
1/300	3.5=1	210x120
1/400	2.5=1	280x160
1/500	2=1	350x200
1/1000	1=1	700x400

LASER SIZE and SCALE for Beirut Laser cutter dimensions 100cmx60cm

Scale	PRINT	Rectangle (cm)
1/50	20=1	50x30
1/100	10=1	100x60
1/200	5=1	200x120
1/250	4=1	250x150
1/300	3.5=1	300x180
1/400	2.5=1	400x240
1/500	2=1	500x300
1/1000	1=1	1000x600

3D PRINTING GUIDELINES

Digital Fabrication Lab, Room 105 architecture basement

General Guidelines

1. The use of this 3D Printer is restricted to academic work and assigned technical classes only. All students have to get the Chair approval in advance for individual printing on the 3DP.
2. Students may not operate the 3D Printer. Only trained personnel may operate the 3D Printer. Unauthorized use of the 3D Printer will result in immediate suspension of 3D printing privileges.
3. Students may not bring files to the 3D Printer until they have read and agreed to all notices and guidelines in this document.
4. Students are expected to maintain a high level of respect for the 3D Printer operator. Disrespect to the operator will result in immediate suspension of 3D printing privileges.

File Creation *(Design, Modeling & Format)*

1. Files can be created in Rhino, Maya, 3d Studio Max or SolidWorks.

2. ALL FILES MUST BE EXPORTABLE AS CLOSED STL FILES! The 3D Printer only recognizes model files in STL format that have no open edges.
3. All files must be expressed in cm
4. Models are limited to a working envelope of 20x20x23 cm Max
5. Students must submit and review their file with the operator prior to printing.
6. The 3D Printer operator will supply each student with an estimate of the time to print student's file.

Scheduling your project

1. The 3D Printing queue is posted on the door in the Digital Fabrication area of the lab. Your name, contact info (Phone & email) and lau Login ID will only be placed on the queue once your file is ready and you have supplied your lau Login ID.
2. Due to the nature of the 3D Printing process, once a project is begun, it must be completed in its entirety.
3. Projects will be completed on a first-come, first-served basis. There will be no exceptions. Please plan accordingly.
4. No design changes will be considered once you have reviewed your file with the 3D Printer operator and the file is being printed. Additional files cannot be added to your printing time.
5. Students will be allowed to submit additional files for printing only after their name has been "worked" off the list. The only exception to this rule is that if the printer queue is totally empty, a student may sign up for one additional project.
6. All scheduling conflicts will be resolved by lab personnel only.

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