**WOODSHOP MANUAL**

**TABLE OF CONTENTS**

I. Wey Hall Student Health and Safety Information  
II. Personal Protection Equipment  
III. Sculpture Studio Guidelines  
IV. General Rules  
V. Hand Tools  
VI. Safety with Power Tools  
VII. Electric Hand-Held Drill  
VIII. Jig/Saber Saw  
IX. Drill Press  
X. Belt Sander/Spindle Sander  
XI. Band Saw  
XII. Scroll Saw  
XIII. Panel Saw  
XIV. Jointer  
XV. Radial Arm Saw  
XVI. Table Saw  
XVII. Fasteners  
XVII. Sandpaper  
XVIV. Choosing Lumber

Compiled and edited by Steve Severt
STUDENT HEALTH AND SAFETY

WEY HALL

1. Spray Painting: Use of spray paints, fixatives and other volatile/odor producing materials **MUST** be done in the Spray Painting Booth in room #106 of the sculpture area. Ventilation system must be turned on.

2. Use of Recycled Containers: Should you have the need to store materials in containers (i.e. mineral spirits in an old peanut butter jar) you are required to label the contents of the container. If at all possible, it is recommended that you photo-copy the original container and tape it to the new container. **All unlabeled containers will be discarded.**

3. Material Safety Data Sheets (MSDS): For every material that is manufactured for use by the work force (in this country) there is a Material Safety Data Sheet. This sheet informs the user of the material's make-up, health hazard (if any), symptoms of exposure, treatment for exposure and specific Personal Protection Equipment (PPE) that is required for the user of the material. Every studio in Wey Hall has MSDS sheets for all materials used in that studio. They are available so that you may be informed of any material hazards present and how you are to protect your health and safety and the safety of others when using these materials.

   NOTE: Students are responsible for obtaining MSDS' for all materials that they bring into Wey Hall. It is recommended that you maintain a folder of MSDS' in your locker so that they are available in the event of an emergency related to their use. Suppliers of these products (i.e. Farmer's Hardware, Lowe's, etc.) are required by law to provide MSDS' to you upon request.

4. Personal Protection Equipment (PPE): In most of the studios it is the student's responsibility to provide their own PPE (dust masks, respirator, safety glasses/goggles, rubber gloves, etc.). Your instructor should provide you with a list of items that you will need to work in the studio safely.

5. Lock Out/Tag Out: When you see this red and white tag displayed on a piece of equipment in Wey Hall, it means that said equipment is not in working order and is not safe to use. Do not, under any circumstances, remove this tag or related safety lock or attempt to use the tagged equipment.

6. Areas surrounding fire extinguishers and electrical panels are marked with red or yellow paint. These areas **must be kept clear of obstruction at all times.**

A tagout warns others that a particular switch, valve or energy source is "locked out" in the off or safe position and should not be operated. Secure locking devices such as padlocks should always be used with a tagout whenever possible. Be sure your employer informs outside servicing personnel (contractors) of your company's lockout/tagout procedures.
Personal Protection Equipment (PPE)

Overview

- 90% of eye injuries could have been prevented with the proper use of safety eyewear.
- Hearing loss is the #1 disability in the US. Yet, noise induced hearing loss is 100% preventable. Hearing loss is gradual and permanent.
- Good respiratory health depends on breathing air that is clean, odorless and leaves no taste. There are many dangerous contaminants that are invisible, odorless and tasteless, fiberglass for example.
- Many products recommend the use of personal safety equipment on their labels and in their instructions. Review safety equipment for additional recommended usage and limitations.
- Proper safety depends on recognizing the need for protection by understanding personal safety hazards and the safety products that can make the difference.

Safety Eyewear:

Impact: Impact Goggles and Safety Glasses help protect against flying debris, projectiles and particles. These products will not protect against chemical/liquid splashes.

Splash: Chemical Splash/Impact Goggles are the ONLY safety eyewear product that may help protect the eyes from chemical/liquid splashes.

Hearing Protection:

Noise created by many power tools and lawn equipment may be hazardous and damage hearing over extended and repeated exposure. Disposable and Reusable Earplugs, as well as earmuffs are options for hearing protection. Generally, the higher the NRR, the better the protection from noise.

Breathing Protection: Dust and chemical exposures may be hazardous to maintaining a healthy respiratory system. A variety of Disposable and Reusable respirators are options to help protect against these hazards. Comfort masks are not lung protection and are ONLY recommended to reduce exposure to cold air and allergens such as pollen.

Head and Face Protection: Falling and flying objects, as well as working in tight spaces can pose a hazard to the head and face. Hard hats and Face shields used in conjunction with safety eyewear are options for head and face protection.
### Personal Protection Equipment (PPE)

<table>
<thead>
<tr>
<th>SAFETY EYEWEAR</th>
<th>TYPE: IMPACT GOGGLES</th>
<th>DEFINITION:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Helps protects eyes from multi-directional projectiles/impacts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Features a durable lens with adjustable headband</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Direct venting system reduces fogging</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fits over most personal eyewear</td>
<td></td>
</tr>
<tr>
<td>AREAS USED:</td>
<td>Appropriate protection for flying particles and dust created by using saws, insulating, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meets ANSI standards and assists in OSHA compliance</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAFETY EYEWEAR</th>
<th>TYPE: CHEMICAL SPLASH/IMPACT GOGGLES</th>
<th>DEFINITION:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Helps protect against chemical/liquid splashes and dust</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Help protect eyes from multi-directional projectiles/impacts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Features a polycarbonate lens with adjustable headband</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indirect venting system reduces fogging</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fits over most personal eyewear</td>
<td></td>
</tr>
<tr>
<td>AREAS USED:</td>
<td>Appropriate protection for chemical/liquid splashes and dust often encountered in lawn/garden, paint spraying, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meets ANSI standards and assists in OSHA compliance</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAFETY EYEWEAR</th>
<th>TYPE: SAFETY GLASSES/EYEGGLASS PROTECTORS</th>
<th>DEFINITION:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Available in a multitude of styles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoor and outdoor styles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Some are treated with anti-scratch, anti-fog and anti-static lens coating</td>
<td></td>
</tr>
<tr>
<td></td>
<td>99.9% UV protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjustable temples and lens and built-in side shields on some models</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Available at a variety of price points</td>
<td></td>
</tr>
<tr>
<td>AREAS USED:</td>
<td>Safety glasses are necessary for all activities that use hand, power or lawn tools and equipment. Safety eyewear is also required for most commercial and industrial applications.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meets ANSI standards and assists in OSHA compliance</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAFETY EYEWEAR</th>
<th>TYPE: FACE SHIELDS</th>
<th>DEFINITION:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Must be used with safety eyewear/goggles to provide impact protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polycarbonate lens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjustable head strap and suspension</td>
<td></td>
</tr>
<tr>
<td>AREAS USED:</td>
<td>A Face shield helps protect the face and neck from flying objects and particles which are common in sanding and cutting applications.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Face shields must meet ANSI standards and be OSHA compliant.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Goggles or safety eyewear must always be worn in conjunction with a face shield.</td>
<td></td>
</tr>
</tbody>
</table>
# Personal Protection Equipment (PPE)

## HEARING PROTECTION

<table>
<thead>
<tr>
<th>TYPE:</th>
<th>DEFINITION:</th>
<th>AREAS USED:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposable and Reusable Earplugs</td>
<td>• Made of expandable foam or soft polymer material</td>
<td>• The time to wear hearing protection is before the work begins.</td>
</tr>
<tr>
<td></td>
<td>• Available with and without carrying case depending on type</td>
<td>• Check the packages for the NRR rating, insertion instructions and other important information.</td>
</tr>
<tr>
<td></td>
<td>• Disposable earplugs require roll-down insertion</td>
<td>• Noises above 85 Decibels (dB) begin hearing damage</td>
</tr>
<tr>
<td>Banded</td>
<td>• Banded earplugs have replaceable pods</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Banded earplugs require push-in insertion</td>
<td></td>
</tr>
<tr>
<td>Earmuffs</td>
<td>• Designed to fully cover ears</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Adjustable headband</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Soft foam cushions to accommodate eyewear temples</td>
<td></td>
</tr>
</tbody>
</table>

## Sound Levels (dB)

- **Jet Engine**
- **Circular Saw**
- **Electric Drill**
- **Power Lawn Mower**
- **Office Gossip**
- **Sleep Disruption may begin**
# Personal Protection Equipment (PPE)

## Respiratory Protection

### (Not Government Approved)

<table>
<thead>
<tr>
<th>Type:</th>
<th>Definition:</th>
<th>Areas Used:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposable Approved Respirators</td>
<td>- N95 Approval&lt;br&gt;- Cup design covers nose and mouth&lt;br&gt;- *Exhalation valve for easy exhalation and cool comfort&lt;br&gt;- Cushioned adjustable nose guard helps customize fit&lt;br&gt;- **Carbon layer provides relief from latex paint odors&lt;br&gt;- Dual straps&lt;br&gt;- Refer to packages for recommended uses and fit instructions</td>
<td>- Respirators are designed to reduce exposures to certain airborne contaminates that can be hazardous to breathe.&lt;br&gt;- Worn over the mouth and nose&lt;br&gt;- Filter and clean the air prior to breathing&lt;br&gt;- Activities that can create hazards include sanding or grinding (harmful dusts), painting (harmful chemicals) and welding (harmful fumes).&lt;br&gt;- Respirator used must be matched to hazard (ie dust respirator would offer no protection from paints)&lt;br&gt;- Check packaging for specific use recommendations&lt;br&gt;- See packaging for approvals and use applications</td>
</tr>
<tr>
<td>Disposable Approved Respirators with Valve*</td>
<td>- Do not confuse respirator and comfort masks. Comfort masks do not protect your lungs.</td>
<td></td>
</tr>
</tbody>
</table>

### (Government Approved)

<table>
<thead>
<tr>
<th>Type:</th>
<th>Definition:</th>
<th>Areas Used:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reusable Respirators with Replaceable Filters and Cartridges</td>
<td>- Disposable and Reusable types available&lt;br&gt;- Ideal for multiple and long-term use situations&lt;br&gt;- Soft rubber or silicone facepiece covers nose and mouth&lt;br&gt;- Adjustable straps&lt;br&gt;- Replaceable filters and cartridges on some styles&lt;br&gt;- Refer to packages for recommended uses and fit instructions</td>
<td>- Good respiratory health depends on breathing air that is clean, odorless and leaves no taste. There are many dangerous contaminants that are invisible, odorless and tasteless (fiberglass for example).</td>
</tr>
</tbody>
</table>
Sculpture Studio Guidelines
For Foundations Students

Wood Shop hours will be posted on the doors of the Sculpture Studio at the beginning of each semester. Sculpture monitors have been specifically selected to supervise the needs of Foundations students. **Foundations students are not allowed in the woodshop outside of these monitored hours.** Keep this manual and all woodshop handouts in a folder labeled "Wood Shop Folder." This folder should be with you any time you are in the Sculpture Studio and will provide useful information throughout your time at ASU.

**Upon entering the Sculpture studio you must:**

1. Sign in on the red clipboard near the door to the tool crib. You should place the letter "F" as a prefix to your name which will alert the monitor to your presence and needs.

2. All tools in the tool crib and woodshop equipment must be checked out through the monitor on duty.

3. Make Great Art!

**Upon leaving the Sculpture Studio you must:**

1. **Clean up** your work area. Use the shop-vac to insure proper clean-up.

2. Put all tools that you checked out back in their proper place. Tools unaccounted for that are checked out in your name will be charged to you.

3. Store your work in the proper place/shelf.

4. Check out with the monitor.

5. Sign out on the clipboard after the monitor has checked you out.

**Wood Products that are NOT Allowed in the Sculpture Studio**

- Exterior Plywood
- Composition Board
- Chip Board
- Pressure Treated Lumber
- Any wood treated for exterior use
- Painted wood

See the display in the woodshop area for examples of these wood products.

**EMERGENCY and other Important Phone Numbers**

For all emergencies including injury, ambulance, fire and police

DIAL 8000

Other important numbers: ASU Police............2150
Infirmiry.............3100
Hospital.............262-4100

There is a phone in the tool crib.
GENERAL RULES

Personal
1. Wear your PPE (personal Protection Equipment) - safety glasses/goggles, ear protection, dust mask/respirator, face shield.
2. Remove jewelry.
3. Wear closed-toe shoes/boots (no sandals or bare feet).
4. Wear sturdy, full-length pants and no loose clothing (sleeves, ties, etc.).
5. Tie long hair back.
6. Never work in the Wood Shop under the influence of drugs or alcohol.
7. Never operate a machine if you are ill or over-tired.
8. No smoking in the Sculpture Studio. Breaks may be taken in the sculpture yard, outside.
9. No bicycles may be brought into the studios.
10. If welding is occurring, adjust welding screens between the areas.
11. Know the locations of the safety exits and the emergency stop switch for machines.
12. Know the emergency phone numbers for assistance (see previous page).

Operation of Tools
1. Never use a machine unless you have been instructed on its use and are clear on the safe and appropriate procedures.
2. Always prepare the work area before you start. Keep the machine table clear of tools and materials except for the stock to be cut.
3. Be sure that the dust removal system is on and the "blast-gate" to the machine is open.
4. Keep guards in place and in use at all times. Do not remove the guard from any machine.
5. Do not adjust guards so that you can slide any part of your hand (fingers) under the machine.
6. Stock must extend beyond the machine guard.
7. Use approved push-sticks, push-blocks, feather-boards, and other safety devices.
8. Allow the machine to reach its full operating speed before beginning to feed the work.
9. Feed the work carefully and only as fast as the machine will cut it easily.
10. Stay alert. Don’t talk to anyone while you (or they) are operating a machine.
11. Turn off the power and allow moving parts to stop completely before removing scraps.
12. Stay with the machine until it is completely stopped.
13. If the machine is dull, out of adjustment, or in some way not working properly, shut off the power immediately and inform the monitor/instructor.
14. See the owner’s manual (kept on file in the tool crib) for more information on any tool.

Clean Up
1. Clean your work area after you are finished. Brushes and shop-vacs are provided to clean benches, tables and machines after use.
2. Ask your instructor about storage of projects between work sessions. This is a shared space and must be preserved as a work area for many students.
3. When you return tools to the tool crib, make sure that cords are wrapped neatly. Take care to place in the cabinet/shelf so that edges of blades/wires will not be damaged.
4. Check with the monitor before leaving.

Plan ahead - avoid rushing through a procedure.
REMAIN ALERT!
Report broken or malfunctioning equipment immediately.
SAFETY
1. Always wear safety glasses/goggles when using hand tools.
2. Always wear appropriate clothing when working with hand tools.
3. Treat/handle all hand tool instruments with care.
4. Be knowledgeable as to the proper hand tools for various jobs (ie. pliers should not be used as a hammer, pliers should not be exposed to excessive heat, wrenches should be used with muscle power only).
6. Don't bend stiff wire with plier tip.
7. Don't bend heavy bars on light duty vises.
8. Don't use pliers on round shanks or the handle of screwdrivers for added turning power.
9. Don't use sheet metal cutting snips to cut heavy wire. There are tools for this purpose.
10. Don't use screwdrivers to pry anything apart.
11. Don't use a toolbox, chest or cabinet as an anvil or for a similar purpose.
12. Don't use a screwdriver as a punch or chisel.
13. Never use a striking or struck tool with a loose or damaged handle.
14. Never use a struck tool with a mushroomed, chipped or damaged head.
15. Never use a hot chisel for cutting stone, concrete or cold metal.
16. Never use a pipe or otherwise extend the handle of pliers or wrenches to secure greater leverage.

The handles of these tools are made for specific workloads. Securing "extra" leverage in this manner will exceed the workload and could cause the handle to break resulting in injury.

RESPECT YOUR CLASSMATES AND FELLOW ARTISTS

Follow the proper procedure for checking out tools from the tool crib.

Return tools to their proper place in the tool crib in clean/sharp condition.

Report any damaged or broken tools to the instructor or monitor.
HAND TOOLS

Hammers

- **Curved Claw Hammer** - Basic hammer. Wooden
- **Ripping-Claw Hammer** for rough work such as removing studs.
- **Ball-peen Hammers** for metal working. **Mallets** for driving chisels and assembling wood joints, and **Sledge** and **Mason’s hammers** for brick, block, and concrete projects.

Types of Screwdrivers

- **Flat blade** driver should be same width as screw head and fit slot snugly.
- **Phillips** driver has a blunt tip; screw slots curve at junction.
- **Reed & Prince** driver has a pointed tip; screw slot meet at right angle.
- **Allen** screw or setscrew is driven by hexagonal key or driver.
- **Posidrive®** screw look like Phillips screws with a square drive added.
- **Clutch head** or butterfly screws are used on some automobile assemblies.
- **Scrutox®** system uses a square drive similar to ratchet and socket sets.
- **Torque®** system is used in some auto seatbelt and door lock systems.

Pliers

- **Slip Joint Pliers** are of two designs - multiple hole and tongue and groove. The purpose of the slip or adjustable joint is to enable the tool to adjust to the size of the object to be held.
- **Solid Joint Pliers** are those whose joint is fixed with a solid pin or rivet and are not adjustable.
- **Cutting Pliers** are of three types - side, diagonal and end cutters. Side cutters have a cutting blade on one side only and are available in long, curved and short nose types. End cutters have cutting blades on the end and are used to make sharp, clean cuts close to the surface on wires, bolts and rivets. Diagonal cutters have two cutting blades set diagonally to the joint and/or handles.
- **Regular Slip-Joint Pliers** - General utility pliers with two jaw-opening adjustments. Some have a shear-type wire cutter.
- **Thin Jaw Slip-Joint Pliers** - Like slip-joint, but made with a slim nose to reach into tight places.
- **Lineman’s or Electrician’s Pliers** - Heavy-duty side cutters designed for all regular wire-cutting needs. Have gripping jaws in addition to cutting edges. High-leverage lineman’s pliers have rivet placed closer to the cutting edges to provide 50% more leverage.
- **Curved Thin Needle Nose Pliers** - Nose is bent at about 90° angle for reaching around objects.
- **Duck Bill Pliers** - Have long, tapered, flat nose for work in restricted places. Used by jewelers, telephone workers, weavers.
- **Wire Strippers** - Feature adjustable stops to cut insulation without damaging wire.
- **End Cutting Nipper** - Features powerful leverage for sharp, clean cuts close to the surface on wires, bolts, rivets.

- **Needle Nose Pliers**
- **Curved, Thin Needle Nose Pliers**
- **Parrot Nose Wrench Pliers**
- **Duck Bill Pliers**
- **Diagonal Cutting Pliers**
- **Wire Stripper**
- **Plumbers Special Pliers**
- **Tongue and Groove Pliers**
- **Lineman’s Side Cutting Pliers**
- ** Locking Pliers**
HAND TOOLS

Wrenches

- **Pipe Wrenches** - Sometimes called stillson wrenches, for assembling pipes and round metal materials.
- **Open-End, Box-End, Combination and Socket Wrenches** - Essential for working on machinery, automobiles, washers, dryers, etc.
- **Socket Wrenches** - Built for speed, these wrenches have ratchet handles with a lever adjustment that reverses the turning direction of the wrench.
- **Nut Drivers** - Has a tip that accepts small sockets to fit hex nuts and screws, metric fasteners, etc.

Files

- **Cabinet rasp** - Half-round form is a versatile type of file for general work. Fast cutting on soft materials but leaves a rough surface. Also available in round form.
- **Bent riffle** - Triangular as shown here, is also available in flat, half-round, and round forms. Very useful type of file for finishing details in wood carving and metal work.
- **Centmoile file** - Designed for sharpening saws that have less than 80 teeth but it also handles filing jobs that require a file with a narrow triangular cross section.
- **Needle file** - Shown with knife cross section is made in wide variety of other shapes. Because it is very slender, it is the type to use for delicate machine and clockwork.
- **4-in-hand rasp file** - Originally called a shoe rasp, has half-rounded cross section. Half of each surface is fine cut, the other is rasp cut for greater versatility.
- **Mower blade file** - Has an integral handle. Some types are double-cut on both sides for fast cutting. Others are single cut on one side to do smooth finishing after shaping cuts.
- **Rattail file** - Also called tapered round file is used to shape and smooth small round recesses. Also to enlarge holes. The taper equips it for a wide range of shop work.
- **Auger bit file** - Has tangs and smooth (toothless) surfaces on one end and flattened surfaces and smooth edges on its other end which suit it for bit filing work.
- **Covex teeth files** - are made in both regular and flexible types. This file handle convex surfaces. Covex types handle concave surfaces on large metal areas such as auto bodies.

Chisels

**For Wood Only**

Most wood chisels manufactured today feature metal-capped handles that you can strike with a hammer or wooden mallet.

For chisels to cut properly, they must be sharp.

Proper storage is another must. Keep your chisels in plastic sleeves or hang them in a cloth that's been lightly treated with household oil.

- **Burr Chisels** - are about 6-8 inches long. Use them to remove lots of wood or to work in tight spots.
- **Pocket Chisels** - are from 9 1/2 to 10 1/2 inches long and are balanced perfectly for hand or hammer operation.
- **For very fine work, use Paring Chisels**. These thin-bladed chisels are operated only by hand.
- **Gouges**, which are rounded for outside or inside cutting, can remove a lot of wood fast, and may be used for forming.

**For Metal/Stones**

- **Cape Chisel** - Used to gouge metal.
- **Flat Chisel** - Used to cut bolts and screws, its wedge action will shear metal.
- **Bricklayer's Chisel** - Used to cut and form masonry and stone material.

- **Cape Chisel**
- **Flat Chisel**
- **Bricklayer's Chisel**
**HAND TOOLS**

**Hand Saws**

**Standard Hand Saws**
Hand saws have 24" or 26" blades. Fineness of cut depends on the number of cutting teeth per inch and tooth shape. A coarse crosscut saw with 7 or 8 teeth per inch is best for fast, rough work or for use on green wood. A fine-tooth crosscut saw with 10 or 11 teeth per inch is best for smooth, accurate cutting on dry, seasoned wood.

**Bow Saws**
Bow saws consist of a tubular steel frame and a saw blade for fast cutting of all woods. Advantages of this general purpose saw are its all around utility use, lightweight and easy handling. Quality features include a tension lever clamp for easy, fast blade insertion and replacement, and hardened, tempered steel blades for longer life.

**Hacksaws**
Hacksaws are fine-toothed saws designed to cut metal. The saws consist of a blade and a steel frame. They require relatively high tension. Blades come in several designs. Among them are coarse, medium, fine and very fine toothed. Regular or standard blades are used for general purpose cutting. Medium blade is good for cutting tool steel, iron pipe and light angle iron. A fine blade cuts drill rod, thin tubing and medium weight materials. The very fine blade is used for extra thin materials, light angle irons, channels, wire rope and cable.

A close quarter hacksaw holds and positions a hacksaw blade so it can be used effectively in narrow spaces and slots.

**Dovetail Saws**
A dovetail saw blade is constructed with the same reinforced ridge found on a backsaw, giving it added rigidity and greater precision.

Dovetails are used in picture framing, cabinet work, toy making, etc.

**Coping Saws**
Coping saws cut irregular shapes and intricate patterns. They consist of a saw blade and steel tension frame. The blade is removable. Blade sizes range from the rotary or wire type of 1/8" wide.

**Backsaws**
A backsaw is a thin bladed saw with reinforced back to provide rigidity necessary in precision cutting.

**Mitre Boxes**
Mitre Boxes are used to help cut exact angles for wood trim, rafters, etc. Better models provide a mechanism for a backsaw.

**Compass or Keyhold Saws**
Keyhole or compass saws cut curved or straight sided holes.
HAND TOOLS

Woodworking Vises

Woodworkers' vises do not mount on top of the workbench, as bench vises do, but at the edge of the bench, with their jaw tops flush with the bench top. Mounted in this way, they do not obstruct large work on the bench.

Jaws of woodworkers' vises are lined with wood or hardboard to protect the work clamped between them. A useful feature on some: A half thread that makes it possible to slide the jaw against the work without a lot of handle turning. The vise is then tightened with only a half turn.

When mounting a woodworking vise to a workbench, use heavy lag screws, which can be tightened with a wrench, instead of ordinary wood screws.

Clamps

- *C* Clamps consist of a "C" shaped frame into which an adjustable screw is assembled. Size of a "C" clamp is measured by its capacity - the dimension of the largest object the frame can accommodate with the screw fully extended. Also important is depth of throat, the distance from the center-line of the screw to the inside edge of the frame. "C" clamps range from 1" to 12".

- Bar Clamps consist of a clamping device built on a bar (usually steel). Their length varies from 6" to 8". The length of the bar determines the capacity of the clamp, which is the dimension of the largest object that can be accommodated between its clamping jaws. "Reach" is the distance from the edge of the bar to the end of the clamping jaws. Screw pressure applies the final clamping load.

- A Clamp Fixture is an adaptation of the bar clamp. A set of clamp fixtures is mounted on a piece of pipe of any length to make an economical, practical bar clamp. The fixtures are easily switched from one piece of pipe to another.

- A Spring Clamp is two metal jaws to which clamping pressure is applied by use of a steel spring.

- Web Clamps apply even clamping pressure around regular and irregular shapes and hold tight by means of a spring-loaded locking fixture.

- A Hand Screw The handscrew adjusts to fit angular work. Its maple jaws take a non-slip, no-mar grip on oddly shaped pieces. Used for assembling and gluing furniture, cabinet work, musical instruments, boats, etc. Available with jaws 4" to 24" long, which open 2" to 17".
HAND TOOLS

Squares

- **Try Square** - Used to check ends of boards for squareness and to mark cutting lines across boards.

- **Combination Square** - Can be used as a ruler or check 90° and 45° angles and contains a small level.

- **Framing Square** - (Also called a Carpenters Square.) Made from a single piece of steel bent to form a right angle. Enables the user to calculate the rise and pitch of a rule. An essential tool for laying out the cuts to be made in stair stringers.

Measuring Tape

- **Retractable Steel Tape** - A standard measuring tool, sizes range up to 25 feet.

12-foot Tape Rule

Levels

- **Carpenters** - Two-foot length is standard. Can be made of wood, aluminum or magnesium.

- **Torpedo** - Less than a foot long. Allows the user to work in tight places and still get an accurate reading.

Carpenter's level

Torpedo level

Cutter for Copper Tubing

Cutter for copper tubing also handles brass, aluminum and thin-wall conduit.

Nail Set Drives

Nail set drives finishing nails below the surface, ready to conceal with wood putty. Textured body gives good grip. Five sizes, from 1/32" to 5/64", overall length 4".
Safety with Power Tools

Power woodworking tools are fast and precise, but they carry a potential for serious injury. If handled with respect, however, these tools are generally quite safe to operate. The following guidelines will help you establish careful habits.

Checklist for safety. To prevent problems, you'll need to know your tools' capabilities and limitations before you start. Your owner's manuals are the best source of specifics—be sure to read them carefully.

- Before you turn on the tool, be sure you're equipped with any necessary support and clamps.

- When operating a stationary power saw, use whatever jig or device is called for to keep your fingers away from the blade. Rippping on both the table saw and radial-arm saw calls for extra caution. Never rip short, narrow, or twisted wood, and always cut small pieces off a large, manageable width, then crosscut if necessary. Also take care when using a dado head: the more material you're removing, the more prone it is to kick back. Before cutting, check that any jigs, clamps, and guides are tight.

- Don't wear loose-fitting clothing or jewelry that could snag in the tool's mechanism; do wear safety goggles. Tie up long hair or tuck it up beneath a tight-fitting cap.

- When you use a power tool, arrange to do so without interruptions or distractions; keep all visitors, especially young children, away from the work area while the tool is running.

- Leave a saw's blade guard in place whenever possible. Though some woodworkers argue that guards block visibility, the potential price of that visibility is not worth it.

- Avoid awkward positions while working, and never stand or place your hand in line with the blade.

- Keep power tools sharp, clean, and lubricated according to specifications. And be absolutely certain to unplug any tool before adjusting it.

Working with electricity. A power tool must be properly grounded unless it's double-insulated. Power tools that are neither grounded nor double-insulated can give a serious—even fatal—shock.

To ground a tool, connect its three-prong plug to a three-hole, grounded outlet. If you have a three-to-two-prong adapter, you can use a two-hole outlet instead, as shown below. Note, however, that unless the adapter's third wire is itself grounded, you're not protected. If the outlet is properly grounded, simply attach the wire to the outlet's cover plate screw. If your outlet is not grounded, you must extend the wire to another grounded object, such as a cold water pipe.

The best defense against a questionable electrical source is double-insulated tools, which contain a built-in second barrier of protective insulation. These tools are clearly marked and should not be grounded (they'll have two-prong plugs only).

If you're setting up a workshop, lighting and power tools should be on different circuits. A tool circuit should be at least 20 amps; stationary power tools may necessitate a 120/240-volt circuit. When working outdoors, it's a good idea to protect your outlets with GFCCs (ground fault circuit interrupters).

Extension cords. The shorter the extension cord, the better. A very long cord can overheat and become a fire hazard. And the longer the cord, the less power it will deliver.

The most important factor to consider is the maximum amp load your extension will need to carry. On every power tool is a nameplate stating its amperage requirement. Add up the requirements of any tools and accessories you plan to run off the cord at any one time; the cord must have an amp capacity that equals or exceeds that sum. The larger a cord's load capacity, the bigger its wires—and the lower its gauge number (see chart at left).

<table>
<thead>
<tr>
<th>Table</th>
<th>Recommended Minimum Wire Gauge for Extension Cords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nameplate</td>
<td>25 ft</td>
</tr>
<tr>
<td>&lt; 5</td>
<td>16</td>
</tr>
<tr>
<td>5 - 8</td>
<td>16</td>
</tr>
<tr>
<td>8 - 12</td>
<td>14</td>
</tr>
<tr>
<td>12 - 15</td>
<td>12</td>
</tr>
<tr>
<td>15 - 20</td>
<td>10</td>
</tr>
</tbody>
</table>

* based on limiting the line voltage drop to 5V at 150% of the rated amperes.
ELECTRIC HAND DRILL

SAFETY
1. Wear safety glasses/goggles.
2. Always unplug the drill before changing the bit.
3. All stock must be properly clamped before drilling.
4. Hold drill firmly with both hands, applying firm downward pressure. Excessive pressure does not speed up drilling (it only damages the bit).
5. Using a sanding attachment with the hand drill should be done in the sculpture yard, outside. A dust mask/respirator is essential with any power sanding.

CLEAN UP
1. Unplug the hand drill from the power source.
2. Remove the bit/attachment from the drill and return to the proper place in the tool crib.
3. Wrap cord neatly around the tool and place on the proper shelf in the tool crib.
4. Sweep or vacuum the work area.

Basic Drilling Technique
Mark the hole location with a sharp awl. Set a combination square next to the drill to help keep the tool aligned. A piece of masking tape offers a quick way to control drill depth.

To prevent splintering out the wood at the drill bit's exit point, clamp a backing board to the workpiece.

As an alternative to the usual masking tape flag, a slip-on stop collar provides a more permanent stop. Make it from a dowel. Cut a dowel (at least ¾ in. larger in diameter than the drill bit) to length, drill through the center, and slip it on the drill. When drilling down to the stop, ease the pressure on the drill to prevent marring the wood.

Control the angle of drilling by using a predrilled block of hardwood as a guide. To ensure accuracy, prepare the guide block on a drill press.

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE ELECTRIC HAND DRILL
SEE THE OWNER'S MANUAL FOR MORE INFORMATION
ELECTRIC HAND DRILL

Reversing Switch Action
The reversing switch changes the direction of rotation.
Move the reversing switch lever to the "FWD" position for clockwise rotation.
Move the reversing switch lever to the "REV" position for counterclockwise rotation.
The switch trigger does not actuate if the reversing switch lever is in the neutral position.

Installing or Removing Drill Bit
CAUTION:
Always be sure that the tool is switched off and unplugged before installing or removing the bit.

Hold the ring and turn the sleeve counterclockwise to open the chuck jaws. Place the bit in the chuck as far as it will go.
Hold the ring firmly and turn the sleeve clockwise to tighten the chuck.

To remove the bit, hold the ring and turn the sleeve counterclockwise.

Switch Action
Tool speed is increased by increasing pressure on the trigger. To start the tool, simply pull the trigger. Release the trigger to stop. For continuous operation, pull the trigger and then push in the lock button. To stop the tool from the locked position, pull the trigger fully, then release it.

CAUTION:
* Before plugging in the tool, always check to see that the switch trigger actuates properly and returns to the "OFF" position when released.
* Always check the direction of rotation before drilling.
* Use the reversing switch lever only when the tool comes to a complete stop. Changing the direction of rotation before the tool stops may ruin the tool.
* When not operating the tool, keep the reversing switch lever in the neutral position.
* Pulling the trigger hard when the reversing switch lever is in the neutral position can cause the switch to break.
Drills and Bits

Drills and bits that you will find in the Woodshop

- Twist drills cut through wood, metal or plastic.
  - Twist Drill

- Screwdriver bits drive and remove screws.
  - Screwdriver Bit

- Hole saws drill oversized holes in wood
  - Hole Saw

- For holes over 1" in diameter, use a spade bit
  - Spade Bit

- Countersinks enable you to set screw heads flush with or below the surface.
  - Wood Drill Countersink

- For making holes in masonry, use a carbide-tipped masonry bit
  - Masonry Bit

- Awls prepare the way for nails and screws in wood.
  - Awl

- Forstner bit cute flat-bottomed holes up to 2 in.
  - Forstner bit

Other drills and bits

- Reamers are for enlarging holes in metal.
  - Reamer

- For holes over 1" in diameter, use an expansive bit, which is adjustable.
  - Expansive Bit

- For making holes in masonry, use a star drill, which you drive with a hammer.
  - Star Drill
JIG SAW

SAFETY
1. Wear safety glasses/goggles.
2. Make all adjustments with the tool unplugged from the power source.
3. All material to be cut must be securely clamped in place.
4. Be very conscious of cord placement when preparing to cut.
5. Be aware of what is underneath the material being cut.
6. Do not carry the tool plugged in with your finger on the trigger.
7. Do not place your hands/fingers in the path of the cut to be made.
8. Be sure that the blade is running at full speed before making blade contact with the material being cut.
9. Unplug the tool before backing out of a jammed or otherwise uncompleted cut.

CLEAN UP
1. Unplug the tool from the power source.
2. Wrap the cord neatly around the tool.
3. Return the jigsaw and clamps to their proper place in the tool crib.
4. Clean up all scrap wood.
5. Vacuum the surrounding area.

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE JIG SAW
SEE THE OWNER’S MANUAL FOR MORE INFORMATION
Bevel Adjustment
TURN OFF AND UNPLUG SAW.

The jig saw shoe may be tilted to permit bevel cutting at any angle from 0° to 45°. To change the angle of the shoe, loosen the two screws, as shown in Figure , and tilt shoe to desired cutting angle with blade. Retighten screws. Cutting angles of 0° through 45° for rough cuts are indicated on the raised portion of shoe when viewed from either side of the saw. A protractor is recommended when very accurate cuts are required. Do not attempt to use the saw with the blade turned sideways while the shoe is tilted.

Always raise the chip shield before bevel cutting.

The shoe can be shifted back so that the saw blade fits into the antisplintering slot in the front of the shoe. Use this feature whenever cutting material that is apt to splinter. Use only hollow ground blades in the antisplintering mode and never attempt to bevel or scroll cut in this mode.

To utilize the antisplintering feature, loosen the two screws shown in Figure and slide the shoe back away from the blade. Carefully align the saw blade so that it fits in the slot and does not touch either side.

General Cutting
Automatic and manual scrolling feature. The scrolling feature permits the saw blade to completely rotate without rotating the entire saw. This feature provides greater convenience and control when cutting intricate curves and small circles especially near corners and obstructed areas.

Be sure board is firmly secured. Hold jig saw by the handle and operate switch to turn the unit on. Don't attempt to turn on the unit when blade is against material to be cut. This could stall the motor. Place front of shoe on material to be cut and hold jig saw down firmly against the work surface while cutting. Don't force the tool, let the blade cut at its own speed. Clamp or support work close to the line of cut; when the cut is complete, shut power off and lay the saw aside before loosening the work.

Manual Scrolling
TURN OFF AND UNPLUG SAW
Mount the blade in the front position. Place the selector in the scroll position by rotating it so that the protruding knob aligns with the scrolling illustration as shown in the figure. The saw blade can be rotated by turning the scroll knob with the tree hand.

Automatic Scrolling
TURN OFF AND UNPLUG SAW
Mount the blade in the rear clamp position. Place the selector in the scroll position as explained under manual scrolling. Without touching the scroll knob, guide the saw in the direction of cut by applying pressure to the handle.

NOTE: Do not attempt to scroll with the saw shoe tilted or with a flush cutting blade installed.
### UNIVERSAL JIG SAW BLADES

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WOOD AND COMPOSITION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 Set</td>
<td>3½</td>
<td>⅜</td>
<td>HC</td>
<td>Fast cutting of wood, plywood and composition materials</td>
</tr>
<tr>
<td></td>
<td>10 Set</td>
<td>3½</td>
<td>⅜</td>
<td>HC</td>
<td>Smoother cutting of wood, plywood and composition materials</td>
</tr>
<tr>
<td></td>
<td>6 Taper</td>
<td>3½</td>
<td>¼</td>
<td>HC</td>
<td>Excellent for pocket cutting &amp; smooth, fast scroll cutting in wood</td>
</tr>
<tr>
<td></td>
<td>12 Taper</td>
<td>3½</td>
<td>¼</td>
<td>HC</td>
<td>Smoothest scroll cutting &amp; pocket cutting in wood</td>
</tr>
<tr>
<td></td>
<td>6 Set</td>
<td>3½</td>
<td>⅛</td>
<td>HC</td>
<td>For fast cutting of plywood, plastics &amp; composition materials</td>
</tr>
<tr>
<td></td>
<td>6 Set</td>
<td>3½</td>
<td>⅛</td>
<td>HS</td>
<td>Deluxe blade for fast, straight cutting of wood, plywood, etc.</td>
</tr>
<tr>
<td></td>
<td>6 Taper</td>
<td>3½</td>
<td>⅛</td>
<td>HS</td>
<td>Deluxe blade for fast smooth cuts in all types of wood</td>
</tr>
<tr>
<td></td>
<td>10 Taper</td>
<td>3½</td>
<td>¼</td>
<td>HS</td>
<td>Deluxe blade makes fast, smooth, deeper cuts in wood</td>
</tr>
<tr>
<td></td>
<td>6 Taper</td>
<td>3½</td>
<td>⅛</td>
<td>HS</td>
<td>Rugged, deluxe blade for straight, smooth &amp; deeper cuts in wood, plywood and masonite</td>
</tr>
<tr>
<td></td>
<td>10 Taper</td>
<td>3½</td>
<td>⅛</td>
<td>HS</td>
<td>Longer lasting blade for deepest and smoothest cuts in wood, plastics, chipboard, etc.</td>
</tr>
<tr>
<td><strong>SPECIAL PURPOSE CUTTING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 Taper</td>
<td>3½</td>
<td>¼</td>
<td>HC</td>
<td>Smooth, non-chip, down-cutting action on veneers, chipboard, laminated plastics, etc.</td>
</tr>
<tr>
<td></td>
<td>8 Set</td>
<td>3½</td>
<td>⅛</td>
<td>HS</td>
<td>For fast cutting of plaster, plaster board and abrasive materials</td>
</tr>
<tr>
<td></td>
<td>12 Set</td>
<td>3½</td>
<td>⅛</td>
<td>HS</td>
<td>Deluxe high speed steel all-purpose blade for cutting nail-embedded wood and abrasive materials</td>
</tr>
<tr>
<td><strong>METAL CUTTING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 Set</td>
<td>2⅜</td>
<td>⅜</td>
<td>HS</td>
<td>High speed steel blade cuts ferrous &amp; non-ferrous metals over ¼&quot; thick. Also used on plastics, and fiberglass</td>
</tr>
<tr>
<td></td>
<td>17 Set</td>
<td>2⅜</td>
<td>⅜</td>
<td>HS</td>
<td>For cutting ferrous and non-ferrous metals over ⅜&quot; thick. Suitable for pipe &amp; tubing</td>
</tr>
<tr>
<td></td>
<td>21 Set</td>
<td>2⅜</td>
<td>⅜</td>
<td>HS</td>
<td>Easily cuts ferrous metals, aluminum, copper, brass, etc., over ¼&quot; thick</td>
</tr>
<tr>
<td></td>
<td>36 Set</td>
<td>2⅜</td>
<td>⅜</td>
<td>HS</td>
<td>Cuts ferrous &amp; non-ferrous metals, plastics, formica, fiberglass, etc., over ¼&quot; thick</td>
</tr>
</tbody>
</table>
SAFETY

1. Wear safety glasses/goggles.
2. Wear a dust mask/respirator when using sanding attachments.
3. Do not wear loose clothing or jewelry.
4. Tie long hair back.
5. Make all adjustments to the machine with the power off.
6. All stock to be drilled must be securely clamped to the table.
7. Use a V-block and clamps when drilling round stock.
8. When drilling long stock, excess length should extend to the operator's left.
9. Be sure the bit/attachment is securely tightened in the chuck.
10. If the bit/attachment being used has a "hex-shaped" shank, be sure that the chuck contacts the flat surfaces of the hex-shape, not the corners.
11. Always check the depth of feed with the bit in the chuck. Be sure that the bit is lined up with the hole in the drill press table.
12. When using a bit larger than the diameter of the hole in the drill press table, use a secondary piece of wood to back the piece being drilled. Set the feed depth properly to avoid drilling into the table.
13. Always check to be sure that the chuck key has been removed from the chuck before turning on the power to the drill press.
14. Never turn on the power to the drill press with the bit in contact with the material to be drilled.
15. Allow the drill to come to full speed before lowering the bit to the stock to be drilled.
16. Feed with slow, even pressure. Do not force the machine. Excessive pressure does not speed up drilling, it only damages the bit.
17. When drilling a larger hole, it is a good idea to drill a pilot hole first, then proceed with the larger bit size.
18. It may be necessary to raise the bit from the hole to clear the shavings when drilling deeper/larger holes (as with spade bits or hole-saws), or if drilling progress slows. Clear the shavings by occasionally raising the bit from the hole, then proceed with drilling.
19. When drilling is complete, raise the bit to the uppermost position, then turn the power off.

CLEAN UP

1. Turn off power to the machine.
2. After rotation has come to a complete stop, remove the bit/attachment from the chuck.
3. Make sure the chuck key is removed from the chuck.
4. Vacuum the table, machine and the surrounding work area before leaving the machine.
5. Return bits/attachments and clamps to their proper place.

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE DRILL PRESS
SEE THE OWNER'S MANUAL FOR MORE INFORMATION
GLOSSARY OF TERMS

BASE – Supports the drill press. For additional stability, holes are provided in the base to bolt the drill press to the floor. (See “Specific Safety Instructions for Drill Presses”)

BACKUP MATERIAL – A piece of scrap wood placed between the workpiece and table. The backup board prevents wood in the workpiece from splintering when the drill passes through the backside of the workpiece. It also prevents drilling into the table top.

BELT GUARD ASSEMBLY – Covers the pulleys and belt during operation of the drill press.

BELT TENSION – Refer to the “Assembly” Section, “Installing and Tensioning Belt.”

BELT TENSION HANDLE – Turn the handle clockwise to apply tension to belt, turn the handle counterclockwise to release belt tension.

BELT TENSION LOCK KNOBS – Tightening the knobs locks the motor bracket support and the belt tension handle, maintaining correct belt distance and tension.

BEVEL SCALE – Shows the degree of table tilt for bevel operations. The scale is mounted on the side of the arm.

CHUCK – Holds the drill bit or other recommended accessory to perform desired operations.

CHUCK KEY – A self-ejecting chuck key which will pop out of the chuck when you let go of it. This action is designed to help prevent throwing of the chuck key from the chuck when the power is turned “ON”. Do not use any other key as a substitute; order a new one if damaged or lost.

COLUMN – Connects the head, table, and base on a one-piece tube for easy alignment and movement.

COLUMN COLLAR – Holds the rack to the column. Rack remains movable in the collar to permit table support movements.

COLUMN SUPPORT – Supports the column, guides the rack and provides mounting holes for column to base.

DEPTH SCALE STOP NUTS – Lock the spindle to the selected depth.

DEPTH SCALE – Indicates depth of hole being drilled.

DRILL BIT – The cutting tool used in the drill press to make holes in a workpiece.

DRILL ON/OFF SWITCH – Has locking feature. This feature is intended to help prevent unauthorized and possible hazardous use by children and others. Insert the key into the switch to turn the drill press on.

DRILLING SPEED – Changed by placing the belt in any of the steps (grooves) in the pulleys. See the Spindle Speed Chart inside the belt guard.

FEED HANDLE – Moves the chuck up or down. If necessary, one or two of the handles may be removed whenever the workpiece is of such unusual shape that it interferes with the handles.

FENCE – Attaches to the table to align the workpiece or for fast repetitive drilling. Removable. Remove fence when it interferes with other drill press accessories.

HEAD LOCKS – Locks the head to the column. ALWAYS lock the head in place while operating the drill press.

RACK – Combines with gear mechanism to provide easy elevation of the table by the hand operated table crank.

REVOLUTION PER MINUTE (R.P.M.) – The number of turns completed by a spinning object in one minute.

SPINDLE SPEED – The R.P.M. of the spindle.

SPRING CAP – Adjusts the quill spring tension.

TABLE SUPPORT LOCK – Tightening locks the table support to the column. Always have it locked in place while operating the drill press.

TABLE – Provides a working surface to support the workpiece.

TABLE ARM – Extends beyond the table support for mounting and aligning the table.

TABLE BEVEL LOCK – Locks the table in any position from 0° – 45°.

TABLE CRANK – Elevates and lowers the table. Turn clockwise to elevate the table. Support lock must be released before operating the crank.

TABLE LOCK – Locks the table after it is rotated to various positions.

TABLE SUPPORT – Rides on the column to support the table arm and table.

THREADED DRAIN (5/8") – Attach a 5/8" (pipe threaded) metal pipe to the threaded opening for draining excess oil into container. For a non-draining surface attach a threaded metal plug. Pipe and plug not included.

WORKPIECE – Material being drilled.
BELT SANDER/SPINDLE SANDER

SAFETY

1. Wear safety glasses/goggles.
2. Wearing a dust mask/respirator is essential when using the sander.
3. Be sure all dust collection systems are on.
4. Always hold stock firmly
5. Stock being sanded must be large enough to comfortably hold (2-4" minimum) while keeping hands and fingers at least one inch away from the sanding surface and should never be thinner than the gap between the sanding belt/disc and the table (1/4"").
6. Sanding on the disc sander should be restricted to the left-hand half of the disc.
7. Sanding on the spindle sander should always be done against the rotation of the drum.
8. Use the table/rest to aid in holding and bracing the stock.
9. Apply firm/even pressure to stock being sanded.
10. If you feel there are any problems with this machine or that it needs adjustment, advise the monitor or instructor.

GENERAL

1. Do not sand painted or previously used wood.
2. Be certain that wood glue and/or wood putty is completely dry before sanding.
3. The woodshop sander is for sanding/shaping wood only (No plaster, metal, plastic, clay or other products).

CLEAN UP

1. Shut off power to the machine
2. Clean the sander and vacuum the surrounding work area before leaving the machine.

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE BELT SANDER/SPINDLE SANDER

SEE THE OWNER'S MANUAL FOR MORE INFORMATION
Getting To Know Your Miter Saw

⚠️ WARNING ⚠️ To avoid injury from accidental starting, remove plug from power source outlet before making any adjustments.

1. **Switch Lock-OFF Release Buttons** - One of these two buttons must be pressed before the power switch can be pressed.

2. **Power Switch** - The power switch used with the "Lock-OFF" button energizes the unit.

3. **Main Handle** - This handle contains the power switch. Pulling this handle down lowers the blade into the workpiece.

4. **Lower Blade Guard/Lower Guard Lip** - The lower blade guard helps protect your hands from the spinning blade. It retracts as the blade is lowered. Lip can be used to raise the lower guard in the event that the guard becomes jammed on a workpiece.

5. **Blade** - Use only 12" (308 mm) diameter blades with 1" (25.4 mm) diameter arbor holes.

6. **Chip Deflector** - Deflects cut-off workpieces from entering the upper guard.

7. **Upper Guard** - Covers upper portion of the blade.

8. **Sliding Fence** - Supports the workpiece. The fence has a cast-in scale to make repetitive cuts easy. The fence also has holes to secure an auxiliary fence if desired.

9. **Stationary Fence** - Stationary fence is bolted to the base and will support the workpiece when the sliding fence is removed.

10. **Kerf Inserts** - Kerf inserts can be adjusted to different blade widths to minimize workpiece tear-out.

11. **Miter Detent Override** - Allows detent action to be locked out, allowing for micro-adjustments to any miter angle.

12. **Miter Lock Knob** - The miter lock knob locks the miter saw table at any desired miter angle.

13. **Miter Detent Lever** - The lever releases the table from the detent.

14. **Bevel Lock Lever** - The front-positioned bevel lock lever locks the head assembly at the desired bevel angle.

15. **Miter Scale/Miter Pointer** - The pointer rotates with the table and blade. It points to the miter scale to indicate the angle setting before a cut is made.

16. **Miter Detent Plate** - The position of the plate can be adjusted to set the accuracy of its detent locations.

17. **Miter Detents** - There are ten (10) miter detent slots for fast and accurate miter cuts of common miter angles.

18. **Table** - Sits in base, provides workpiece support, rotates for desired miter cuts and rotates the head assembly. The front extended part of the table is called the miter arm.

19. **Base** - Provides working surface to support workpiece.

20. **Tool Mounting Pads** - The four corners of the saw provide areas to clamp, bolt or nail the saw to a flat work surface.
Getting To Know Your Miter Saw

NOTE: To view items 21 through 31, see page 8.

21. **Base Extension Clamping Levers** – Lock the base extensions at the desired positions.
22. **Sliding Base Extensions** – Provide extra work support. Useful when cutting long workpieces.
23. **Rubber Deflector** – Attaches to bottom of chute. Deflects dust into the chute.
24. **Dust Chute** – Directs sawdust up and through the elbow and to the bag.
25. **Elbow** – Connects the dust chute to the dust bag. Can be rotated to direct dust.
26. **Dust Bag** – Has a zipper at the bottom. Bag can be uncoupled from elbow for emptying.
27. **Mechanism Lock Lever** – Holds saw in full back position for chop cuts or fully extended for transporting.
28. **Link Knob** – Attaches guard link to the pivot post.
29. **Lower Guard Link** – Allows for smooth movement of the lower guard.
30. **Clamp** – Use to hold the workpiece to the table and base – insert into clamp post location (item 39).
31. **Brush Cap** – Keeps motor brushes in position. Provides access for inspecting and replacing brushes.
32. **Depth Stop Screw** – Turn the knob end to adjust the blade depth for cutting grooves.
33. **Depth Stop Plate** – Plate can be swung out to limit the depth of the blade travel.
34. **Pivot Post** – Provides support for the saw head, dust collection system and other functional parts.
35. **Axial Glide Mechanism** – Allows saw to smoothly slide in and out. Can be locked in full rear or fully extended positions.
36. **Bevel Scale and Pointers** – Scale is large and angled - allows user to easily read bevel angles. Pointer indicates what the current angle is.
37. **Bevel Post** – Provides rotating support for all miter saw parts above the table.
38. **Bevel Detent Pin (Crown Molding Setting)** – When engaged, it locks the head assembly to the bevel angle of 33.9° to the left or right.
39. **Clamp Post Locations** – Two vertical post holes in the base – provided to insert the clamp (item 30).
40. **Miter Detent Plate Screws** – Four screws accessible through holes in the miter scale. These screws are loosened when adjusting position of the detent plate.
41. **Bevel Range Selector Knob** – Allows selection of 3 bevel ranges: “0-45° Left”, “0-45° Right” or “Max. Bevel Angle to 47°.”
42. **Arbor Lock** – Press arbor lock button to keep blade from rotating when loosening or tightening arbor bolt during blade removal or installation.
43. **Head Assembly Lock Pin** – Used to lock the head assembly in the lower position for transporting.
44. **Glide Movement Controller** – Adjusts to regulate movement of the glide mechanism.
Preparing for Saw Operations
Body and Hand Position

⚠️ WARNING ⚠️ Position your body and hands properly to make cutting easier and safer. Failure to follow all instructions, identified below by bullet (*) symbols, may result in serious personal injury (see Figure 30).

- Hold workpiece firmly against table and fence to prevent movement.
- Keep hands in position until trigger has been released and blade has completely stopped.
- Never place hands on mechanism components.
- Keep feet firmly on the floor and maintain proper balance.
- Follow the miter arm when mitering left or right. Stand slightly to the side of the saw blade.

⚠️ WARNING ⚠️ The lower guard may not automatically open under certain cutting conditions; for example, when trying to cut workpieces that are near the maximum cutting height capacity. Under these conditions or during the blade travel motion of cut, the workpiece can stop the lower guard movement before the downward motion of the arm could pre-open the lower guard.

If this occurs:
Workpiece must be securely clamped. This frees a hand to raise the guard by the lip just enough to clear the workpiece (see Figure 31).

Start the saw and begin your cut.
Once you have cleared the position where the lower guard may bind, release the guard and it will continue to operate automatically as you cut.

Figure 30. Hand Positions
- Never place hands near cutting area. Keep hands and arms outside the “NO HANDS” zone.

“NO HANDS” ZONE – is defined as the entire table plus the fixed portion of the base on the right and left side of the table and portions of the fence within this boundary. This zone is labeled with “No Hands” symbols placed on the fixed base.

- Be aware of the path of the saw blade. Make a DRY RUN with the saw “OFF” by conducting a simulated cutting cycle, and observe the projected path of the saw blade. Keep hands out of the path of saw blade.

DRY RUN – It is important to know where the blade will intersect with the workpiece during cutting operations. Always perform the simulated cutting sequence with the power tool switched “OFF” to gain an understanding of the projected path of the saw blade. Mentally note where the path of the saw blade will fall and set up your work to keep your hands and arms out of the path of the spinning blade. Adjust your clamps and fences so that the smooth lower guard and cutting action is not interfered with during cutting operation (see Figure 30).
Saw Operations
Switch Activation

For safety, the switch lever is designed to prevent accidental starts. To operate safety switch, press the switch “Lock-OFF” button with either thumb to disengage the lock, then pull the power switch lever and release the switch “Lock-OFF” release button (see Figure 39). When the power switch lever is released, the switch “Lock-OFF” button will engage the safety switch automatically, and the lever will no longer operate until either “Lock-OFF” button is pressed again.

NOTE: The power switch lever is made with a hole to accommodate a long shackle padlock to prevent unauthorized use of the saw (padlock is not provided with tool). The lock's shackle diameter may be up to 1/4".

Figure 39. Switch Activation
Saw Operations

Chop Cuts

What's a Chop Cut – Saw Features

- A "chop cut" is a cross-cut made when the saw is held to the rearmost position and is operated like a conventional (non-sliding) miter saw. Using the chop cut method lowers the cross-cutting capacity; however, many users prefer using this method because it is quicker when making repeat cuts. This method can also produce more accurate cuts because the saw head is locked in the retracted position.

- This saw has bevel angle stops that accurately stop at critical angles: 45° Left/Right and 0° Right. It comes factory-set and should not require adjustment. However, after extensive use or if the tool has received a hard impact, it may require an adjustment.

- A chop cut can cut pieces with a width of 5-1/2" or less

Preparing for Chop Cut

1. With the saw head in the UP position, push it back over the fence to the rear.
2. Engage the mechanism lock lever (item 27 – page 9) by lifting up the finger tab. Check that mechanism movement is stopped.
3. Properly position your workpiece and clamp it firmly to the table and/or fence.

WARNING Use clamping position that does not interfere with operation. Before switching "ON," lower head assembly to make sure clamp clears guard and head assembly.

Making a Chop Cut

1. Activate the switch, then fully lower the saw head to make the cut.
2. Hold the saw head down until the blade comes to a complete stop. Return the saw head to the UP position. Remove workpiece.

Figure 42. Chop Cut
Saw Operations

Slide Cuts

What's a Slide Cut – Saw Features

- A "slide cut" is made with the head assembly unlocked and able to move away from the fence. This movement is supported and precisely controlled by the axial glide system. The maximum cross-cutting capacity is utilized by using this method.

- A slide cut is best used for cross-cutting workpieces wider than can be done with a chop cut – pieces wider than 5-1/2" and up to a maximum width of 13-3/8" across.

**WARNING**: NEVER pull the saw toward you during a cut. The blade can suddenly climb up on top of the workpiece and force itself toward you.

Preparing for Slide Cut

1. Place the saw head in the UP position.

2. Disengage the mechanism lock lever (Item 27 – page 9) by pushing down on the finger tab. With the head assembly in the UP position, move it fully to the front and back to check that axial glide system moves smoothly.

3. Properly position your workpiece and clamp it firmly to the table and/or fence.

**WARNING**: Use a clamping position that does not interfere with operation. Before switching “ON,” lower head assembly to make sure clamp clears guard and head assembly.

Making a Slide Cut

1. Grasp the switch handle and pull the saw head assembly (in UP position) away from the fence – see Arrow 1 in Figure 43.

2. Activate the switch, and then fully lower the saw head assembly – on larger pieces, this action may also start the cut – see Arrow 2 in Figure 43.

3. Push down and back so the saw head assembly moves toward the fence and to the full rear position until you complete the cut. See Arrow 3 in Figure 43. **NOTE**: If high resistance is felt, do not apply excessive force – stop cutting, wait until blade stops and investigate problem.

4. Hold the saw head down until the blade comes to a complete stop. Return the saw head to the UP position and remove the workpiece.

Figure 43. Slide Cut
Saw Operations
Using Miter Detent System

1. Loosen the miter lock knob about 1/2 turn.
2. Grip the lock knob, and then reach down with your index finger to pull up on the miter detent lever – pull lever until it is out from the detent plate.
3. While gripping the lock knob and lever, rotate the saw's table. Stop table rotation at the desired angle as indicated by the miter scale pointer.
4. Release the lever into a detent in the detent plate or at an angle between detents. If close to a detent, use the detent override feature.
5. Tighten the miter lock knob before cutting.

Miter Detent Override

The miter detent override system locks out the automatic detent action. When the desired miter angle is close to a standard detent slot, this feature will hold the detent lever wedge from engagement (i.e., the user wants to be at 44-1/2°, but detent wedge wants to pop into the 45° detent). When the detent override is used, the detent system is disabled and the table will move smoothly to any position within its range.

Engaging the Miter Detent Override
1. Pull up and hold the miter detent lever – the lever is located under the turntable's front arm (see Figure 41).
2. Press down on the top half of the detent override button and then release hold of the detent lever. The override button will remain in the DOWN position (see Figure 41).
3. The turntable is free to rotate.

⚠️ WARNING ⚠️ With the table free to rotate, the miter lock knob must be tightened before attempting any cutting.

Disengaging the Miter Detent Override
1. Pull up the miter detent lever and the detent override system will automatically disengage. The override button will return to the UP position.
2. Loosen the miter lock knob to allow the table to rotate to a new position – the detent lever is now free to engage the preset detent slots.

Figure 40

Figure 41. Detent Override
BAND SAW

SAFETY

1. Wear safety glasses/goggles.
2. Make all adjustments to the machine with the motor off (blade should not be moving).
3. Set the upper blade guide (guard) no more than 1/8" above the wood being cut.
4. Check for proper blade size and type. A chart is posted on the large band saw (the Woodshop generally uses a 1/2" blade).
5. Always support round stock with a V-block.
6. When cutting curves, observe the minimum radius for each blade width. This chart is posted on the band saw.
7. Make "release" cuts before cutting long curves.
8. Be sure to support out-feeding material when ripping long stock. If a person helps with this they only support the work. They should never pull or guide the work.
9. Never stand to the right of the band saw. This is the most dangerous position in the event that a blade breaks.
10. Always keep hands/fingers away from the blade. Never line up fingers/thumbs with the cut.
11. The blade should be running at full speed before a cut is started.
12. Feed the wood with even/gentle pressure. Never force the wood into the blade and never lean into your work. If the motor starts to labor during a cut, you should try reducing the feed speed of the wood into the blade. If this does not help, stop the saw and check for blade sharpness.
13. Hold work firmly against the table. Do not attempt to saw stock that does not have a flat surface, unless a suitable support is used.
14. Always feed material evenly. Never crowd, twist or jerk the material being sawed.
15. Stop the machine before removing scrap pieces from the table.
16. If the cut is uncompleted, jammed or otherwise to be backed out, turn off the machine before attempting to reposition the piece.

CHANGING THE BLADE

If the blade breaks, turn off the power and ask for assistance from the monitor/instructor. Do not open the cabinet.

CLEAN UP

1. Shut off the power to the machine.
2. Lower the blade guard to the table so that the blade is not exposed.
3. Clean the band saw and work area before leaving the machine.

Protect your sight.

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE BAND SAW
SEE THE OWNER'S MANUAL FOR MORE INFORMATION
BAND SAW

Tension Adjustment Knob: Controls blade tension by raising or lowering wheel.
Table Tilt: Tilt from 10 to 45°.
Table Pin: Keeps slotted table in alignment.
Table Insert: Supports stock close to blade.
Tilt-Lock Knob: Locks table at angle.
Upper Blade Guide: Carries blade supports.
Thrust Bearing: Supports back of blade.
Lower Blade Guide: Also contains thrust bearing and guide blocks.

BAND SAW MINIMUM CUTTING RADIUS

Turning radius may vary depending on type of blade and amount of set. But each blade – depending on its width – can cut continuously without buckling, any curve having a radius as much or more than the specified minimum turning radius of the blade as shown in the chart.
Always use the widest blade possible and limit use of narrow blades for sawing small, abrupt curves and for fine, delicate work.

This chart is posted on the Rockwell Bandsaw
**Parallel Sawing**

To make a cut parallel to a curved edge, clamp a guide block to the desired distance from the blade. Keep the edge tight to the block as you push the board into the blade.

**Cutting Tight Curves**

When cutting tight curves, relieve the pressure on the blade by first sawing relief cuts to the layout line. Also known as "release" cuts.

**Cutting Round Stock**

Never freehand round stock—it could twist and jam your fingers into the table. Instead, hold the piece firmly in a V-shaped jig as you move the stock through the blade. For accurate cuts use the V-jig with the miter gauge.

**Cutting in Two Planes**

To cut a three-dimensional form, make the cut in the first plane and then tape the offcut back onto the work. Turn the work 90° and make the second cut.

**Cutting Circles**

Make a jig to support the work and to index it to the blade at the desired radius. To use the jig, drill a pivot hole at the center of the work, set it on a pin set at the desired radius. Slide the jig and work into the blade, then turn the wood on the pivot to make the circular cut.
SCROLL SAW

SAFETY
1. Wear safety glasses/goggles.
2. Be sure that the rear of the cart supporting the saw is braced against a stationary object (wall).
3. Check for proper blade size and type.
4. The maximum stock thickness is 2 inches.
5. Make sure the blade tension is properly adjusted. Improper tension will cause the blade to break.
6. Material hold-down/guard should be positioned so that it rests on the stock being cut.
7. Make all adjustments to the machine with the motor off. The only adjustment that can be made on the scroll saw with the motor running is the blade speed.
8. The scroll saw features a variable speed control. To increase the speed, turn the knob clockwise ("eight" is the max. speed). Use slower speeds for metal, plastic, harder or very thin woods.
9. Always keep hands and fingers away from the blade.
10. Never line your fingers up with the blade/line to be cut.
11. Hold the work firmly against the table. Do not attempt to saw stock that does not have a flat surface unless a suitable support is used.
12. Always support round stock in a V-block.
13. Allow the blade to come to its full speed before starting a cut.
14. Feed the stock into the blade at a moderate speed.
15. Always feed the stock evenly. Never twist, crowd or jerk the material being cut.
16. Feed the wood with even/gentle pressure. Never force material into the blade. If the motor labors during a cut, try reducing the feed rate of material. If this does not help, stop the saw and check for blade sharpness.
17. Turn off the machine if material is to be backed out, cut is incomplete or if blade is jammed.
18. Stop the machine before removing scrap pieces from the table.

CHANGING THE BLADE
Scroll saw blades will break for several reasons: feeding stock too fast, twisting stock, moving stock sideways, dull blades, improper blade tension (too tight or too loose).

You will need to know how to change the blade if/when this occurs.
1. Turn the power off to the machine.
2. Release the blade tension by pushing the tension lever all the way back.
3. Loosen the thumbnut for the upper blade clamp.
4. Loosen the thumbnut for the lower blade clamp.
5. Make sure that the teeth for the new blade point forward and down toward the table.
6. Insert the blade into the lower blade clamp and tighten the lower thumbnut.
7. Pull up on the blade. Maintain upward tension while inserting the blade into the upper blade clamp and tightening the upper thumbnut.
8. Adjust the blade tension by pulling forward on the blade tension lever until proper tension is achieved (do this gradually (in several steps), checking for proper tension each time).

CLEAN UP
1. Turn off power to the machine
2. Unplug cord and wrap neatly.
3. Be sure that allen wrench for material hold-down/guard is returned to its proper place.
4. Vacuum/sweep the tool, cart and surrounding work area.
5. Move the cart to an out of the way area of the woodshop.

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE SCROLL SAW
SEE OWNER'S MANUAL FOR MORE INFORMATION
PANEL SAW

SAFETY

1. Wear safety glasses/goggles.
2. The panel saw is designed for cutting large panels down to manageable size. As the overall panel size becomes smaller, other types of cutting tools become more convenient and safe to use.
3. Inspect the wood for nails, staples, screws or embedded material.
4. Maximum stock thickness is 1 3/4".
5. Place the stock to be cut with its "backside" facing you. This provides the smoothest possible cut on the "face" side of the panel.
6. Be careful when placing material on the rollers. Dropping heavy material on the rollers will cause the rollers to be knocked out of alignment.
7. When crosscutting (vertical cuts) the workpiece must be supported on at least two rollers.
8. If a piece is supported on both sides of the cut in such a way that it allows the material to bow and pinch the blade, it may produce a kickback. Do not cut pieces smaller than the saw carriage.
9. Do not place your hands on or under the saw carriage or in the path of the blade.
10. Do not try to retrieve a piece of cut material while the blade is rotating.
11. When you feed material through the tool, do it slowly, smoothly and without stopping.
12. If you need to restart the blade in mid-cut, allow the blade to come to a complete stop. Then back up the saw before restarting.
13. Always wait for the blade to come to a complete stop before changing positions.
14. Panels to be cut horizontally must always be fed against the rotation of the saw blade. Ask a monitor/insstructor for assistance with horizontal cuts.

GENERAL

AVOID KICKBACK. Kickback is a violent reaction to a pinched or binding saw blade. It throws the saw blade upward when crosscutting and throws the workpiece out when ripping. Firm control, proper support of the workpiece, and concentration on the job are essential to reduce the risk of injury from kickback.

CLEAN UP

1. Return the carriage to the uppermost position.
2. Vacuum the entire work area before leaving the machine.

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE PANEL SAW
SEE THE OWNER'S MANUAL FOR MORE INFORMATION
PANEL SAW

Main Components of Saw

Carriage

Crosscutting (work supported on at least two rollers)

Saw Motor in Ripcutting Position
JOINTER

SAFETY
1. Wear safety glasses/goggles.
2. Be sure that dust collection system is on and the "blast-gate" to the machine is open.
3. Inspect the wood for nails, staples, screws or embedded material.
4. Before attempting to joint or plane, each work piece must be examined for stock condition and grain orientation.
5. The grain of the wood must run in the same direction you are cutting. At times it may be necessary to plane against the grain when working with a swirly or burls in wood. With this type of stock, the operator must use a lesser depth of cut and a slow rate of feed.
6. The blade should project no more than 1/16" for hardwood, 1/8" for softwood.
7. Never stand or have any part of your body in line with the path of the cutter blades (the "infeed" side, or to the right when facing the front of the jointer/spray booth).
8. Never perform any operation "free-hand". Always use the fence to position and guide the work.
9. Hold the stock to be cut firmly.
10. Always hold the stock to be cut firmly against the fence.
11. Never remove the cutterhead guard from the jointer.
12. Never joint (edge) a board that is less than 3 inches wide, less than 1/4 inch thick or less than 12 inches long without using the jointer push blocks.
13. If stock is longer than twice the length of the infeed or outfeed table, another helper or support table/roller must be used for infeed and outfeed support.
14. When feeding stock through the machine, move the hands in an alternate motion from back to front as the work continues through the cut. Never pass the hands directly over the cutter knives while holding onto the stock. As one hand approaches the knives, remove it from the stock in an arc motion and place it back on the stock in a position beyond the cutter knives (see figure 2 in illustrations).
15. **3 Inch Rule** When feeding stock through the jointer, follow the 3 inch radius rule: the hands should never be closer than 3 inches to the cutter head (see figure 1 in illustrations).
16. Never apply downward pressure to the end of stock directly over the cutter head. This may result in ripping the stock into the cutter knives along with the operator's fingers.

CLEAN UP
1. Turn off the saw and wait for the blades to stop turning before clearing scrap or shavings made during a cut.
2. Clean up scrap wood.
3. Sweep/vacuum the work area before leaving the machine.

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE JOINTER
SEE THE OWNER'S MANUAL FOR MORE INFORMATION
FIGURE 1
NEVER surface stock less than 12 inches long or 3 inches wide, or 3 inches thick without a hold down push block.

3 INCH RULE When working a piece of wood the jointer, follow the 3 inch radius rule. The hands must never be closer than 3 inches to the cutterhead (Fig. 1).

FIGURE 2
HAND SAFETY It is good practice to move the hands in an alternate motion from back to front as the work continues through the cut. Never pass the hands directly over the cutter knife while holding on to the stock. As one hand approaches the knives, remove it from the stock in an arc motion and place it back on the stock in a position beyond the cutterknife (Fig. 2).
NOTE: At all times hold the stock firmly.
BASIC JOINTER OPERATIONS

Before making any cuts on the stock, make a few practice cuts by raising the infeed table to "O" and disconnect power source. In this manner you will acquaint yourself with the feel of jointer operations without the danger of serious injury.

SURFACING
Adjust depth of cut. It is better to make cuts of approximately 1/32 inch for hardwoods and 1/16 inch for softwood. This will enable you to have better control over the material being surfaced. Make several passes if necessary to obtain proper stock removal. Never surface pieces shorter than 12 inches or thinner than 3/8 inch without the use of a special work holding fixture. Never surface pieces thinner than 3 inches without the use of a push block. On stock shorter than 12 inches use a single two-hander push block (Fig. 3A). On stock longer than 12 inches use two push blocks as shown in Fig. 3B.
With narrow stock, use the type push block shown in Fig. 3C.
When surfacing short stock over 4 inches wide, use two (2) push blocks to guide material over cutterhead (Fig. 3D).

SURFACING: LONGBOARDS
The use of push blocks will help prevent hands from coming in contact with cutterhead in the event of a kickback and as trailing end of board passes over cutterhead.

When surfacing long stock, place push block near the front of piece and start feeding wood with the right hand until guard has opened and cut is started (Fig. 4A). Place second push block near the rear of the infeed table and continue feeding stock using the hand-over-hand method (Fig. 4B). Before the left hand is in the 3 inch area of the cutterhead, move it over to the outfeed side as shown in Fig. 4C. As soon as possible follow with the right hand over to the outfeed side and continue through with cut (Fig. 4D).
JOINTER

When the stock is longer than twice the length of the infeed and outfeed tables, another helper or support table must be used to support the stock.

FIGURE 4A
Left hand pushes down toward fence as right hand starts feed.

FIGURE 4D
On outfeed side both hands pull stock through.

JOINTING (EDGING)

Never edge a board that is less than 3 inches wide, less than 1/4 inch thick, or less than 12 inches long, without using a push block!

LONG STOCK
When edging long pieces, the same procedures apply for surfacing long pieces. CAUTION: When workpiece is twice the length of the jointer infeed or outfeed table use an infeed or outfeed support.

DEPTH OF CUT
Begin by feeding stock with right hand and apply pressure to front of stock with push block. When edging, make cuts of approximately 1/16 inch for hardwood and 1/8 inch for softwood.

PREVENT KICKBACK
When edging wood wider than 3 inches, lap the fingers over top of the wood, extending them back over the fence such that they will act as a stop for the hands in the event of a kickback. Keep stock firmly against the fence (Fig.5).

FIGURE 5
Move fence forward to expose only amount of cutterhead required.
RADIAL ARM SAW

SAFETY
1. Wear safety glasses/goggles.
2. Do not cut wet, warped or knotty wood on the radial arm saw.
3. Stock to be cut must be 8" or longer. It must extend beyond the red lines marked on the table.
4. Be sure the power is off and the blade is not rotating before making any adjustments.
5. Make sure the clamps and locking handles are properly tightened.
6. Always keep the safety guard in position.
7. Never reach around the table.
8. Do not cross hands when operating the saw.
9. Keep your hands away from the path of the blade!
10. Do not perform any operation "free-hand".
11. Make sure the stock to be cut is held tightly against the fence.
12. Stand to the left of the blade.
13. Maintain a firm grip on the saw handle with your right hand to prevent it from coming forward while turning the power on with your left hand.
14. Allow the saw to reach full speed before making a cut.
15. Using your right hand, pull the saw slowly across the wood.
16. The saw tends to feed itself into the wood. Therefore, it is necessary to regulate the rate of cutting by holding the saw back. Otherwise, it will feed faster than it can cut causing the motor to stall.
17. The saw blade should not be pulled out any farther than is necessary to complete the cut.
18. The saw blade should not extend beyond the table in any operation you perform.
19. Return the saw to the rear of the table after each cut.
20. Do not release your hold on the saw until the blade comes to a complete stop.

CLEAN UP
1. Shut off the power.
2. Clean up any scrap wood.
3. Sweep/vacuum the radial arm saw and work area before leaving the machine.

Watch your hands!
Remain alert!
Avoid rushing through any procedure!

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE RADIAL ARM SAW
SEE THE OWNER'S MANUAL FOR MORE INFORMATION
RADIAL ARM SAW

OPERATING CONTROLS

The following is an explanation of the operating controls of the Delta 10" Radial Saw. We suggest you study these explanations carefully to familiarize yourself with the controls before turning on the power, to avoid damage to the saw or personal injury.

A - TRACK ARM CLAMP KNOB. Controls swing of track arm for all miter cutting operations. Locks track arm at any angle for the full 360° rotation. To rotate track arm loosen clamp knob and rotate arm. The arm will stop at the 0° and 45° positions right and left. To move the arm past these points the track arm index knob (B) must be pulled out.

B - TRACK ARM INDEX KNOB. Locates 0° and 45° position, right and left, of the track arm.

C - YOKE INDEX LEVER. Locates each 90° position of the yoke for ripping or cross-cutting operations. When rotating the yoke the yoke clamp handle must first be loose.

D - YOKE CLAMP HANDLE. The yoke clamp handle must be loose when rotating the yoke to the rip or cross-cut position.

E - ANTI-KICKBACK DEVICE. When ripping, the yoke is positioned and clamped so that the blade is parallel to the fence. The rear of the blade guard is lowered until it almost touches the workpiece. The anti-kickback rod is then lowered so that the fingers catch and hold the workpiece. Never rip from the anti-kickback end of the blade guard.

F - OVERARM ELEVATING HANDLE. Controls the depth of cut in all operations. Turning the handle raises or lowers the overarm.

G - CUTTINGHEAD CLAMP KNOB. Locks cuttinghead at any position on the track arm. When ripping the cutting clamp knob must be tight.

H - BEVEL INDEX KNOB. Locates 0° and 45° positions of the motor when bevel cutting. When tilting the motor for bevel cutting, the bevel clamp handle must first be loose.

I - BEVEL CLAMP LEVER. Controls tilt of motor for bevel cutting operations. Locks motor at any desired angle on the bevel scale.

J - TABLE CLAMP KNOBS. Allows the operator to quickly set the desired fence position.

K - ON-OFF SWITCH. Conveniently placed at eye level, switch can be turned on or off in an instant for added operator protection.

L - MITER SCALE. Indicates degrees left and right for setting track arm.

CROSS-CUTTING

The first operation which should be learned on the radial saw is cross-cutting. Cross-cutting consists of supporting the workpiece against the fence and pulling the saw blade through the material at right angles to it.

When cross-cutting, the track arm (A) should be indexed at "0" and the track arm clamp handle (B) Fig. 3, tightened. The fence should be clamped between the table boards. The saw blade is to be to the left and behind the fence. The workpiece is placed on the table and butted against the fence. The saw blade should be clear of the fence and table when the machine is turned on. Then the saw blade is lowered until it lightly cuts into the table surface. The operator should position himself a little to the left of the machine for better visibility while cutting. Pull the saw blade across the work, just far enough to cut it off, and return the saw blade to its starting position. Wait for the blade to stop before touching the cut off piece. CAUTION: The operator must always be conscious of where his hands are; that they are clear of the blade and holding the workpiece firmly. The operator should always be sure to return the cutterhead carriage to the full rear position after each cross-cut operation.
TABLE SAW

SAFETY
1. Wear safety glasses/goggles and face shield.
2. Inspect wood carefully for nails, staples, screws or embedded material.
3. Never attempt to cut warped stock.
4. The blade should project a maximum of 1/8" to 1/4" above the material being cut.
5. Be sure the guard is overlapping the blade and that the height adjustment is set so that the guard is lightly resting on the stock being cut.
6. Use the guard on all operations in which the blade cuts through the thickness of the stock.
7. Never stand or have any part of your body in line with the path of the saw blade.
8. Never reach behind or over the blade with either hand for any reason.
9. Do not lean into the saw when making a cut.
10. Do not perform any operation "free-hand". Always use either the rip fence or the miter guage to position and guide the work.
11. Do not force stock through the blade.
12. The miter/cross cut guide is used for making "cross cuts" (cuts across the grain of the wood).
13. Move the rip fence out of the way when cross cutting.
14. Never use the fence as a "cut-off-guage" when cross cutting.
15. The rip fence is used to make "rip cuts" (cuts with or along the grain of the wood).
16. Use a feather board to firmly hold the piece against the fence when making rip cuts.
17. Always use a push stick(s) when ripping narrow stock.
18. Hold stock being cut firmly against the guide and table. One hand should be holding the stock against the guide while the other hand is pushing the guide (cross cut) or stock (rip cut).
19. Always hold the stock firmly against the miter guage or fence.
20. Always wait until the blade comes to a complete stop before clearing scrap pieces from the table.
21. Use other safety devices (board buddies, miter stock hold-down clamp, etc.) whenever possible.

GENERAL
KICKBACK - Kickback is a violent reaction to a pinched or binding saw blade. It throws the stock being cut back (and, generally to the left) toward the front of the table saw. Factors that increase the chance of kickback include: dull blades, forcing the stock through the blade, improperly secured/guided stock, foreign material (staples, nails, screws, rocks) embedded in the material being cut and/or warped, twisted, low quality wood. Although it does not eliminate the risk, proper use of the safety devices provided in the wood shop greatly reduce the chance of kickback.

CLEAN UP
1. Turn off the power to the machine and wait for the blade to come to a complete stop.
2. Return the blade to a position beneath the level of the table (the blade should not be exposed).
3. Clean up scrap wood.
4. Sweep/vacuum the machine and the surrounding work area before leaving.

STAY ALERT, PLAN AHEAD, AVOID RUSHING THROUGH A PROCEDURE!

ALL GENERAL SAFETY RULES APPLY TO THE OPERATION OF THE TABLE SAW
SEE THE OWNER'S MANUAL FOR MORE INFORMATION
Motor: 1½ to 5 hp.
Blade: Can range in diameter from 8 to 12 in.
Blade Guard: Keeps hands away from blade, includes integral splitter and anti-kickback pawls.
Table Insert: Supports stock around blade.
Rip Fence: Sets and locks parallel to blade, guides work through blade—most secure versions lock to front and back rails.

Miter Gauge: Runs in groove parallel to blade. To guide board through cross cut, adjust head to desired angle, lock down, hold board edge against head.
Blade-Angle Adjustment: Turn to tilt arbor. Lock at desired angle.
Blade Height Adjustment: Turn to raise or lower blade, lock at desired setting.
On-off Switch: Safest types are magnetic (switching relay)—cannot switch back on after power interruption.
RIPPING AND CROSSCUTTING

Ripping

Set and lock the rip fence to the desired setting, adjust the feather board to bear against the board edge. The auxiliary fence, ending just past the far end of the blade, helps keep the board from binding on the blade. Push the board through the blade with a pushstick. Support the cut board with a roller stand or table.

To rip a board with a wavy or bowed edge, fasten it to a straight-edged strip of plywood. Hold the plywood edge to the rip fence as you run the board through the saw.

Crosscutting

Crosscut narrow pieces of wood using the saw’s miter gauge. The attached wood fence ensures a more accurate cut. A sandpaper strip prevents the stock from creeping during a cut. To make duplicate cuts, clamp a stop on the fence at the desired distance from the blade. To make duplicate offcuts, set a block on the rip fence to index the cut. Don’t let offcuts accumulate between the blade and the fence—they could vibrate into the blade and kick back at you. Never use the fence itself as a stop—the offcuts could jam between the blade and fence and fling back.
TABLE SAW

CROSS CUT SET UP

Anti-kickback device set to lightly touch stock being cut.

Guard positioned over blade. Adjusted to be lightly touching stock being cut.

Blade adjusted no more than 1/4" above the height of the stock.

Rip fence moved out of the way. Never used to cross cut stock.

Stock to be cut-free of nails, etc. Held against miter guide. Left hand holds stock firmly against guide & table. Right hand used to slowly push stock through the blade.

RIP CUT SET UP

Anti-kickback device adjusted to lightly touch stock.

Guard in proper position: covers blade and adjusted to lightly touch stock being cut.

Feather board clamped in place to provide pressure against fence and help prevent kickback.

Blade adjusted to no more than 1/4" above stock to be cut.

Rip fence properly adjusted to be parallel with the blade and locked in position.

One push-stick here to provide downward pressure and pressure against the fence.

One push-stick here to move stock forward and provide downward pressure.

Position of operator
**FASTENERS**

### Types of Bolts

Machine bolts are made in both square and hex head forms and have either square or hex nuts. Bolts are available with coarse and with fine threads.

Carriage bolts have coarse threads. The head variations include a countersunk flat-topped head in addition to the round head. Should keep the bolt from turning when the nut is tightening.

Stove bolts are made with slotted round, flat, or oval heads and they have coarse threads. Originally used in stove construction; now sold as general utility bolts.

### Head Styles and Applications

- **Flat Head** — Has flat top and conical bearing surface. For use where flush surface finish is required. Standard manufacture with 82-countersinking. Available with both slotted and recessed drives.

- **Round Head** — General purpose head for standard fasteners, available for slotted or recessed drives.

- **Oval Head** — Same dimensions as flat head except top surface rounded. For other than flush surface applications. Available for slotted or recessed drives.

- **Pan Head** — Most popular head style with flat bearing surface. Large diameter with straight sides and low profile. Standard in machine and tapping screws for slotted and recessed drive.

### Bolt and Screw Heads

- **Hexagon Head** (Chamfered)
- **Square Head** (Chamfered)
- **Truss Head** (Slotted or Pitched)
- **Round Head** (Slotted)
- **Flat Head** (Slotted)

- **Oval Head** (Slotted)
- **Truss Head** (Slotted)
- **Fillister Head** (Slotted)
- **Flat Head** (Phillips Replaced)
- **Square Head** (Cap Screw) (for Allen Key)

### Types of Screws

- **Flathead screws** are used in applications where the head must be flush with the surface or slightly below it. Both slotted and Phillips types are available.

- In **Oval head screws**, the lower portion of the head is countersunk and the top is rounded. They are easier to remove and better looking than flathead screws.

- **Round head screws** are utility screws, used where the fastened piece is too thin to permit countersinking, and also on pieces that may require a washer.

- **Dome head** — A decorative form of flathead screw concealed by a dome cap. Dome heads are categorized as ornamental and usually need to be special ordered.

- **Phillips head** screws have crossed slots to minimize screwdriver slip-out. Cross slots are available in most head types. A Phillips-type driver is required.

- **One-way screws** are designed to prevent burglary and theft. If anyone should attempt to remove the screw, the screwdriver would slip out of the slot.

- **Dowel screw** — This is the screw to use for end-to-end joints and similar applications unsuited to conventional screws. Usually available at large hardware outlets.

- **Hanger bolt** (or screw) has one end that is threaded like a screw so it can be driven into wood; the other end is threaded to accept a square or hex nut.

- **Lag bolt** (or screw) is actually a heavy-duty screw and is made in sizes up to 1½" in length. The head is square or hex shaped and driven with a wrench.

### Screws

- The above illustrates how these 3 different types of common heads appear when driven into the wood.

- The oval head screw extends above the surface in a slight oval. The round head screw protrudes slightly above the surface in a flat circle. The flat head screw is flush with the surface when driven into the wood.

### Screw Head Slots

- Screw head slots: Phillips, Slotted
FASTENERS
Washers and Nuts

Washers are used to increase the tightness of a fastener, to prevent friction and leaking, or to prevent the fastener from pulling out. Washer size is determined by the inner diameter. The size of the fastener head will determine what diameter washer to use.

Flat Washers - come in various thicknesses and diameters.
Lock Washers - have teeth either on the inside or the outside to prevent the loosening of a fastener. A split lock or spring lock washer grips and secures the nut.
Nuts - generally have square or hex-shaped heads and come in many variations of thickness and finish. They are also available as lock nuts, having nylon threaded inserts to prevent loosening.
Wing Nut - is designed to be tightened or loosened by hand.
Cap Nut - similar to a regular nut, but has a domed cover to serve as protection or decoration.

Nail Types and Uses

**Common Nail**: General-purpose heavy-duty type used in construction and rough work. Large head won't pull through.

**Penny** = the letter "d" used in length measurement of wood nails. English symbol signifying a pound in weight, related to the weight in pounds of 1000 nails. Sizes range from 2d (2-penny/1" long) to 60d

<table>
<thead>
<tr>
<th>SIZE</th>
<th>LENGTH &amp; GAUGE</th>
<th>DIA. HEAD</th>
<th>APPROX. NO. TO LB</th>
<th>SIZE</th>
<th>LENGTH &amp; GAUGE</th>
<th>DIA. HEAD</th>
<th>APPROX. NO. TO LB</th>
</tr>
</thead>
<tbody>
<tr>
<td>2d</td>
<td>1 inch, No. 15</td>
<td>11/64</td>
<td>845</td>
<td>10d</td>
<td>3 inch, No. 9</td>
<td>5/16</td>
<td>65</td>
</tr>
<tr>
<td>3d</td>
<td>1 1/4 inch, No. 14</td>
<td>13/64</td>
<td>540</td>
<td>12d</td>
<td>3 1/4 inch, No. 9</td>
<td>5/16</td>
<td>60</td>
</tr>
<tr>
<td>4d</td>
<td>1 1/2 inch, No. 12 1/2</td>
<td>1/4</td>
<td>290</td>
<td>16d</td>
<td>3 1/2 inch, No. 8</td>
<td>5/16</td>
<td>45</td>
</tr>
<tr>
<td>5d</td>
<td>1 3/4 inch, No. 12 1/2</td>
<td>1/4</td>
<td>250</td>
<td>20d</td>
<td>4 inch, No. 6</td>
<td>5/16</td>
<td>30</td>
</tr>
<tr>
<td>6d</td>
<td>2 inch, No. 11 1/2</td>
<td>17/64</td>
<td>165</td>
<td>30d</td>
<td>4 1/2 inch, No. 5</td>
<td>7/16</td>
<td>20</td>
</tr>
<tr>
<td>7d</td>
<td>2 1/4 inch, No. 11 1/2</td>
<td>17/64</td>
<td>150</td>
<td>40d</td>
<td>5 inch, No. 5</td>
<td>5/16</td>
<td>17</td>
</tr>
<tr>
<td>8d</td>
<td>2 1/4 inch, No. 10 1/4</td>
<td>9/32</td>
<td>100</td>
<td>50d</td>
<td>5 1/2 inch, No. 3</td>
<td>1/2</td>
<td>13</td>
</tr>
<tr>
<td>9d</td>
<td>2 3/4 inch, No. 10 1/4</td>
<td>9/32</td>
<td>90</td>
<td>60d</td>
<td>6 inch, No. 2</td>
<td>17/32</td>
<td>10</td>
</tr>
</tbody>
</table>
Sandpaper

In the old days, luthiers used patches of shark skin to smooth violin backs to a velvet finish. These days, woodworkers can choose from a wide variety of abrasive materials and backings to meet specific sanding needs.

Sandpaper Types and Applications

**Flint**
- Yellow color. Inexpensive but quick-wearing. Ineffective on hardwoods.

**Garnet**
- Red color. Slightly harder and longer lasting than flint. Use to hand-sand both hard and soft woods. Produces a smooth finish.

**Aluminum-oxide**
- Brown color. Synthetic material harder than natural abrasives. Use for hand- or power-sanding of all woods and plastics. To minimize clogging, choose open-coat type for sanding paint and resinous softwoods.

**Stearate-coated aluminum-oxide or silicon carbide**
- Grey or gold color. The zinc stearate coating acts as a lubricant, allowing clog-free sanding of softwoods (pines), synthetic finishes and sealers. (Never use prior to applying lacquer.)

**Silicon Carbide**
- Black color. Extremely hard synthetic abrasive. Use with water or mineral oil as a lubricant when sanding hardwoods and finishes. Finest grits produce a mirror-like polish.

<table>
<thead>
<tr>
<th>Sandpaper Grades</th>
<th>Description</th>
<th>Grit</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Coarse</td>
<td></td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
<td>1/2</td>
</tr>
<tr>
<td>Coarse</td>
<td></td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>2/0</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>120</td>
<td>3/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150</td>
<td>4/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>180</td>
<td>5/0</td>
</tr>
<tr>
<td>Fine</td>
<td></td>
<td>220</td>
<td>6/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>240</td>
<td>7/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>280</td>
<td>8/0</td>
</tr>
<tr>
<td>Very Fine</td>
<td></td>
<td>320</td>
<td>9/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>360</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>500</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
<td>—</td>
</tr>
</tbody>
</table>

**Using Sandpaper**

When hand-sanding, ensure a flat surface and extend the life of the paper by using a cork or rubber sanding block. Use commercially made blocks or shape one out of a softwood (pine) to suit a particular situation. For a smooth finish, sand to 120 grit for soft woods and open-pore hardwoods; go to 220 for dense hardwoods. Use progressively finer grits, sanding enough to smooth the surface and to remove the scratches from the previous grit. Use finer grits to sand between finish coats.

To hand-sand odd-shaped forms, fold the sandpaper as shown. Expose a fresh surface as needed.

For power-sanding, buy sheets precut to the size of the machine. To speed changing paper, choose either pressure-sensitive adhesive (PSA) or hook-and-loop backed paper. Never bear down on the machine—instead, go slowly and let gravity and the tool do the work for you.

**Tip:** Store sandpaper in sealed plastic bags to prevent moisture degradation.
How to Pick Lumber

Even within the same stack of lumber, you'll often find striking differences between individual pieces. Whenever possible, sort through the stacks yourself; most lumberyards will let you look and choose if you neatly repile the stacks. Here's what to look for.

Moisture content. When wood is sawn, it's still "green"—that is, unseasoned. Before it's ready for use, the best lumber is dried, either by air-drying or kiln-drying. Kiln-drying, the more expensive process, reduces the moisture content of the wood to less than 8 percent.

Almost all hardwoods you'll find will have been kiln-dried. Softwoods come either air- or kiln-dried, or green. For interior woodworking projects, buy kiln-dried lumber whenever possible. If you do choose the air-dried type, look for wood stamped "MC-15"; this indicates a moisture content not exceeding 15 percent. If you opt for green wood, you're asking for trouble later from splitting, warping, or shrinkage.

Vertical or flat grain? Depending on the cut of the mill saw, lumber will have either parallel grain lines running the length of the piece (vertical grain) or a marbled appearance (flat grain). Vertical grain results from quarter-sawn lumber—a cut nearly perpendicular to the annual growth rings. Flat grain results when pieces are flat-sawn, or cut tangential to the growth rings.

Vertical-grain lumber is stronger and less likely to warp or shrink noticeably. On the other hand, flat-sawing generally produces more "figure"—the attractive patterns produced by knots, crotches, pores, and growth rings.

Weathering and milling defects. Examine the available lumber closely for defects, many of which are illustrated below. Reject pieces that have obvious defects.

To test for warping, lift each piece by one end and sight down the face and edges. A crook (or crown) is an edge-line warp, a bow a face warp. Cups are bends across the face; twists are multiple bends. Pieces with long, gentle bends can sometimes be planed flat or made straight when they're nailed.

Other defects to look for include knots and knotholes, checks, splits, shakes, and wane. Tight knots are usually no problem; loose ones may fall out later—if they haven't already left holes. Checks are cracks along the annual growth rings in the wood; splits are checks that go all the way through the piece; and shakes are hollows between growth rings. Wane means that the edge or corner of the piece has either untrimmed bark or a lack of wood.

Also be on the lookout for general problems such as rotting, staining, insect holes, and pitch pockets (sap reservoirs below the surface). Try to avoid the "bull's-eye pieces" milled from the center of the log; they tend to crack and warp more easily than other pieces.

COMMON LUMBER DEFECTS

Watch for these flaws when you're choosing lumber.
Defects in Wood

Like all living things, wood is not perfect. Natural impediments to growth, or damage inflicted during the seasoning, storing or machining processes, produce defects that affect the appearance and workability of the wood.

Wood Defects

**Knots:** Knots appear when the board includes a cross section of branch. Knots degrade strength and affect appearance.

**Pitch pockets:** These are voids between grain layers that are filled with pitch. Commonly found in softwoods, pitch pockets may bleed pitch after the board is milled. They sometimes continue to bleed after the board is finished.

**Bark pockets:** In these areas, the wood has encased a section of bark. Bark pockets degrade appearance and strength.

**Insect and fungal damage:** Insects create holes. Fungi can cause stains (spalting). Advanced damage can weaken the wood.

**Warp:** Boards cut from stressed areas of a tree (near the base of large branches, for example), are susceptible to warping. Improper storage or seasoning can also be a cause. Warped boards produce excessive waste in the milling process.

**Shakes:** This separation of the wood between growth rings can be caused by growth problems, felling of the tree, or improper seasoning.

**Checks:** If the wood is dried too quickly, internal stresses may overpower the wood and cause it to separate along the growth rings. Most boards usually have some surface checking or end checks, but deep splits and honeycomb can render a board unusable.

**Machine burn, waves:** Dull planer knives can burn the surface of the wood. Improper feed speeds can create undulations. The boards must be thinned further to remove these defects.
Choosing Lumber

Lumber of the same species and size is graded on a scale: the top grade may be virtually flawless, the bottom grades virtually unusable. At the mill, lumber is sorted into grades, then identified with a stamp or inventoried by species and grade name. Lumberyards sometimes refer to these grades by different names, so look for a grading stamp or ask for help.

All grading distinctions are based on defects. The most economical approach is to decide what you can live with and buy the lowest acceptable grade.

**Softwood grades.** Softwoods are broken down into two basic categories: dimension lumber (graded for strength) and boards (graded for appearance).

For woodworking projects, you'll usually need appearance-graded boards. The most common grading system, employed by the Western Wood Products Association, is shown in the chart at left. Use the chart and the additional guidelines that follow to help you choose.

For a perfect, natural finish, buy top lumber. If you plan to paint, buy a lower grade—paint hides many defects. No. 2 and No. 3 Common grades are economical choices, but you must be selective. And if only one side will show, you may find a lower-grade board with one defect-free face that will suit your purpose.

To thicken the plot, certain lumber species, notably redwood and Idaho white pine, have their own grading systems. Look for these grades of redwood, listed in descending order of quality: Clear All Heart, Clear, B grade, Select Heart, Select, Construction Heart, Construction Common, Merchantable Heart, and Merchantable. For Idaho white pine, the categories are Supreme, Choice, Quality, Sterling, Standard, and Utility.

Dimension lumber is rated primarily for strength in house framing, but it can be used in woodworking when extra strength or thickness is required. Select Structural is the top of the line.

**Hardwood grades.** Hardwoods are graded by the number of defects in a given length and width of board. The chart at left gives the grading system used by the National Hardwood Lumber Association.

The best grades are Firsts, Seconds, and a mix of the two called FAS. These grades apply to clear wood at least 8 feet long and 6 inches wide. Next comes Select, which permits defects on the back. Select is followed by No. 1 and No. 2 Common. Lesser grades are often unusable.

Between FAS and Select are two subgrades: FAS 1 face and Select and better. The former, graded FAS on one side but No. 1 Common on the back, may be an economical choice.

---

**COMMON SOFTWOOD GRADES**

<table>
<thead>
<tr>
<th>Boards 1&quot; and thicker</th>
<th>Selects</th>
<th>C and better D Select</th>
<th>Finish</th>
<th>Superior Prime</th>
</tr>
</thead>
</table>

**General-purpose boards (knotty)**

<table>
<thead>
<tr>
<th>WWPA grades</th>
<th>No. 2 Common and better</th>
<th>No. 3 Common</th>
<th>No. 4 Common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative common grade names</td>
<td>Construction Standard better</td>
<td>Standard and Utility</td>
<td></td>
</tr>
</tbody>
</table>

**Dimension lumber 2 by 2 through 4 by 18**

<table>
<thead>
<tr>
<th>Light framing</th>
<th>Standard and better Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 by 2 through 4 by 4</td>
<td>Stud</td>
</tr>
<tr>
<td>2 by 2 through 4 by 6 10' and shorter</td>
<td>Select Structural No. 1 No. 2 No. 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structural light framing</th>
<th>Select Structural No. 1 No. 2 No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 by 2 through 4 by 4</td>
<td>No. 2 and better</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structural joists and planks</th>
<th>Select Structural No. 1 No. 2 No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 by 6 through 4 by 18</td>
<td>No. 2 and better</td>
</tr>
</tbody>
</table>

---

**COMMON HARDWOOD GRADES**

<table>
<thead>
<tr>
<th>Boards 1&quot; (%6) and thicker</th>
<th>Firsts</th>
<th>Seconds</th>
<th>FAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selects</td>
<td>No. 1 Common</td>
<td>No. 2 Common</td>
<td></td>
</tr>
</tbody>
</table>