Safety Manual

Model Shop

Judson University

Elgin, Ill

ARC101 - Shop Stewardship, Materials, and Processes

Student Responsibility Acknowledgement Sheet

As a student enrolled in ARC101, I acknowledge and agree to the following while making use of the Model Shop during this course, as well as for the remainder of my time here as a student at Judson University:

- I will read the Judson University Model Shop Safety Manual.
- I will obey the Model Shop Rules while using the Model Shop.
- I will follow all directions given to me by the instructor or student shop supervisor.
- I will ask the instructor or student shop supervisor for assistance whenever I have questions or feel that I cannot perform an operation safely.
- I understand that the principle of stewardship is to be followed while working in the shop. Therefore, I will be a good steward of all resources available to me in the shop; I will not knowingly waste supplies or damage shop equipment.
- I understand that I am responsible for all tools that I use in the shop or check out from the shop. If tools are lost, stolen, or damaged through misuse while I am responsible for them, I understand that my student account will be charged to cover their repair or replacement. If tools I check out of the shop are returned late, I understand that I am responsible to pay the accrued fines.
- I understand that the safety rules for the use of equipment inside the shop are to be followed while using borrowed equipment outside of the shop.
- I understand that the shop is an inherently dangerous place to work, and that no matter how diligent I am, one cannot eliminate all possibility of injury. I also understand that the instructor and student shop supervisors are not the guarantors of my safety. Therefore, I will be responsible for my own health, safety, and welfare while working in the shop.
- I understand that the use of the woodshop is a privilege, not a right, and my failure to carry out these responsibilities will result in the loss of my shop privileges.

_____

Major

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Printed Name

Signed Date

Fall 2017

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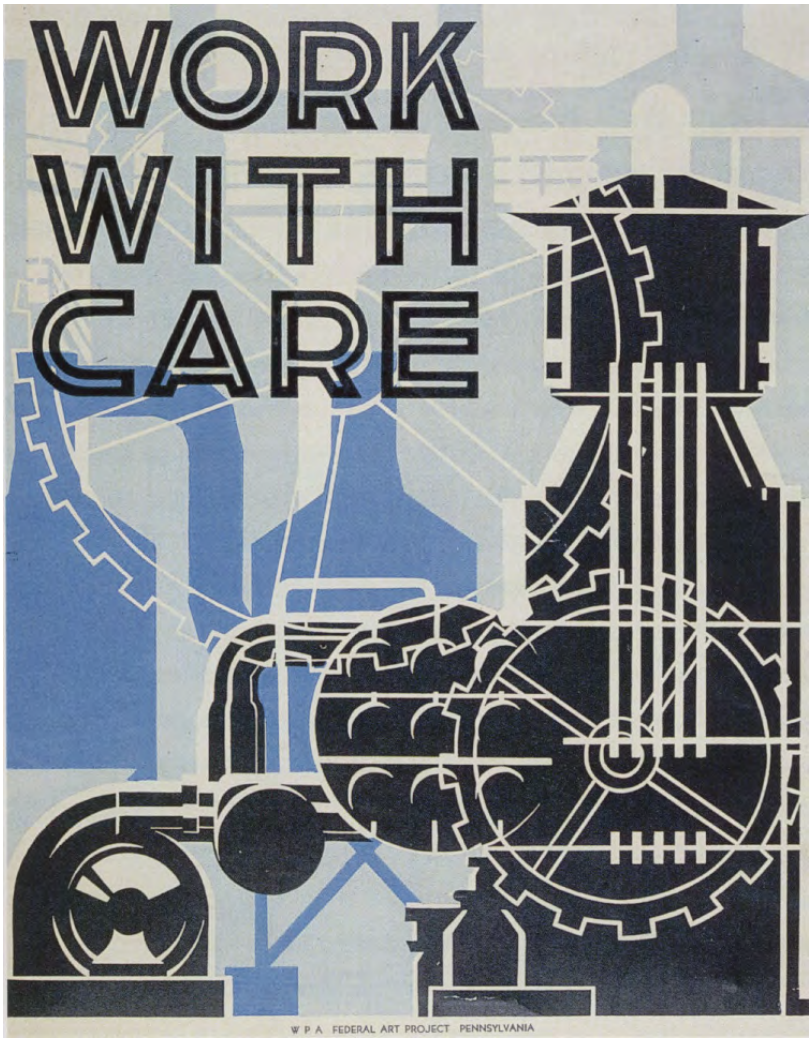
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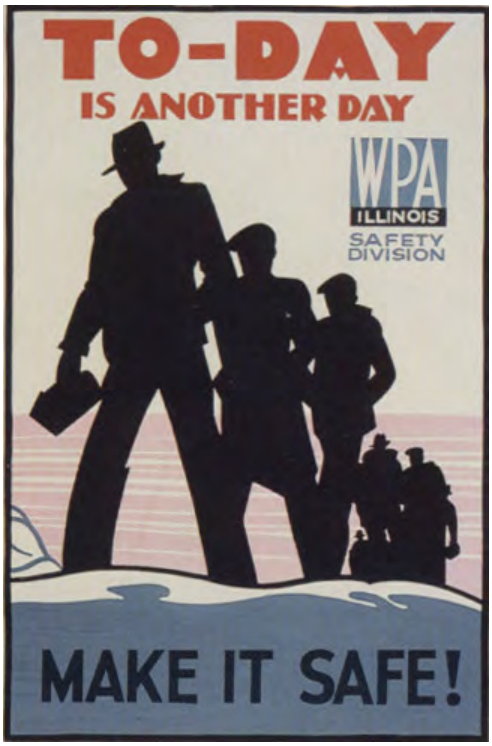
Forward

The primary mission of the Model Shop is to simply support you, as a student enrolled in classes in the departments of Architecture & Interior Design and Art & Design here at Judson University, with the tools, assistance, and knowledge you will need in order to complete projects that will be required of you in your various classes. While that may be the base mission of the Model Shop, it is my sincere hope that during your time here, you will develop a certain appreciation for materials, as they are the vocabulary with which you speak as a designer. I also hope that you develop an appreciation for craft, regardless of the medium, but especially when working with wood (which just happens to be my favorite medium). While anybody can slap together something and call it done, it takes someone with a certain sense of pride in their work, curiosity about what may be possible, and the patience and willingness to stay at it until it is done well that marks a student who is serious about the craft itself and its use as a vehicle to express themselves through design. One of the things that keeps the craft interesting and constantly evolving is the **differing visions that people have for how they interface with the craft**. As a craft, woodworking is **almost unlimited in its ability to express the vision of the designer**. It is my hope that you will see that potential and take an interest in learning how to take advantage of it.

For those of you who fall into the category of wanting to learn more about the craft, know that I (and my staff) will be here to support you with whatever it is that you may need; be it as mundane as telling you the best places to go to buy supplies, or more involved like teaching you some new skill or some subtle aspect of a process you are using. As with all crafts, it is that attention to detail and subtleties that separate those who are serious about the craft from those who are not. Those who are willing to slow down and pay close attention to what they are doing will always achieve the best results. Craft is not a monologue; it is a dialogue between the material and the maker. The material itself should be guiding you, even while you are working to transform the material.

Stewardship

While stewardship may not be an obvious thing to talk about in the context of a shop safety class, it is the core concept of this class. Being a steward of something simply means that you have a responsibility to take care of something. For the purposes of this class, we will address stewardship in three distinct areas. These three areas are summarized as follows:



Personal Stewardship: This is the stewardship of the body God has given you. Take care of yourself in the shop and be a good steward of what God has given you. While actual accidents are unavoidable, reckless behavior that leads to an "accident" **is** avoidable.

Environmental Stewardship: This is the stewardship of God's creation. From using what you learn here in school to make wise decisions about how to design in an environmentally-friendly manner, to helping the shop use materials efficiently, this is all part of caring for (being a good steward of) creation.

Corporate Stewardship: This is the stewardship of the resources God has given to this institution. From using the machines in a manner that will not damage them, to being responsible about the consumption of resources within the shop, this is all a part of being a good steward of the resources available to us here at Judson.

Shop Safety

Personal stewardship being the primary focal point of this class, shop safety is the biggest subject we will discuss across the semester, and should remain front and center in your mind every time you make use of this shop, for as long as you are a student here at Judson. One of the first things to understand about shop safety is a very simple concept: failing to follow the rules for the safe operation of the machinery will make you an inherently unsafe person. **An inherently unsafe person is**

unsafe not only to themselves, but also to everyone else working in the shop with them. Working safely helps to protect not only you, but everyone else in the shop as well. Only you can be responsible for your own safety, and working safely will require that you maintain a high level of self-discipline while working in the shop. All too often it is so tempting to think "I know the proper way to do this, ***BUT*** it would be so much easier/faster if...." This is the type of thinking that all too often ends with a trip to the hospital.

Always plan in advance for time you will need to be in the shop for your school projects, and always give yourself ample time to do the work at hand. Work in the shop should be a careful, planned, deliberate exercise, not a frenetic burst of nervous energy. The Norm Abrams mantra of "measure twice, cut once" is in line with an approach towards work that is not rushed, but is instead paced, purposeful, and deliberate. **You must take ownership of your own health and safety**; I cannot do that for you, nor can any of the student shop supervisors.

Respiratory Safety

Although the shop is equipped with an industrial-quality dust collection system, it cannot eliminate all wood dust, and it has almost zero impact on dust raised by hand tools or portable power tools. Because wood dust is known to aggravate a wide variety of respiratory ailments, you will be well advised to wear a dust mask any time you work in the shop if you are a person who suffers from such an ailment. Additionally, certain woods are listed by some regulatory agencies as known carcinogens; your efforts to limit your exposure to wood dust will be appreciated by your lungs. Because you must take ownership of your own health, safety, and welfare while working in the shop, **you are urged to wear a dust mask if you are working with equipment that is not connected to the dust collection system or if you have any respiratory ailments.** Dust masks are available in the shop for your use for exactly this purpose.

Hearing

This is also an area where you must take ownership of your own health, safety, and welfare. Exposure to loud noises for prolonged periods of time can cause permanent hearing loss. You will need to be your own judge as to what constitutes a noise source that is loud enough to require hearing protection. To protect your ears from damage due to such exposure, we have a supply of ear plugs for your use. Worn properly, they will provide you with ample hearing protection. If you do not know how to fit them correctly into your ears, ask the shop supervisor for assistance.

Vision

Your vision is probably the sense most susceptible to damage while working in the shop. Because of this, **we require that everyone who enters the shop** wear proper eye protection. This can be in the form of safety glasses or eyeglass shields, which are worn over prescription eyeglasses. Eyeglasses alone are **not** acceptable eye protection for the shop environment.

General Shop Safety

First Aid

There is a first aid kit in the shop that is kept on top of the Jobox at all times. If any sort of unfortunate mishap should occur, please immediately notify the shop supervisor who is on-duty, and they will assist you with use of the first aid kit.

General Fire Safety

The single biggest cause of fires in shops is electrical in nature; the runners up are improper handling of flammable liquids and saw dust explosions. No matter how safely we work, we can never eliminate the risk of fire in the shop. Because of this, **always know where the fire extinguishers are and** how to use them.

Flammable Liquids

In the course of finishing (varnishing, staining, painting, etc.) your projects, you will almost certainly use flammable liquids of some sort. The first rule for the use of flammable liquids is this: **talk to the shop supervisor *before* using any flammable liquids in the shop.** Failure to dispose of waste liquids and rags created by the finishing process presents a potentially serious fire risk. The shop supervisor will direct you in the proper handling and disposal of these materials.

Electrical

Electrical problems are the single biggest cause of fires in shops. The first rule of electrical safety is this: do not overload an electrical circuit. If a

circuit breaker does trip, do not simply reset the breaker and start working again. Contact the shop supervisor for assistance, and figure out why the breaker tripped. **A tripped circuit breaker is a symptom of a problem, not the problem itself.**

General Machine Safety / Set-Up

Machine Safety Placards

While the basic ground rules for the use of the shop as a whole are laid out in the Model Shop Rules, there are additional specific rules of operation for each machine in the shop. For every piece of fixed power equipment in the shop, there is a safety placard posted on or nearby that machine. If it has been awhile since you last used a particular machine in the shop, please take a minute to read the appropriate placard or review the appropriate section of the Model Shop Safety Manual **before** you turn on the machine.

Machine Calibration

This is the last "general rule" that applies to all the machines in the shop: **check it for square first**. You should do this every time you start to work on a machine. There is no guarantee that the machine is set to square. If the machine is out of square, any hope for precise work will be lost. **Always check for square first.**

Model Shop Rules

1. **DO NOT WORK IN THE SHOP UNLESS A SHOP SUPERVISOR IS PRESENT.**
2. Shop is for use by current Judson students who have passed ARC101, staff, faculty, and Model Shop members.
3. Sign in upon entering the shop to work.
4. **Wear proper eye protection while in the shop,** regardless of what you are doing.
5. Do not wear loose-fitting clothing; push up all long sleeves; no open-toe footwear.
6. Tie back shoulder-length and longer hair; remove all hanging / dangling jewelry.
7. No iPods / earbuds / headphones when working with any power equipment.
8. Review the safety manual or posted safety placard for each piece of machinery **before** operating.
9. Maximum capacity of the shop is approx. 10-14 students (or less, depending on situation). Shop Supervisor reserves the right to refuse entry if the shop has, in his/her judgment, reached capacity.
10. Architecture/Interiors/Art/Design students have priority over others; school work has priority over personal work.
11. Shop Supervisor reserves the right to eject any student from the shop who is working in an unsafe manner.
12. **Do not remove anything from the Jobox**; ask a shop supervisor to get those tools for you.
13. **Sign out all tools removed from the shop. Tools not returned within 72 hours will accrue fines of $1.00 per tool, per day. You will be billed for anything you do not return.**
14. No balsa wood or treated lumber is allowed in the shop. Treated lumber may only be machined with portable tools, outdoors. Recycled / used lumber may be used only with permission from the Model Shop Manager.
15. All glue, sandpaper, nails, screws, etc., and scrap wood stored under the Sliding Compound Miter Saw are free - please be considerate of others in their use. All other materials in the shop are for sale; talk to the shop supervisor for pricing. Sales are by e-check and credit/debit cards only. Surcharges on all sales are per current Judson University policy.
16. Talk to shop supervisor **before** using paint/thinner/varnish/chemicals. Dispose of all contaminated waste properly. See shop supervisor for instructions.
17. **Stop working ten minutes before leaving and clean up** (this includes sweeping floors around all work areas, clearing workbench, and using the shop vac to clean off all machines used).
18. **Return all tools from the Jobox** to the Shop Supervisor. Return all tools from the tool storage wall cabinet yourself.
19. **Remove supplies/project from the shop** when leaving the shop.
20. Sign out when leaving the shop.

Basic Woodworking Concepts

Working with Wood

Before beginning to work with wood as a designer or fabricator, it is best to have some knowledge of the material itself. As a product of nature, wood comes with all sorts or quirks and irregularities that, while giving it its inherent natural beauty, also tend to complicate working and living with the material. For example, wood changes size as the humidity in the air changes. Remember that door at home that always sticks in the summer, but opens without a problem in the winter? The higher humidity in the summer results in the wood swelling, which equals a door that won't close properly. As a designer or fabricator, you will need to be aware of the natural properties of wood in order to successfully work with wood.

Strength of Wood

The first, and most basic, rule of working with wood is that the strength of wood lies along its grain. Pieces cut cross grain have but a fraction of the strength of a piece of wood where the grain is oriented properly. As a designer or fabricator, failure to remember this first rule will almost certainly result in structural failure of your project.

Glue Joints

Probably the second most important basic rule of working with wood is to understand that to successfully join together two pieces of wood (as is almost always going to be required when building something), the joint needs to accomplish two goals: create a surface for the glue to work, and (if possible) create some form of mechanical attachment. The mechanical attachment can be either through the use of a fastener like a screw, or it can be inherent in the design of the joint itself.

The rules for gluing two pieces of wood together can be summarized as follows:
End grain to end grain glue joints equals very weak joints.
End grain to face or edge grain glue joints equals fair joints.
Edge or face grain to edge or face grain glue joints equals very strong joints.

The means by which you create the mechanical attachment in the joint are unlimited. The joint can be as simple as a screw holding things together, or as complicated as the joinery used in **traditional Japanese house construction**. Joinery can be integral to the design of the piece**, played up for maximum visual effect**, or can be completely unseen to the viewer. If you can think of a way to connect the wood so that some form of mechanical attachment is achieved, while also allowing for some form of glue surface to be created, you will have created a valid wood joint.

Cutting Wood

Before beginning to work in the shop, it is good to understand the basic vocabulary of the types of cuts that the various machines in the shop are capable of making. What follows a basic listing of the standard types of cuts that can be made to a board in the shop. This list can be broken into two distinct classes of cuts: through cuts, and partial depth cuts. Through cuts, as the name implies, are when you cut all the way through a given board, cutting it into two or more pieces. Partial depth cuts, as the name implies, are cuts that do not go all the way through the thickness of a board.

Types of Through Cuts are as follows:

Rip Cut: Cutting parallel to the grain, with the blade perpendicular to the top surface of the board. Think of this as making the board narrower.

Beveled Cutting parallel to the gain, with the blade not perpendicular to the top **Rip Cut:** surface of the board. Think of this as a Rip Cut with a knife edge.

Cross Cut: Cutting perpendicular to the grain, with the blade perpendicular to the top surface of the board. Think of this as making the board shorter.

Beveled Cutting perpendicular to the gain, with the blade not perpendicular to the **Cross Cut:** top surface of the board. Think of this as a Cross Cut with a knife edge.

Miter Cut: Similar to a Cross Cut, but made with the cut not perpendicular to the grain. This is the cut you make when building a picture frame.

Compound Similar to a Miter Cut, but made with the blade not perpendicular to the **Miter Cut** top surface of the board. Think of this as a Miter Cut with a knife edge.

Types of Partial Depth Cuts are as follows:

Rabbet Cut: Partial depth cut, at any edge of the board.

Dado Cut: Partial depth cut, made in the middle of the board, running across the grain of the board.

Groove Cut: Partial depth cut, made in the middle of the board, running with the grain of the board.

Basic Marking and Measuring Equipment:

We use a variety of tools in the shop for marking and measuring. In most cases, there is no right or wrong tool for the job; there is simply the one with which you are most comfortable using. We have, in the shop, the following basic tools for performing marking and measuring work:
Tape Measure, Carpenter's Square, Combination Square, T-Square, Pencil, Marking Gauge, Saddle Square, Compass, Beam Compass, Dial Caliper.

System of Measurement

For those of you who grew up on the metric system, you will need to learn how to work in our English system of measurement, as everything we do in the shop involves the use of this system of measurement; all machines in the shop are calibrated in the English system of measurement. Unlike the metric system, where everything is divided into units that are all based on powers of ten, our English system can be a bit confusing in that it is based on fractions that are all powers of two (1/2, 1/4, 1/8, 1/16, etc., for fractions of an inch) and groupings of 12 (inches per foot), 3 (feet per yard), 1760 (yards per mile), and 5,280 (feet per mile). While the system as a whole can be very confusing, for the purposes of working in the shop, you will really only need to know how to work with inches and feet.

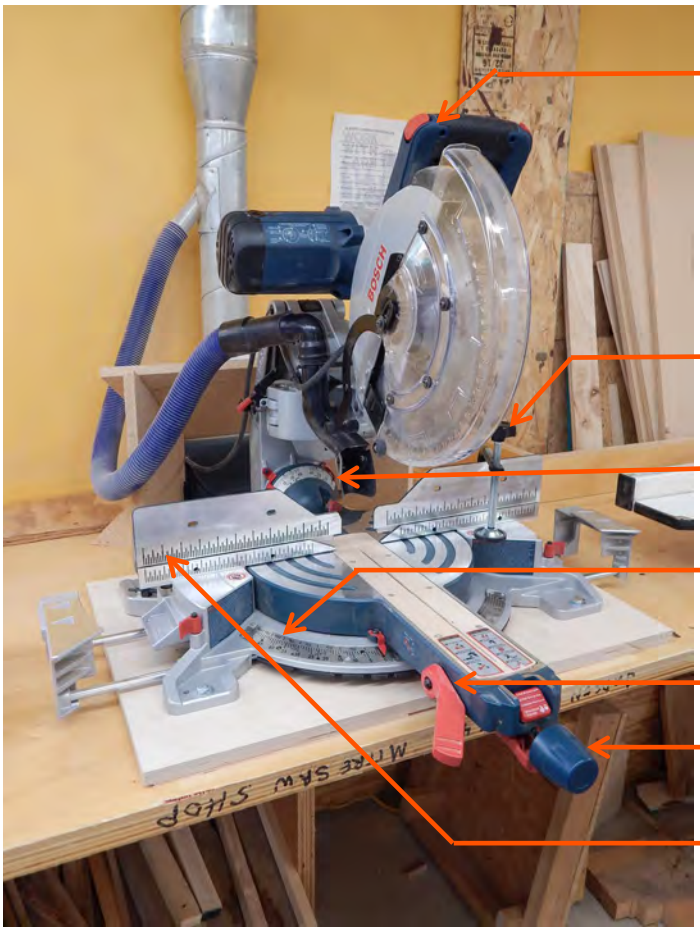
Inches and feet are the two most-common units in the English system of measure of lengths. There are 12 inches in a foot. For smaller measurements, there is no absolute rule as to how to express a particular measure. For example, twenty six inches could be expressed as twenty six inches just as easily as it could be expressed as two feet two inches. Inches are divided into fractions based on powers of two. Thus, we typically will not use measurements like 0.40 inches or 0.20 inches, but instead will use three eighths of an inch (0.375") or three sixteenths of an inch (0.1875"). Typically, the smallest fraction of an inch with which we will work will be thirty-seconds of an inch (0.03125").

When expressing lengths of measure as written numbers, use the ' symbol to denote feet and the " symbol to denote inches. Thus, six and thirteen sixteenths inches is expressed as 6 13/16". Ten feet three inches is expressed as 10'-3". Sixteen inches can be expressed as 16" or 1'-4". One foot and 5/8 inches is expressed as 1'-0 5/8" or 12 5/8". Even if you are familiar with the English system of measurement, you may still experience some difficulty in being able to quickly read a tape measure or ruler that is calibrated in the English system. Both English system natives and non-natives alike may find some benefit from the following link that discusses the basics of **how to read a tape measure**.

Varieties of Wood

Trees, like the rest of God's creation, exist in an absolutely dizzying array of diversity. The **lumber that those trees produce** is an even more diverse lot, as one tree, depending on how it is processed, can yield several very different types of lumber. Those different types can be a result of how the tree was cut up, what part of the tree was cut, or different combinations of those two factors. The spectrum of colors of wood available globally is far more interesting, and far more diverse, than the standard tans, browns, and reds to which we are accustomed here in North America. Whatever species you decide to use for a particular project, the one thing I would encourage you to do is to make stewardship of creation something that you always keep in focus while designing.

Gliding Compound Miter Saw



The gliding compound miter saw is a **circular saw** that glides on an armature and has a head that is adjustable about two axes, allowing it to make crosscuts, miter cuts, and compound miter cuts. It is designed to cut across the grain of the wood, making boards shorter. While the table saw is capable of making the same cuts as the gliding compound miter saw, the gliding compound miter saw will do the same job with a greater degree of accuracy and safety. Because it is a circular saw, this saw can only make straight-line cuts; **attempting any sort of free-hand or curving cut will result in kickback**.

The gliding compound miter saw works by cutting through a stationary board that is held tight to the fence (which acts as a reference edge for the saw). The fence prevents the board being cut from moving during the cut and also holds the board perpendicular to the blade. To maintain accuracy and safety, **only boards that have a clean, jointed (straight) edge should be cut on this saw** and the jointed edge **must** be placed tight to the fence. The single biggest danger of this saw is getting your fingers caught in the blade. To avoid this type of injury, simply **keep your fingers at least 6" away from the blade when operating the saw**. Outside of that, the most common difficulty that users of this machine experience is that of kickback. **Kickback** is what happens when a rotary cutting action is stopped suddenly and the inertial forces of the machine are dissipated very quickly. The cutting action is most commonly stopped because the wood slips just a bit and is then able to pinch the trailing edge of the blade. In the case of this machine, the resultant force of the kickback is that the head of the saw tends to jump up and backwards, towards the operator. Because of this, stand ever so slightly to the side of the machine when using it. This will prevent you from being hit by the machine if kickback does occur. To minimize the risk of kickback, **always** place a clean, jointed edge towards the fence, use a firm grip on both the machine and the board being cut, and always use the clamp, if it will reach.

As with every other piece of equipment in the shop, one should **always cut against the rotation of this machine**. If you conceptualize the blade of the gliding compound miter saw as a large wheel, that wheel will want to roll towards you when the machine is running; to cut against the rotation of the machine, you must push the machine away from you. Thus, to operate the machine, pull it out all the way towards you, turn it on, push it down into the wood, and make the cut by pushing the saw away from your body. Do not start to lift up the head of the saw until you feel the saw hit the stop at the end of its horizontal travel. For the cleanest possible cut on the end of your board, do not lift up the saw until it stops moving.

The rules for this saw are as follows:

ALWAYS make certain you are cutting on the “right” side of your line.

ALWAYS place a clean, jointed (straight) edge towards the fence.

ALWAYS stand slightly to the side of the machine

NEVER attempt curving or free-hand cuts.

ALWAYS use the hold-down clamp, if it will reach your work piece.

NEVER place your hand closer than 6” from the blade.

ALWAYS maintain a firm grip on both the saw and the work.

NEVER start the saw with the blade touching the work.

ALWAYS allow the saw to attain maximum RPM’s before contacting the work.

ALWAYS push the saw through the work (away from your body) with a steady down- swing and forward motion.

NEVER push so hard or fast as to stall the motor.

ALWAYS allow the saw to come to a complete stop before moving work.

Table Saw

Outfeed table

Blade Guard / Riving Knife / Anti-kickback pawls

Rip Fence

Rip fence width indicator

Miter Gauge track

Miter Gauge

The table saw is, like the sliding compound miter saw, a circular saw. This means that it can only be used to make straight cuts. The table saw excels at making rip cuts and bevel cuts (cuts that make your board narrower), but it is also perfectly suited to do all the same crosscutting functions that the sliding compound miter saw does (cross cuts, miter cuts, compound miter cuts). In most instances though, you will be best served by using the gliding compound miter saw for crosscutting functions, as it is safer and more accurate than the table saw for those cuts.

Unlike the gliding compound miter saw, where the wood was held fast to a reference edge and the saw passes through a stationary board, the table saw works by pushing the board through a stationary saw blade. Because of that important difference, kickback on the table saw is very different than it is on the gliding compound miter saw. If the board pinches the blade and causes a kickback on the table saw, the saw will very violently throw the board back at the operator. Kickback on the table saw is not something that you can fight by simply pushing harder, as kickbacks can happen with enough force to knock you off your feet. This is a very serious point for concern and most of the discussion here on the table saw is designed to help you avoid kickbacks.

To address the danger of kickbacks, the table saw comes equipped with a combination blade guard (to help keep your fingers out of the blade) and riving knife with anti-kickback pawls (to help prevent kickbacks). **ALWAYS** use the blade guard/riving knife, unless it is physically impossible to do so (e.g. partial depth cuts require the removal of the blade guard and riving knife). The riving knife helps prevent kickbacks by keeping the board travelling in a straight path as it exits the blade. The anti-kickback pawls on the riving knife help prevent kickback by grabbing and stopping any board that is starting to move backwards through the saw. These two features, along with good operator technique will greatly reduce the probability of experiencing kickback on this saw.

The other major safety danger on the table saw is that of simply getting your hand caught in the blade. For fairly obvious reasons, this is almost always a catastrophic injury to the operator. The blade guard and good technique will go far in helping to avoid that kind of operator injury. Even better than that though, is the safety feature incorporated into the SawStop table saw that the Model Shop uses. This particular brand of table saw comes with safety technology that is capable of bringing the blade to a complete stop in 0.005 seconds after contacting human flesh, turning a potentially catastrophic injury into a very minor cut. Much like the airbags in your car (which you would never set off just to see them work), we hope to never actually see this safety feature work. For an eight-second video of this system in action, **click here**; for a one-minute description of how it works, **click here**; for a five-minute demonstration and description of the technology, **click here**.

The one minor downside to this technological marvel is that if can have false activations of the safety system, which result is about $200 worth of costs and down time for the machine. To help avoid unnecessarily tripping the safety system, there are several materials that must be cut in by-pass mode (similar to when you turn off the airbags in your car). When by-pass mode is required, shop staff will make the cuts for you. If in

doubt about the material you want to cut on the table saw, please contact a shop supervisor before starting any cuts. The list of materials that must be cut in by-pass mode is as follows:

- Wood that is wet, wood that has wet glue in or on it, mirrored plexiglass, foil-backed foam insulation, OSB (oriented strand board), black foamcore, black mat board, recycled wood that used to have metal fasteners in it (even if they have all been removed), composite panels, any foil or metallic plastic, anything cut on the laser cutter.

When using this saw, you must start with a reasonably flat board with a clean, jointed (straight) edge. The jointed edge must ride along the rip fence (for rip/bevel cuts) or be held to the miter gauge (for cross-cutting functions). This helps to assure that the board follows a perfectly straight path into the blade. Attempting a cut on the table saw on a board without a jointed edge is an invitation for kickback, as it can induce a pivoting motion as the board passes through the saw, helping to pinch the blade. Stability of the board as it moves through the saw is probably the single biggest thing that you, as an operator, can control to help assure a safe cut. Motion of the board relative to the blade (other than just moving straight ahead into the blade) is what can cause kickbacks with this saw. Because of this, **NEVER** attempt free-hand or curving cuts on this saw. The process of safely making a cut with this saw is largely about keeping the board moving into the blade in a perfectly straight line, while also keeping your hands clear of the blade and your body out of the kickback zone.

When using this saw for rip/bevel cuts, the rip fence is typically positioned to the right of the blade, but can be set to the left, for left-handed users. For bevel cuts, the rip fence **must** be positioned to the right of the blade, as it incredibly dangerous to tilt the blade towards the fence (it creates a trap, which almost always results in kickback). To make a cut (for right-handed users), position your body slightly to the left of the blade, just out of the path of any potential kickbacks. Your right hand feeds the material into the saw, while your left hand is both holding the board down and tight to the rip fence. Push blocks are **mandatory** on all rip/bevel cuts that are less than 6" wide. If you need to make a cut so narrow that it is not possible to do so with the blade guard in place, you will be best served by making the cut on a different machine.

When using this saw for crosscutting functions, the use of either the miter gauge or crosscutting sled is required. **NEVER** make crosscuts against the rip fence. If making crosscuts, use of the crosscut sled is preferred, as it is more stable and thus, safer. If making miter or compound miter cuts, use of the miter gauge is required. To make these cuts, simply hold your stock tight against the crosscut sled or miter gauge, and pass the stock through the saw.

Like any other danger in the shop, an intelligent operator can greatly reduce, but not eliminate, the dangers that this machine presents. Reduction of this danger can be accomplished by proper set-up of the saw, inspection and preparation of the piece being cut, proper operator technique when running the saw, and simply standing out of the path of potential kickbacks. **Do not be afraid to use the table saw, but do, above all, approach it with respect, intelligence, and patience.**

The rules for this machine are as follows:

ALWAYS use the blade guard/riving knife (unless the operation you are doing prohibits its use).

ALWAYS ask for assistance if you have questions or are uncertain or afraid for any reason.

ALWAYS get assistance if you are planning to cut anything of large size.

ALWAYS consult the Shop Supervisor for proper blade selection.

ALWAYS set the blade depth to just above the depth of the gullets on the blade.

NEVER make a freehand cut (a cut made without the aid of the rip fence or the miter gauge)

NEVER run a board through the saw if the reference edge is not straight. If it needs to be straightened, have a shop supervisor run it through the jointer first.

NEVER run a board through the saw that may rock back and forth during the cut. If the board is cupped, cut it with the cup facing downward.

NEVER rip a badly twisted board.

ALWAYS cut so the waste wood is on the side of the blade opposite the ripping fence.

NEVER crosscut against the rip fence.

ALWAYS stand to the side of the blade. Do not work with your body in-line with the blade of the machine.

NEVER start the saw with the work touching the blade.

NEVER reach over the saw blade while it is moving

NEVER allow your hands to cross over the throat plate.

NEVER allow your left hand to travel beyond the front plane of the blade.

NEVER back up once you have started a cut. If the work will not advance forward, maintain a steady hand on the work, and turn the machine off.

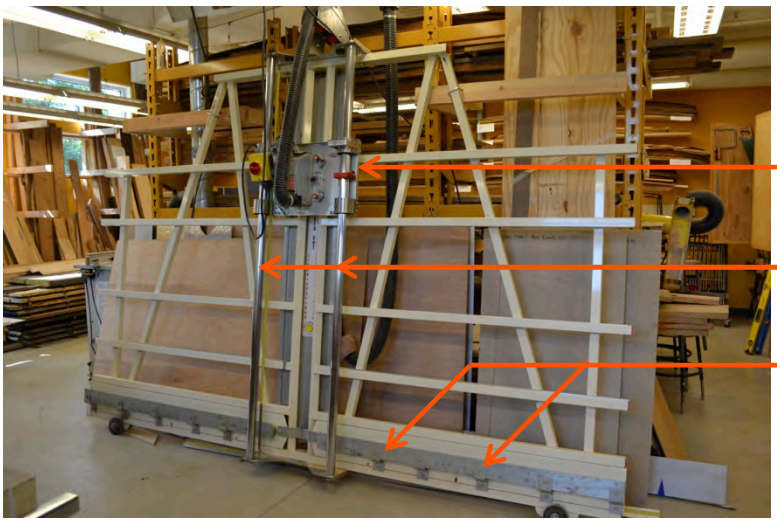
ALWAYS feed the stock into the machine as evenly as possible. When ripping, push the stock forward with your right hand, and hold the stock tight to the fence with your left hand.

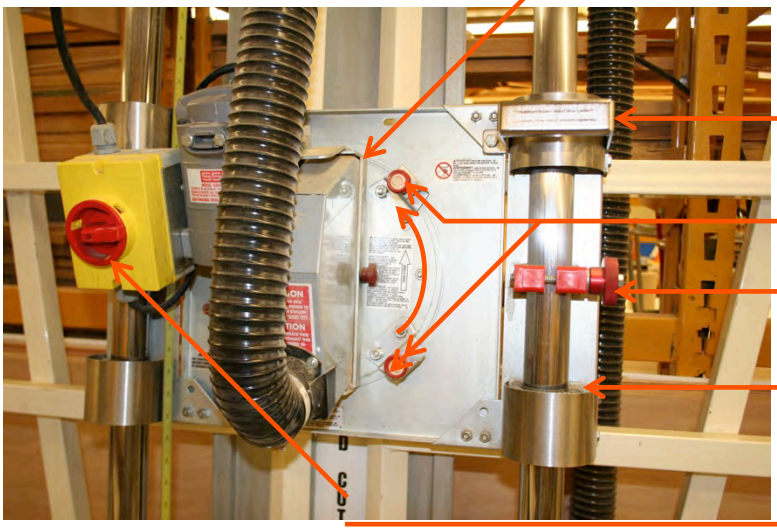
ALWAYS use a pusher stick on cuts less than 6" wide.

NEVER remove waste stock from next to the blade with the machine running.

ALWAYS shut off the machine and lower the blade when you are done working.

Panel Saw



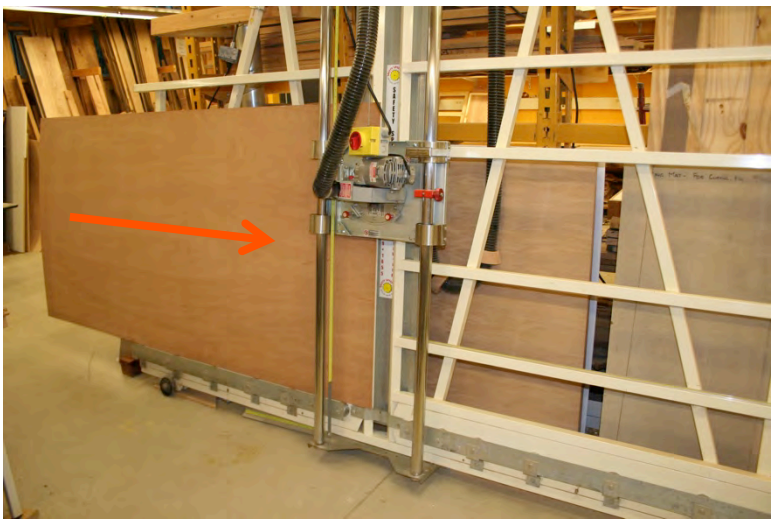


The **Panel Saw** is a circular saw, mounted in a carriage that travels along two guide tubes, which are mounted on a large metal frame. The purpose of a panel saw is to cut large panel goods (sheets of plywood, MDF, OSB, particle board, etc.). Cuts made on a panel saw can either be to final shape and size, or can simply be initial cuts to reduce the overall size of the panel down to something that is more manageable on the table saw. The panel saw is great for cutting down large panel goods, but not at all suited for cutting down panel goods once they fall below about 24" x 24" in size.
Cutting limits are as follows:
Maximum panel thickness: 1 3/4"

Maximum cross cut: 64″
Maximum rip cut: 8′-0″

Crosscuts (when you push the saw down vertically through the material) must have material (either the piece you want or the waste stock) resting on at least two support rollers, either to the left or to the right of the saw. If you are crosscutting very narrow strips (1″ wide or less), make certain that the chatter guard (the red plastic spring-tensioned crescent that is visible only when you look behind the carriage) is resting on the larger piece, not on the narrow piece that is about to be cut off. If you do not position this correctly, the piece being cut off will very likely jam against the chatter guard and prevent the saw from making the cut.

To transition between crosscuts (when the blade is oriented vertically) and rip cuts (when the blade is oriented horizontally), simply pull out the indexing pins and rotate the turntable. When the turntable has rotated exactly 90°, the indexing pins will drop into a locked position, assuring that the turntable is being held at exactly the correct angle.



Rip cuts (when you push the material horizontally through the saw) should be no less than 30″ long. When making rip cuts, the vertical tape measure can be used to set up the saw prior to the cut. Simply push the saw up or down into position, reading the width of the rip cut on the yellow vertical

tape measure (by the left-hand guide tube) against the triangular indicator that is located in the upper-left portion of the carriage.

When the saw is in the right position, tighten the carriage travel lock knob and make the cut.

The Rules for this machine are as follows:

NEVER crosscut when your material is not supported by at least two guide rollers on either side of the machine.

NEVER attempt a rip cut on material that is less than 30" long (if possible, simply rotate the material 90 degrees and cross cut it instead).

NEVER reach behind the carriage when the saw is running.

NEVER hold down material with your hand positioned in the path of the carriage.

NEVER cut material that is too small to be cut safely on this saw.

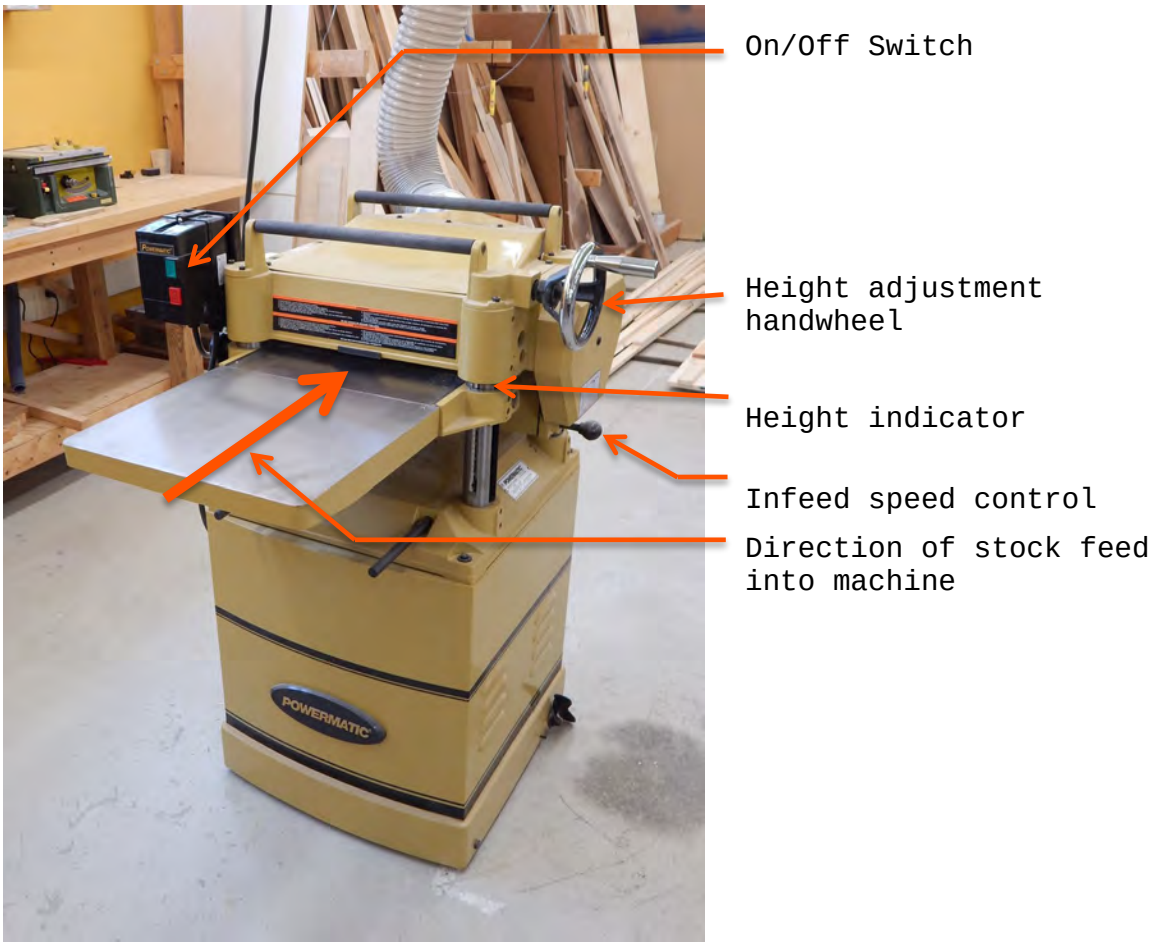
ALWAYS feed material into the saw at a reasonable pace.

ALWAYS back up the saw a bit if restarting the saw in mid-cut.

ALWAYS make crosscuts by moving the saw through the material from top to bottom.

ALWAYS make rip cuts by moving material through the saw in the direction of the arrow on the turntable.

Planer



The planer is used to plane boards, which means that it shaves off the top surface of the board to smooth out the board, reduce the thickness of the board, and leave the board a consistent thickness. While it may seem that the planer will produce a perfectly flat board all on its own, it will not. Any bowing or twisting present in a board at the start of planning will be minimized by sending it through the planer, but not eliminated. If you must have a PERFECTLY flat board, it must be flattened on one side by sending it through the jointer before sending it through the planer. The shop staff must assist you with this process.

The planer works through the use of a powered infeed roller, powered

outfeed roller, and a spinning cylindrical cutterhead, all of which are positioned over the board passing through the machine. The infeed roller pushes the board into the cutterhead, while the outfeed roller pulls it out of the cutterhead. Between the infeed and outfeed rollers is the spinning cylindrical cutterhead, which holds 72 carbide knives arranged in five helical rows. These knives are what shaves off the top surface of the board as it is fed through the machine.

The planer will handle stock up to 15″ wide and 6″ thick. The longest piece of stock that can be planed down is limited only by the physical layout of the shop itself, as the machine itself has no maximum board length limitations. The shortest piece of stock that can be planed down is 12″; any less than this and the stock will not be able to be grabbed by the outfeed rollers before the infeed rollers let go of it (a potentially dangerous situation). The machine is equipped with two feed rates; high speed (20 feet per minute) for rough planing, and low speed (16 feet per minute) for finish planing.

Because planing a piece of wood does present a danger of kickback, the planer is equipped with anti-kickback fingers at the front of the machine. As with any safety feature, these fingers will reduce, but not eliminate the danger of injury due to kickback. Therefore, it is a good idea to simply step to the side of the machine after feeding your work piece into the machine.

The rules for this machine are as follows:

ALWAYS “wand” the board before planing to check for screws, nails, staples, etc.

ALWAYS wire brush the faces of the board to remove excess dirt and grit.

ALWAYS check the board for serious defects, loose knots, etc.

ALWAYS plane with the grain of the wood.

NEVER attempt to plane a board less than 12″ long.

NEVER attempt to plane a board less than 3/16″ thick.

NEVER attempt to plane more than 1/8″ off the thickness of any stock in one pass.

ALWAYS make sure you have adequate clearance on the outfeed side of the machine.

NEVER change feed speeds on the machine with the machine turned off.

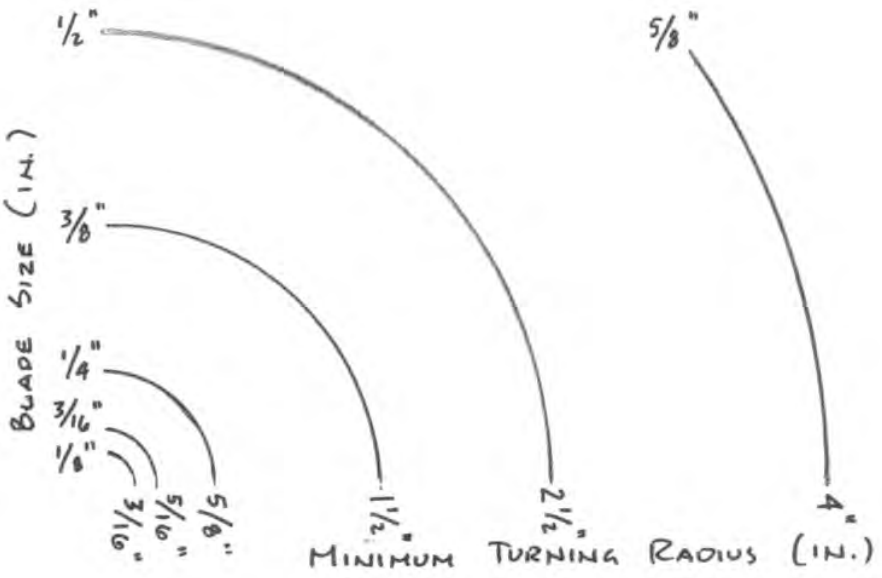
ALWAYS step to the side after feeding your work piece into the machine.

Band Saw

The band saw derives its name from the fact that the blade is a continuous band of metal. This blade is fitted over two large motor-driven metal wheels which power the blade and produce the cutting action. Because the blade travels in a downward liner path, the danger of kickback (which is the result of a disruption to a rotary cutting process) is eliminated. This downward linear motion of the blade also helps in that the phenomenon of lift that can be experienced on the table saw is also eliminated on this saw because the blade is actually working to hold the wood down to the table. The band saw is easily the **single-most versatile machine in the shop**, capable of doing a wide variety of tasks.

The band saw is equipped with both a rip fence and a miter gauge, which means that it is able to make all the same cuts as the table saw. However, unlike the table saw, the table, tips to determine the bevel angle, not the blade. Also unlike the table saw, rather than adjusting the height of the blade to determine the depth of the cut to be made, you adjust the blade guard to expose more of less of the blade as needed. Even if you have the blade guard set at the appropriate height, **ALWAYS** be aware of where your hands are relative to the blade (**especially if attempting to cut through oddly-shaped items**). The rule to follow for the band saw is to **NEVER** bring your fingers within the 3" of the blade.

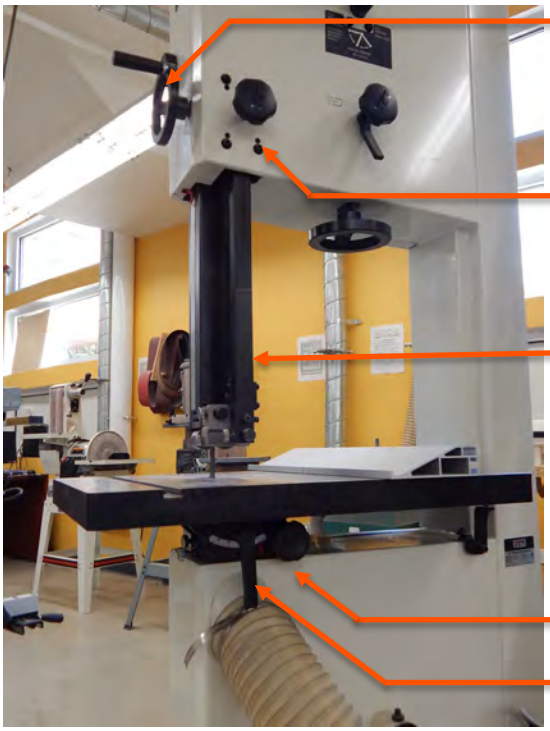
Because the blade is relatively small and travels in a linear path, the band saw is also able to make curving cuts, which are accomplished without the aid of any fences or attachments. Despite the fact that there is no danger of kickback**, you should never back up in the middle of a cut while the machine is running.** If you find that need to make a "second pass" at a cut, either turn out of the piece through the waste material, or turn off the machine and back up the blade. The ability to make curving cuts is
controlled through the size of the blade installed on the machine. The smaller the blade, the smaller the radius you will be able to cut in the work. Blade size vs. minimum cutting radius is summarized in the chart below:



There is one additional operation that the band saw is able to do that cannot be done efficiently on any other machine in the shop: **resawing**. Resawing lumber is when you cut through the width, rather than the thickness of a board. For example, if you wanted to cut a piece of wood that was 6" wide x 2" thick x 4' long into two pieces of lumber each measuring 6" wide x 1" thick x 4' long, you would use the band saw for

this operation.

Unlike the table saw, one can break the blade on the band saw the band saw **simply by forcing the work through the saw too quickly**. Additionally, while it is virtually impossible to stall the motor on the table saw, **one can stall and damage the motor on the band saw if the work is forced through too quickly or improperly.** While blade breakage is usually benign, a broken blade can sometimes shoot off to the side of the machine. Because of this, do not stand there when the machine is running.



Blade Guard height adjustment hand wheel; loosen adjustment lock knob **FIRST!**

Blade Guard height adjustment lock knob

Blade Guard

Table angle adjustment knob

Table angle indicator and lock

Adjustments to the white 18″ Band Saw

The rules for the Band Saw are as follows:

ALWAYS have a shop supervisor check blade tracking before starting the machine.

ALWAYS get assistance if you are going to cut anything large.

ALWAYS make sure what you want to cut will feed through the machine.

ALWAYS ask for assistance if you have any questions about the operation of the machine.

ALWAYS adjust the upper guide to be about 1/8" above the piece being cut.

ALWAYS make release cuts before starting a long cut.

NEVER force material through the saw too quickly.

NEVER back up in the middle of a cut while the machine is still running.

ALWAYS cut on the "right" side of the line.

ALWAYS cut near, but not on top of your line. Sand down to the line after you are done cutting.

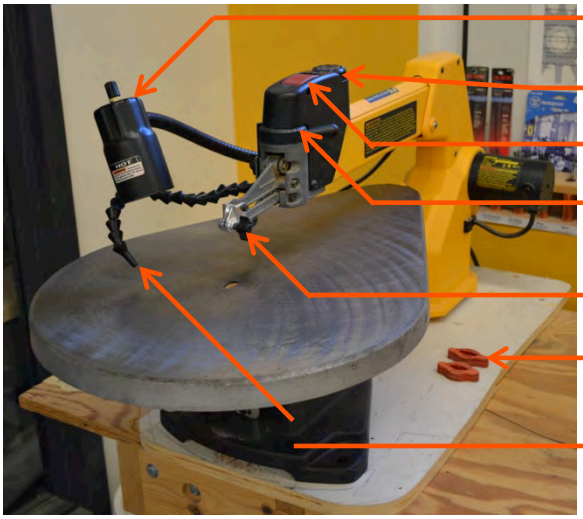
ALWAYS use a pusher stick to finish the cut if your fingers would otherwise come within 3" of the blade.

NEVER use the fence and miter gauge together.

NEVER stand to the side of the blade when the band saw is running.

ALWAYS use a V-block to cut dowel rods or tubing.

Scroll Saw



Light

Speed control

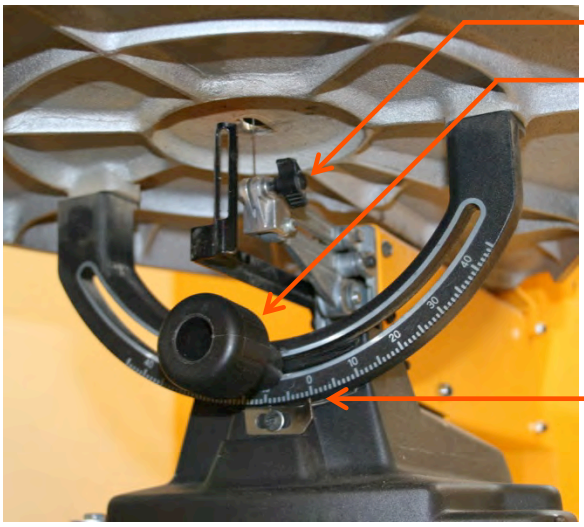
On/Off switch

Blade tension control

Upper blade chuck thumb screw

Wooden “wrench” for blade chuck thumb screw

Air nozzle (to blow away sawdust while cutting)



Lower blade chuck thumb screw

Bevel angle adjustment lock knob

Bevel angle indicator

The scroll saw is a reciprocating saw, which means that the blade cuts by making repetitive up/down motions against the material being cut. Because of this fact, there is no danger of kickback on this machine. This saw is not equipped with any sort of rip fence or miter gauge, which means that all the work done on this saw is freehand. If you have to cut through very thin material, or need to make **very fine/intricate cuts** in a material, this is probably the best saw in the shop to use. Like the band saw, the table top tilts left and right to allow for beveled cutting.

The blades for the scroll saw are held in tension between the upper and lower blade chucks. Operating the saw without the blade properly tensioned (you should be able to pluck the blade like a guitar string, albeit a tone-deaf guitar string) will result in blade breakage; always check blade tension before turning on the scroll saw. If the saw changes the noise it is making during the middle of a cut, it is most likely due to the blade slipping in the chuck and losing tension. To help prevent this, use the red wooden "wrenches" to help you tighten the blade chuck thumb screws. You need to get the thumb screws tighter than what one can typically achieve by hand alone BUT, use the wrench to nudge it just a bit; do not bear down full-force when using the wooden "wrench" as this will break the chuck assembly.

Scroll saw blades are very small and because of this, the scroll saw is able to complete cuts with a very small turning radius (as little as about 1/32"). When equipped with a spiral blade (ask the shop supervisor if you need to use this) the scroll saw can perform cuts with a 0" radius, as the spiral blade is non-directional. With the spiral blade there is no "forward" or "reverse" feed direction; every direction is "forward" feed. Think of it as equivalent to cutting with a laser.

Unlike the band saw, the scroll saw is perfectly acceptable to back up in the middle of a cut with the machine still running. With a spiral blade, this is obviously a moot point, because the blade is non-directional. It is always advisable to cut close to, but not on top of, the line drawn on your work piece when working with the scroll saw. You can use the sanders in the shop to sand down to your line after you are done using this machine.

The scroll saw also has the ability to make "closed" cuts, making it one of only two machines in the shop capable of doing that type of cut (a "closed" cut being a cut that is completely interior to the board, contacting no edges of the board). To do a closed cut, you must first drill a hole in the work piece (through what will be waste stock when you are done), then remove upper end of the blade from the machine, insert it through the work piece, and reinstall the blade. When you are done making the closed cut, you simply reverse this process to free your board from the machine.

The rules for the scroll saw are as follows:

NEVER reach under the table while the machine is running.

NEVER start the machine with the work piece in contact with the blade.

ALWAYS keep your fingers clear of the blade.

NEVER attempt to saw a piece that will not sit flat on the table.

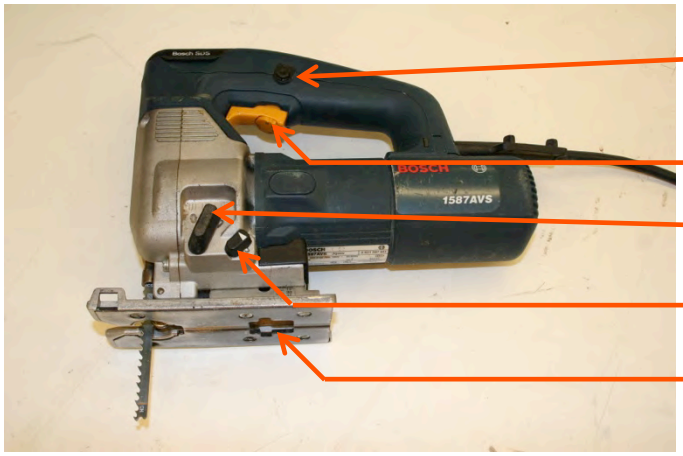
ALWAYS make release cuts before starting a long cut in a large piece.

ALWAYS feed the work with a slow, steady hand. Forcing the work will result in blade breakage.

ALWAYS use the slowest reasonable speed for the cutting operation at hand (the finer the radius to be cut and the thinner the material being cut, the slower the optimum speed).

ALWAYS stop the machine before removing scrap from the table.

Portable Jigsaw



Trigger lock (locks machine in "on" position)

Variable-speed trigger

Blade orbit selector

Chip blower lever

Adjustable footplate (tilts for bevel cuts)

The portable jigsaw is essentially a portable version of the scroll saw. The only major difference between the two (other than portability) is that the blade on the jigsaw is much larger than that of the scroll saw, as the jigsaw blade is not held in place by tension. Because of the difference in blade size, the portable jigsaw cannot make as tight of turns as the scroll saw. It also differs in that the portable jigsaw cuts on the up stroke, rather than the down stroke, as the scroll saw does. This means that breakout (the slight shattering on the surface of the work piece) happens on the top side of the work piece, instead of on the bottom side, as is the case with the scroll saw. Compared to the scroll saw, breakout is much more pronounced, and cutting rates are faster, because the teeth on the blade are so much more aggressive.

This saw works great on large, difficult to handle work pieces simply because it is often easier to maneuver a portable saw through a large work piece than it is to maneuver a large work piece through a stationary saw. If ever you have a project where you know the jigsaw would be the "right tool for the job," I strongly suggest that you do your layout lines on the back side of the work piece. This will keep breakout limited to the back side, and will result in a much cleaner finished side to the work.

The speed at which the saw runs is determined by how far you squeeze the variable-speed trigger. Run the saw at a speed at which you are comfortable. To lock the saw "on" at full speed, simply squeeze the trigger all the way, depress the trigger lock, and let go of the trigger. Pick an appropriate blade orbit, based on the kind of cuts you will be making. The blade can be set to travel in a straight-up-and-down motion (position "0"), slightly elliptical orbit (position "I"), or more pronounced elliptical orbits (positions "II" and "III"); straight-up-

and-down is best for curving cuts, while an elliptical orbit is best for fast, straight cuts. If you would like the machine to assist with blowing sawdust out of the way, turn on the chip blower (turn the chip blower lever clockwise).

The rules for the portable jigsaw are as follows:

ALWAYS make sure you have adequate clearance either beside, or beneath, where you will be cutting. It is very easy to damage a workbench without even knowing it.

ALWAYS make sure the work piece being cut is well supported. Failure to do this will cause excessive vibration and will make sawing both difficult and dangerous.

ALWAYS make release cuts before starting a long cut.

ALWAYS keep your hands clear of the blade.

ALWAYS feed the machine at an even steady pace. Do not stress the machine by forcing it through the work.

ALWAYS make sure you keep the cord out of the path of the blade.

NEVER back up with the machine running. If you have to back up, simply stop the saw, remove it, and reposition it.

ALWAYS bring the saw to a complete stop before removing it from the work.

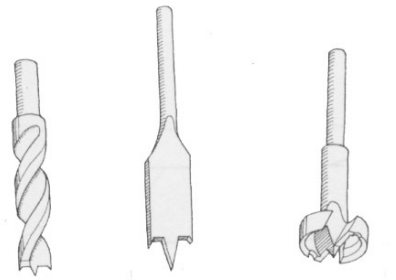
Portable Drill

Portable drills are hand-held power tools, shaped much like a pistol, that have a motor-driven chuck that rotates a drill or driver bit (the chuck is at the tip of the machine, and is what holds the drill or driver bit). This tool is used primarily to drill holes and drive in fasteners. There are two basic varieties of portable drills: battery operated (cordless), and corded. The cordless drill in the shop has a few more features than our corded drills, but beyond that, personal preference will usually dictate which type you use. The only exception to this is when using the pocket hole system, which requires the higher RPM's that only the corded drill is able to reach. The discussion that follows is based on our cordless drill.

The cordless drill has two gears, a low and a high gear. The gear selector is on the top of the drill. The speed at which the drill turns is controlled by the trigger switch. In low gear, the drill will turn between 0 and 450 RPM. In high gear, the drill will turn between 0 and 1250 RPM. Low gear is best for driving in screws; high gear is best for drilling holes. The drill has two directions; forward (clockwise), and reverse (counterclockwise). The maximum torque the drill can apply is set via the numbered clutch next to the chuck. Set to a low number, the clutch will start "slipping" at a very low load. This can be used for very delicate work, such as when driving very small screws. Set to number 20, the clutch won't slip until a very high load is reached, such as when driving in very large screws. There is also a position for drilling on this dial. In this position, the clutch is locked, and will not slip.

Drilling in Wood

The shop has two types of drill bits that can be used in the portable drill: twist and spade bits. Twist drills are the most commonly used drill bits. They are available in sizes from 1/16" to 1/2", in 1/64" increments. They cut cleanly, but have a tendency to clog with wood chips, especially in very small or very deep holes. Spade bits cut faster, don't clog, and are available in larger sizes than twist drill bits, but are much rougher on the wood. Use them only where quality is not of concern. Regardless of the bit type you are using, if the bit binds in the hole while you are drilling, stop the drill, reverse directions, and attempt to back the bit out of the hole. **To help prevent injury to yourself, you should always clamp your work piece down to the table before drilling.**



Pictured to the right are all three types of drill bits to be found in the shop. Twist and spade bits (as discussed above), and Forstner bits. Forstner drill bits, unlike twist and spade bits, cut extremely cleanly, are available in very large sizes, and have the ability to make flat bottomed holes in wood. They are available in sizes ranging from 1/4" to 2 1/8". **Forstner drill bits are for use on the drill press only**.

Whenever you drill anything, it is important to protect the tabletop with a piece of scrap. This will prevent you from "accidentally" drilling into the tabletop, and will also help prevent breakout on the back side of the piece (breakout is when the surface of the wood shatters at the exit point of the drill).

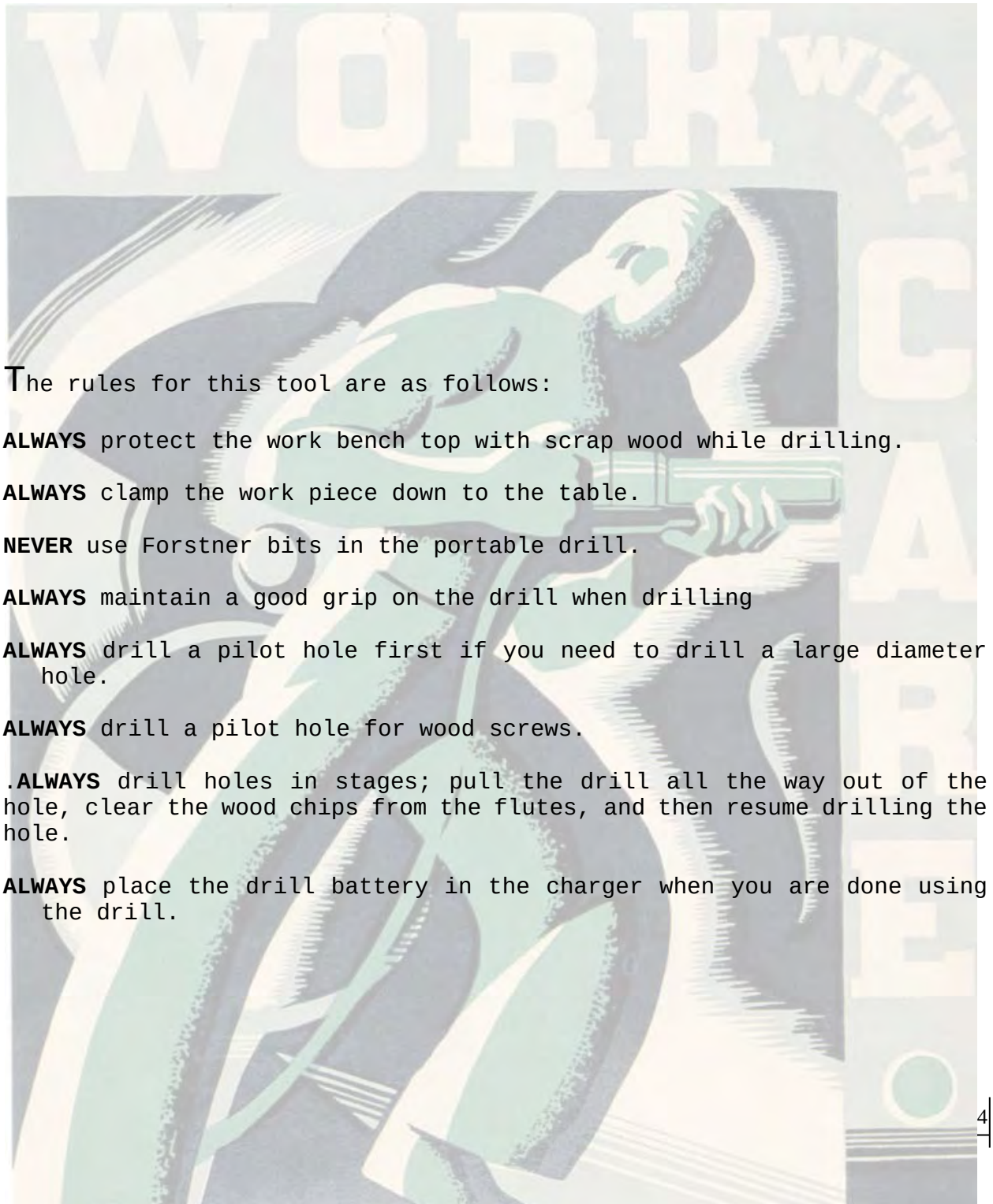
Driving Screws

When using the portable drill to drive in screws, the place to begin is to first drill a hole where you want to drive in the screw. This initial hole is called a pilot hole, and is essential to do if you do not want to fracture your board. The simplest pilot hole is just a hole drilled into the wood to a depth that is equal to the length of the wood screw. This type of pilot hole works only if you are using a fastener (e.g. roundhead screw) where the head of the fastener will tighten against the top surface of the board.

Variants on the simple pilot hole are called countersinking and counterboring and make use of flat-head screws. Countersinking is when you drive in a flat-head screw such that the head of the screw is flush with the surface of the wood. Counterboring is when you drive in a flat-head screw such that the head of the screw is sunk below the surface of the wood. We have a special set of drills in the shop that will

drill either of these types of pilot holes in one step.

When driving in screws, be sure that you do not drive them in too far. Round-head screws should be driven in only until the head snugs up to the surface of the wood. Flat-head screws should be driven in only until the head seats in the countersink/counterbore hole. Using too much force will usually either split the wood or shear off the head of the screw.



The rules for this tool are as follows:

ALWAYS protect the work bench top with scrap wood while drilling.

ALWAYS clamp the work piece down to the table.

NEVER use Forstner bits in the portable drill.

ALWAYS maintain a good grip on the drill when drilling

ALWAYS drill a pilot hole first if you need to drill a large diameter hole.

ALWAYS drill a pilot hole for wood screws.

.**ALWAYS** drill holes in stages; pull the drill all the way out of the hole, clear the wood chips from the flutes, and then resume drilling the hole.

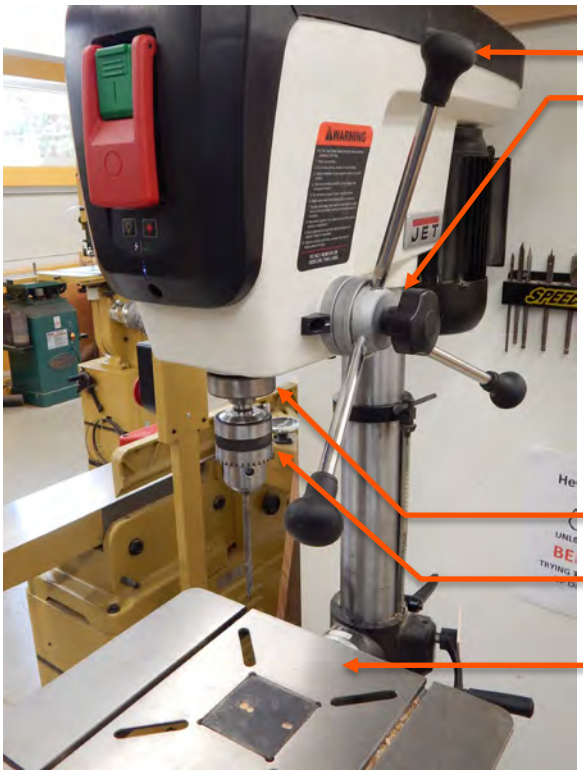
ALWAYS place the drill battery in the charger when you are done using the drill.

Drill Press

Drill bits and cutting oil (for drilling in metal

On/Off switch

Worktable



Quill travel handle

Quill travel adjustment / lock knob

Quill

Chuck

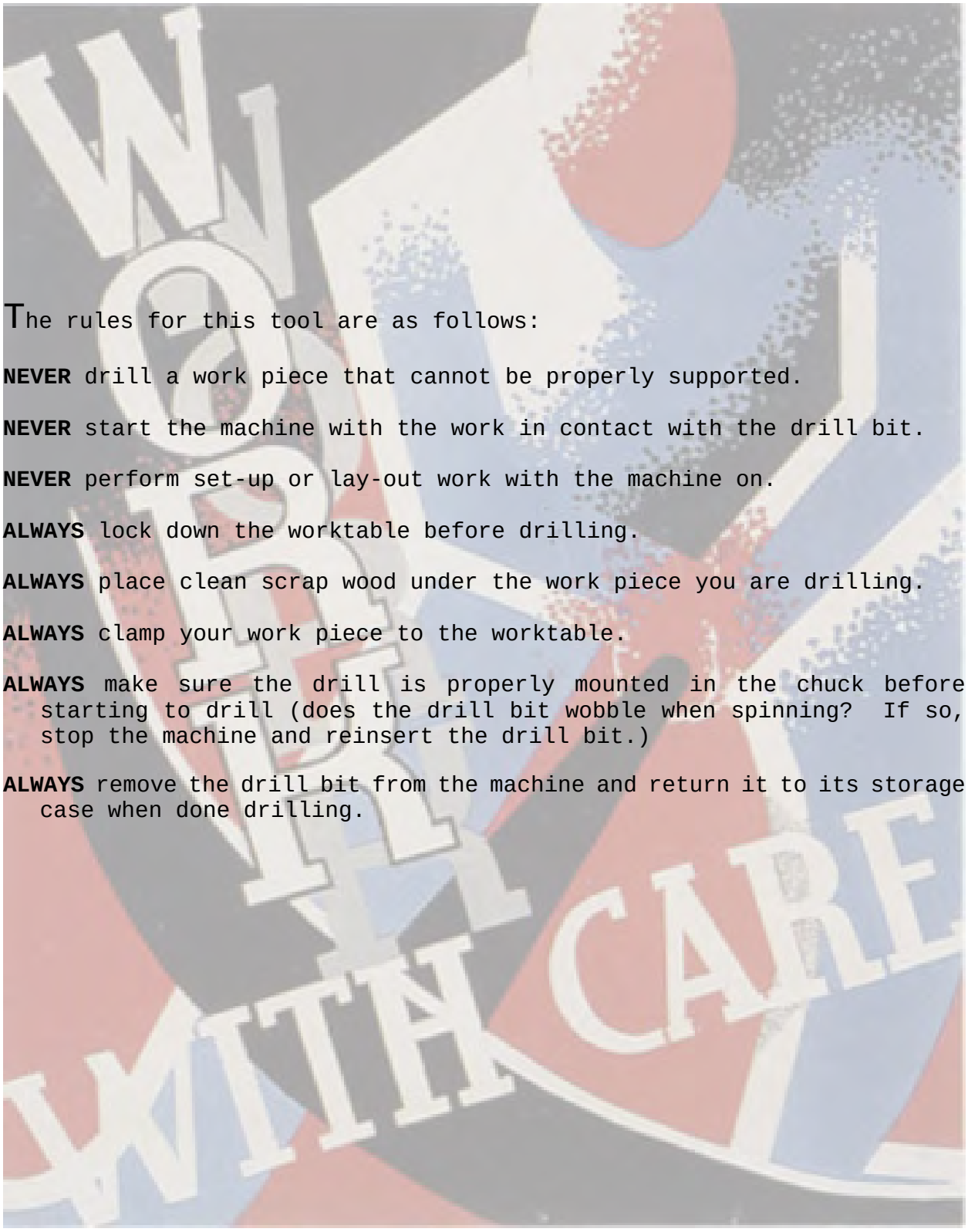
Worktable height adjustment crank handle (table height lock is on opposite side of column from the crank handle)

The drill press, similar to the portable drill, is a tool that uses a motor to drive a chuck that is designed to hold drill bits. However, unlike the portable drill, the drill press is a stationary machine, packing considerable heft when compared to a portable drill. Because of this there is a higher risk of danger to the operator of the drill press than there is to the operator of a portable drill. Also unlike the portable drill, the chuck is able to travel, as it is mounted into a quill, which travels up and down relative to the worktable.

Because this tool is stationary and has a worktable that is held at a known angle (typically perpendicular to the long axis of the drill bit), the angle of the hole being drill is accurate, controlled, and uniform. If you ever need to drill at some angle other than 90 degrees, the work table can be tipped to the left or right. Additionally, the depth of the hole being drilled is controllable and repeatable, through use of the quill travel-stop adjustment. If you find that you need to raise or lower the worktable in order to do a particular task, first **unlock the worktable by loosening the lock handle on the opposite side of the column from the work table height adjustment crank**. With the table unlocked and able to move freely, raise or lower the worktable by turning the worktable height adjustment crank, then lock the worktable in place. Do not operate the drill press with the worktable unlocked.

Our drill press is able to turn at speeds between 250 and 3000 RPM. Unlike the portable drills, there is no infinitely variable speed control; the speed is determined by the position of drive belts on pulleys at the top of the machine. We typically keep the speed set at 1450 RPM, which is a good general speed for woodworking. If you are doing an operation that requires a different speed (such as drilling metal), have the shop supervisor change the speed for you.

Probably the single biggest operational danger with the drill press is having the bit bind up while you are drilling, which then places significant rotational forces on the piece being drilled. The danger of this is that the work piece will either be flung off the work table or torqued around into your midsection. Because of this danger, **you must always clamp your work piece down to the drill press table**. Doing so will greatly reduce this risk. If you need to drill into something that is too small to be clamped down, simply hold the work piece in the jaws of a wood clamp, and either clamp down the wood clamp or just hold it steady with your free hand. Same as with the portable drills, always put a piece of scrap material under whatever you are drilling. Additionally, always set the quill travel-stop adjustment so that you will not drill into the cast iron worktable and damage the drill bit you are using.



The rules for this tool are as follows:

NEVER drill a work piece that cannot be properly supported.

NEVER start the machine with the work in contact with the drill bit.

NEVER perform set-up or lay-out work with the machine on.

ALWAYS lock down the worktable before drilling.

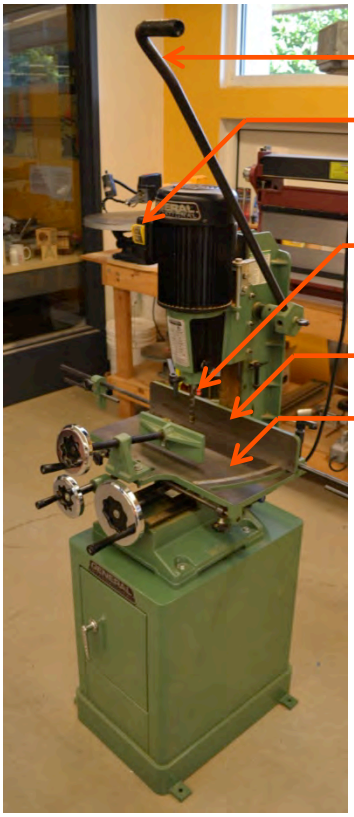
ALWAYS place clean scrap wood under the work piece you are drilling.

ALWAYS clamp your work piece to the worktable.

ALWAYS make sure the drill is properly mounted in the chuck before starting to drill (does the drill bit wobble when spinning? If so, stop the machine and reinsert the drill bit.)

ALWAYS remove the drill bit from the machine and return it to its storage case when done drilling.

Hollow Chisel Mortiser



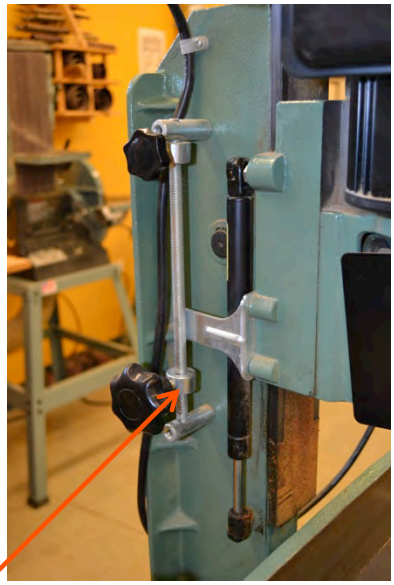
Lever arm

On/Off switch

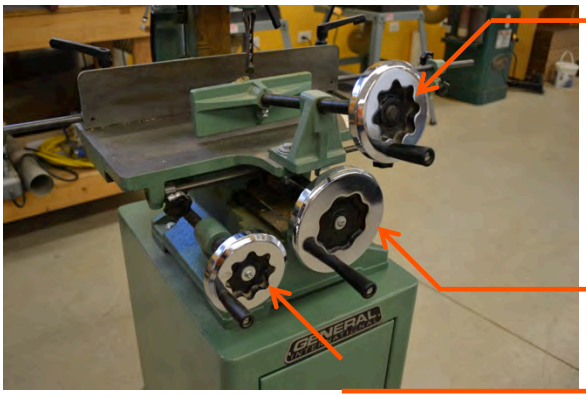
Hollow chisel

Fence

Worktable



Depth stop



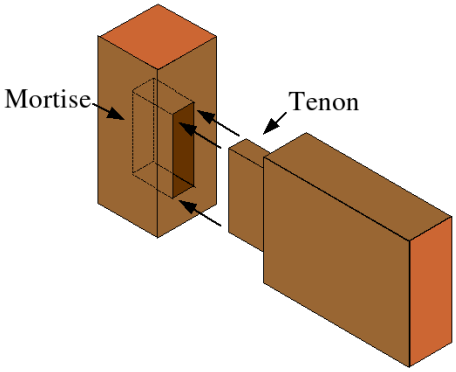
Work hold-down hand wheel

Left/Right table adjustment hand wheel

Front/Back table adjustment hand wheel

The hollow chisel mortiser is machine that allows you to cut square holes into wood in one simple operation. It is essentially a modified drill press that is designed to hold square, hollow chisels with a drill bit housed in the center of the chisel. The drill bit removes most of

the material while the hollow chisel completes the cutting action. The bit is forced through the material being cut by simple mechanical advantage; there is a really big lever arm on which you pull. The primary use for this machine is in cutting mortises used in mortise and tenon construction. It is a great time-saver, as cutting square holes by any other method is a very labor-intensive process.



We have a variety of hollow chisel mortising bits available for this machine, ranging from 1/4" to 3/4" in size. Please take note that installing the bits in this machine takes a bit of know-how, and thus, the shop supervisor should always assist you when setting up this machine. When cutting mortises that are larger than the chisel mounted in the machine, make the initial cut with the chisel, move the worktable left/right and/or front/back, and then make the next cut with the chisel, overlapping where you just cut by just a little bit. If you need to do non-orthogonal work, the fence can pivot up to 30 degrees and the entire head of the machine is able to tilt 45 degrees left or right. When you are done cutting a mortise, take some care when removing your work piece, as the chisel can become very hot during use.

The rules for this tool are as follows:

ALWAYS clamp work piece securely against the fence.

NEVER cut mortises into work pieces that are not solidly supported by the table.

NEVER do set-up or lay-out work with the machine on.

ALWAYS adjust the depth stop to avoid drilling into the table.

ALWAYS have scrap under your work piece, if you will be cutting mortises all the way through the work piece.

NEVER force the machine. Cut at a pace that the machine can handle.

ALWAYS turn off the power before removing work piece from the table.

NEVER turn on the machine with the bit in contact with the work piece.

ALWAYS keep fingers away from the mortising bit.

Mortise and Tenon illustration from:
http://www.decorartsnow.com/decorartsnow/wpcontent/uploads/2013/09/Mortise_tenon.png

Sanding

Any discussion of sanding needs to begin with the thing that is common to all sanding processes: sandpaper. While you may think that sandpaper is generic, it is not. Different abrasives act differently during the sanding process, and thus are used for different applications. Of all the types of sandpaper abrasives that are available, the two we use in the shop are aluminum oxide and silicon carbide. Aluminum oxide sandpapers are best for sanding bare wood, while silicon carbide sandpapers are best for sanding such finish coats as paint, shellac, or polyurethane.

Within any type of sanding abrasive, various papers are graded according to coarseness; the term used to describe coarseness is “grit.” Thus, you can have 80 grit sandpaper, 240 grit sandpaper, 3000 grit sandpaper, etc. The grit numbering system is simply a way to universally describe the size of the abrasive particles in question. Abrasives can vary in coarseness from the sandpaper used in floor sanders (where the sandpaper looks more like it has gravel imbedded in it), all the way down to superfine sandpapers used in some industrial processes (where you can hardly tell that it is sandpaper). Grit is graded by number; the higher the number, the finer the sandpaper. Thus, 80 grit sandpaper is great for starting sanding on a project, while 400 grit sandpaper is best used between finish coats of varnish in a project. We typically stock sandpaper in 80, 120, 180, 240, and 320 grits.

Once you select a sandpaper and begin the process of sanding, it is important to remember that the sanding process is not a one-step process. You should begin sanding with rough sandpaper, and then move your way through progressively finer grit papers until you have completed the job of sanding. Generally, start with the 80 grit paper to shape the wood and remove any serious damage or mistakes. 120 is for general finishing work (and to remove the damage that the 80 grit paper caused), while 180 or 240 grit papers are best for final sanding.

The most important rule of sanding is to remember to always **sand with the grain of the wood whenever possible**. While the damage that the sanding process causes to the surface of the wood may not be initially visible to your eye, it will become more visible during the finishing process. Sanding with the grain of the wood helps to greatly minimize the impact of this phenomenon.

Another thing to remember while sanding is that if you have to sand any major unevenness out of the wood, you will always do best to use a sanding block of some type; anything that has some give behind the sandpaper itself (your hand, the rubber pad on the bottom side of a portable sander) will tend to just follow the irregular surface and not

do much to remove it. If you are faced with a situation like this, a sanding block and elbow grease is what will work best, if the sanding station can't be utilized.

Portable Sanders

The portable sanders we have in the shop come in three basic varieties: orbital (the sanding pad travels in a circular orbit), random orbital (the sanding pad travels in an inconsistent circular orbit), and belt (which is simply a portable version of the sanding belt on the sanding station). The orbital and random orbit sanders are great finishing sanders. Either will do a very good job of preparing the wood stock for finishing. Neither is much good at removing large amounts of wood. The belt sander, on the other hand, removes stock at a very high rate of speed, making it very useful for initial sanding of very rough stock or such tasks as removing paint/gesso. It should never be seen as a finishing sander, as it is far too aggressive for that kind of application.

Operational Rules for Portable Sanders:

5" dia. Random Orbit Sanders

ALWAYS use sandpaper designed for the machine.

ALWAYS align holes in sandpaper with holes in pad at bottom of sander if provided.

ALWAYS use with the dust collector attached if provided.

ALWAYS empty dust collector after use.

1/2 Sheet Orbital Sander

ALWAYS use traditional sheet sandpaper in this machine.

ALWAYS use with the dust collector attached.

ALWAYS empty the dust collector after using.

Portable Belt Sander

ALWAYS check belt for damage before operating.

ALWAYS check belt for proper alignment before starting.

ALWAYS maintain a good grip on the machine while in use.

NEVER start the machine with it in contact with the work piece.

ALWAYS keep the machine moving over the work surface; failure to do this will result in unevenness in the surface of the work piece.

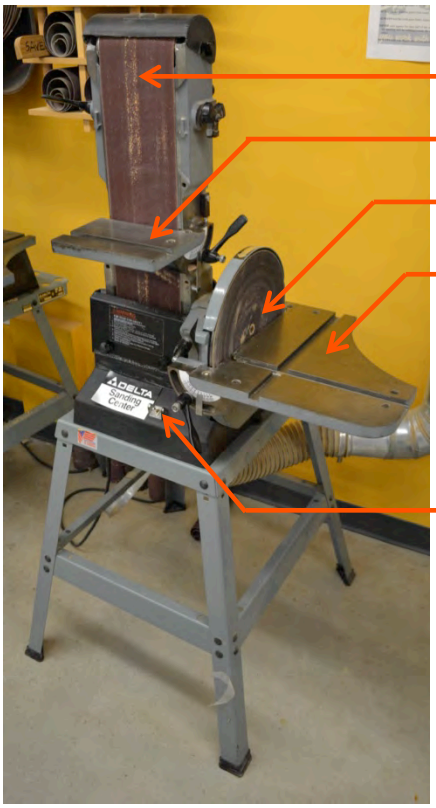
ALWAYS keep the power cord out of the path of the machine.

ALWAYS use with the dust collector attached.

ALWAYS empty the dust collector after using.

See the shop supervisor if you need to replace the sanding belt on this machine.

Sanding Station



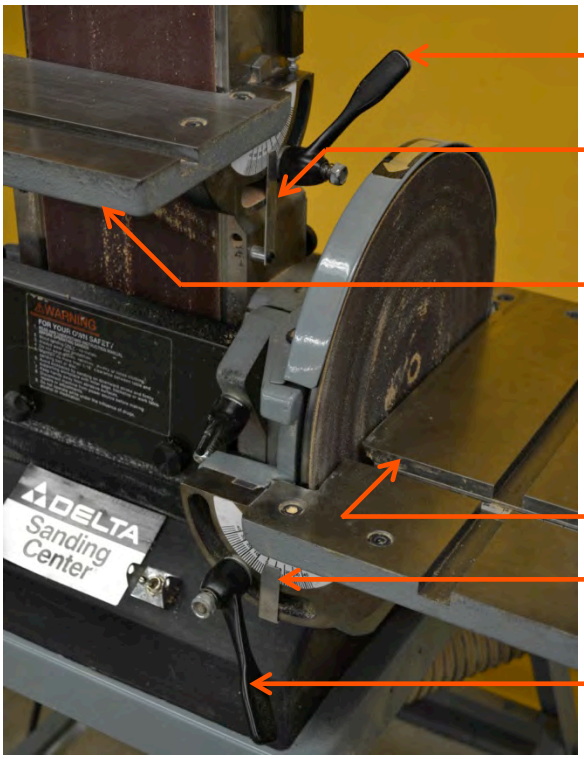
Belt sander

Belt sander work table

Disc sander

Disc sander work table

On/Off switch



Belt sander work table locking handle

Belt sander work table angle indicator

Miter gauge track

Miter gauge track

Disc sander work table angle indicator

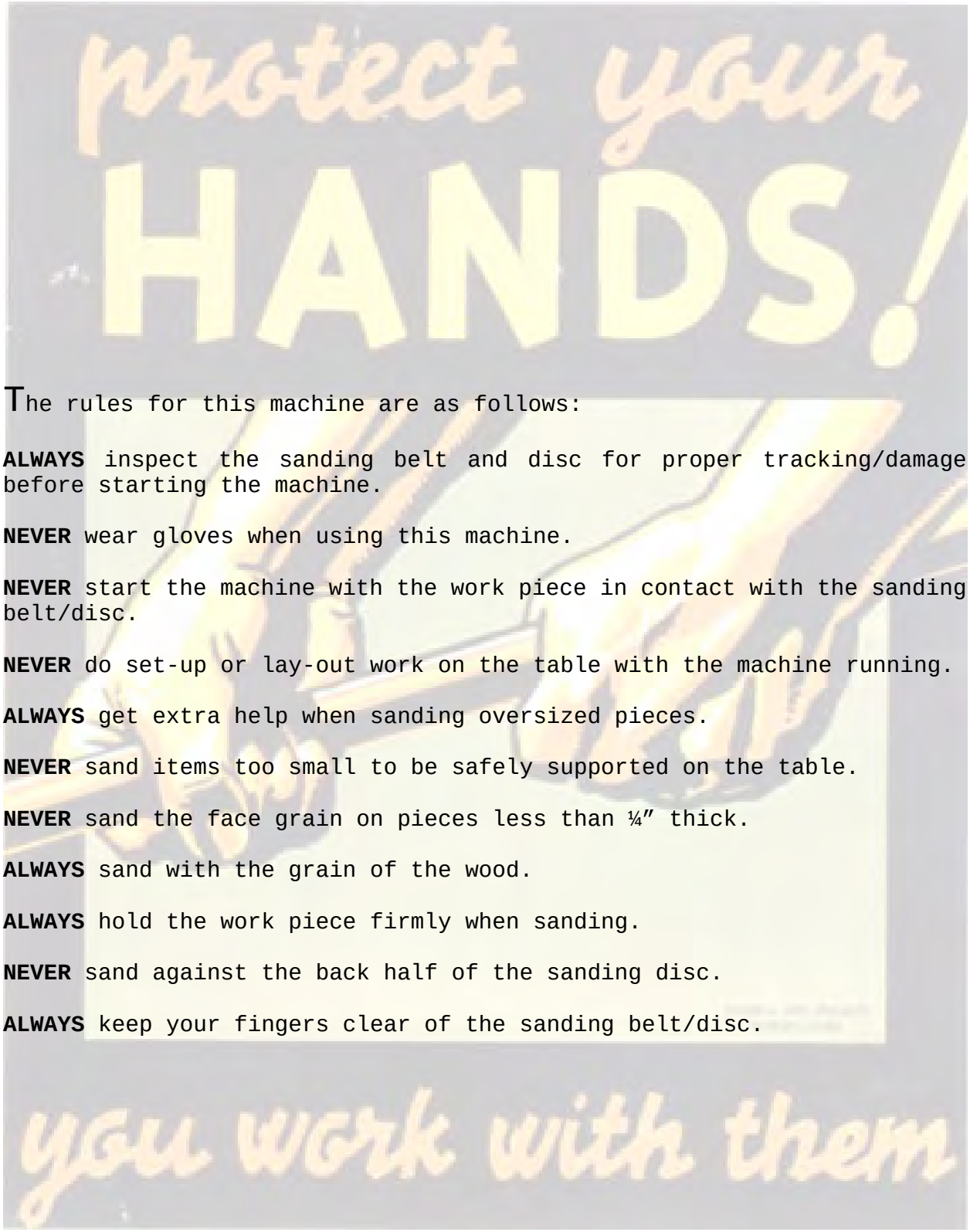
Disc sander work table locking handle

The sanding station is a stationary sanding machine that performs two different types of sanding operations: belt and disc sanding. Belt sanding utilizes the sanding belt on the left side of the machine; a 6″ wide by 48″ long belt of sandpaper that travels in a downward fashion. Disc sanding utilizes the sanding disc on the right side of the machine; a 12″ diameter disc of sandpaper adhered to a steel platen that rotates. Belt sanding is best for sanding flat surfaces, while the disc sanding is best utilized for sanding convex surfaces. We have two identical sanding stations in the shop. The one on the left will always be loaded with 80 grit sandpaper, while the one on the right will always be loaded with 120 grit sandpaper.

The metal work tables on both sides of the machine are able to tilt 45º up and 45º down. Like all the machines in the shop, take the time to be sure the sanding stations are set to square before you start sanding. When setting the table to a particular angle, take the reading off the angle indicators as a suggestion, not reality.

There are two primary operational guides to always keep in mind when using this machine. First, **keep the work piece moving at all times.** If you are working with the belt sander, always keep the work piece moving from side to side. Failure to do this will sand fine grooves into your work piece. If you are working with the disc sander, constantly rotate the work

piece as you feed it into the machine, keeping the curve you are trying to sand tangential to the sanding disc at all times. Failure to do this will sand flat spots into what should otherwise be a curving surface. Second, **do not press too hard.** Like some other machines in the shop, the sanding stations motors can be stalled under high loads. Like all the machines in the shop, use your ears, as well as your eyes when using this machine. If the speed of the machine is steadily decreasing, lessen the pressure you are applying.



The rules for this machine are as follows:

ALWAYS inspect the sanding belt and disc for proper tracking/damage before starting the machine.

NEVER wear gloves when using this machine.

NEVER start the machine with the work piece in contact with the sanding belt/disc.

NEVER do set-up or lay-out work on the table with the machine running.

ALWAYS get extra help when sanding oversized pieces.

NEVER sand items too small to be safely supported on the table.

NEVER sand the face grain on pieces less than ¼" thick.

ALWAYS sand with the grain of the wood.

ALWAYS hold the work piece firmly when sanding.

NEVER sand against the back half of the sanding disc.

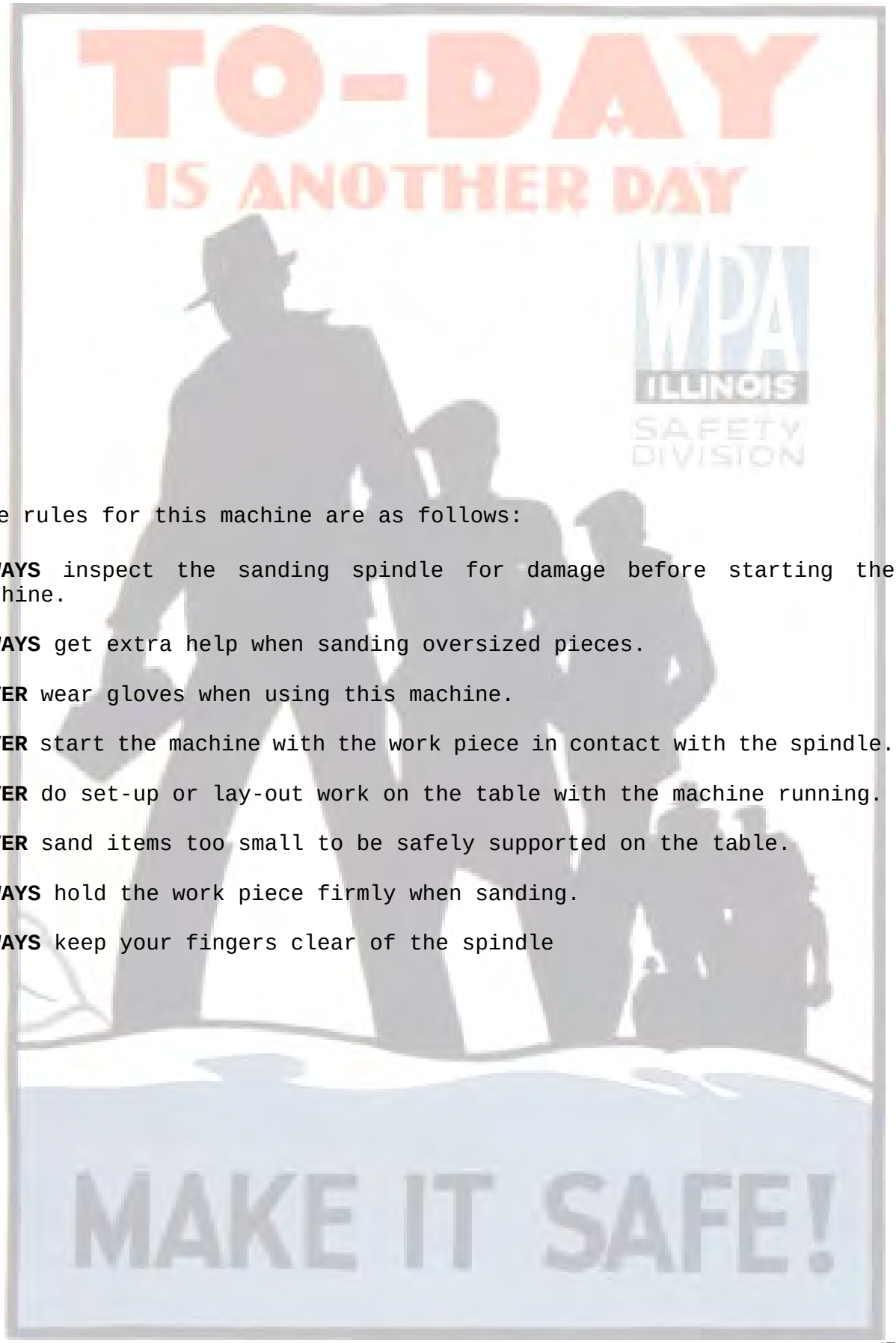
ALWAYS keep your fingers clear of the sanding belt/disc.

Oscillating Spindle Sander

The oscillating spindle sander is a stationary sanding machine that uses a motor to drive a sanding spindle in a rotary fashion while simultaneously also driving the spindle in a reciprocating up/down motion. The sanding spindles that are available for use on the machine vary from about 1/4" in diameter all the way up to 4" in diameter. It comes with a large cast iron work surface, which can be tipped forward up to 45 degrees. This machine is intended to sand concave surfaces and the interior edges of "closed" cuts.

Before starting sanding, look over the piece that needs to be sanded, and pick a sanding spindle that is most appropriate for the task. If you wish to sand a "closed" cut, always leave ample room on all sides between the sanding sleeve and the work piece. For example, if you want to sand a circular hole, select a sanding spindle that is no more than about ½ the diameter of the hole you wish to sand. Selecting a spindle that too closely matches the diameter of the hole you wish to sand can very easily lead to loss of control of the work piece. If you are sanding the concave edge of a board, pick a spindle that most closely matches the radius of the edge you want to sand.

Once you have selected an appropriate spindle, have the shop supervisor install it for you. When you start sanding, the sanding station rule about keeping the work piece moving applies here as well. Using **LIGHT** pressure (this will help you keep control of the work piece) sand up to the lines drawn on your work piece. Best results will be attained if you move the work piece against the rotation of the spindle (from right to left, if sanding against the front-facing edge of the spindle).



The rules for this machine are as follows:

ALWAYS inspect the sanding spindle for damage before starting the machine.

ALWAYS get extra help when sanding oversized pieces.

NEVER wear gloves when using this machine.

NEVER start the machine with the work piece in contact with the spindle.

NEVER do set-up or lay-out work on the table with the machine running.

NEVER sand items too small to be safely supported on the table.

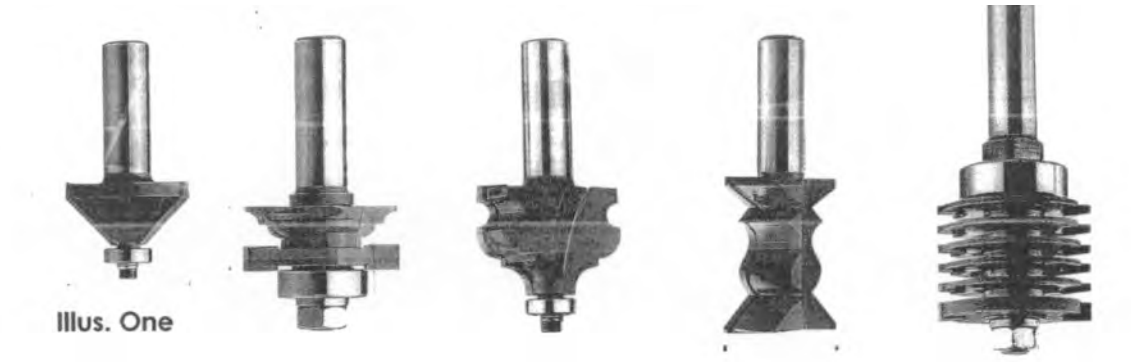
ALWAYS hold the work piece firmly when sanding.

ALWAYS keep your fingers clear of the spindle

Portable Router

The portable router is a portable power tool consisting of a high-speed motor (capable of 23,000 RPM) that drives a collet (which holds the bit), both of which are mounted into an adjustable base (which sets the depth of the cut). The portable router is used for a wide variety of purposes: decorative edges, grooves, rabbets, free form “carving,” and joinery are just a few examples.

The type of cut that this machine makes is determined by the type of bit that is mounted in the machine. At the most basic level, router bits come in two types: straight cutting bits and edging/profiling bits. Straight cutting bits are able to cut into any surface of the board, as all the exposed edges of the bit are able to cut. Edging/profiling bits are able to make cuts only to the edges of a board and typically have a portion of the shank extending past the end of the cutting profile. Higher quality edging/profiling bits include a ball bearing at the end of the shank. The ball bearing allows the bit to ride along the edge of the board without burning the wood. Cheaper edging bits that do not include the ball bearing tend to burn the wood when cutting, due to the heat from friction that is created by the rotating bit. A small sample of the types of bits available for this machine are pictured below:

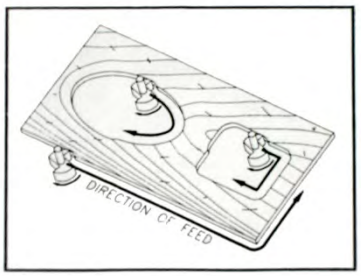


Illus. One

The maximum depth of any cut made by the router is limited by the cutting depth of the bit you are using; this depth will vary from bit to bit. When using the portable router, **make multiple graduated passes if you have a lot of material to remove.** Typically, **you should never try to cut more than about 1/4" to 3/8" of material away in any one pass.** You should very quickly get a feel for what a reasonable depth of cut for a particular bit should be while you are going through test passes on a piece of scrap. Making cuts that remove too much material in a single pass will tend to make operation of the machine unstable, resulting in erratic cutting.

As with almost all other machines in the shop, you should always cut against the rotation of the machine. Failing to do this will result in what is called a "climb cut" which is when the machine is pushed into the material in the same direction as the rotation of the bit. Climb cutting is dangerous, and can result in loss of control. The illustration below shows the proper direction in which to move the router in order to avoid "climb cutting."

If you need to cut a groove in the board at a fixed distance from the edge of the board, you can either create a fence for yourself using clamps and scrap wood, or you can make use of edging attachment for the portable router.



The rules for the operation of this machine are as follows:

ALWAYS wear hearing protection when using this machine.

ALWAYS wear a dust mask when using this machine.

ALWAYS be sure the cord will travel freely through the entire length of you cut.

NEVER use bits with a diameter greater than 1″ in this machine.

ALWAYS maintain a firm grip on the machine.

NEVER adjust depth of cut when machine is running.

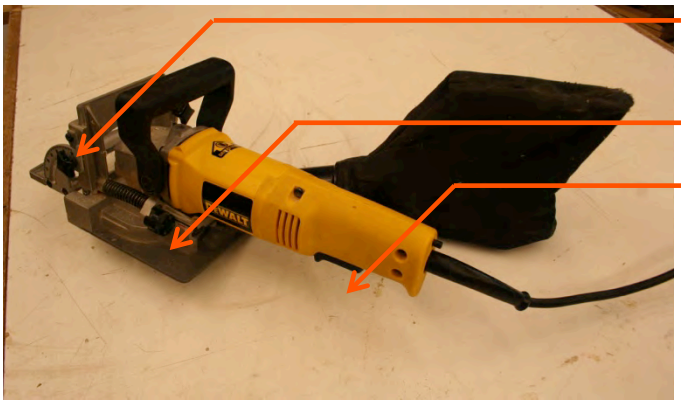
NEVER operate this machine in a horizontal or upside down orientation.

ALWAYS feed material into the machine against the rotation of the machine.

ALWAYS be sure motor is fully stopped before setting machine down.

NEVER set down the machine so that the cutting bit is in contact with the table top.

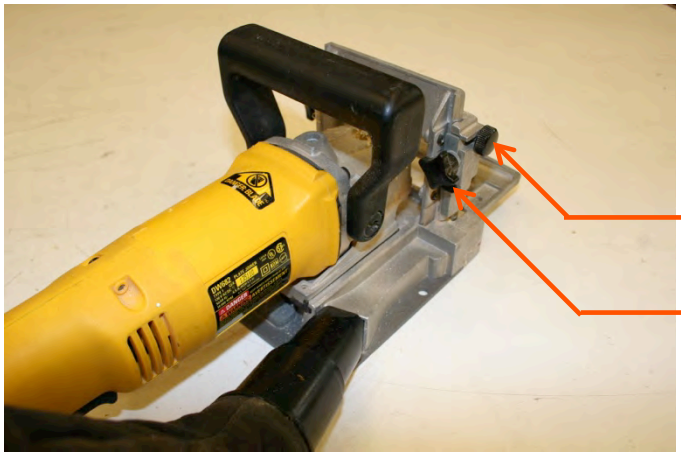
Biscuit Joiner



Fence angle indicator and lock

Biscuit size selector

On/Off switch



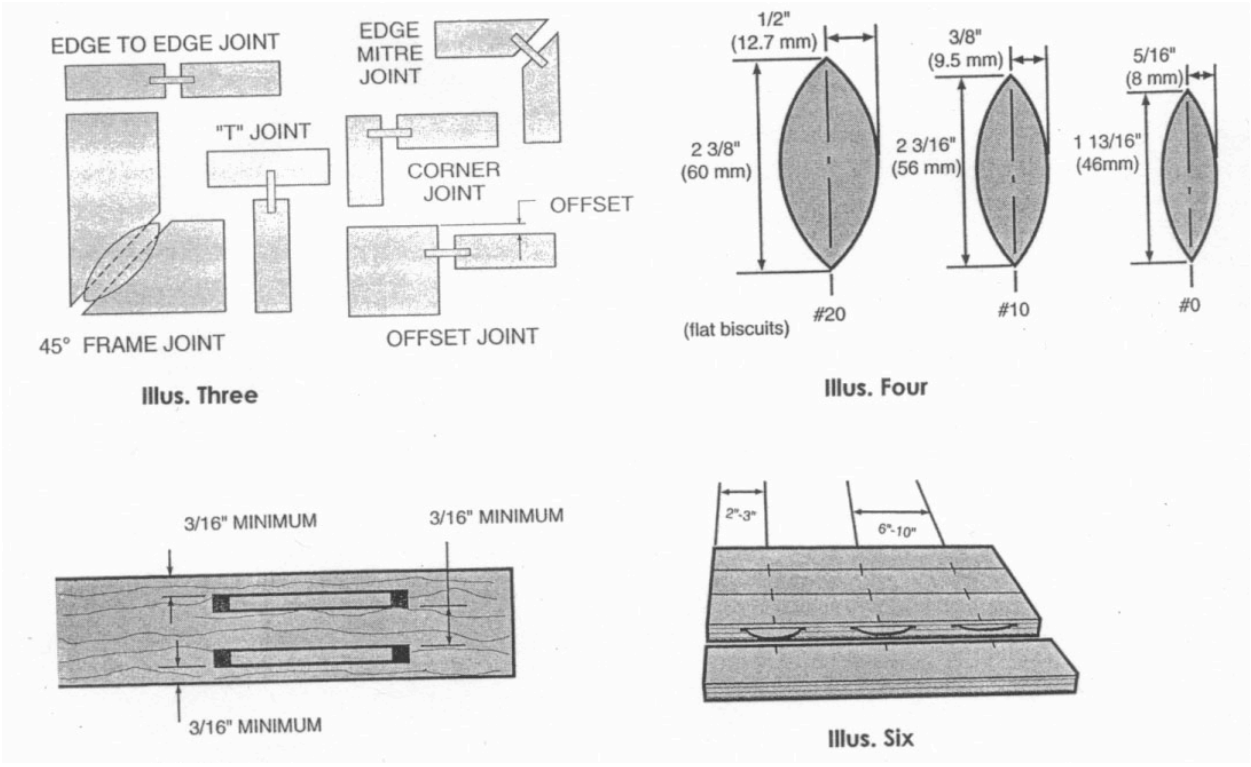
Fence height adjustment knob

Fence height indicator and lock

The biscuit joiner is a machine that houses a very small (4" diameter) circular saw and is designed such that the machine will only make very shallow plunge cuts into the edge of a board with the circular saw blade. When the biscuit cut is made to the edges of two boards that are to be joined together, a space is created that allows the insertion of an elliptical wood biscuit, which helps to reinforce the glue joint. The biscuits are made of compressed wood, which means that when they come in contact with the wood glue, they swell to create a very tight fit in the slot, helping to further reinforce the joint. Biscuit joinery is a modern replacement for using wood dowels to do edge joining, and can be completed in far, far less time than doweling. As illustration three shows, biscuit joinery can be used in a variety of joint types.

Biscuits are available in three standard sizes: #0, #10, and #20 (see illustration four). The general rule of thumb is to always use the #20 biscuit unless you are using ½" thick material, or the physical dimensions of the project require a smaller biscuit size. The biscuits should be placed in the center of the thickness of the pieces being joined, unless the piece is more than 1" thick, in which case, you simply use two rows of biscuits (see illustration five). Biscuits should generally be placed 6"-10" apart running down the length of the joint, with the end biscuits being placed 2"-3" from the ends of the board (see illustration six).

To use the machine, first set the biscuit size selector to match the biscuit size you will be using. Set the fence to 90°, then adjust the fence height to one-half the thickness of the material being joined (unless you are joining material that requires two rows of biscuits). The scale on the fence height adjustment measures the distance from the fence to the centerline of the blade.



Illus. Three

Illus. Four

Illus. Six

The rules for the operation of this machine are as follows:

NEVER attempt to join material that is less than ½" thick.

ALWAYS unplug the machine before making any adjustments to the machine.

ALWAYS clamp down the work piece when cutting with the biscuit joiner.

ALWAYS empty the dust collection bag after using the machine.

Pocket Hole Joiner

Much like the biscuit joiner, the pocket hole system is a relatively new technique for joining boards together. The pocket hole system is very simple in concept: using a jig and specialized drill bit, one piece of wood is counterbored at a shallow angle such that the head of the installed wood screw will be below the surface of the wood (see illustration below). The screw used in this procedure is a specialized self-tapping wood screw, which eliminates the need to drill a pilot hole in the mating piece. Because of this, this joinery technique is not only strong, but also requires very little time to complete.

To complete a joint using this technique, use the following procedures:

Mark out where you want the screws to be placed on the piece that will receive the pocket holes. Insert the Kreg drill bit into one of the plastic wings on the side of the clamping unit, and set the collar on the drill bit so that the shoulder of the drill bit reaches the mark that corresponds to the thickness of the wood being joined. Insert the marked work piece into the Kreg jig, and drill at full speed until the collar on the drill bit touches the Kreg jig.

If edge joining, use face clamps to align the faces of the work before driving in the screws to complete the joint. If joining pieces at 90°, you should place the pieces in one of the right-angle support jigs that were built for this task. Spread wood glue on one of the faces of the joint, secure the pieces to be joined in the right-angle jig, and drive the Kreg pocket hole screws into the pocket holes.

The rules for the operation of this tool are as follows:

ALWAYS consult the manual if joining wood pieces that are any thickness other than 3/4".

ALWAYS use a screw size that corresponds to the thickness of wood being joined (see manual).

NEVER use screws that are not made specifically for the pocket hole joiner.

ALWAYS use a corded drill to drill the pocket hole.

Hot Wire Cutter

The hot wire cutter is a simple tool, designed to do one simple task: cut through Styrofoam. The tool utilizes a heated element to do the cutting, and thus its name. There are three different tools that all run off the same power supply unit; a scroll table, a hand tool, and a scribe.

The scroll table (shown on the right) holds the wire steady, at a given angle, while you feed the work piece into the cutting wire in much the same manner as the scroll saw. The angle of the wire is adjustable; 45 degrees left or right tilt is possible. Work can be performed free hand, or a fence can be clamped to the table, to allow you to make cuts in a perfectly straight line, much the same as with the table saw or the band saw.

The hand tool, as its name implies, is for doing free-hand work. The cutting wire can be stretched straight across, or shaped into just about any cutting edge that you need.

The scribe tool is, as its name implies, for scribing lines. It can be thought of as being like a pen for “drawing” lines in the surface of the foam. It is not a knife, and should not be used as one. That type of work should be done on the scroll table.

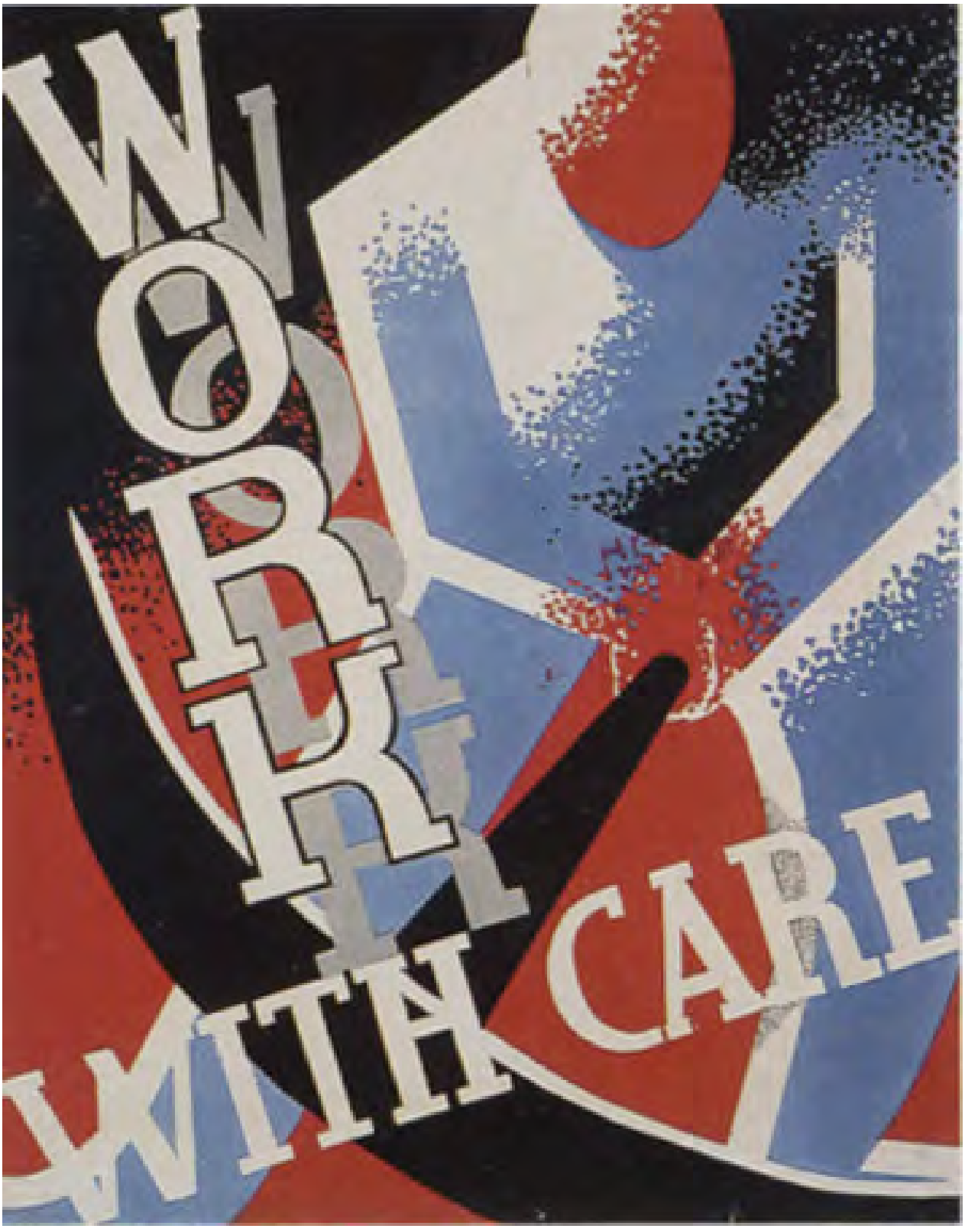
The rules for the operation of this tool are as follows:

NEVER cut anything other than white beaded Styrofoam with this tool. This means that the foam must be white, and you must be able to clearly see the cellular structure of the foam, just like you can with Styrofoam cups. Cutting foams other than white beaded Styrofoam will result in off-gassing of toxic fumes.

ALWAYS use in a well ventilated space. If possible, open up the door to the outside, to permit a good supply of fresh air to the space in which you are working.

ALWAYS take care to not touch the wire while cutting!

NEVER use a power setting higher than what is needed for the task at hand. Start at a low power setting, and keep turning up the power until it will cut the material at hand.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WITH CARE