A Thinly Disguised Lecture on Safety

At the Black Hills School of Woodworking, Tim Haggar was one of many students who became good friends. Tim designed and built several pieces of furniture for his family, including this dining room table.

For several years I taught people how to become competent woodworkers. Most of them were retiring from other professions, and their ranks ranged from doctors, college professors and social workers to lawyers and artists. They all had one thing in common when they walked into my shop: they believed in perfection.

But woodworking is not a precise science. It's an interpretive craft that can sometimes grow into an art form. The material is naturally unstable, the machines are not metalworking accurate, most projects are custom, no two boards are alike… and no two woodworkers are alike, either. A lot of the time, builders who use solid wood rather than plywood are reacting, rather than acting. We start out with a plan and the wood does something to change it. One of the best craftsmen I ever knew had a twenty-foot long banner on one wall of the shop that said:

"A great woodworker is one who knows how to fix his ****-ups!"

That's a really accurate assessment. The more advanced one becomes over the years, the less one sticks to the plan. Very few of the best furniture builders rely much on tape measures. They are more concerned that all four legs are equal, rather than that they are all precisely 18 inches long. Cabinetmakers need to be accurate, but furniture builders need to be satisfied.

It's about instinct and feeling, and that only comes with practice. Sam Maloof used his band saw as a carving tool. He worked on parts until they looked and felt right, rather than making them perfectly match a blueprint. I spoke with Jim Krenov on the phone once, after his sight had essentially failed him, and he was in the shop building a hand plane… by touch. When we designed and built furniture at the Black Hills School of Woodworking, I tried to instill in my students a sense of form and function, rather than mere technical prowess. Yes, we covered all the bases, but my heart would soar when somebody walked past the tape measure and made a pencil mark where he felt a cut should be, rather than where the plan said it should be.

I believe that the first mistake new woodworkers make – and this is just because they're nervous in an unfamiliar realm – is to be too literal. If the plan calls for 18-inch legs and you accidentally cut one at 17-7/8, then resist the call to be rigid. Don't waste stock making a new leg: just trim the other three. If the length is critical, maybe you can add an unseen pad to the bottom of each foot, or make the tabletop an eighth thicker. Be fluid in your thinking, and blueprints will evolve into designs. You'll replace frustration with fun, and build something unique – even if it's only minutely so.

Table Saws

If there is a bow or twist in a board, it can **bind** between the fence and the blade, and cause **kickback**. That's where the board is shot back from the blade toward the operator (you!), where it can cause a major injury, or worse. Think about this: each tooth on a 10-inch blade spinning at 3450 RPM travels more than 100,000 feet per minute – which is more than 1,200 MPH! That's faster than the speed that a bullet travels when it's shot from a pistol.

If that tooth catches the wood and throws it at you, there is no ducking. The key is to prevent the problem, rather than react to it. Anything that slides against a fence needs to be straight and flat. That's true whether you're working on the miter saw, router table, shaper, table saw or any other piece of fenced equipment.

If the wood is being run against a fence, then that edge MUST be straight. As a teacher, lots of people asked me what equipment they should buy to get up and going in woodworking. My feeling is that, before you buy a table saw, you should buy a jointer so you can make parts straight before you cut or shape them.

Your fingers should never be too close to a table saw blade. That's what push sticks are for. If you follow that rule, then you will change the danger associated with the saw from cutting and throwing, to just throwing.

A saw will throw the work at you when it binds. That means the teeth are grabbing the edge of the cut (called a kerf), rather than slicing straight. Somehow, the work is being fed to the blade at an angle. That could be because the edge against the fence isn't straight and flat, or else the fence isn't parallel to the blade. Before you fire up a table saw, use a dial caliper to make sure the blade is parallel to the miter gauge grooves, and then to the fence. If you're running a contractor saw (they usually have legs), you'll probably have to make adjustments by loosening the bolts that attach the motor to the bottom of the table, which can be a challenge. If you're running a cabinet saw (the base is enclosed), the motor is attached to the cabinet, not the tabletop, so the top can be loosened and adjusted separately. Hybrid saws vary. Refer to your manual for directions.

If a part begins to bind, hold on as strongly as you can and turn off the machine. If you let go or loosen your grip, it's coming at you. The table saw in my shop has a button on the front that I can hit with my knee to turn off the power. If your saw's OFF switch isn't hands-free, there are kits and plans online for a shut-off device for most machines. Many of them involve a spring-loaded bar or lever that you can hit with your leg. Don't wait until you need it, to install it…

<u>Saw Stop™</u>

There's a company that builds really good table saws that have a sensor that will stop the power instantly if your hand touches the blade. The saws are spendy, but so is a new finger. This device <u>does not prevent kickback.</u> It prevents fingers being hurt if they contact the blade. Here's how the company describes it on sawstop.com:

"The blade carries a small electrical signal, which the safety system continually monitors. When skin contacts the blade, the signal changes because the human body is conductive. The change to the signal activates the safety system.

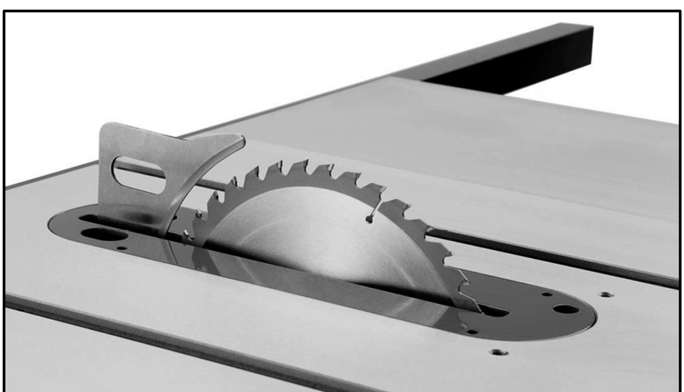
"An aluminum brake springs into the spinning blade, stopping it. The blade's angular momentum drives it beneath the table, removing the risk of subsequent contact. Power to the motor is shut off. All this happens in less than 5 milliseconds!"

As I understand it, every time the safety device triggers, you'll need to buy a new blade and a new aluminum block. In my personal opinion, I think it would be nice if the device just dropped the blade below the table without having to crash it into the aluminum block. But it sounds as though the impact is what triggers the blade dropping, so perhaps it's physically impossible to avoid the expense.

I personally don't own a SawStop saw because I prefer to rely on good practices, not engineering, to save fingers. *Again, your fingers should never be within several inches of a table saw blade.* There are myriad devices out there designed to keep your fingers away from the blade's tips. They include guards, shields, feather-boards, rollers, hold-downs, sliding tables, miter gauges and so on. The two most obvious tools are push sticks… and common sense. For example, don't ever reach over the blade while it's running. Just wait until it stops.

<u>Riving Knives</u>

There's an inexpensive anti-kickback device (shown below, courtesy of grizzly.com) called a riving knife. It was once available only on high-end professional saws, but it's now offered on many hobbyist models. A riving knife goes up, down and tilts with the blade. It's essentially a splitter that sits behind the blade, and stops a kerf (saw cut) closing and binding on the blade. If the wood grabs the blade, it will be thrown back at you. The riving knife keeps the cut open, but it does more than that.



The riving knife shown here is on a Grizzly G0715P table saw, and unlike traditional splitters it doesn't get in the way.

Most traditional splitters are tall like the one shown here, and are often used to drop a large clear plastic guard and evil-looking, serrated anti-kickback pawls over the blade. They have to be removed

for lots of cuts because they get in the way – for example, when you're using a miter gauge with a fence that supports work on both sides of the blade. Woodworkers are human, and they get tired of installing and removing the cumbersome guard. So, many people end up just removing it altogether. I often feel that the guard's purpose is more to protect the manufacturer from lawsuits than to protect the woodworker from mishaps, but I still suggest leaving it in place as much as possible. Oh, and in that vein – the guard has been removed from some photos in this book for clarity.

One problem is that some cuts don't go all the way through the wood. That is, the blade doesn't emerge through the top of the wood. Say, for example, that you need to make a ½-inch deep groove in a ¾-inch thick board. You can't make that cut with a traditional splitter in place, because the splitter is taller than the blade. The uncut wood will bump into the splitter, and stop you pushing the work across the saw table. With a riving knife, the top of the splitter is no higher than the top of the blade, so the cut can be made.

If you already own a saw and it doesn't have a riving knife, take a look at the MJ Splitter from microjig.com. It's an incredibly simple plastic device that is very inexpensive, easy to use and easy to install. You can quickly remove the splitter, or plug it back in. It only works for standard cuts (it doesn't tilt with the blade).

<u>Fences and Reaction Wood</u>

Aligning the fence is paramount. If the fence is farther away from the blade at the back than the front, the wood will try to wander away from the fence back there. Your instinct will be to push it harder against the fence to close the emerging gap. You're now asking the blade to cut at an angle. The board is going to get trapped and bind at the front of the blade.

If the fence is farther away from the blade at the front than the back, you're trying to feed the board into a funnel. Think about it…

Once the fence is perfect, take a look at the wood.

If the board isn't flat, it won't be stable. Either the ends or the middle won't be riding the table, and that's an invitation to kickback. It will 'bounce'. Your reactions are nowhere in the vicinity of the speed of the blade – you won't be able to compensate fast enough. It'll take off and fly at you in the blink of an eye. Flat boards only…

If the board isn't straight it will push or pull the blade toward or away from the fence, causing binding and kickback. Sight down each and every board to make sure it's flat and straight. Sometimes you just can't see the flaw in the wood before you start to cut. **Reaction wood** stores energy, which is released as the blade goes through it. This is wood that has grown in a direction other than vertical. It might be a leaning trunk, or a horizontal branch. The tree builds up strength on the weak side of such wood, to fight gravity. When the saw releases the energy, the kerf either springs open and pushes against the fence, or closes tightly on the blade.

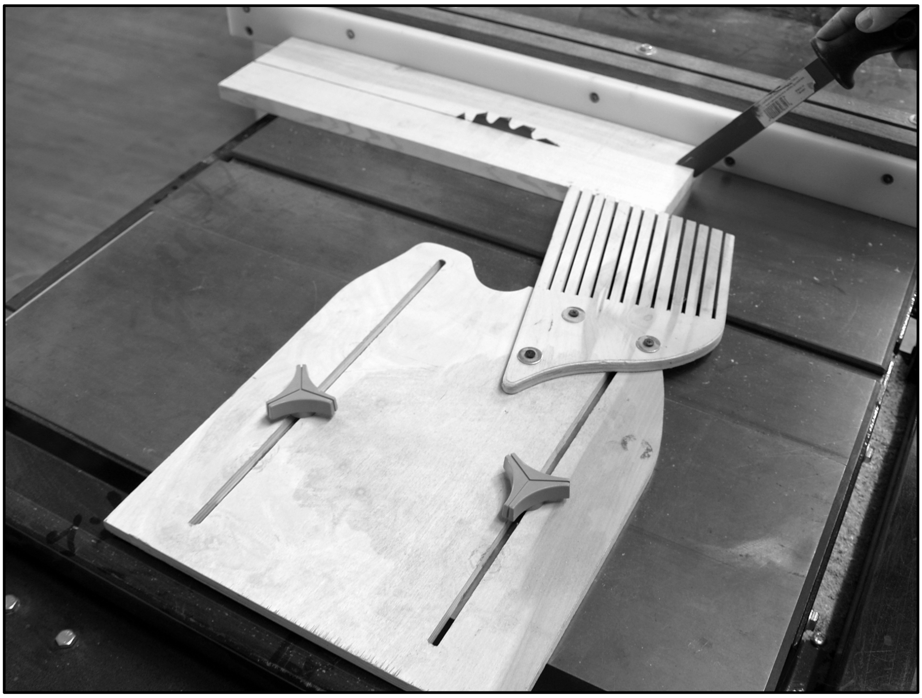
Tree limbs make great firewood and lousy lumber.

If a board begins to react, hold tight and stop the saw. Then throw the board into a woodstove. Even if you can straighten it out temporarily, it will react again at some future date and perhaps split or warp a tabletop or a cabinet door panel. Burn it, before it burns you.

Feather-Boards and Hold-Downs

One advantage to buying a table saw with a cast iron top is that you can drill and tap the metal for threaded knobs. That allows you to install shop-built feather-boards and other devices that hold wood to the fence and the table. The feather-board shown on page 7 is held in place with two ¼" threaded bolts with plastic knobs, and these are available at most hardware stores.

Buy an inexpensive ¼" tap that matches the thread count on the bolt. It will say the diameter of the required holes on the tap package, and after you drill them drip some oil on the tap and slowly ream the threads. The tap is tapered, so it will pop into the hole with ease. Just turn it a quarter turn or so and reverse, and then go another quarter turn, and so on. You'll find it's a whole lot simpler than you might imagine. Note that the feather-board is mounted BEFORE the blade. It must keep the wood pressed against the fence, not the blade. The wood must travel all the way past the feather-board before the cut is completed, or the feather-board will force the waste into the blade.



To make the feathers, clamp a stop (a chunk of wood) to the table saw fence, placing it so that you get the desired finger length (about 6-9" works well, depending on species and thickness). Make a cut along the grain, and then move the fence about 3/8" to make the next cut. The stop will ensure all the cuts are the same length. If you decide to make it in two parts like the one shown, the plywood for the base should be 3/8" or ½" thick or the feathers will be too high off the table. Note that the wood in the photo is being fed to the blade with a push stick. That one was purchased from Rockler (rockler.com) a couple of decades ago, and it's aluminum. On today's version (item 20333), the blade is plastic, but there's a magnet in the handle so the stick will attach to the saw and always be handy.

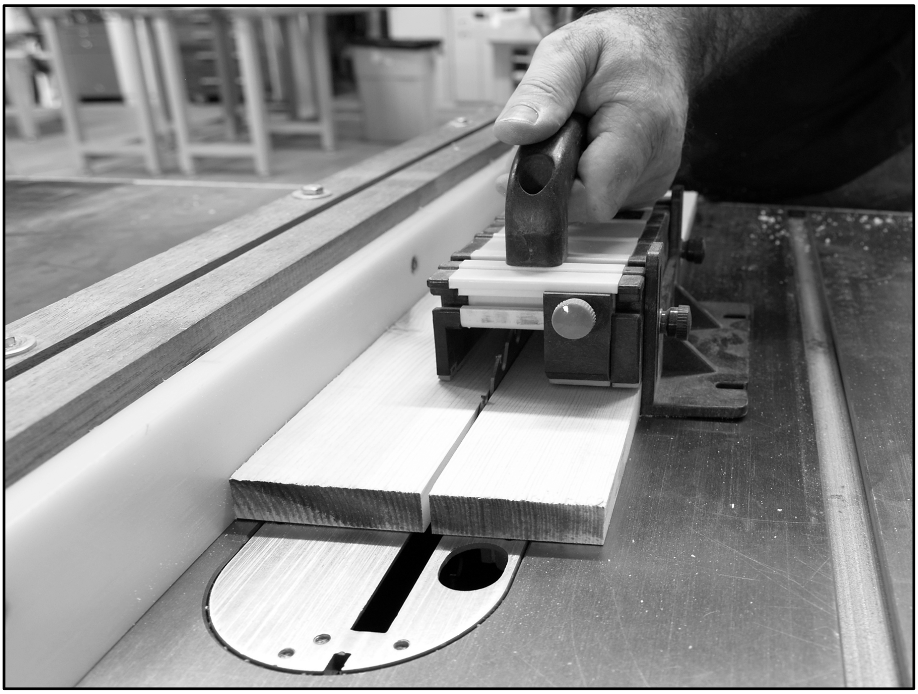
The wheel shown in the photo on page 8 only turns in one direction. Called a Board Buddy™, it's designed to push the wood down to the table, and also guide it toward the fence. If the saw decides to send the wood backward, the wheel locks. I attached a length of hardwood to the top of my fence after routing a T-groove in it, so I could attach jigs like this.

Push down on the handle, and the wheel rises if you need to pull the wood toward you after the blade stops. Turn the bolt at the back to increase or decrease the downward pressure. It's a handy gizmo and I tend to use it on larger work-pieces. On narrow stock, it gets in the way of my push-stick. I have two, and use both when cutting larger pieces of plywood.

The device shown on page 9 is the GRR-Ripper™ from Micro Jig (microjig.com). I've been using it for years with short and small pieces of stock. The only hesitation I have about recommending it is that you have to remember to check the blade height and its position on every single cut. I know this because I used to have two of these…

The GRR-Ripper allows you to push the stock down on the table and tight against the fence, and also gives you enough gripping power to push the wood forward through the blade. The wing on the side rides along the tabletop and prevents tipping on narrow boards.

There are a number of other common sense rules about table saws that old pros follow and newcomers need to learn. For example, keep the floor around the saw swept. Loose sawdust can cause you to lose your balance and fall toward the saw, where your natural reaction will be to reach out to steady yourself. That can be disastrous if you hit the blade with your fingers, or push something into the blade.



Don't set the blade too high. Some new woodworkers think that the blade should be as high and perpendicular to the wood as possible, so it's at maximum power. But a blade traveling at the speed of a bullet has all the power it needs at lower altitudes. I like to set the height so the bottoms of the gullets – the dips between the tips, or teeth – are revealed by about ¼" (see the picture on page 8). That lets the gullets eject waste to avoid heat build-up, but also reveals very little of the blade.

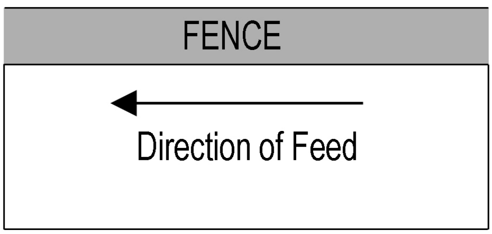
If you need a narrow piece of stock, cut it off a wide board. For example, rout molding profiles on the edges of a wide board and then rip them to width. Running thin stock through a table saw is dangerous. If you need to make a thin board even thinner, run it through a thickness planer or a band saw… or use a hand plane.

If you've never used a table saw, find a professional to show you how. A local cabinetmaker or furniture builder will often let you watch him work, and may even allow you to make a few cuts. Be wary of people who build things that look a little amateurish: if they don't take the time to produce a good product, they won't take the time to learn proper safety techniques. Rather than pick up their bad habits, start watching better woodworkers on YouTube™.

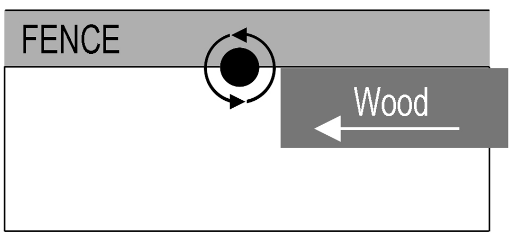
Never brush dust away with your hand: get in the habit of blowing it away, even when the machine is turned off. When a blade isn't spinning, it's still sharp. And NEVER reach across a spinning blade!

Router Tables

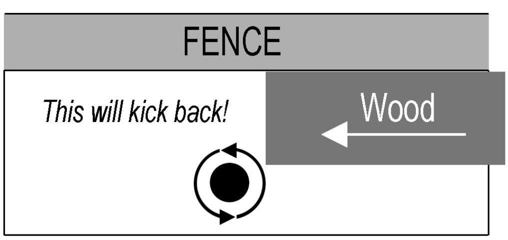
Aside from the dressing tools (planer and jointer, and we'll look at those in a minute), the next most used piece of milling equipment in the average one-man shops is a router table. There are some great factory models on the market, and lots of simple plans online and in magazine back issues for shop-built ones.



Feed right to left against the fence...



On through cuts, bit should be partially in the fence



Never feed wood between the bit and fence

The biggest mistakes that new woodworkers make with router tables are related to feed. Wood always travels from right to left on an inverted router (one that is attached to the bottom of a tabletop). After you have a lot of experience, you will discover climb cuts. But for now, stick to the right-to-left rule.

There are two types of cuts, through and hidden. Through cuts are ones where you can see the tip of the router bit – it emerges from the wood. Hidden cuts are one where the bit is only cutting partway through the stock, so the tip is hidden.

On through cuts, never feed work between the bit and the fence. It will bind and get thrown back at you.

The bit should be partially buried in the fence for those cuts. If you leave a gap between the fence and the bit, and try to feed the wood through the gap, the cutter at the back of the bit will be spinning in the wrong direction. Take a moment to think about that.

The same is not true of blind cuts, where the bit is traveling along the middle of the underside of a board – for example, when milling a groove. This is safe because the cutter can't grab the edge of the board. The back of the cutter is pretty much just spinning in the air, because the front of the cutter has already removed the stock.

New woodworkers tend to set the bit too high. Deep cuts need to be made in several incremental passes – removing a small amount of stock and then raising the bit. The amount you can remove in a pass depends on the density of the species (balsa or hickory?), the size and shape of the cutter, the power of the router, and the speed at which the wood is moving. We'll discuss all of those in the section on router tables, but for now keep this in mind: patience is a virtue. Try taking a very small amount on the first pass, and increase the height of the bit (called the depth of cut) or move the fence back a little on the second pass until you feel some resistance. If you're slowing the motor (the sound gets lower in tone, and louder), then back off. On the other hand, if there's absolutely no resistance, try going a bit deeper – not too much, now! Burning usually means you're asking too much of the bit, or it's dull.

Another thing that new woodworkers do is either over tighten the bit in the collet to the point that they destroy the threads, or under-tighten and the bit starts coming out. You can check for the latter by looking at the cut: is it a little deeper near the end? The bit needs to be snug. Read the router instructions: they usually tell you how much to tighten the collet.

Some routers have a double-lock. When you're opening the collet to remove a bit, the action might get easy for a minute and then get hard again. That is, you need the wrenches, and then it opens with your fingers, and then gets stuck again and you have to reach for the wrenches. This is intentional. After you use the wrenches the second time, the bit will usually slide right out.

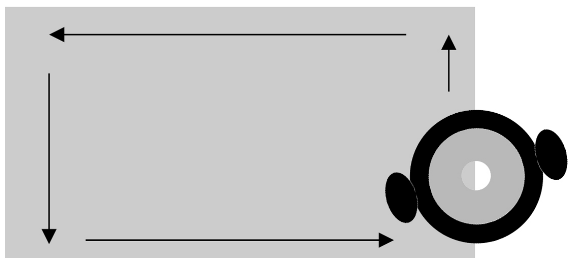
If you have a router without a double-lock and the bit won't come loose after the collet is open, gently tap the wrench against the shaft of the bit –NOT the shaft of the router (you might knock it out of alignment) – and it will usually loosen its grip.

Never, ever use a lubricant to make bits easy to remove.

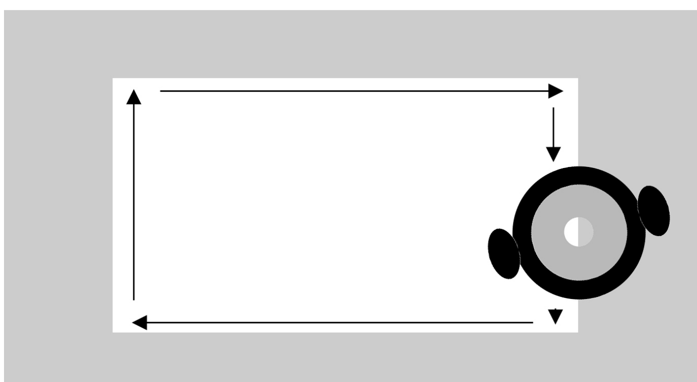
Portable Routers

If the router is mounted in a router table, it's upside-down and the bit is spinning anti-clockwise. But if you use the router as a portable tool in a base, then it is right side up and the bit will be spinning clockwise. To see what I mean, chuck a bit in an unplugged portable router and take a good look at it. Tip it upside-down. Notice how the cutters face one way? Now tip it back to its normal orientation. Notice how the cutters face the other way?

Understanding this simple physical reality is essential to using the router, because it determines the direction of feed. On a router table, the wood moves from right to left.



Counter-clockwise on an outside cut
(We're looking down from above)



Cloclwise on an inside cut

But in a portable base (above) the router moves, and the wood remains stationary. The router travels counterclockwise around the outside of a board, but clockwise when making an inside cut (such as decorating the inside edge of a picture frame).

The Jointer

The standard way to dress boards is to run one wide face across the jointer to flatten it and then to make the second face parallel to the first by running it through a thickness planer.

Always build a bridge on the jointer. This means that the highest point should be in the middle of the board, rather than at the ends. If you try to joint an edge where the ends are farther from the machine's bed than the middle, it will just rock. By letting the knives remove the high points on the ends first, you'll quickly get to a straight edge. And if you push down too hard on the middle of the bridge, the knives won't be able to trim just the ends. If you forego the jointer and just run a board through the planer, it will be perfectly parallel but not flat. If you only joint the wide faces and don't use the planer, it will be flat but not parallel – that is, it may not be an even thickness.

Use a pad and a push-stick. Most injuries on the jointer occur when the woodworker uses his hands to push the board down to the bed. Both my father and my friend Mark (who is a nationally renowned woodworker) lost fingertips that way. If the board isn't wide or thick enough to keep your fingers four inches from the knives, then use wooden or plastic devices to keep it against the fence and the bed. If the bed is cast iron, consider drilling and tapping it to install feather-boards right before the knives and on the fence. If you do, then all you'll need is a push-stick.

Band Saws and Drill Presses

These are the two most disrespected machines in the shop when it comes to safety. They're slow and quiet, and they don't seem frightening. But they're responsible for a very large share of woodshop injuries. So, here are a few tips to keep in mind.

On the band saw, close down the guard on the blade as much as possible. Don't leave several inches of teeth exposed just because you're "only making one small cut". Don't adjust the guard while the blade is moving, even if it is almost stopped. Consider whether you can pull the wood through on the last couple of inches of a cut, rather than pushing it and getting your fingers too close to the blade. Don't try to turn too tight a radius: the blade can actually snap.

On the drill press, clamp everything down rather than trying to physically hold onto it when using larger bits. A hole-saw can spin that piece of wood faster than greased lightning.

And remove the chuck key!

The Miter Saw

I always thought that the old radial arm saws were quite scary to use. Since the advent of sliding miter saws, one doesn't see too many of those old beasts any more. I've seen more injuries on radial arm saws than any other machine or tool, so maybe their demise is a good thing. If you're setting up shop and somebody offers you one, my advice is to accept it… and put it on eBay™ right away!

Miter saws still bear watching. They're a whole lot safer, but they, too, demand respect. The number one rule with them is to make sure the wood is flat on the bed and tight against the fence. New woodworkers are often unpleasantly surprised when they make a cut and the kerf closes on the blade and bounces the saw head in the air, or throws the wood across the room. That happens when the workpiece is tight against the fence at the ends but there's a small gap in the middle, so the blade will bind as the cut is made.

When making compound miter cuts, see if you can clamp the wood to the bed or fence, rather than using your hands close to the blade to hold it. If you do use clamps, make sure the blade won't hit them.

Thickness Planer

Need wider boards?

One of the things that new woodworkers tend to do is to use boards at their finished dimension before edge-gluing them.

Let me explain…

If the final product needs to be 3/4" thick, a pro will start with 4/4 H&M rough stock, clean up the edges on the jointer, edge-glue and clamp the boards, and let them sit overnight. After the assembly has cured, he'll run the part through the thickness planer (planing all the boards at once). He won't plane the boards individually and then edge-glue them, because it never works. You never get a perfect joint.

If you joint the edges and glue the boards together while they're still rough, you can then joint and plane the wide faces after the glue dries – and end up with thicker boards. But if you plane the wide faces before gluing the edges together, they simply won't line up and you'll have to plane them again, which wastes more material.

You can try all you want to line up the two edges perfectly with splines, biscuits or dowels, but glue is slippery and won't let you.

If possible, don't use biscuits near the ends when making wider boards. They tend to show up after trimming. (What's worse than seeing a worm in an apple you just bit? Seeing half a worm…)

A biscuit's primary design attribute is not strength. Their main advantage is that they keep things lined up as you're clamping, and the glue provides the strength. Biscuits do add some shear resistance, but they are of most value to a woodworker when they are used as an alignment aid.

Unfortunately, buried biscuits have a tendency to reappear when one crosscuts a board later on. Your heart may sink when you pick a cabinet part off the table saw, and see half a biscuit showing in the newly cut edge. Be careful where you place them.

A Few Other Safety Notes

If it’s possible to use a push-stick, then do so.

Thin boards cause accidents. To make thin moldings, first mill profiles on the edges of wider boards and then rip them to width on the table saw, rather than passing thin stock across the router table or table saw.

Never wipe dust off a machine with your hand. Blow it away. Get in this habit from day one, and yell at yourself when you're too lazy to remember it. Just pucker your lips and blow the dust away. Never use fingers, because even a stopped bit can cut – these are, after all, sharpened steel tooling. And if one gets in the habit of blowing dust when the bit is idle, one might even remember to do it when the bit is spinning…

The most dangerous tool in the shop is you. (What, you want political correctness here? We're talking about your fingers and eyes.) Being preoccupied, overconfident, in a hurry or distracted are the main causes of accidents. If you find you're not focused, turn off the shop lights – using a finger that you probably just saved – and go do something else for a while. Like, take a nap…