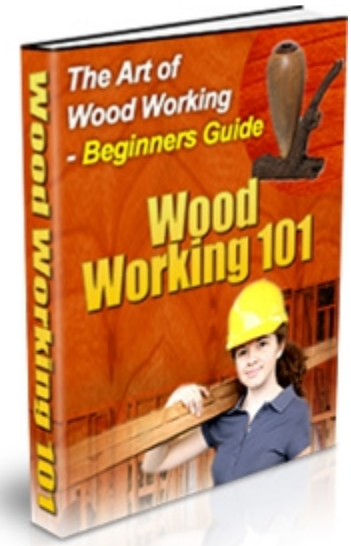


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Introduction To Woodworking

Woodworking encompasses a great number of diverse activities, including turning, woodcarving, marquetry, cabinetmaking and joinery, however, every specialist craftsman or craftswoman has at some time mastered the fundamentals of measuring and marking, dimensioning, assembling and finishing – considered the basics of woodworking skills that are the core of any woodworking calling.

The ability to think in three dimensions is needed to mark out the wood for a project and to imagine how one component fits with another and in what order is required of a woodworker. You will also need to know which tools will give the best results, depending on the level of accuracy required and the properties of the wood you are using.

Dimensioning is the process of reducing raw materials accurately to size. This almost invariably entails planning components square and true – a procedure that is simple in principle but takes a lot of practice to become perfect.

Cutting and assembling a variety of joints are part of all but the simplest of woodworking projects. Long been regarded as a measure of a woodworker's skills, joinery needs a steady hand-eye coordination, but experience will tell you the best way to fasten one piece of wood to another attractively and discreetly without sacrificing strength.

One necessary addition to these pivotal skills is an appreciation of how wood behaves. It is a unique, living material that continues to swell and contract with changes in humidity, a factor that a woodworker must deal with in the design and construction of every project. Some woods are easier to work with than others, and each piece, regardless of the species, is exclusive in the way the grain turns and twists.

There is no one right way to do anything in woodworking. The right way is the way that works best for you and what works best is a balance between the time something takes, the tools available, the pleasure you take in the process and the quality of results you are looking for.

There are arguments for both the use of hand tools and the use of machines for woodworking. Some say that using hand tools allow you to develop the 'knack' of cutting and shaping wood without tearing the grain. While other woodworking experts proclaim that you can often complete a project in less time with hand tools because of the set up required for the mechanical tools. Others believe just the opposite. We will discuss both options, hand tools and machine tools in this book.

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With a little patience, the right tool and techniques and a good set of plans, you don’t have to be Bob Villa to build something you’ll treasure for years to come.

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Safety First

Any discussion of woodworking machinery should begin with shop safety; hand tools require safety precautions as well. Woodworking machines are made to cut, chop, abrade, slice, drill and shave materials that are considerably harder then human skin. When used carelessly, machines are dangerous and when used properly, machines can be a wonderful help.

Wherever woodworkers gather, stories of accidents and near-misses come up sooner or later. Perhaps the term ‘accident’ is misleading here because ‘accident’ implies the injured person is a ‘victim’ of circumstances beyond their control; in most cases, it may be more appropriate to say that the ‘perpetrator’ suffers the consequences of his or her own carelessness.

Consciousness of safety is the first requirement of good craftsmanship. Here are several things you can do to protect yourself while working with wood, either with machines or hand tools.

- Wear hearing and eye protection when using saws, routers, sanders and other equipment. To keep splinters and dust out of your eyes, use large plastic safety goggles, a face shield or safety glasses.

    1. Goggles – the rigid lenses of safety goggles are surrounded by a soft plastic frame that fits and seals against the contours of your face. The sides are ventilated to prevent condensation and they can be worn over prescription eye glasses.
    2. Hearing protectors – earplugs and padded ear muffs protect your hearing from overexposure to noise. Always wear protectors when using noisy power tools that could cause long-term damage to your hearing.

- Keep your workshop area clean and neat so you won’t trip over a scrap of wood or an extension cord at an inconvenient moment.
- Tie up long hair; don’t wear loose-fitting clothing or any jewelry. All of these items can get caught in the machines and drag you towards the blades or other sharp parts.
- Don’t use machinery when you are tired or have consumed alcohol – any amount of alcohol, even a little bit is too much for operating machinery. This type of machinery is dangerous enough when you are fully alert, so why increase the odds of an accident?
- Focus on what you are doing at all times and take a break if you mind starts to wonder. You are most likely to have an accident when performing the same operation over and over again. Walk away for a few minutes between cuts.

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- If you are not comfortable making a cut or aren't sure if a particular cut is safe, get advice or help before you try it. Find a friendly woodworker to ask, perhaps at the local high school or college.

- Keep saw blades sharp. The harder you have to push, the less control you have over the wood. This can cause slips and loss of fingers or worse

- Be prepared for accidents. Consider these questions:

    1. Where is your telephone?
    2. Where is your first aide kit? – You should always have an extensive first aide kit available at all times.
    3. Where is the nearest person who can help you? – You should never be alone while woodworking.
    4. Can you give clear directions to your shop over the telephone?
    5. Are you familiar with basic tourniquet and first-aid techniques?

- If a serious accident does occur, call 911, not your friend. Your friend will not be able to help you if you suddenly go into shock on the way to the hospital.

- If you should be unfortunate as to sever any fingers, take them with you to the hospital in case they can be reattached. Severed fingers should be wrapped in gauze and soaked in a cup of salty water that is kept cold in ice; the fingers should never touch the ice.

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Health concerns –

Breathing sawdust is not healthy; it can be allergenic, toxic and carcinogenic. The sawdust from some imported woods, including teak, is particularly harmful and is know to cause skin rashes and repertory problems several studies have shown that woodworkers have a high rate of nasal cancers.

Because even a little sawdust can clog sinuses and aggravate allergies, try to wear a mask whenever you make dust, whether it's from machinery or sandpaper or sweeping the floor. Masks range from thin paper with an elastic strap to the thick rubber with a replaceable toxic-fume-proof filter. They heavy-duty masks are generally unpleasant to wear so some compromise will need to be made between efficiency and comfort.

Some of the solvents and finishes used in furniture finishing are also allergenic, toxic and carcinogenic. Petroleum distillates in commercial oil finishes, naphtha and benzene are all suspicious of contamination. Because many of these solvents are toxic to the human body by breathing or through skin contact, it's a good idea to wear rubber gloves and a toxic-vapor mask when working with them.

Wood shop accidents happen in an instant, especially with power tools. The results can be irreversible and even life-threatening. Your first line of defense against mishaps is really simple; Think Before Acting. Respect the capabilities and dangers of your tools and know how to use them safely.

Plan your work so you can get help lifting or moving heavy objects. Set high standards for tool maintenance and operations. Never use dull blades or bits. Remove guards and other safety devices only when absolutely necessary. And keep your work area clear of debris and clutter.

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Hardwoods Vs Softwoods

Lumber can be grouped into two broad categories – softwoods and hardwoods – based on a botanical distinction. Hardwoods are those species that come from leaf-bearing trees that produce flowers, fruits or nuts. Common North American hardwood lumber includes maple, oak, ash, walnut, cherry, beech, birch and poplar.

There are many less common Western hardwoods as well, like butternut, mesquite, holly, pear and sycamore. Other countries log innumerable hardwood species as well. Some of these exotics include teak, mahogany, ebony, rosewood, bubinga, purpleheart and pear. These exotic woods can be purchased through the Internet or specialty catalogs; however, they are pricey and may only come in a limited size.

Softwoods come from the large family of cone-bearing trees that bear needles rather than leaves. Firs and pines of all sorts, redwood, cedar and cypress are typical North American softwoods made into board lumber. Because these species are well suited for construction purposes, all lumber used fro framing and roughing construction comes from softwood trees.

They are sufficiently strong for structural applications, yet are easy to work with common hand or power tools. Another advantage is that cone-bearing trees grow rapidly and develop straighter trunks and branches than the hardwoods. And finally, more softwood trees can be planted per acre than hardwood trees so they produce a higher lumber yield in less time.

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Common misconceptions –

It is a common misconception that hardwoods are called hardwood because the wood is hard, while softwood is so named because they are soft. it is true that many hardwoods are more difficult to machine than softwoods, however the distinction actually has nothing to do with the hardness or workability.

Southern yellow pine, for example, is heavy dense softwood used for stair treads and large framing lumber. It machines and accepts fasteners in a manner like that of hardwoods. Walnut and poplar are common hardwoods, but they can be routed and sawn as easily as cedar or redwood.

Even pricing is not a good indicator of hardwoods or softwoods. More softwood is manufactured into building materials than furniture-grade lumber, but what dose become lumber can be quite expensive. Take for instance, clear sugar pine lumber, it is just as costly as premium cherry or white oak.

Actually, the basic economics of supply and demand have more to do with lumber pricing than the particular species of wood or even it's grade designation.

Choosing what to use –

Woodworking projects can use both softwoods and hardwoods. Generally, hardwoods end up as indoor projects such as furniture, trim-work, cabinetry and turnings because the wood grain and figures are highly desirable. Softwoods tend to become outdoor furniture, children's projects such as tree houses and other sorts of utility or painted projects. These are merely general guidelines. If money is no object, you can build children's furniture from practically any furniture-grad lumber you have.

The answer to – what species should I choose for a particular project? – is not cut and dried.

Ask yourself a few questions –

- *Is this an indoor or outdoor project?* Most wood will degrade over time in the presence of water or ultra violet sunlight. Moisture is another 'deadly' threat to wood; it invites mold and wood-boring insects. Some of the most durable outdoor woods include western red cedar, cypress, white oak and redwood. These lumbers contain natural oils or profiling compounds that resist rot and help repel insects. Boatbuilding woods such as mahogany and teak are excellent choices, although they are much more expensive than the common weather-resistant species.

  Consider using a pressure-treated wood if you are not using it for food or contact with skin (such as a chair or bench). It takes paint well once the

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infused chemicals dry and the wood tends to be warranted fro decades against rotting. Be careful and wear a dust respirator when machining pressure-treated lumber to keep from inhaling the sawdust, which contains the treating chemicals.

- *Will the project be painted or receive a clear finish*? For painted projects, choose wood that has a smooth texture without a heavy grain pattern. Ideally, the lumber should sand and finish so smoothly that the grain entirely disappears. Good paint-grade hardwoods include birch, aspen and birch. These also tend to be less expensive than hardwoods with more attractive wood grain patterns. Softwoods generally produce a blotchy, uneven tone when they are finished with a stain, but they make excellent economical painted woods. Pines, firs and other 'white woods' are good candidates fro paint finishes.

- *What thickness and proportions of lumber does your project require*? Nearly all the board lumber you will find in a home center or lumberyard will be milled to ¾-inch thickness. There could be a small amount of 'craft' woods in ¼-inch thickness made of oak or poplar as well as laminated blanks in a few sizes up to 3 inches thick. Lengths of 'craft' woods will be limited to about 3 feet. Some projects require large panel such as tables and entertainment centers and if you don't own a jointer and clamps to glue your own wide panels from narrower boards, your local home store probably stocks pre-glued sanded panels as wide as 3 feet and up to 8 feet long.

- *Which project parts will show*? Commonly practiced in furniture building is to use a secondary or cheaper lumber on the insides and backs of pieces and the more expensive, nicer wood on the outer areas of the furniture. Places that secondary wood might be used are drawers, shelves inside a cabinet, the backs of cabinets and desks, under the tabletop, legs, etc. Poplar and pine are often integrated into projects as secondary wood pieces.

- *What does your budget allow*? Lumber is expensive, particularly if you buy it completely surfaced. Sometimes sticker shock will push you over the edge and make your choice of lumber obvious. When tallying up the amount of lumber you will need, factor in another 20 to 30 percent additional wood. The overage invariably gets used in the end. If the price is out of reach, consider using a more economical wood and staining it to match the color of a more expensive wood.

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Various Styles Of Saws

There are many things to consider when choosing a saw blade – making safe, smooth cuts with your radial arm saw, table saw; compound slider miter saw or chop saw depends on having the correct blade for the tool and, for the kind of cut you would like to make. Performance varies from blade to blade and presently, not a lack of them in the stores today, so choose wisely.

Choosing the correct saw blade –

It's not all that complicated, really. In order to put together a top rate saw blade assortment of your own, you required to identify a small amount about what diverse blades do and what distinguishes the top-quality from the cheaper ones. Once you figure this out, you'll be able to decide the blade that is best for the type of woodworking you will be doing and you budget can afford.

There are blades that are intended to do a number of things. Some blades are for crosscutting wood, ripping wood, cutting veneered panels and plywood, cutting melamine, cutting non-ferries metals and cutting plastics and laminates. Combination blades and general purpose, these blades are for using two or additional kinds of cuts. The amount of teeth, the gullet, the hook angles (the tooth angle) and the tooth configuration all determines how good the saw blade is.

Amount of teeth –

Saw blades with less teeth move the wood faster furthermore blades with more teeth offer a smoother cut. For example, a 10' blade considered for ripping wood usually has fewer than 25 teeth plus are intended to move the material quickly through the machine along the extent of the grain. With the least little bit of effort and leaving a fresh cut and a least amount of scoring, the higher quality rip blade will out perform a lower quality rip blade which is not designed to make mirror-like smooth cuts. (mirror meaning both edges are the same).

Alternatively, a crosscut blade is well thought-out to give you a even cut crossways against the grain of the wood without any tearing or splintering. Between 60 and 80 teeth are found on the crosscut blade. Remember, moving less material, each tooth comes in contact with the wood less and this means a crosscut sharp edge makes numerous additional single and smoother cuts than the ripping blades. A polished finish will appear on the wood if using a good quality crosscut cutting edge.

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Gullet –

The space missing from the blade plate in front of each tooth, which allows for chip removal, is called the gullet. In the crosscutting blade, the chips are fewer and smaller per tooth so the gullet is much smaller. In the ripping blades the rate is much faster than the crosscutting action and the chips are bigger so therefore the gullet needs to be bigger to accommodate the larger amount of material coming through it.

The hook angle –

Rather than be perfectly in line with the blade, the teeth are tipped either inward or outward, depending on the configuration of the blade. Hook angle is the slant shaped connecting a tooth face and a line drawn down the middle of the blade across the tip of the tooth. A downbeat hook angle signifies the teeth tip away from the path of rotary motion and the reverse is said for the positive hook angle. A zero hook slant demonstrates the teeth are in line with the midpoint of the blade.

A very aggressive hook angle (degrees of 20 or more) will also have a very fast cutting rate. A negative or low hook position will have a slower supply rate and will stop the blade from 'climbing' the material as often happens.

Tooth configurations –

The way the blade cuts is often affected by the way the tooth is shaped and the way they are grouped together. The configuration has to do with the way a blade will cut, if it's a crosscutting, ripper or laminates cutter.

Hand saws –

No one can deny the aggressive speed of a table saw or a sliding chopsaw, however, for joinery; it's hard to beat the backsaw's precision for slicing just what you need. Hand saws are much cheaper and easier to control than machine saws. The backsaw can hold the sharpest, thinnest of blades and they can slice wood with minimum waste and maximum control.

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Measure Twice, Cut Once

Most woodworkers don't give much thought to most basic tools in their shop, they are too busy picking out the best chisels, scrapers, clamps, special jigs, tool, woodworking machinery, hand planes and all manner of accessories to make their work go smoothly and more accurate. What they are missing is the measuring and marking tools.

Look at what you own in the way of measuring and marking tools. Many of the frequent troubles in woodworking are out of a four-sided figure frames, casework, joints that fit poorly, etc. can be traced back to the measuring and marking mistakes. The culprit is usually only a matter of using the incorrect measuring and marking too for the job. A tape measure was not calculated for the extremely accurate measurements that most woodworking projects require.

Making for some exacting work, in most woodworking projects, the first thing you do is marking and measuring linear dimensions. Miscalculations as small as 100th of an inch when marking and measuring in such complicated joinery or small, tight parts will later show up as gaps in joints or uneven parts or a host of other less-than-perfect results.

Depending on how correctly you are able to interpret a measurement into an objective mark on a piece of wood is the outcome of measuring from point 1 to point 2. Holding down a tape measure while trying to accurately mark off a measurement is a difficult task, mainly because tape measures are not meant to lay flat. An accurately calibrated and readable marking and measuring tool is needed for all woodworking projects.

Rules and tape measures –

Since even the best measuring tools are relatively inexpensive, most woodworkers acquire a variety of rules and tape measure to meet different need. However, it is advisable to use the same rule or measuring tool throughout the project, just in case there is any variation between one tool and another. Purchase both rules and tape measures with standard and metric graduations – but take care not to confuse one system with the other once you have begun to mark out a work piece. You can measure one piece of wood accurately and then use it as a template for the other pieces if more than one of the same size is needed, this will save you time in the marking and measuring department.

1. Tape measure – retractable steel tapes, measuring from 6 to 16 ft (2 to 5m) long, are usually graduated along both edges. A lock button prevents the tape from retracting automatically. Some tape measures incorporate a liquid-crystal display that tells you how far the tape had been pulled from its case; a built-in memory retains the measurements when the tape is

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retracted. Self-adhesive steel tapes are sold without cases fro sticking along the front edge of a workbench.

2. Four-fold rule – The folding carpenter's rule made from boxwood with brass hinges and end capes is still popular among traditional artist. Most folding rules are 3ft (1m) in length fully extended. Because it is relatively thick, you have to stand a wooden rule on edge in order to transfer measurements accurately to the work. Similar rules made from plastic are sometimes made with beveled edges to overcome this problem.

3. Straightedge – every workshop needs at least one sturdy metal straightedge, measuring between 1ft 8in (500mm) and 6ft 6in (2m) long. A beveled straightedge is ideal for making accurate cuts with a marking knife and for checking that a planed surface is perfectly flat. Some straightedges are etched with standard metric and/or graduations.

Squares and T-Bevels –

Squares are used to make sure things are at a right angle to one another. In a woodshop, these things might be the edge of a board, the shoulder of a tenon, the fence on a jointer and so on. However, square is an abstract term. Looked at closely enough, nothing is truly square; some things just approach the idea of being square than others. There are three types of square generally used in woodworking.

1. Try squares – are the most commonly used squares among furniture makers. They have blades of brass or steel (generally from 6in to 12in long) set in a thicker wood or metal stock. If the stock is wood, it should be faced with metal to ensure long-term accuracy. The reliability of try squares can vary sharply, even among those made by the same manufacturer.

2. Engineer's square – these are similar in design to the try squares, but made entirely of steel. Blades lengths start at approximately 2 in. these squares are more reliable than try squares, probably because engineers are a more demanding bunch than woodworkers. Engineer's squares can be used interchangeably with try squares in a woodshop.

3. Framing squares – these are made for house building. They have two large blades that form a right angle. One blade is 2in wide by 24in long; the other is 1 ½ in by 18in long. Framing squares are not expected to be precise as try squares or engineer's squares.

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Marking tools –

1. Pencils – every shop needs pencils for marking out your designs and marking wood in order to keep track of jointed surfaces and which piece fits together where.

2. Knives – these are indispensible in a woodshop for tasks such as marking tenon shoulders and cutting cardboard templates. Knives are a preference, pocket knives, box cutters; utility knives with a retractable blade are all useful in a woodworking shop.

3. Awls – these are sharp, pointed instruments with a variety of uses. They differ in the fineness of their points and the thickness of their shafts. A fine-pointed awl is useful for marking out joinery and scribing lines and a thick-shanked, broad-pointed awl is good for making pilot holes in wood prior to drilling. The dimple it leaves when tapped with a mallet forms an exact starting point for a drill bit.

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Chisel Basics

There are only a few truly indispensible hand tools for woodworking today. Near the top of the list would be the basic chisel. This is a tool that does it all, from carefully paring away thin shavings in intricate detailed work to quickly scooping out large chunks of waste wood. You will find chisels in every basic aspect of woodworking from furniture making to trim carpentry to woodcarving.

There are several different types and sizes of chisels one should carry in their woodworking shop and each is designed for a specific job. You could consider purchasing a 4 piece set which includes ¼-, ½-, ¾- and a 1 inch beveled bench chisel with blade lengths from 4 to 6 inches. Plastic handles are best because they can stand up to being hit by a mallet and are comfortable to hold for long periods of time. If you only have the budget for one, purchase a ¾ inch chisel and be sure to purchase a reputable brand because quality counts, it will hold up to repeated sharpening longer.

Using your chisel –

To chisel a shallow mortise or notch at the border of a piece of wood, begin by placing the indentation edge with a blade grove. And then, place the beveled edge in front of the throw away area, position the chisel edge in the subsequent line, holding the chisel perpendicularly and tap with your mallet which makes the cuts around the border. Place the bevel downward; make one-sided cuts from the stock facade to the boarder cuts to make the indentation walls. Following the angled boundary cuts to the preferred deepness, rotate the chisel bevel side up and cut diagonally against the grain and taking away the majority of the unusable portion. When the indentation has come to its estimated dimension, use tiny cuts to help reach its final size and deepness.

Use a wide bevel chisel, with the bevel up in a semi-circular sweeping motion with the straggling end of the blade doing the slicing if you need engrain paring done.

The easiest and quickest way to slice a cavernous mortis is to first drill a sequence of holes with a drill bit that is to some extent tinier than the depth of the hole. Then use the chisel to shear away the throw away pieces amid the holes.

Concave curves can be trimmed by using a chisel so as to be somewhat wider than the width of the reserve. Press down on the blade while rotating downwards on the handle and pushing straight ahead all while holding the bevel down.

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Sharpening –

For fast cutting and clean, a sharpened edge is necessary as well as for individual safety. An unsharp tool make a rough cut – you want everything to be smooth – but the additional strength necessary to drive the tool could cause you to have less control over the situation which could lead to accidents.

By honing a chisel regularly on a water or oil stone, you will keep it sharp and in top shape for cutting and scraping. The cutting edge bevel is typically around 20 to 35 degrees, however you don't have to hone the complete bevel, in its place, hone a small, minor bevel at the top to a little more of an angle than the most important bevel.

Set the bevel steadfastly on the stone and then rise the chisel about five degrees. Shift the blade back and forth until a wire edge builds on the back of the blade. Flip the blade over and lay it entirely level on the stone, glide it back and forth a few times to eliminate the edge of wire. Pare across an endgrain as a check for unevenness.

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Choosing Hand Tools

There are many woodworkers who believe that using hand tools and only hand tools is the way to make anything. From furniture to birdhouses, only hand tools will do for them. Others will use a combination of hand tools and portable power tools and perhaps sedentary equipment like a table saw or other large machinery which helps move the process along faster.

Hand tools are quiet and help you connect with the wood on a different level than using machines to rip or cut the wood. Here is a list of several hand tools you should have in case you find yourself wanting to become one with the wood.

Chisels – always purchase a good set of wooden-handled bench chisels (¼ in, ¾ in, 1in) and a ¼ in mortise chisel. Wooden handles are more comfortable and more visually appealing than plastic and if they ever split or get chipped you can replace them with little effort. Western chisels are preferred to the Japanese chisels, which some say requires too much work, especially if you're just getting started in woodworking. If you can afford it, buy a 2in wide bench chisel in addition to the four smaller ones. Its extra-wide blade is ideal for paring tenons.

Sharpening stones – waterstones are cleaner than oilstones. They come in a variety of grits, 800-, 1,200-, 4,000- and 6,000- grit stones.

Combination square – usually comes in 12 in. this tool will mark out stock at 90 and 45 degrees and can double as a ruler and a marking gauge. Buy the best you can afford because you will be using it the most.

Hammer – a good 13-oz, claw hammer is ideal for general cabinet work and is useful for installation work as well. They are inexpensive yet get the job done right the first time.

Caver's mallet – this is useful for driving joints home and for chopping out mortises. A medium-sixed turned lignum vitae mallet is approximately $20-25.

Dovetail and tenon saws – used for cutting small pieces, an 8in dovetail saw with a turned handle and 18 teeth per inch. A 10in brass-backed dovetail saw with 14 teeth per inch for cutting dovetails and tenons. Japanese saws will also do a great job; however, they can require delicate handling and replacement blades are often expensive.

Block plane – block plane can either be a low-angle or the regular angle. They are solid, compact and well made. A block plane is useful for planning small parts, flushing surfaces and planning end grain.

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Smoothing plane #3 – a smoothing plane is used for final planning of surfaces as well as for shooting edges on short pieces and for faring joints. Expect to pay upwards of $100 for a good smoothing plane #3.

Rabbet plane – there are several planes that fit the bill, this plane is used to trim rabbets, plane into corners and trim joints flush. Some of them have a removable front half to convert it to a chisel plane.

Spokeshaves – this is a type of plane used primarily to round edges, make spindles and fair concave curves. The short sole of a spokeshave is mounted between tow handles. The blade is generally held in place with a cap iron. They can be used with either a pulling or a pushing motion.

Cabinet scraper – they are inexpensive, work well and last for what seems like forever. Scrapers are good for smoothing hardwood and veneered surfaces, either before or in lieu of sanding.

Burnishers – these are smooth rods of hard steel used to put an edge on a scraper. They can be round, oval or triangular in section. A highly polished burnisher creates a smooth edge on the scraper, which in turn leaves the scraped wood smoother. The shank of a Phillips-head screwdriver often works well as a burnisher.

Drill bits – the drill bits found in a woodshop include twist drills, brad-point bits, Forstner bits and spade bits, each has a distinct advantages and limitations.

Clamps – there are a number of clamps used to squeeze pieces of wood together particularly during assembly and gluing. **Bar clamps** consists of two jaws mounted on a length of steel bar, usually and I-shaped in section. A **pipe clamp** is similar except that it substitutes a pipe for the I-bar and is less ridged. Bar and pipe clamps are best suited for assembling wide surfaces, such as tabletops and fro putting together large carcasses.

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Adhesives For Woodworking

Although there are approximately 1,500 adhesive products manufactured in the Untied States, less than a dozen are suitable for woodworking. Before getting into the individual types of adhesives, it might be helpful to know how glue bonds wooden parts together. It is helpful to understand a little about the chemical makeup of wood and how an adhesive interacts with these components during the bonding process. Wood is a complex mixture of organic chemicals and water.

About 95 percent of a board consists of cellulose, hemicelluloses and lignin, which form the structural matrix of wood and give it its rigidity, strength and elasticity. The remaining five percent contained in dry wood is composed of tannins, essential oils, resins, gums, coloring agents and sugars. This chemical mixture of extractives is responsible for wood's smell, color and decay resistance. Unfortunately, extractive in some resinous woods, such as teak and rosewood can interfere with the gluing process.

Once an adhesive is applied to adjacent wood surfaces and the pieces are clamped up, the structural elements of the wood of wood are linked together by the bonding process. First, the liquid adhesive is absorbed into the wood and its polymer molecules intermingle with the structural fibers of wood. Then, the adhesive's polymer molecules coalesce or come together, surround the structural fibers and harden, mechanically interlocking the fibers.

Thermosetting glues such as epoxy, urea formaldehyde and resorcinol cure by a chemical reaction, usually after two components have been mixed, while thermoplastic adhesives, such as yellow and white glues cure by evaporations. Once either type of glue is dry, the think layer of cured adhesive between the two wood surfaces acts like a bridge holding the boards together.

Polyvinyl acetates –

Yellow and white glues are probably the most often and most popular glues used in woodworking today. Both are polyvinyl acetates (PVA) adhesives that come in three main varieties: yellow aliphatic resin, white or craft glue and cross-linking PVA emulsion. All of these have a balanced set of properties, which make them ideal fro gluing wood. They are easy to use, have quick grab, set rapidly clean up with water, are non-toxic and work in most wood-gluing situations. In addition, the liquid adhesives will spoil if frozen. However, PVA adhesives have poor creep resistance and they should never be used in structural assemblies, like load-bearing beams, without some form of mechanical fastening such as nails or screws.

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Resorcinol and urea formaldehydes –

Urea formaldehyde and resorcinol formaldehyde adhesives are most frequently used for bonding wood when strong, creep- and water-resistant bonds are required. Urea formaldehyde (UF) adhesive sometimes called plastic resin glue comes as a one-part powder. The powder is a mixture of dry resins and hardeners that if kept dry will remain storable indefinitely. Water is added to dissolve the chemicals and activate the adhesive. The pot life after mixing is relatively long, but the viscosity of the activated glue slowly increases until after about an hour, the adhesive is too thick to work with. Once cured, UF adhesives produce structural bonds and the tan glueline is hardly noticeable even on light-colored woods. Interior load-bearing beams and hardwood plywood panels are often glued with UF adhesives. However it is not 100 percent waterproof.

Resorcinol formaldehyde or RF adhesives have high strength, exceptional solvent resistance and when properly cured, will withstand prolonged immersion in water, making them perfect for marine applications. RF glues come as two-part kits: part one is the resorcinol resin dissolved in ethyl alcohol; the other part contains powdered parafomaldehyed. The premeasured components are stirred together to activate the adhesive, but careful mixing is necessary to avoid lumps.

Working with RF and UF adhesives can cause health issues, so work in a well ventilated area, wear a mask and take breaks whenever possible. This is because they both give off a formaldehyde gas.

Epoxy –

With their high strength, great gap-filling capacity, ability to structurally join difficult-to-bond materials and waterproof nature, epoxies are surely the high-performance adhesives of the woodworking world. Epoxy consists of an epoxy resin and an amine hardener. Typically equal parts of resin and hardener are mixed to activate the adhesive and start the curing process, which works by chemical reaction rather than solvent evaporation. The exact mixing proportions are fairly critical; too much of either component will adversely affect bonding strength. Because of the lack of solvent, epoxy has an exceptional gap-filling ability.

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Sharpening Tools – Get To The Point

There are several ways to keep your woodworking tool sharp. Most are kept sharp by using an abrasive whetstone to wear the metal to a narrow cutting edge. The better-quality natural stones are more expensive, but you can get satisfactory results from cheaper, synthetic stones. As part of the sharpening, whetstones are lubricated with water or oils to make sure the steel does not overheat and to prevent fine particles of metal and stone from clogging the abrasive surface.

Generally, whetstones are sold as rectangular blocks – know as bench stones – for sharpening everyday tools or as small knife edges or teardrop section stones for honing gouges and carving chisels. Blades can also be sharpened on a perfectly flat metal plat that has been dusted with abrasive powder.

Oilstones –

The majority of man-made and natural sharpening stones are lubricated with light oil. Novaculite generally considered to be the finest oilstones available are only found in Arkansas. This compact silica crystal occurs naturally in various grades. The course, mottled-gray Soft Arkansas stone removes metal quickly and is used for the preliminary shaping of edged tools. The white Hard Arkansas stone puts the honing angle on the cutting edge, which is then refined and polished with the Black Arkansas stone. Even finer is the rare translucent variety. Synthetic oilstones are made from sintered aluminum oxide or silicon carbide. Categorized as coarse, medium and find, man-made sharpening stones are far cheaper than their natural equivalents.

Waterstones –

Because it is relatively soft and friable, a sharpening stone that is lubricated with water cuts faster than an equivalent oilstone; fresh abrasive particles are exposed and released constantly as a meta blade is rubbed across the surface of the waterstone. However, this soft bond also makes a waterstone vulnerable to accidental damage, especially when honing narrow chisels that could score the surface. Naturally occurring waterstones are so costly that most tool suppliers offer only the synthetic varieties which are almost as efficient.

Diamond stones –

Extremely durable coarse – and fine-grade sharpening ‘stones’ comprise a nickel plated steel plate that is embedded with monocrystalline diamond particles and bonded to a rigid polycarbonate base. These fast-cutting sharpening tools, available as bench stones and narrow files, can be used dry or lubricated with water. Diamond stones will sharpen steel and carbide tools.

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Metal lapping plates –

Available as alternatives to conventional sharpening stones, oiled steel or cast-iron plates sprinkled with successively finer particles of silicon carbide produce an absolutely flat polished back to a plane or chisel blade and razor-sharp cutting edges. For the ultimate cutting edge on steel tools, finish with diamond-grit compound spread on a flat steel plate. Diamond abrasives are also used to hone carbide-tipped tools.

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Making Joints

Square-ended butt joints –

It is possible to make flat frames and simple box structures utilizing square-cut corner joints. Use sawn wood for rough carpentry, but plane the wood square beforehand for good-quality cabinet work. Since glue alone is rarely adequate to make a sturdy butt join, hold the parts together with fine nails or glued blocks of wood.

Mitered butt joint –

The classic joint for picture frames, the mitered butt joint makes a neat right-angle corner without visible end grain. Cutting wood at 45 degrees produces a relatively large surface area of weight frames, just add glue and set the join in a miter clamp for a while.

Edge-to-edge butt joint –

Lumber selection is an important as good edge-to-edge joints when making wide panel from solid wood. To make sure the panel will remain flat; try to use quarter-sawn wood – that is, with the end-grain growth rings running perpendicular to the face side of each board. If that is not possible, arrange them so the direction of ring growth alternates from one board to the next. Also try to make sure the surface grain on the boards runs in the same direction, to facilitate the final cleaning up of the panel with a plane. Before you get to work, number each board and mark the face sides.

Tongue-and groove joint –

Use a combination plane to cut a tongue-and-groove joint by hand. This kind of plane is similar to a standard plow plane, but comes with a wider range of cutters, including one designed to shape a tongue on the edge of a workpiece. Cut the tongue first, then change the cutter and plane a matching groove.

Doweled frame joints –

Frames made with doweled butt joints are surprisingly strong. Nowadays, most factory-made furniture incorporates dowel joints even for chair rails, which must be capable of resisting prolonged and considerable strain. In most cases, two dowels per joint are sufficient. Place them a minimum of ¼ inch from both edges of the rail.

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Edge-to-edge dowel joint –

When constructing a wide solid-wood panel, you can make a particularly strong join between boards by inserting a dowel every 9 to 12 inches.

Carcass butt joints –

When constructing a carcass with butt joints that are reinforced with multiple dowels, it pays to buy extra-long slide rods and additional drill bit guides for the doweling jig. A doweling jig is required for many of the doweled joints. This can be an expensive piece of machinery and if you are not going to use it very often, it might be worth looking into renting one or borrowing one from someone.

Corner bridle joint –

A corner bridle joint is adequate for relatively lightweight frames, provided they are not subjected to sideways pressure, which tends to force bridle joints out of square. The strength of the bridle is improved considerably if you insert two dowels through the side of the joint after the glue has set.

Mitered bridle joint –

The mitered bridle is cut in a similar fashion as the conventional corner joint, but is a more attractive alternative for framing, because end grain appears on one edge only.

T-bridle joint –

The T-bridle joint serves as an intermediate support for a frame and with modifications, is sometimes used to join a table leg to the underframe when a long rail requires support. Unlike the corner bridle, which is relatively weak under sideways pressure, the t-bridle is similar in strength to the mortise-and-tenon joint.

Lap joint –

A basic lap joint is only marginally stronger than a straightforward butt joint, but it is an improvement in appearance since most of the end grain is concealed. As a result, it is sometimes used as a relatively simple way of connecting a drawer front to drawer sides.

Through mortise and tenon joint –

The through joint, where the tenon passes right thought the leg, is used a great deal for construction frames of all kinds. With the end grain showing, possibly with wooden wedges used to spread the tenon, it is an attractive businesslike

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joint. Always cut the mortise first, since it is easier to make the tenon fit exactly than the other way around.

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Deciding What To Build

The first step of any woodworking project involves planning. Simple project may take just a bit of forethought before you're ready to build, but more complicated furniture usually takes much more preparation. Either way, some degree of planning is essential.

Project planning has three basic stages: determining what to build, working out the details through drawings and prototypes, then calculating materials and cutting lists from your drawings.

Maybe your family has outgrown the kitchen table and you want to replace it with something a bit out of the ordinary. You can design any table you want and customize it to suit your individual needs or tastes. Maybe you've had your eye on an Arts and Crafts sideboard at the local furniture gallery, but it's priced beyond your means.

Building one yourself allows you, rather than the furniture gallery, to control the quality and cost. Possibly you just want to try some new woodworking techniques or tools to expand your skill base. The motivation to build something has any number of sources.

Gathering ideas – whatever your motivation may be for building something, chances are you've already thought about enough to have some initial ideas about a design. The idea-gathering stage is an important one. It's the time to let your imagination go without committing to any one idea. Feed your ideas with lots of concrete options so you can start to clarify a design.

Furniture stores are great places to examine different examples of various styles and types of furniture designs. Look at friends and families furniture, clip out photos from magazines and catalogs and keep them in a folder for ideas of what you would like to build.

Furniture follows some classical style trends and always has. Certainly everything you make doesn't have to conform to an accepted style, but basic furniture design is the end result of centuries of trial and error. Study proportions of cabinetry, tables, chairs and chests to get a sense for how furniture functions in harmony with the human body.

You'll know a comfortable chair when you sit in one, even if you can't pinpoint why it feels so supportive, seat size, leg height and the tilt of the back rest are all factors that contribute to comfort.

Evaluate your skills, tools and budget – keep your skill level in mind as you study furniture. Furniture with delicate inlays, relief carvings or parts that join at angles

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or curves will be more difficult to build than pieces with straight lines and minimal ornamentation. If you're just starting out, consider making projects in the Arts and Crafts, Shaker and country styles. These are good options for building sturdy furniture without needing advanced woodworking skills or a full arsenal of machinery or tools.

Try a new technique here or there within the furniture style your skill level to keep every project interesting. Your roster of skills will grow bit by bit without jeopardizing the success of a whole project.

Building sensibly means working with some project budget in mind. When you pockets for a project aren't deep the dollars will go farther by building with ¾ inch lumber rather than thick slabs of exotic hardwood. It's almost always true that the larger your project becomes physically, the more it costs. One way to help keep from blowing the budget on big projects is to substituted sheet goods for solid lumber.

Sheet goods are generally less expensive and you can steer clear of the wood movement issues you'll face when designing panels made of solid wood. Remember to include the cost of special hardware you project will call for, such as slides, hinges, doorknobs and drawer pulls. These items definitely add to the bottom line of what your project costs to build.

Before embarking on a project, have a look around your workshop at the tools you own. Do you have all the equipment you will need for cutting out your project parts, shaping the edges, assembling wood panels or smoothing the part surfaces? If your project parts are small and curved, how will you safely cut the tiny curves?

A scroll saw is the best tool for this task. Will you need one or can you modify the design or accomplish the task another way? Think through the construction phase of the project and how you'll manage each machining step. Otherwise, you could end up midway through the project and stumped over how to proceed. If you can't accomplish the project without buying a new tool, will you budget support the expenditure?

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Creating Working Drawings

This is where the fun begins! You get your first look at the project-to-be and you can work out the bugs in the overall look of the piece without laboring over the details. Approach concept sketching by giving your hand 'free rein' to draw and redraw any inspirations that comes to mind. This is not the time to worry about perfect symmetry, properly scaled portions, crisp lines or exacting curves. You can take care of all that later when you produce the mechanical drawings. Do not however go on from sketching to drafting until you have something you really like. It's too time-consuming to make major design changes at the drafting stage.

Choose an artist's sketchbook and a soft #2 lead pencil with a pink-tipped eraser. Avoid using anything harder because their lines are difficult to erase from typical sketch paper. Hold the pencil lightly and just move across the page until something comes to you. Allow your arm to move with your hand as you make long lines and turn the sketch pad as you naturally sweep your wrist across the paper when drawing angled lines.

One of the benefits of doing 'freehand concept sketches' is that you can easily create a series of 'what-if' views. Instead of redrawing the form over and over, simply trace it onto a piece of translucent paper, leaving out the areas that will be changed in the 'what-if' views. Or you can photocopy as many basic outlines as you'd like and then flesh them out with your new design idea.

Once you have settled on a concept sketch that comes closest to what your idea is, it's time to assign some dimensions to the project. By setting out the design to scale in a mechanical drawing, you can see clearly how the size and shape of components relate to one another. Methods and sequences of joinery also become more obvious. These working drawings are a bridge between your freehand concept sketches and a master cut list.

Drafting basics –

These skills are mostly common sense: make sure your board is free of lead and eraser debris before taping paper to it. Align the bottom of the paper to the parallel rule and then secure it to the board with a piece of tape in each corner. Keep a scrap piece of paper between your hand and the drawing to avoid smudging your work. Use a brush to wipe away eraser debris, not your hand. Once you establish a baseline on your drawing, draw any degree angle to it using either angle templates or a protractor and straightedge.

Begin the angled line precisely on a dimension mark by fires holding the pencil to the mark and then sliding the template or straightedge to it. if you reverse this process, parallax can play tricks on your eyes, causing you to misjudge the

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placement of the pencil. Draw out a waver-free line by tilting the pencil slightly into the corner formed between the edge of the template and the paper.

A mechanical drawing is nothing more than a happy meeting of lines that indicate the outline of an object and where measurements are being made to. Unless these lines vary in some way, the drawing can be difficult to read.

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Finishes And Fillers

There are many finishes, each of which has strengths and weaknesses. They vary in ease of application, water resistance, solvent resistance, dirt resistance, surface buildup toxicity, durability, gloss and easy of repair. The most commonly used finishes are oils, varnish and urethane, oil/varnish mixtures, wax, wiping varnishes, shellac and lacquers.

Oils –

Tow types of oil are used to finish furniture: linseed oil which is pressed from flax seed and tung oil (also known as China wood oil) which comes from the nut of the tung tree. Though tung oil originated in China, much of it is now exported from South America. Tung oil is superior to linseed oil, with greater water resistance and less tendency to yellow over time.

In their purest forms, these oils dry slowly and stay relatively soft. to make them dry faster and harder, they are often treated with heat and/or additives in the manufacturing process. Treated linseed oil is called 'boiled' linseed oil.

The advantages of oil finishes are:

- Ease of application, you just put some oil on the wood with a rag, let it soak in and wipe off the excess.

- Appearance – properly applied, oil finishes dry in the wood, rather than on top of it. The absence of surface buildup gives the wood a visual and tactile immediacy that most other finishes lack.

- Ease of repair, stains and scratches can be sanded out and re-oiled without stripping the entire surface. However, on woods that change color because of oxidation or exposure to sunlight, a freshly sanded spot will stay a different color for quite a while.

The disadvantage of oil finishes are:

- Relatively little protection against liquids, moisture and scratches.
- Many coats are required to develop a decent buildup.
- Wet oil can bleed out of the pores for hours, unless you stay on hand to wipe the surface, bleed-out dries into shiny little spots.

Varnish and Urethane –

Varnishes are surface coatings traditionally made by cooking oil and resin together and combining the mixture with thinner, mineral spirits. Modern

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varnishes usually substitute synthetic alkyd resin for natural resin. Urethane is very similar to varnish, except that it contains some proportion of polyurethane resin.

Varnish is applied with a brush, dries much harder than oil and takes a long time to dry. Excellent resistance to water solvents and moisture, as well as abrasion protection, makes varnish an ideal finish for marine and outdoor uses. Practice and care are required in applying varnish, which readily shows brush marks, traps air bubbles and picks up dirt particles.

Oil/varnish mixtures –

Oil/varnish mixtures are applied like oil but dry faster and harder with fewer coats required to build up a good-looking finish. There is no appreciable surface coating to destroy the tactile quality of the wood. Although they are nowhere near as protective as thick coats of straight varnish, oil/varnish mixtures definably provide better moisture and liquid resistance than does oil alone.

Disadvantages of oil/varnish mixtures are greatest on tabletops because standing water penetrates them. The results can be discoloration of the finish and/or discoloration and change of texture in the wood.

Wax –

Waxes are generally used as a coating over other finishes, rather than as a primary finish. It does not provide much protection, but can greatly enhance appearance. Common waxes used on furniture include paraffin, carnauba and beeswax. Most commercially sold paste-wax finishes include one or more of these waxes, mixed with solvent to make them soft enough for easy application.

Wiping varnishes –

Many of the ‘oil’ and ‘tung oil’ products sold to woodworkers these days are actually wiping varnishes – varnishes that have been thinned with a high proportion of mineral spirits, although some ‘tung oil’ products don’t contain any tung oil. Wiping varnishes are applied like oil finishes, but dry as thin surface co9ating. Since very many applications would be required to build up a sufficient depth of finish to allow the shiny surface to be buffed out evenly, a thin varnish coating tends to look streaky and cheap.

Shellac –

Shellac is made from a secretion of lac beetle. It originated in the Orient and was long the premier finish for fine European furniture, but has generally been

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replaced by more durable synthetic lacquers. Shellac is brittle, as are varnish and lacquer. The fine crackling we associate with antiques is shellac's response to the seasonal movement of wood. Shellac is also quickly damaged by water or alcohol. Natural shellac has an orange tint that some furniture makers feel favorably warms up the appearance of dark woods.

Lacquers –

Lacquers describe a broad family of synthetic finishes. These include more traditional nitrocellulose-based lacquers and the new water-based lacquers. Lacquer is generally applied with spray guns and the so-called 'padding lacquer' is really shellac. Like varnish and shellac, lacquer is a surface finish.

Fillers –

The pores of open-grained wood such as oak and mahogany tend to telegraph through a surface finish especially in reflected light. Unless the pores are filled ahead of time, many layers of finish must be applied and sanded flat to fill them before surface buildup can begin. Fillers are fine-grained pastes or powders that can be tinted to match the wood.

They are used to fill open pores before applying finish. Traditionally, plaster of Paris was used to fill mahogany before French polishing. Now, paste filler that is made from silica that has been mixed with a binder of varnish or oil and thinned with naphtha.