Bending Wood

Man has bent wood for millennium, Native Americans bent wood for boats, kerf boxes and their legendary shooting bows. Some wood can be bent green, it is easier to bend when it has dried to 30% moisture content so that most of the bound water is evaporated and only free water remains in the cells. This prevents the cells from rupturing from internal hydraulic pressure. At this percentage the wood fibers are completely saturated with water. Soaking or steaming the wood prior to bending is best for bending some woods.

There are certain woods that bend better than others and hardwoods are generally easier to bend than softwoods, yew and cedar being the exception. Other softwoods such as Douglas fir, pine and redwood can after soaking or steaming be bent to moderate curves. American hardwoods that are easy to bend are American elm, oak, ash, locust, beech, yellow birch and Osage orange are good bending woods. Maple and walnut can also be bent as can imported mahogany, except African mahogany. Saplings of hickory, witch hazel, Osage orange and willow are relatively easy to bend green, both with and without the bark on the tree. Surprisingly, cherry, which tends to be brittle is an excellent bending wood.

Wood, except green wood needs to be softened or plasticized to allow it to be bent successfully. This can be accomplished by soaking in water or exposing the wood to steam, which is water heated above the boiling point (212°F at sea level). Soaking requires a much longer time for the wood to be softened, heating the water can accelerate this but it can take several days. The lignin in wood is softened at about 180°F Fahrenheit. Steaming on the other hand can soften the wood enough to bend in minutes instead of hours. Heating thin strips of wood can soften them enough for bending as is done by musical instrument makers. The thin strips are heated and a little water is dabbed on the surface during bending to create a little steam, the wood is not soaked.

Wood that is softened will need to be bent and held it in place until it has dried, this again can take several days and if supported can shorten the time required. Wood will recover somewhat after it is released from its clamps or bending jig, additional bend beyond that which is necessary can compensate somewhat for the recovery. Most bent pieces of wood such as a bow back of a chair will eventually be held in their final position by the seat of the chair. If it is unsupported then the recovery will need to be taken into consideration. Different woods and even different boards of the same tree will bend differently and will also have differing degrees of recovery, it is not an exact science. When you become familiar with bending different species of wood you will notice that most generally behave in a fairly predictable manner but always be ready for a surprise.

For soaking wood in order to facilitate bending you will need a large enough container to completely submerge the wood in the water. A long wooden trough is the best choice providing you do not want to apply any heat to hasten the softening. The trough needs to be made of a wood that can stand up to water and does not have acids that will discolor the soaking wood and is water tight. Metal troughs need to be of a metal that will not rust in the water or be affected by the acids in woods such as oak and walnut. Zinc or tin coated iron will work fine. The seams need to be watertight and the whole unit must be able to take a heat source to warm the water. The wood being soaked must be held under water and weights need to be used to keep the wood from floating. Bricks and rocks work well and can stand in the water without reacting. Stickers of non-reactive wood need to be placed below and between to separate stacks of wood to allow all surfaces to be equally exposed to water.
For steaming wood to soften for bending, the wood must be contained in an atmosphere of steam for equal exposure to all surfaces of the wood. Bending or steaming boxes, constructed of quartersawn wood that will stand up to the temperature and humidity are made long enough to hold the longest pieces being bent. These boxes were made with access to each end with wooden plugs filling the openings once the box is loaded with wood. Holes drilled on both sides of the box at intervals with wooden dowels act as shelves and stickers to hold and separate the wood within the steaming box. A steam source is usually provided at one end under the box. Elevating the steam box above the steam kettle brings the work up to an easy working level. The box is slightly tilted away from the steam source to allow the cooled condensed water will drain away. Small holes in the bottom will help the water flow away. The steam box doesn’t need to be airtight as the pressure created by the steam needs to escape as does the condensed water. The amount of time needed in the box depends upon the species and thickness of the pieces being bent.

For gentle curves and slight bends wood can be bent over a form and allowed to dry. When making dramatic bends it is usually necessary to clamp the ends of the piece being bent to prevent compression fractures and failures. Banding with a strap on the outside of severe bends will prevent the grain from erupting and fracturing during bending. The clamping is necessary to prevent the wood fibers from sliding along the grain, the wood on the inside of the piece around the bend is under compression and the wood on the outside of the bend is under tension and the clamped or blocked ends are needed. When clamping the ends allow for additional wood as the clamped area might become distorted when the wet wood is tightly clamped.

Block clamping is done with a strap of metal with blocks riveted on the same side at each end of the strap. These need to be coated with oil to prevent rusting. The wood is cut to fit exactly between the blocks at each end. The blocks need to be big enough to completely cover then end of the wood. As the strap and wood is bent (the strap on the outside of the bend) the wood pushes out on the blocks and the grain cannot slide as the tension and compression build up. The strap on the outside prevents rupture and the form or jig on the inside prevent the wood from collapsing.

The best wood for bending is clear straight grain, preferably from wood that has been split assuring straight grain. Wood bends best tangentially rather than radially on the outside bend. In other words, quartersawn is not the best to bend. Knots, twisted wood, and other defects should be avoided however curly wood can be bent.

Once the wood is been softened with soaking or steaming it needs to be bent into the desired shape, allowing for recovery. This should be done as soon as the wood is removed from the water or steam, you can bend the wood as long as it is hot, so you may only have a minute or two to get the bending done. If the wood cools off it needs to be put back in the steam box or water tank to heat up again. Now the tricky problem, how to hold the wet (and hot if steamed) wood into the
proper shape? Severe bends require end clamps or blocked straps will need special jigs that form the entire shape of the bend to support the wood under pressure as it is being bent.

For smaller work or wood not bent too much simple jigs, clamps and devices can be used to hold the wood until it dries. Some woods or bends require continuous support to prevent twisting or fracturing. Some only require a simple clamp made of string and a stick forming a tourniquet that simply holds the ends until dry.

![Diagram of bending jig](image)

If more than one or two pieces are going to be bent in a particular shape, a dedicated bending jig can be made to hold the work. If different shapes are required a bending board can be made. This consists of a stout backboard with a series of holes drilled around the surface into which large pegs can be inserted and the wood bent around the pegs. Other holes are used to secure another peg opposite the first with a space between for the wood and wedges. By using pegs and wedges you can form, hold and clamp the pieces into place.

By using this method additional clamps are not required, remember this wet wood will require time in the jig, tying up the clamps for a long period of time. New holes can be drilled as needed or additional bending boards can be constructed. Some chair makers use the seats of the chair to hold the work as it dries; this requires that the seats be roughed out prior to bending. Others form the shape around a log or tree to form the shape and tie the ends with string. Any method you can devise to hold the work until it dries will come in handy.

After the wood has completely dried it will need to be further worked, if the pieces are close to their final size, scraping and sanding to remove the raised grain might be all that is necessary. Other pieces might need further work, but most of this should have been done prior to bending, as it can be difficult to work some pieces after they are bent. Any piercing or drilling should be done after the wood is bent and completely dry.