1. How a Tool Cuts Wood

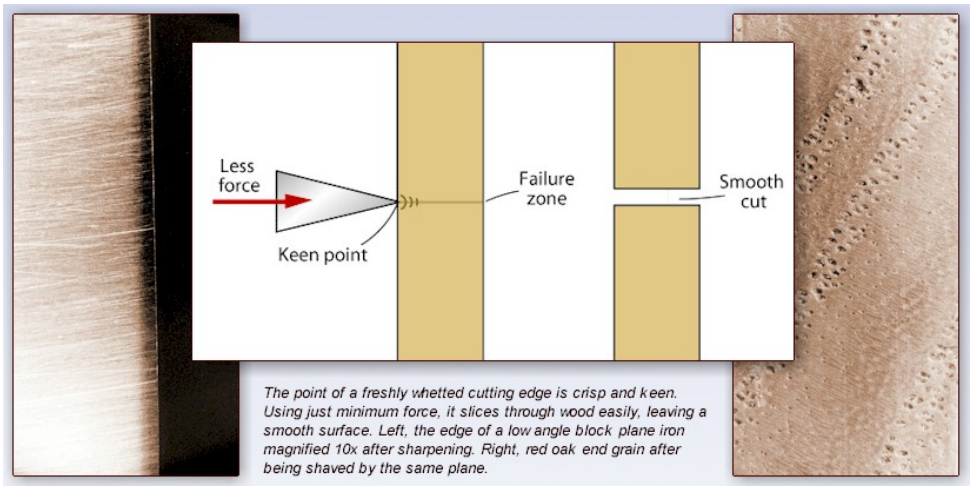
efore you begin to sharpen a dull cutting edge or grind a new one, it helps to understand just how a tool cuts wood. It seems a simple thing, especially since you may do it hundreds of times a day in your own workshop. But on close inspection, cutting wood is a wonderfully involved process.

A DEFINITION OF CUTTING

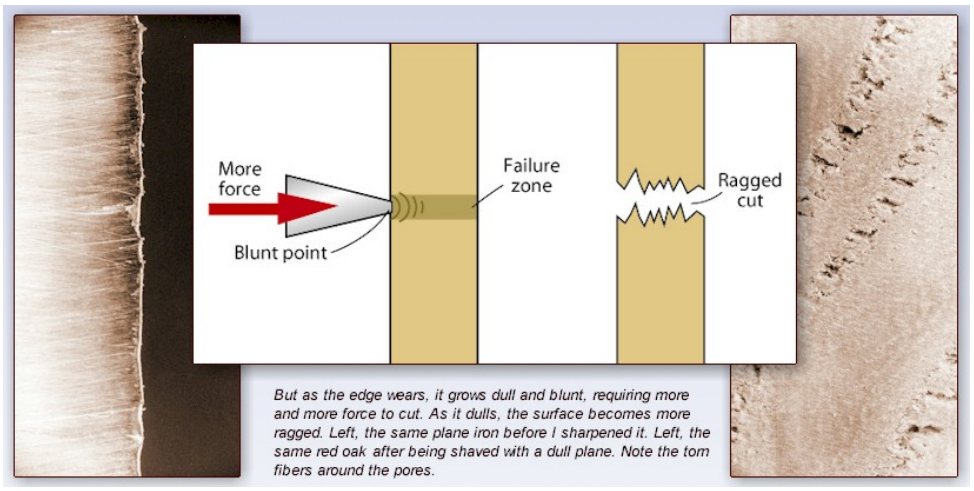
Down at the level where the edge meets individual **wood fibers**, cutting is synonymous with breaking. The point of the tool presses against the wood fibers with enough force that they break, separating into two pieces.

A cutting edge concentrates all the force driving the tool at its point. And because a sharp edge contacts only a small amount of the wood surface, the resistance is confined to a tiny area. The keener the point, the smaller the resistance, and the smaller the force required to cut. The wood fibers separate along a narrow line described by the path of the tool, and the cut surface appears smooth and even.

A blunt or dull tool contacts a larger surface area. Consequently, there is more resistance and it requires more force to cut. The fibers fail along a wider, poorly defined line, and the cut is ragged.



The point of a freshly whetted cutting edge is crisp and keen. Using just minimum force, it slices through wood easily, leaving a smooth surface. Left, the edge of a low angle block plane iron magnified 10x after sharpening. Right, red oak end grain after being shaved by the same plane.



But as the edge wears, it grows dull and blunt, requiring more and more force to cut. As it dulls, the surface becomes more ragged. Left, the same plane iron before I sharpened it. Left, the same red oak after being shaved with a dull plane. Note the torn fibers around the pores.

CUTTING EDGE GEOMETRY

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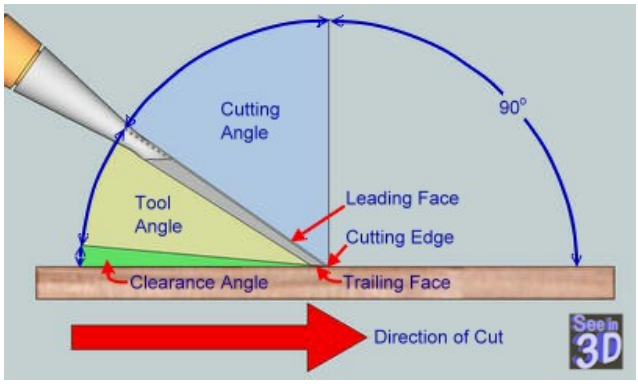
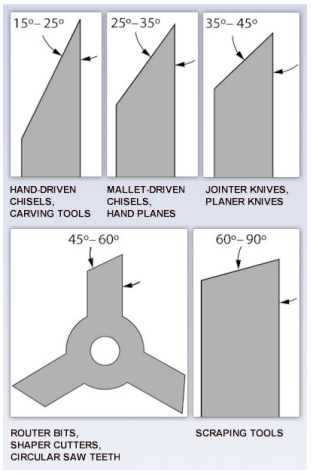
Sharpness isn't the only attribute that affects the cut. The angle at which the tool is sharpened, the angle at which it attacks the wood, and the shape of the cutting edge also determine how a tool cuts.



TOOL ANGLE

Every cutting edge has a leading face and a trailing face. The angle between the two is the tool angle — the smaller the angle, the less force required to cut. Small tool angle reduce the "wedge effect' of the tools -- they displace less material as they are driven into the wood and therefore require less force. But if the angle is too small, there's too little metal to buttress the cutting edge and it wears quickly. It may even break or buckle.



What tool angle is best? That depends on the tool and how it's used. Mallet-driven tools have more obtuse angle than hand tools because they are driven with more force. For the same reason, power tools have greater angles than mallet-driven tools.

Mythconceptions

TRUE SHARPNESS – Tool angle is often confused with sharpness. It's not true that the smaller the angle, the sharper the tool. Sharpness refers to the condition of the edge, not its angle. A router bit, for example, has a high tool angle. But when the point is keen, the edge is sharp.

CUTTING ANGLE

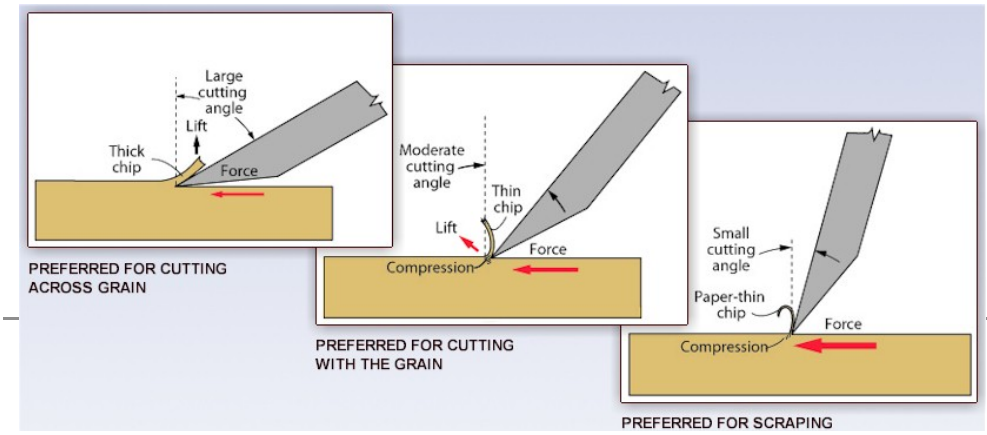
The angle at which the cutting edge meets the wood — the cutting angle — is measured from an imaginary line perpendicular to the wood surface. This, more than any other angle, controls how the tool cuts. At a large cutting angle, it lifts the wood fibers as it cuts them; at a small cutting angle, the tool compresses the fibers, then shears them off.

Because it's more difficult to compress fibers than lift them, the force required to remove a given amount of wood increases as the cutting angle decreases. Consequently, you must either supply more force or take thinner shavings.

CLEARANCE ANGLE

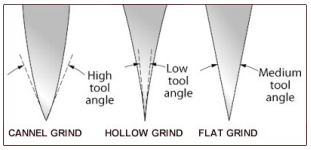
The angle between the trailing face and the work is the clearance angle. The size of this angle is not particularly important *as long as there is one.* Without a clearance angle, the cutting edge will not contact the wood.

The absence of a clearance angle is often the reason you cannot cut wood when you find yourself working with an improperly sharpened tool or an extremely dull tool.



GRIND

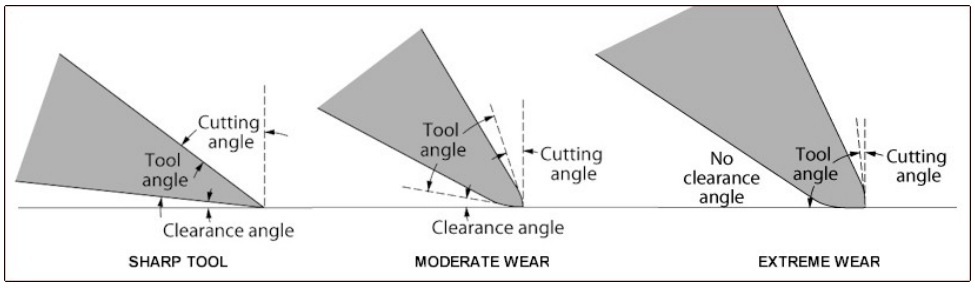
These angles are affected by the shape or grind of the tool. There are three ways to grind a cutting edge — convex (cannel grind), concave (hollow grind) and flat. Chopping tools such as axes often have cannel grinds. The tool angle is high and requires much force to cut, but the cutting edge is very durable. Light-duty tools such as carving chisels are sometimes hollow ground. This reduces the tool angle, making it easier to cut, but the cutting edge is less durable. A flat grind offers a good balance between cutting ease and durability.



TYPES OF GRINDS

GROWING DULL: CHANGING GEOMETRY

As a cutting edge wears, the geometry changes. The edge rounds over — more in the trailing face than the leading face, since the trailing face is in contact with the wood. As this happens, the tool angle increases while the cutting angle and clearance angles decrease. More and more force is needed to drive the tool through the wood, and the cut surface becomes rougher.



Changing Tool Geometry

SEEING THE LIGHT – If you suspect a cutting edge is growing dull, inspect it under a bright light. Because the surfaces of a sharp tool come to a crisp point, the cutting edge reflects no light. But once the edge wears, the rounded surface reflects a line of light. Nicks in the edge show up as bright spots.