

# Tool geometry: the two Rs

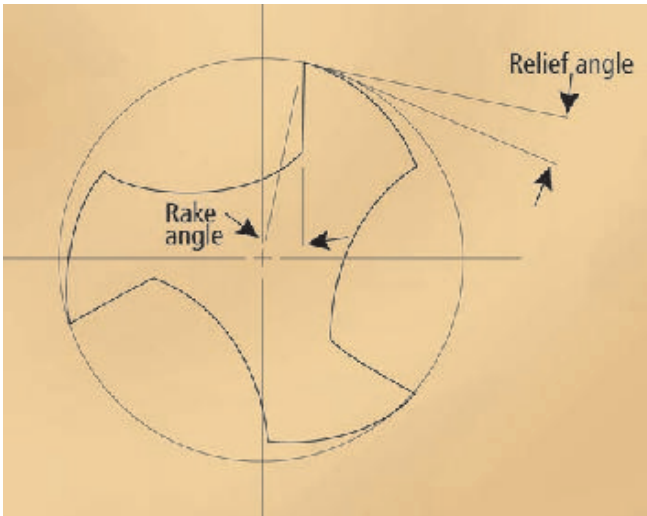
BY ROBERT CHAPLIN

Many elements make up a cutting tool's geometry. Two key ones are rake and relief.

The rake, or top face, is the area of the cutting tool that contacts the chip. The rake angle is the angle between the top cutting surface of a tool and a plane

from the workpiece surface, producing a thin chip with less heat-carrying capability, requires less force to create a chip and has a large shear-plane angle. Positive-rake tools can be applied to ferrous materials, as well as difficult-to-machine materials such as stainless steel, and are recommended for applications requiring fine surface finishes.

A neutral, or zero, rake gives a tool characteristics that fall between a negative and a positive rake. A neutral rake



The rake is the angle of inclination between the face of the cutting tool and the workpiece. The relief is the space in back of the cutting edge to prevent rubbing.

perpendicular to the surface of the workpiece.

Relief, or clearance, refers to a space behind the cutting edge. This clearance prevents the tool from rubbing the workpiece. Relief angle is a measure of the clearance between the surface below the cutting edge and a plane perpendicular to the rake face.

Rakes can be negative, positive or neutral. A negative rake produces the strongest cutting edge, demands the highest amount of force to create a chip and generates a short, thick chip with high heat.

Negative-rake tools are recommended for roughing, interrupted cuts and “skin milling,” where the surface material is hard or abrasive and chemically active. Because of a negative rake’s tendency to generate BUE, which can cause galling on the surface, it is seldom used for finishing.

A positive rake directs the chip away

has less strength than a negative rake, but more than a positive rake. The chip is directed neither upward nor downward, but, in general, parallel to the workpiece surface.

Choosing the correct relief is equally important to the success of an application. Too small a relief angle when cutting a soft, abrasive material compresses the back of the cutting edge. This causes premature tool wear. Increasing the relief angle relieves this condition. Conversely, if the material is hard and tough, a higher relief angle may cause chipping, due to insufficient support given to the back of the cutting edge. Decreasing the relief angle relieves this condition.

## About the Author

Robert Chaplin has been active in the manufacturing industry for 67 years and recently published a book titled *Metal Removal Technology*.