



AA (Arithmetic Average) - See "Ra".

Abrasion Wear - Wear that occurs when hard particles on the underside of the chip pass over the tool face and remove tool material by mechanical action. These particles could be abrasive inclusions in the workpiece, fragments of a built-up edge, or particles of tool material which have been removed by adhesion.

Adhesion - Metal build-up on cutting edge, usually caused by operation at too low speeds.

Adhesion Wear - Wear caused by the fracture of welds which are formed as part of the friction mechanism between the chip and the tool. When these minute junctions are fractured, small bits of tool material are torn out and carried away on the underside of the chip or by the workpiece.

Advanced Cutting Tool Materials - Cutting tool materials able to withstand the extremely harsh environment of elevated cutting tool speeds and the resulting temperatures. These materials include ceramic, PCD and PCBN substrates.

Amorphous - Noncrystalline; having no molecular lattice structure, which is characteristic of the solid state.

ANSI - American National Standards Institute.

Arbor - A device designed to carry and drive an arbor-type cutting tool. It can be mounted in or on the spindle of a machine tool.

Backlash - A reaction during the metalcutting process where the potential energy of the object in motion is suddenly released when the object stops, typically causing the device to quickly snap backwards relative to the last direction of motion.

Base - The surface of the shank which bears against the support and takes the tangential pressure of the cut.

Black Oxide - A black finish on a metal produced by immersing it in hot oxidizing salts or salt solutions.

Boring - A machining process in which internal diameters are made in true relation to the centerline of the spindle. It is most commonly used for enlarging or finishing holes or other circular contours.

Breakout - Term used to describe an uneven break of workpiece material as the insert exits the part.

Brinell Hardness (BHN) - A test to determine the hardness of metallic materials. It consists in applying a known load to the material surface to be tested through a hardened steel ball of known diameter. The diameter of the resulting permanent impression in the metal is measured and then calculated in the Brinell hardness number.

Built-Up Edge (BUE) - An insert edge condition problem that is characterized by the adhesion, or build-up, of layers of workpiece material to the top rake surface of the insert.

Burring - A condition whereby small slivers of workpiece material roll out over the shoulders and points of the workpiece as the tool exits the cut.

CAD (Computer-Aided Design) - Product-design functions performed with the help of computers and special software.

CAE (Computer-Aided Engineering) - Engineering functions performed with the help of computers and special software.

CAM (Computer-Aided Manufacturing) - The use of computers to control machining and manufacturing.

Cemented Carbide - A sintered combination of cobalt or other binder metal and refractory metal carbides suitable for use as a cutting tool material.

Ceramics - A cutting tool material (substrate) comprised of aluminum oxide and metal alloys (i.e.: TiC), or silicon nitride. Ceramics are capable of higher speed machining than carbides on steel, irons and super-alloys, but have less toughness and thermal shock resistance.

Cermets - A cutting tool material (substrate) comprised of titanium carbonitride and metallic binder, usually nickel and/or cobalt. Cermets combine some of the high-speed characteristics of ceramics with improved toughness for semi-finish and finish machining of steel and stainless steels. Cermets have greater chemical wear resistance than most tungsten carbide grades, but have less toughness and thermal shock resistance.

Chamfer -

- (1) A beveled surface to eliminate an otherwise sharp corner.
- (2) A relieved angular cutting edge at a tooth corner.
- (3) The surface formed by cutting away sharp corners and edges formed by two faces of a piece of metal.
- (4) A bevel on the cutting edge of a carbide cutting tool for the purpose of increasing its strength. The angle is measured from the cutting face downward and may vary from 1 to 45 degrees.

Chamfering - Metal turning operation used to remove sharp edges from workpiece diameter.

Chatter - Chatter is a condition of vibration involving the machine, workpiece and cutting tool. Once this condition arises it is often self-sustaining until the problem is corrected. Chatter can be identified when lines or grooves appear at regular intervals in the workpiece.

Chemical Vapor Deposition - See CVD.

Chipping - An insert edge condition problem that is characterized by breakage of the insert's cutting tip during the cutting action.

Chuck - An attachment for holding a workpiece or a tool in a machine.

Chucker - Machine normally used to cut a part whose diameter is larger than length.

CIM (Computer-Integrated Manufacturing) - The use of interconnected computers and special software to assist in all phases of production.

Clearance - The angle below or behind the cutting edge to be forced into the work. Without clearance, the tool will not cut. It is also the term used for secondary relief in some cases.

Coated Carbide - Coated carbides have a thin layer of very hard material deposited on their surface. This material can be deposited by either physical or chemical vapor deposition. Coated carbides permit a significant increase in cutting speed and add crater and abrasion resistance in high productivity machining operations. Also see CVD and PVD.

Collet - Flexible-sided device that secures a tool or workpiece in a similar fashion as a chuck, but can accommodate only a narrow size range. Collets typically provide greater gripping force and precision than do chucks.

Composites - Materials composed of different elements held together by a compatible binder.

Counterbore - As applied to a milling cutter. An enlargement of the cutter bore at one or both ends to provide space for a nut, screw or bolts, or to provide clearance for a shoulder on arbor or spindle. A recess to facilitate manufacturing.

Crater Wear - An insert edge condition problem that resembles a relatively smooth, regular depression produced on the top of the insert (rake face).

Crest (screw thread) - The outer most surface of the thread form which joins the flanks.

Cubic Boron Nitride - See PCBN.

CVD (Chemical Vapor Deposition) - A process that deposits, or coats a film of hard refractory material on the cutting tool in a sealed reactor to about 1000° C with gaseous hydrogen at atmospheric or lower pressure. Volatile compounds are then added to the hydrogen to supply the constituents of the coating. The higher temperature CVD process provides improved abrasion and crater wear than the PVD process, although it causes poorer toughness through residual tensile stresses in the coatings.

Cycle Time - The time required to complete all machining operations on the workpiece.



Deformation - The permanent change in the shape of a cutting tool due to cutting forces and temperature. Deformation generally occurs in high speed or heavy machining. Deformation can be “plastic” (permanent) or “elastic” (non-permanent).

Depth Of Cut (doc) - The perpendicular distance between the original and final surfaces of the workpiece.

Depth Of Cut Notch (docn) - An insert edge problem that appears as chipping or wear at the doc line on the rake face and flank of the insert.

DIN - German Institute for Normalization (DIN) standards that are developed by a non-profit organization of approximately 130 standards committees with representatives from all technical areas.

Drilling - Hole making with a rotary, end-cutting tool having one or more cutting lips and one or more helical or straight flutes or tubes for the ejection of chips and the passage of cutting fluid.

Ductility - The ability of a material to deform plastically without fracturing, being measured by elongation or reduction of area in a tensile test, by height of cupping in an Erichsen test, or by other means.

Economics - Economics dictate that the cutting tool material or grade you select should ideally be one that will yield the highest productivity (metal removal rate) at the lowest cost while providing correct and consistent tool life.

Edge Preparation (insert) - A conditioning of the cutting edge. Edge preparations include chamfering, honing, and T-land or a combination of hones and lands.

Edge Wear - Edge wear appears as wear along the flank of the insert, below and immediately adjacent to the cutting edge. Uniform edge wear is the preferred method of insert failure because it can be predicted. Also referred to as flank wear.

End Cutting Angle - The angle between the cutting edge on the end of the tool and a line perpendicular to the side edge of the straight portion of the tool shank.

Engine Lathe - A floor mounted machine on which work is rotated about a horizontal axis and shaped by a cutting tool. This definition can also apply to CNC lathes. The term “engine lathe” is a carry-over from when lathes were powered by steam engines.

Face -

- (1) The surface of the cutting tool on which the chip impinges as it is separated from the workpiece.
- (2.) To machine the flat, or end surface of the workpiece, such as facing a surface of a bar before or after turning.

Facing - Machining along the centerline towards the center of the end of the workpiece. Cleaning of one end of material for the purpose of ultrasonic evaluation. This process is also used to make two ends parallel to each other.

Feed Rate - The rate of change of position of the insert relative to the work while cutting. Usually expressed in inches per minute (ipm) when milling and inches per revolution (ipr) when turning.

Finish (surface) - See Surface Finish.

Flank - That surface which is adjacent to the cutting edge and below it when the tool is in a horizontal position for turning. The flank of a thread is either surface connecting the crest with the root. The flank surface intersection with an axial plane is theoretically a straight line.

Flatness - An even, smooth horizontal surface without depressions or elevations when gauged along the same plane. Also see Surface Finish.

FMS (Flexible Manufacturing System) - An automated or near-automated manufacturing system that is designed to manufacture a variety of similar parts. Also associated with machine tools grouped in “cells” for efficient production.

Forging - Squeezing red-hot steel between dies to strengthen it.

Fracture (insert) - When a large enough part of the insert breaks off to cause immediate failure of the cutting edge.

Fracture Toughness - A measure of the energy a material will absorb prior to fracture.

Galling - Developing a condition on the rubbing surface of one or both mating parts where excessive friction between high spots results in localized welding with subsequent spalling and a further roughening of the surface.

Geometry (insert) - The physical characteristics of an insert.

Grade - A designation given to a composition for a particular coated or uncoated cemented carbide cutting tool material.

High-Speed Spindles - Generally speaking, high-speed spindles are regarded as high-performance spindles that run over 8,000 rpm and are balanced and/or balanceable.

Honed (Edge Preparation) - The process of blunting and strengthening of the cutting edge by means of abrasives. It may be done by hand or machine. Also see Edge Preparation.

Hot Hardness - See Red Hardness.

Hypereutectic - An aluminum alloy containing more than 12.2% silicon (Si). Silicon is added to aluminum to improve casting qualities in addition to providing corrosion resistance, low thermal expansion, and high thermal conductivity. Also see Hypoeutectic.

Hypoeutectic - An aluminum alloy containing less than 12.2% silicon (Si). Also see Hypereutectic.

Inscribed Circle - The circle which can be constructed internal to any closed figure or shape such that all sides of the figure are tangent to the circle. The inscribed circle is most often used to describe the dimensions of a triangle, pentagon, hexagon, or octagon.

Insert Lock Screw - Usually identifies a screw with a Torx or hex socket that is used to retain inserts in the toolholder.

ipr (advance (inch) per revolution) - A feed value reporting how far the insert advances during one revolution, defined as

$$\text{ipr} = \frac{\text{ipm}}{\text{rpm}}$$

ISO - From the Greek word Isosceles meaning “the same as”. The International Organization for Standardization located in Geneva, Switzerland, issues these standards for the purpose of setting standards which all countries can agree upon.

“K” Factor - The “K” factor is a power constant that represents the number of cubic inches of metal per minute that can be removed by one horsepower input.

K-Land - See T-land.

Knoop hardness - Microhardness determined from the resistance of metal to indentation by a pyramidal diamond indenter, having edge angles of 172° 30' and 130°, making a rhomodal impression with one long and one short diagonal.

Land - Area immediately behind cutting edges.

Lead (screw thread) - The distance a screw thread advances axially in one revolution. On a single start, the pitch and lead are identical. The lead is equal to the pitch, times the number of starts.

Lead Angle (chip thickness) - Increasing the lead angle reduces chip thickness for any given feed rate. This chip thinning process occurs by spreading the same amount of material over a greater length of the insert cutting edge.

Lead Angle (cutting forces) - Increasing lead angle allows the cutting edge to gradually enter and exit the workpiece surface. This helps reduce radial pressure. However, increasing the lead angle increases axial pressure and can cause deflection of the machined surface of thin cross-section parts.

Lead Angle (defined) - The angle between the cutting edge of the insert.



Inserts

Lead Angle (screw thread) - On a straight thread, the lead angle is the angle created by the helix of the thread at the pitch diameter with a plane perpendicular to the axis. The helix angle is the complement to the lead angle.

Face Mills

Lubricity - Slipperiness; the property that diminishes friction. Tantalum carbide and titanium carbide are used to produce lubricity in steel cutting grades of tungsten carbide to reduce crater and wear.

End Mills

Machinability - The relative difficulty of a machining operation with regard to tool life, surface roughness, and power consumption.

Die and Mold

Machinability Factor (C_m) - Indicator of the machinability, or degree of difficulty, in machining various workpiece materials.

Slotting

Machinability Rating - A rating expressed as a percentage rating to the difficulty of machining a given material. It is usually based on the 100 percent rating of A.I.S.I. B-1112, Cold Rolled Steel when turned at 180 sfm under normal cutting conditions. A high rating number means the material is easier to machine.

Thread Milling

Major Diameter (screw thread) - The largest diameter of a straight screw thread. This applies to both internal and external threads.

Widia Cutters

Mandrel - Workholder for turning that fits in the inner diameter of workpieces. Three common types of mandrels are expanding, pin, and threaded.

Vintage Cutters

Microstructure - The structure of polished and etched metals as revealed by a microscope at a magnification greater than ten.

Accessories

Minor Diameter (screw thread) - The smallest diameter of a straight screw thread. This applies to both internal and external threads.

Technical Data

Negative Rake - A rake angle that is less than 90° between insert rake face and surface of work.

Nest - A removable part of a toolholder or milling cutter designed to support the cutting insert. Also called anvil or seat.

Mat'l Database

Nose - The corner angle formed by joining the side-cutting and end-cutting edges of a tool.

Nose Radius - The radius on the tool between the end and side cutting edges.

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Notching, Depth of Cut - See Depth of Cut Notch (docn).

Overshoot - A condition resulting in the deviation from the normal path or designated value caused by momentum carried over from the previous step, as when a tool is rapidly traversed over a considerable distance to begin a cut.

PCBN (Polycrystalline Cubic Boron Nitride) - An ultra-hard cutting tool material (substrate) consisting of polycrystalline cubic boron nitride with a metallic or ceramic binder. PCBN is available either as a tip brazed to a carbide insert carrier or as a solid insert. Primarily used to machine hardened ferrous material.

PCD (Polycrystalline Diamond) - An ultra-hard cutting tool material (substrate) consisting of a synthetic polycrystalline diamond tip brazed to a carbide insert carrier. Primarily used to machine non-ferrous materials at high speeds.

Pitch (screw thread) - The distance from a point on a screw thread to a corresponding point on the next thread measured parallel to the thread axis.

Pitch Diameter - (Simple Effective Diameter) On a straight thread, the pitch diameter is the diameter of the imaginary co-axial cylinder, the surface of which would pass through the thread profiles at such points as to make the width of the groove equal to one-half of the basic pitch. On a perfect thread, this occurs at the point where the widths of the thread and groove are equal. On a taper thread, the pitch diameter at a given position on the thread axis is the diameter of the pitch cone at that position.

Positive Rake - A rake angle that is more than 90° between insert rake face and work surface.

Profiling - Machine operation where the tool does not move parallel to the workpiece, but follows contours.

PVD (Physical Vapor Deposition) - PVD is a process that deposits, or coats, a film of hard refractory materials on the cutting tool by heating the tools in a sealed reactor to about 500° C in a vacuum chamber. A vaporized or ionized compound is then deposited on the tools by ion plating, magnetron sputtering, or arc evaporation. The PVD process is designed to improve coating toughness and prevent chipping of the cutting edge.

Quick-Change Tooling - This tool changing procedure involves changing an entire pre-gauged cutting unit as opposed to changing an individual insert. Quick-change tooling helps to minimize time lost for changing tools and making setups.

Ra - A measure of roughness. An arithmetical average (also referred to as "AA") that is very close to root mean square (rms) except the Ra(AA) measures 11 percent lower. The squaring process used in obtaining the rms average gives added weight to the larger ordinates of the surface roughness.

Radial Runout - The total variation in a radial direction of all cutting edges in a plane of rotation. Also known as total indicator reading.

Rake Angle - The angle between the face of the cutting tool and the work. If the face of the tool lies perpendicular to the work, it has a zero-degree, or neutral rake. If the angle of the tool face makes the cutting edge more acute, then it has a positive rake, if more blunt, then it has a negative rake.

Red Hardness (Hot Hardness) - Ability of a cutting tool material to withstand extremely high temperatures without softening or degrading.

Refractory Metal - A metal having an extremely high melting point. The term is typically used in reference to metals that have a melting point above the range of iron.

Relief - The clearance angle behind or below the cutting edge which allows the cutting edge to be forced into the work. It is sometimes divided into primary relief (adjacent to the cutting edge) and secondary relief (beyond the primary relief). See Clearance.

Rigidity - The inflexibility, or stiffness of a machine set-up and the associated fixtures. Rigidity is extremely important for successful metalcutting.

RMS (root mean square) - A measure of roughness or average deviation from the mean surface of the machined workpiece. The mean surface is the perfect surface that would be formed if all of the roughness peaks were cut off and filled into the valleys below the surface.

Rockwell Hardness (HRC) - A measure of hardness calculated from the difference in depth of penetration of an indenture between a major and a minor load. The more commonly used Rockwell scales are Rockwell "C" (HRC), using a diamond spheroconical penetrator, and a Rockwell "B" (HRB), using a 1/16 inch diameter steel ball penetrator.

Root (screw thread) - The inner most surface of the thread form which joins the flanks.

Roughness - Fine irregularities in the part surface texture produced by the cutting action. See Surface Finish.

rpm (revolution per minute) - defined as

$$\text{rpm} = \frac{12 \times \text{sfm}}{\pi \times D}$$

Semisynthetic Cutting Fluid - Water-based chemical solution that contains some amount of oil.

sfm (surface feet per minute) - defined as

$$\text{sfm} = \frac{\pi \times D \times \text{rpm}}{12}$$

Shank - The main body of a single point tool or toolholder.

Side Cutting Edge Angle - The angle between the side cutting edge and the projected side of the shank or holder (also see Lead Angle).



Soluble-Oil Cutting Fluid - Fluid in which oil is suspended in water. Also known as emulsified oil, the fluid is a mix of oil and water in ratios of 1:5 to 1:100, depending on the oil and the machining application.

Square Shoulder - Lead angles of 0° create 90°, or square, shoulders.

Starting Feeds and Speeds - The process of correctly setting the initial cutting specifications. Correct starting feeds and speeds will dramatically increase productivity and reduce costs.

Surface Finish -

- (1) Condition of a surface as a result of a final treatment.
- (2) Measured surface profile characteristics, the preferred term being roughness.
- (3) Physical characteristics of the machined workpiece surface.

Surface Symbols - ANSI approved symbols that are used to designate control of workpiece surface irregularities.

Synthetic Cutting Fluid - Water-based solution that contains no oil.

T-Land - A negative land that is ground on the face of the insert from the cutting edge inward. T-land and T-land with honed edge preparations offer maximum insert edge protection and strength, although significantly increasing the cutting pressure of the operation. See Edge Preparation.

Tangential Force - Action in a direction tangential to the revolving workpiece and represents the resistance to the rotation of the workpiece.

Thermal Cracks - Separations in the cutting tool generally visible in the crater or top face of the cutting tool due to high-temperature gradients encountered in some metalcutting operations. To decrease thermal cracking effects, a more heat-resistant grade is selected.

Thread Angle (included) - The included angle between the individual flanks of the thread form.

Threading - Producing external threads on a cylindrical surface. Three common types of threading are die threading, single-point threading, and thread milling.

threads per inch (tpi) - The number of threads per inch measured axially. The terms pitch and tpi are often used interchangeably.

TIR (total indicator reading) - See Radial Runout.

Tool Wear Factor (Cw) - Indicator of approximate tool wear.

Torque - The torque generated by tangential forces is calculated using the following formula:

$$T = Ft \times D/2 \text{ (in.-lb.)}$$

Trepanning - Cutting a groove in a solid part in the form of a circle and removing the center core in one piece. Shallow trepanning, also called face grooving, is usually performed with a curved blade.

True Rake Angle (TRA) - Describes the angle between the reference plane and the face of the insert, as measured in a plane normal to the cutting edge. It affects horsepower consumption, cutting forces and tool life, and is derived from the combined angles of the axial rake, radial rake and lead angle. The true rake equals the radial rake when the lead angle equals zero.

Turning - A machining process in which a workpiece is held and rotated against a single-point tool to form flat or contoured surfaces concentric with the longitudinal axis of the workpiece.

Turning Center - A lathe-type NC machine tool capable of automatically boring, turning outer and inner diameters, threading, and facing parts. It is often equipped with a system for automatically changing or indexing cutting tools.

Turret Lathe - Differs from the engine lathe in that the normal compound rest is replaced by pivoting, multi-tool turrets mounted on the cross slide and tailstock.

Ultimate Material Strength - The maximum strength or stress that a material is capable of withstanding without breaking under a gradually and uniformly applied load.

Uncoated Carbide - Uncoated cemented carbide was first produced by combining tungsten carbide with a cobalt binder, and today this material can be modified with other materials. Uncoated tungsten carbide grade usage, in standard insert configurations, is slowly fading from the metalcutting scene due to productivity gains promised by coated carbides.

Undercut - A cut shorter than the programmed cut resulting in a command change in direction. Also a condition in generated gear teeth when any part of the fillet curve lies inside of a line drawn tangent to the working profile at its point of juncture with the fillet.

Undershoot - The tendency of a machine to round off the corners of a programmed path because of servo lag, backlash, and overall quality and rigidity of the machine.

Waviness - The widest-spaced irregularities measured along the workpart surface. Also see Surface Finish.

Workhardening - When the cutting condition is such that a high temperature is produced at the cutting point engagement of the workpiece, the high temperature will cause the material to harden at a higher Rockwell rating than it was originally.