





## EMG EDGE PREPARATION, DEVELOPED BY CONICITY TECHNOLOGIES, CAN BE APPLIED TO NEARLY ANY MATERIAL TO IMPROVE THE PERFORMANCE OF A WIDE VARIETY OF CUTTING TOOLS.

By William Shaffer

Users of “superhard” materials such as CBN (cubic boron nitride) in cutting tools commonly believe that chamfering—also known as applying a “T-Land” or “K-Land”—is necessary for extending tool life. For example, an article published a few years ago in *Modern Machine Shop* states that “to protect the cutting edge from chipping, a T-Land or K-Land is a must on hard-turning inserts.<sup>1</sup>” This practice is so widely accepted that many industry professionals have never even seen a CBN cutting tool without a chamfer; and they assume that it is a necessary feature of the tool.

However, with the advent of advanced edge preparation technology, alternatives to chamfering now exist. Chamfering is no longer a necessity for CBN cutting tools. In fact, in most cutting tool applications, chamfering has been proven to be a sub-optimal solution that limits tool life and diminishes cutting performance.

# The RIGHT CHOICE for Machines, Services and Tooling for the Gear Industry



Print and Online  
Services Available

**gearsolutionsonline.com**  
**1.800.366.2185**

**GEAR Solutions**  
Your Resource for Machines, Services and Tooling for the Gear Industry

Published by  
Media Solutions, Inc.  
P.O. Box 1210  
Pelham, AL 35124

## Mitigating the Tool Brittleness

Cubic boron nitride (CBN) tools, first developed over 20 years ago, provided the machining industry with a harder alternative to carbide tools. CBN (also called PCBN, polycrystalline cubic boron nitride) is a manmade material second only to diamond in hardness, but unlike diamond CBN is stable under high temperature conditions (up to 1000°C), which are normally created when machining hardened ferrous or super alloy materials.

CBN tools permit metal cutting at feeds and speeds much higher than with conventional cutting tool materials, and they are capable of turning, boring, and facing hard materials which otherwise could be formed only by grinding. Because CBN tools maintain a structurally stable cutting edge, surface finishes normally are excellent, close tolerances are maintainable, and dramatic productivity increases can be expected.

Although their superior hardness quality cannot be disputed, superhard cutting tool materials like CBN are extremely brittle, and any chip or flaw on the cutting edge can create a platform for tool failure. At the time of the development of CBN materials, the diamond grinding wheel industry had made significant improvements in wheels for grinding carbide, but the need to grind these new superhard materials created a demand for higher performing grinding wheels and methods. In the same time period of the introduction of the PCBN material, there was a need for proper grinding wheel technology and an absence of effective edge preparation technology. Until the edge prep technology had a chance to advance, a chamfer was the only practical option available for mitigating chipping.

## The Rationale for Chamfering

The practice of chamfering derives from the old machinist practice of “sticking” a cutting edge with a diamond stone. Tooling professionals found that, by rubbing the edge of the tool with a diamond stick, that action could improve tool life while reducing chatter and other machining difficulties.

A chamfer is defined as a beveled edge connecting two surfaces. Prior to chamfering, a tool typically has a 90° corner. The chamfering process removes the sharp edge from the corner, resulting in two new sharp edges, each greater than 90°. Typically, a 20° T-Land is applied, producing a 110° cutting edge on the tool and a band along the tool edge that is between 0.004” to 0.008” wide (see photo 1).

The blunter edge, a 110° angle, versus a 90° angle—gives the cutting edge added strength,



PHOTO 1

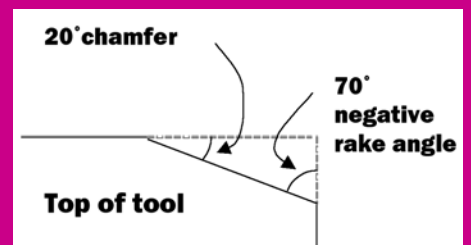


FIGURE A

reducing the propensity of the tool to chip. The advantage of a chamfered tool is that the tool lasts significantly longer than a tool with a square or positive edge.

However, while chamfering helps reduce chipping, thereby extending tool life, it also introduces unintended consequences that decrease tool performance and limit tool life. The negative cutting surface created by the chamfer limits the natural chip flow, creating a "pinching" of the chips between the tool and workpiece. That action, coupled with the blunt cutting edge, significantly increases tool pressure and heat.

## The Problem with Chamfering

The problem with chamfering is that the blunter edge angle ( $>90^\circ$ ) means that the cutting tool meets the workpiece at a negative rake angle ( $<90^\circ$ ). A  $20^\circ$  chamfer results in a "super" negative cutting angle, with a rake of only  $70^\circ$  (figure A).

With such a negative rake angle, a plowing effect occurs, causing the workpiece material to become trapped during cutting between the tool and the workpiece. This problem occurs because the feed rate of a tool when cutting hardened materials is typically less than the width of the T-Land chamfer. It has also been found that, in most hard turning applications, the feed rate normally does not exceed one half the width of the chamfer. This condition can be referred to as "under-feeding."

The chip flow on the tool with the chamfer (figure B) shows the extreme change in direction of the chip and also illustrates the tendency of the cut chip to dig into the surface of the chamfer,



PHOTO 2

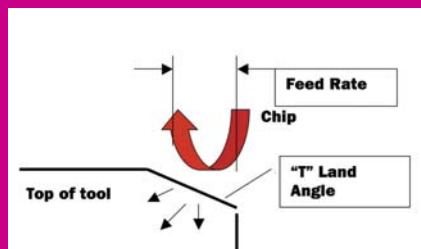


FIGURE B

increasing pressure and producing the common "cratering" shown in photo 2.

Once crater wear has reached sufficient depth and width, the forces created by the chip flow begin to change from the normal perpendicular plane to the horizontal plane. Combined with the  $20^\circ$  negative surface that the T-Land is presenting to the workpiece, the chip tends to get trapped in the crater, allowing the tool material to be stressed in tension rather than

in compression, causing the tool to fracture in a horizontal plane.

The crater caused by the chip flow will continue to grow until it either: (a) wears deep enough, causing the tool to break-out and down the flank side of the tool or; (b) causes the tool to fracture parallel to the topside of the cutting edge. Photo 3 shows a crater that caused a tool to break down the flank, and photo 4 shows a spall-type fracture across the top of the tool. In

We sell new & used gear machines along with heavy industrial machinery.



TOS OFA 71A  
710mm Max. Dia.  
450mm Max. Hob Head Travel



We have the largest gear cutting capacity in Canada.

Havlik Gear has a gear cutting capacity of 8000mm dia and 1250mm face



455 Sheldon Drive, Cambridge, Ontario, Canada, N1T 2B7  
Tel: 519-624-6240 Fax: 519-624-4119 havlik@sympatico.ca  
[www.havlikinternational.com](http://www.havlikinternational.com)

PHOTO 3



PHOTO 4



PHOTO 5



photos 3 and 4, the remnants of the original crater wear are still visible.

One of the essential benefits of CBN cutting tools is that they can operate at high speeds, triple or quadruple the speed of carbide tools. At these speeds, most of the heat escapes with the chip and not into the tool or the workpiece. However, in practice, the plowing effect of chamfer tools causes the trapping of chips and the retention of heat. This action significantly increases tool pressure and helps to explain the root cause for premature failure of CBN tools used in hard turning, as well as other applications.

## Alternative Solution without the Disadvantages

In recent years a new precision edge prep technology, Engineered Micro-Geometry (EMG™), has been developed by Conicity Technologies. This new technology serves the same function as chamfering—protecting the edge of the CBN cutting tool—but without the attendant chip-pinching problems caused by the negative rake angle of a chamfer. EMG applies a specific geometrically shaped rounded edge (radius, oval, or waterfall-shaped), which makes the cutting edge stronger. A radius edge preparation is shown in photo 5.

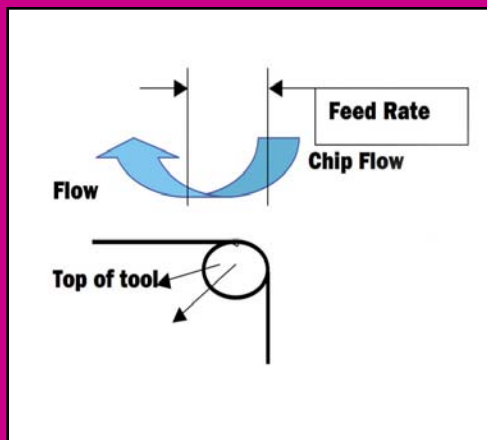


FIGURE C

**GEAR GRINDING**

**FIRST GEAR**  
ENGINEERING & TECHNOLOGY

**FROM PROTOTYPES TO HIGH VOLUME GEAR CUTTING, FIRST GEAR IS YOUR STRATEGIC PARTNER FOR OUTSOURCING.**

Whether your requirements are for spur gears, helical gears, internal gears or external gears, we are the source for all your gear cutting. We do custom and production gear manufacturing of spur gears and helical gears in all quantities from one gear to hundreds of thousands.

ISO 9001 : 2000 Certified

**www.first-gear.com**  
7606 Freedom Way | Fort Wayne, IN 46818 | 260.490.3238

**KISSsoft**  
Calculation programs for machine design

**Leading calculation software for efficient gear box design**

**KISSsys**  
Dimensioning and optimization of gearboxes  
Fast analysis of variants and switched gears  
Automatic documentation

**KISSsoft**  
Dimensioning and design optimization of machine elements  
Various unique calculation tools  
ISO, ANSI, DIN, AGMA, VDI, FKM

**GEAREXPO**  
The Worldwide Gear Industry Event  
**2007**

Visit us at  
**GEAR EXPO**  
booth 649

**KISSsoft, USA, LLC**  
3719 N. Spring Grove Road  
Johnsburg, Illinois 60050

(815) 363-8823  
dan.kondritz@KISSsoft.com  
www.KISSsoft.com

MEMBER OF

**Sharing Knowledge**

A specific geometrically shaped rounded edge, correctly applied, also eliminates scratches commonly present when chamfers are applied during grinding. By removing the microscopic scratches/flaws and rendering the tool material as smooth as possible, the edge of the cutting tool is in the best condition to "attack" the workpiece material.

When using radial style edge prep, the tool feed rate will always be greater than the size of the edge prep. Therefore, the 90°-rake angle of the tool effectively clears the cut chips, without trapping material between the cutting tool and the workpiece (see figure C). Tool forces and heat are reduced dramatically, thereby significantly increasing the life of the tool.


The chip flow on the tool with the EMG radius edge prep allows the chip to escape the cutting zone and reduces the angle of incidence with the cutting tool. Allowing the chip to exit without interfering with the natural curl of the chip reduces the tool pressure and tool temperature.

## Conclusion: A Myth Dispelled

Considering the fact that the contact zone of a cutting tool and the workpiece is microscopic in size, it makes sense that the tool must be

prepared at that microscopic level. This is the definition of Engineered Micro-Geometry, and it is why a tool that has the EMG edge preps cut cleaner and freer than the traditional chamfered edge prep.

More than five years of testing at the shop floor level by major end users has verified that Engineered Micro-Geometry edge preparation provides superior protection against normal edge failure by chipping without the loss of performance caused by a T-Land.

The performance enhancement of EMG on tool cutting edges has not been limited to PCBN style inserts. The radial edge prep has shown that in carbide drill performance, EMG versus T-Lands on drill cutting edges, performance of the drills has been significantly increased while the quality of the hole, size, and finish has increased as well. That conclusion derives from field experience with more than 100,000 drills that were edge-prepped with EMG for end user applications. Therefore, the benefits of EMG edge preparation are applicable to nearly every carbide, cermet, ceramic, PCD, and CBN cutting tool application. The same technology can be applied to improve the performance of endmills, reamers, form tools, and many other types of cutting tools. 

### ABOUT THE AUTHOR:

William Shaffer is executive vice president of Conicity Technologies. He can be reached at (877) 752-6132 or [bshaffer@conicity.com](mailto:bshaffer@conicity.com). Visit online at [[www.conicity.com](http://www.conicity.com)].

### REFERENCE:

*Modern Machine Shop*, "Taking the Fear Out of Hard Turning." April, 1996. Gardner Publications, Inc.

# MAXIMUM STORAGE

## in minimum space



**STOR-LOC MODULAR DRAWER SYSTEM**  
880 N. Washington Ave. Kankakee, IL 60901  
Toll Free: 1.800.786.7562 • Fax: 1.800.315.8769  
email: [sales@storloc.com](mailto:sales@storloc.com)  
[www.storloc.com](http://www.storloc.com)

