eastec®

MAY 14-16, 2019

EASTERN STATES EXPOSITION
WEST SPRINGFIELD, MA

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Official Media Partner

sme MEDIA | Manufacturing Engineering | SMART manufacturing

Unique Tooling Solutions for Maximizing Productivity

Jack Kohler / Applications Engineer / Greenleaf Corporation

eastec®

Founded in 1945 by
Walter Greenleaf, Sr.

Family owned and operated

Facilities in PA and NC

400 + Employees

Sales in over 60 countries

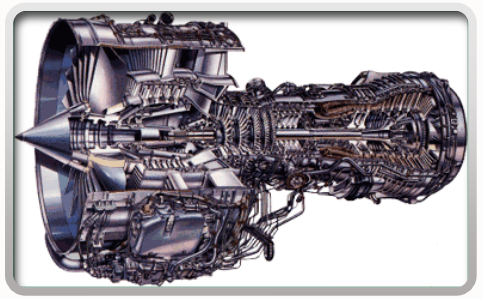
Greenleaf Europe and Greenleaf China

Saegertown, PA
Location

Greenleaf Corporation designs and manufactures standard and special Ceramic and Carbide Inserts and the supporting Steel Tooling.

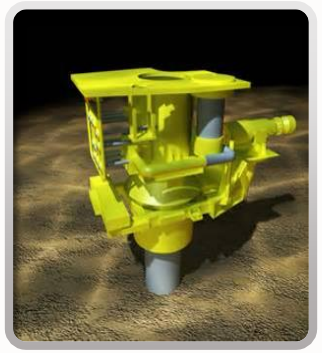
ISO 9001 Since 1994

Where You Find Greenleaf

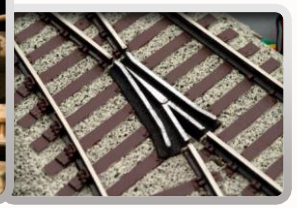


Aerospace

Die & Mold

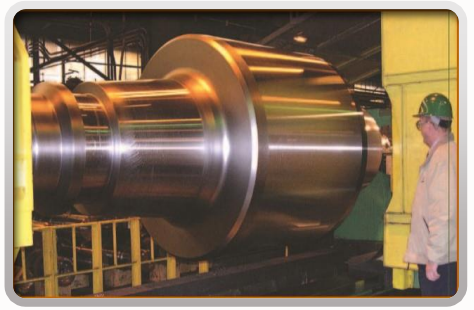


Oil & Gas, Energy



Railroad

Bar Peeling &
Tube Scarfing

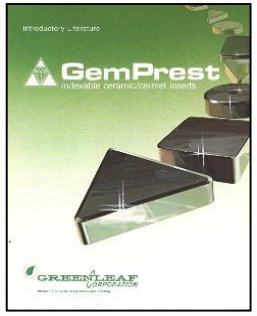


Roll Turning &
Heavy Machining

Crank/Cam

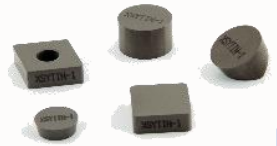
A History of Continuous Innovation

1945



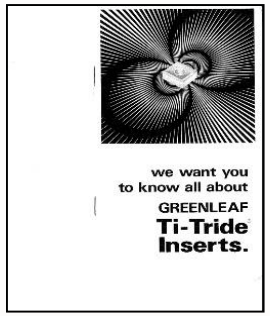
1973

2006



2016

1971



1985

2011

Maximizing Productivity

What is Productivity?

$$\frac{\text{OUTPUT}}{\text{INPUT}}$$

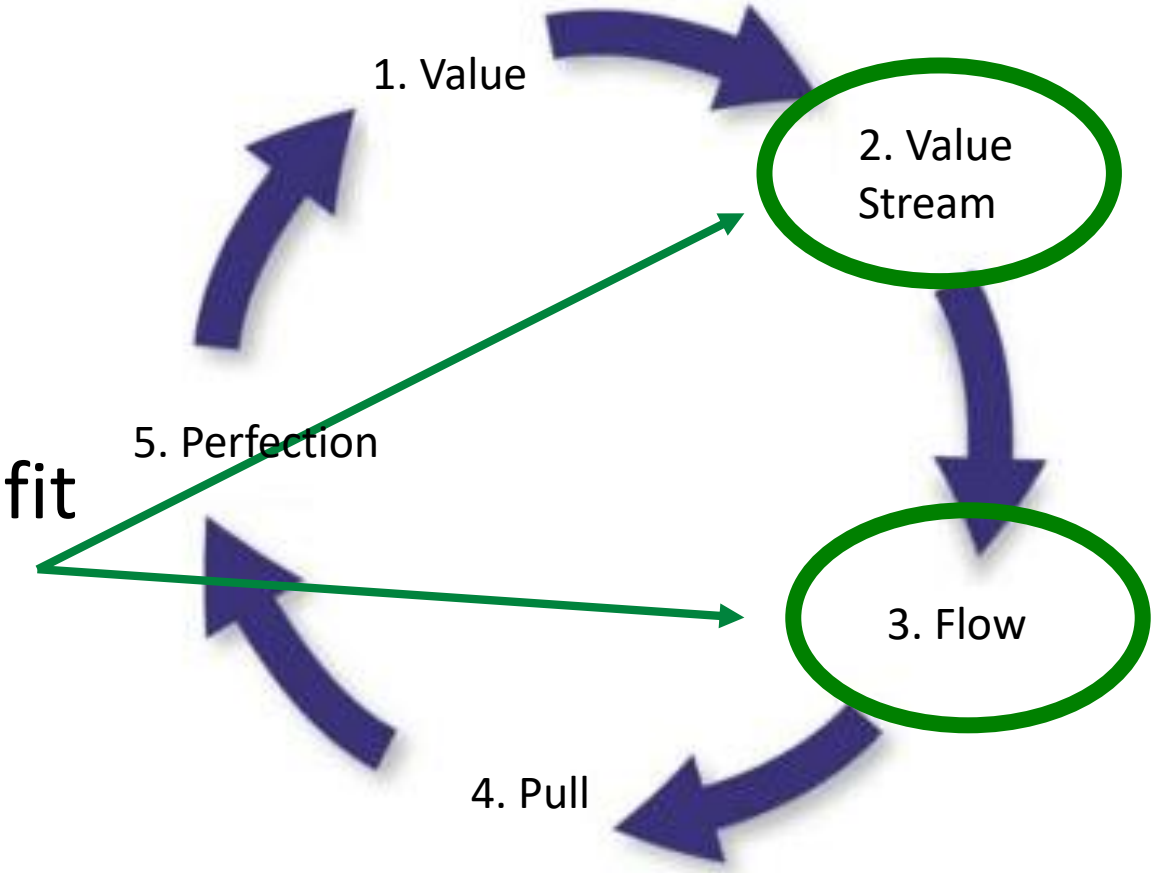
Converting inputs into useful outputs.

Maximizing Productivity

Eliminate waste or unnecessary steps. Which speeds up the process and saves time that = Money!

Maximizing Productivity

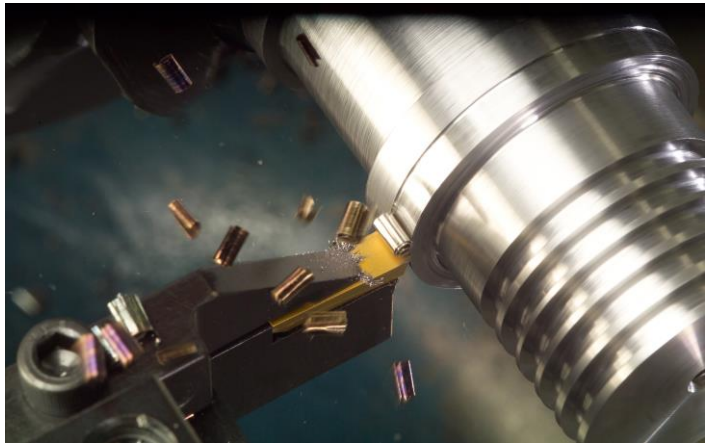
Lean Manufacturing

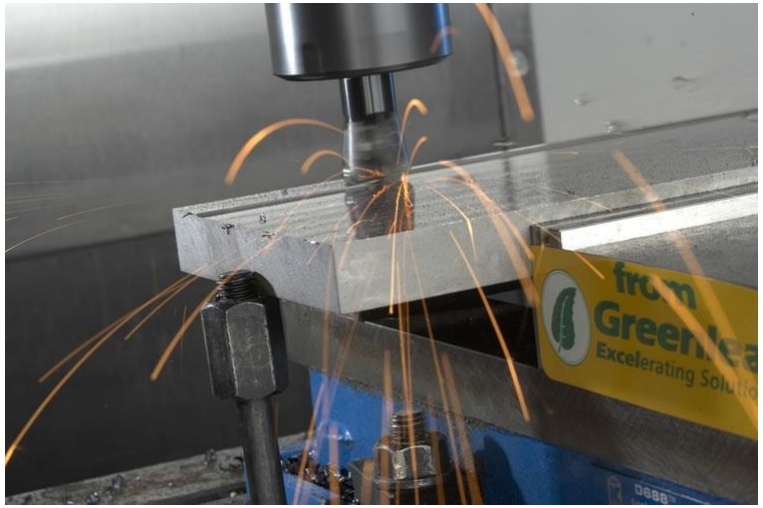


Where does Greenleaf fit into this cycle?

2. Eliminate steps
3. Save time

Greenleaf's Productivity Solutions



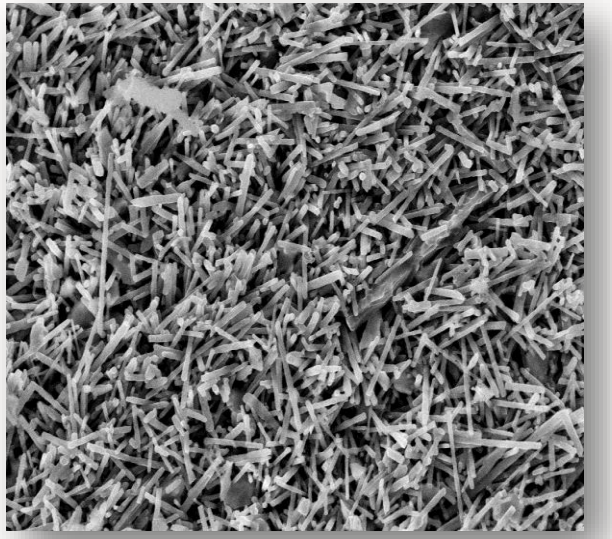


Today's Agenda

1. What are whisker-reinforced and phase-toughened ceramics?
2. Properties of whisker-reinforced and phase-toughened ceramics
3. Common HRSA materials suitable for machining with ceramics
4. Applications most suitable for machining with ceramics
5. Programming tips for machining with Ceramics
6. Tool maintenance and handling
7. Tool wear and how to evaluate tool life

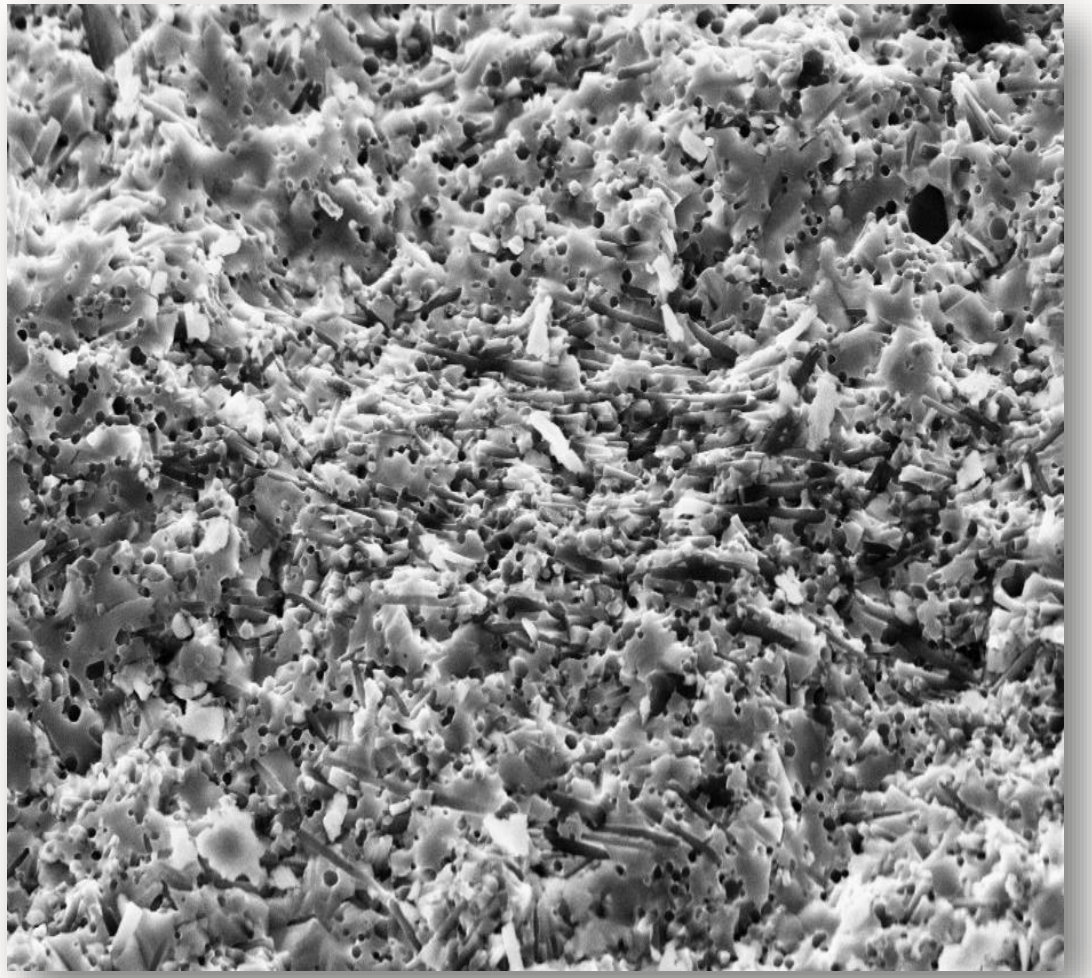
Whisker-Reinforced Ceramics

SiC Whiskers



+

Aluminum Oxide (Al_2O_3)



Whisker-Reinforced Ceramics

Greenleaf WG-300: The Most Significant Advance in Cutting Tool Materials Since Coa

Greenleaf Ceramic/Ceramic Composites

What are they? Proven ceramic cutting tool materials reinforced with a lattice of small single crystal silicon carbide "whiskers". The combination produces materials with the abrasion resistance of ceramics but with the strength and thermal shock resistance of cemented carbides. WG-300, the first grade in this new family of cutting tool materials, has over twice the fracture toughness of traditional ceramics, and is ready for immediate delivery from stock in a variety of insert styles.

FRACTURED SURFACE 4000 X

WG-300, readily ident by its green color, and c Greenleaf composites, be used in ways you ne thought possible:

- with ground-in chipf
- on interrupted cuts
- at speeds from as lo 50 sfpm to as high a 5000 sfpm
- on older less rigid machines
- even with positive ra

GREEN

GREENLEAF DRIVE, SAEGERTO

Greenle

MACHINING HARDENE FOR THE WIND TURBINE

Objec faces a

Probl plete a rent to

Soluti getting Tool life

RCGN-3V

CRDPN-203V

RCGN-4V

CRDPN-204VS

Greenleaf

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Saegertown, PA 16433
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www.greenleafglobalsupport.com

METAL REMOVAL RATES UP TO 10X GREATER THAN CARBIDE AND 3X GREATER THAN SIALON

WG-700™

WG-700™ is the latest coated whisker-reinforced ceramic material from Greenleaf Corporation. ***WG-700™*** offers extended tool life at high cutting speeds. Its superior toughness combined with a nano layered "platinum" coating allows ***WG-700™*** to excel in the machining of difficult-to-cut materials, such as nickel- and cobalt-based super alloys.

Higher feed rates, more speed & longer tool life!

INSERT	Current Ceramic RNGN-45	WG-700™ RNGN-45 T1
SPEED	900 SFM (275 M/min)	1200 SFM (366 mm/min)
FEED	.008"/Rev (0,20 mm/Rev)	.012" (0.30 mm/Rev)
DOC	.070" (1,78 mm)	.070" (1,78 mm)
METAL REMOVAL RATE	4.2 in³/min (69 cm³/min)	8.4 in³/min (137.6 cm³/min)
	-Heavy notching & top chipping -Unable to complete cut	-Minimal notching -Twice the metal removal rate

With ***WG-700™***, customers can expect superior wear resistance and toughness at high speeds and feeds, maximizing their production capabilities in these ultra-competitive times.

Greenleaf's products are engineered to provide optimal performance against a wide range of materials under the most rigorous metal cutting conditions. In addition to specially engineered tool-holding systems and a comprehensive line of carbide inserts, Greenleaf offers high-quality ceramic and ceramic composite materials, which can be custom designed for specific machining applications.

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Greenleaf (Hunan) High-Tech Materials Co., Ltd.
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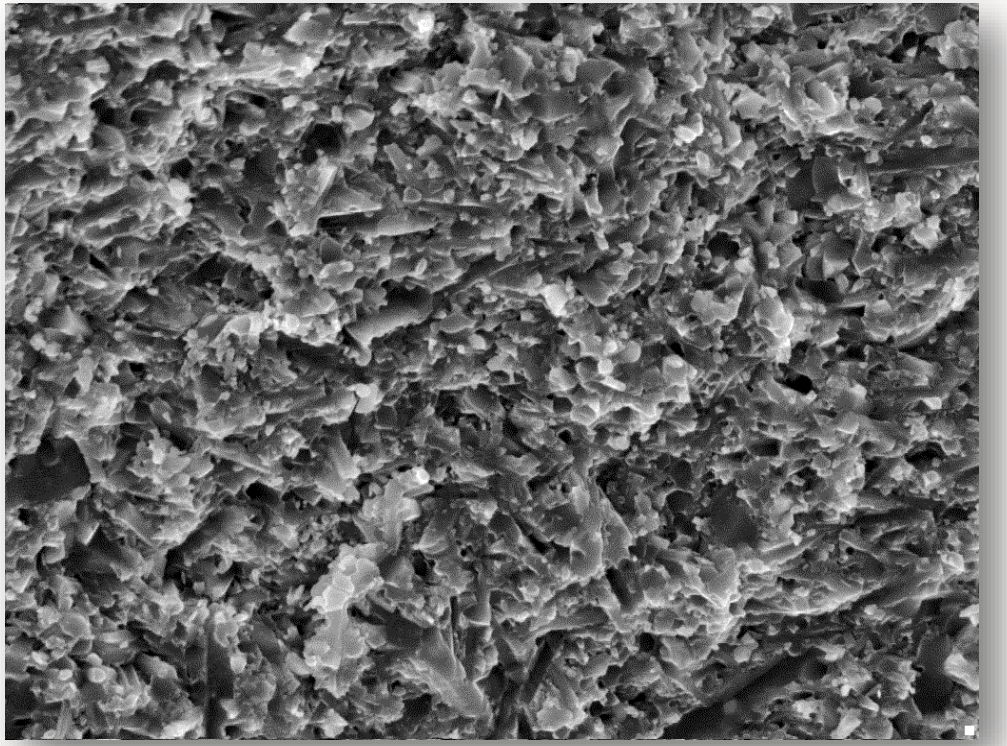
+86-731-84658507
info@greenleafcorporation.com.cn

MADE IN THE USA

Greenleaf Corporation is ISO 9001 Certified.
U.S. Patent No. 6,447,896 B1

Phase-Toughened Ceramics

Unique ceramic blend



In-place grain growth

Phase-Toughened Ceramics

Greenleaf
Tooling Solutions

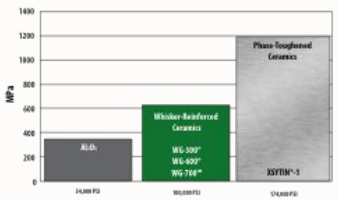
What Are Phase-Toughened Ceramics?

Phase-toughened ceramics are ceramic-composite cutting tools offering almost twice the strength of other commercial ceramic-composite cutting tools. Greenleaf offers XSYTIN®-1 — the first of its kind.

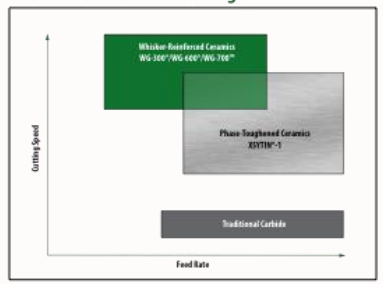
XSYTIN®-1

- XSYTIN®-1 is engineered to provide ultra-high strength and wear resistance for demanding, high-force cuts.
- Applied at extreme feed rates, XSYTIN®-1 has the ability to greatly enhance productivity while providing predictable performance.
- With a wide operating range, XSYTIN®-1 elevates productivity in more materials than any other ceramic cutting tool on the market today.

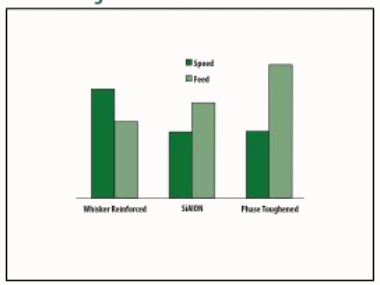
Comparable Strength



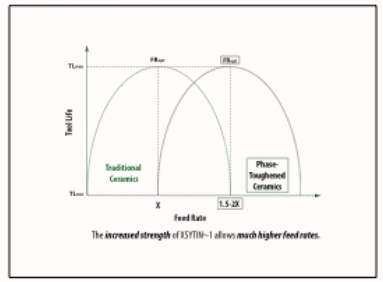
Ceramic vs. Carbide Turning



Phase-Toughened vs. Traditional Ceramics

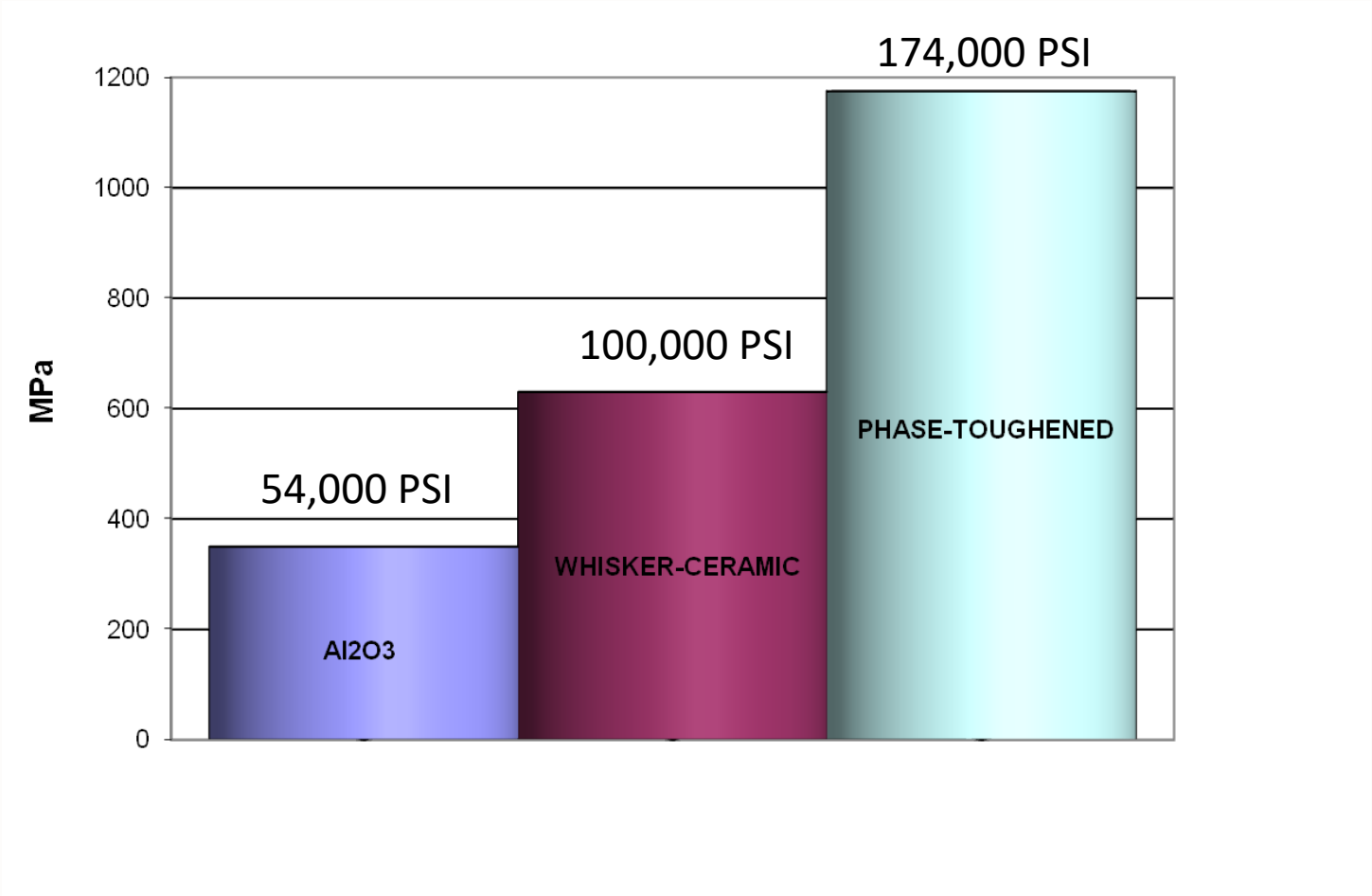


Tool Life vs. Feed Rate

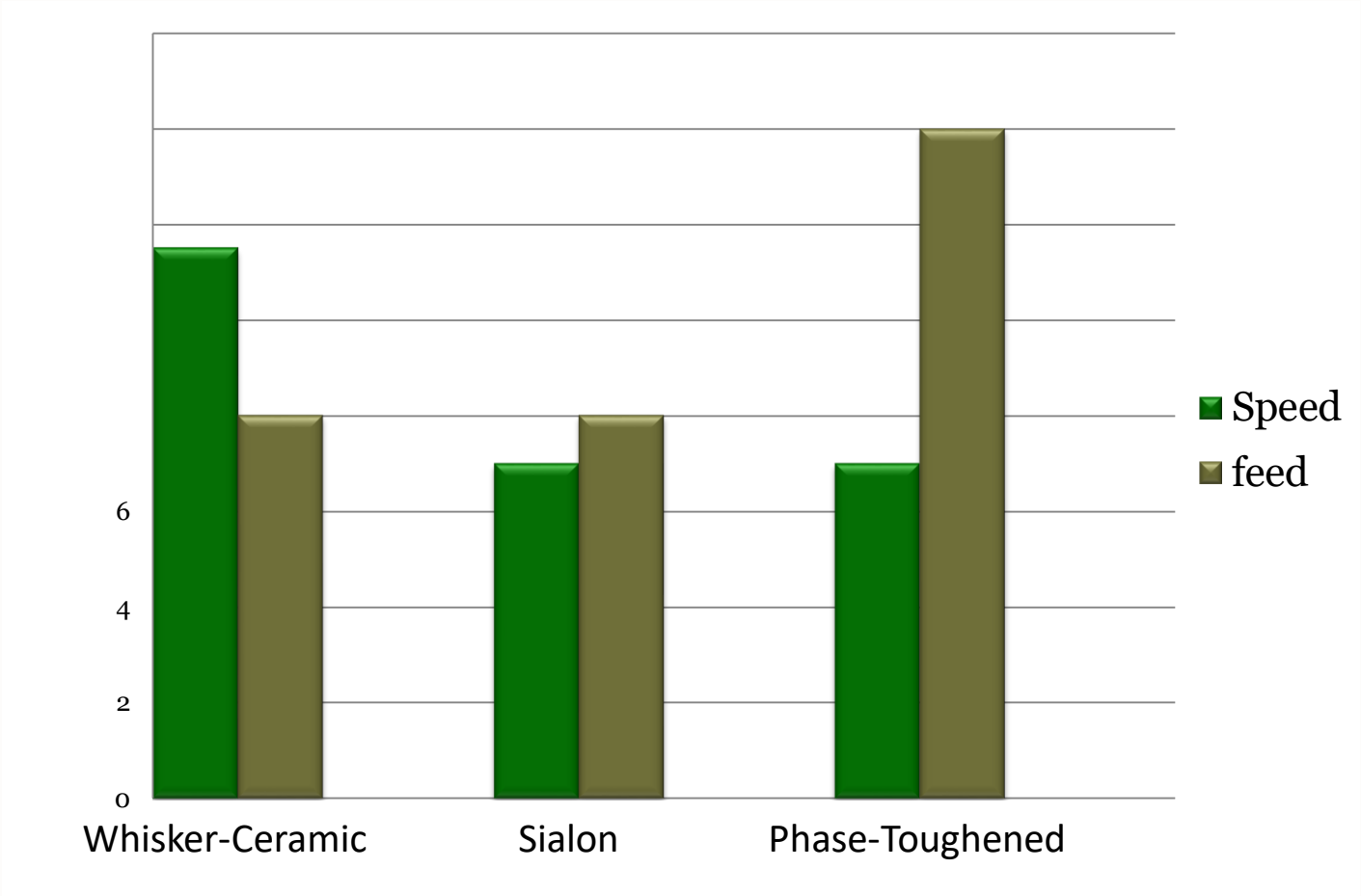


The *increased strength* of XSYTIN®-1 allows *much higher feed rates.*

Comparable Strength

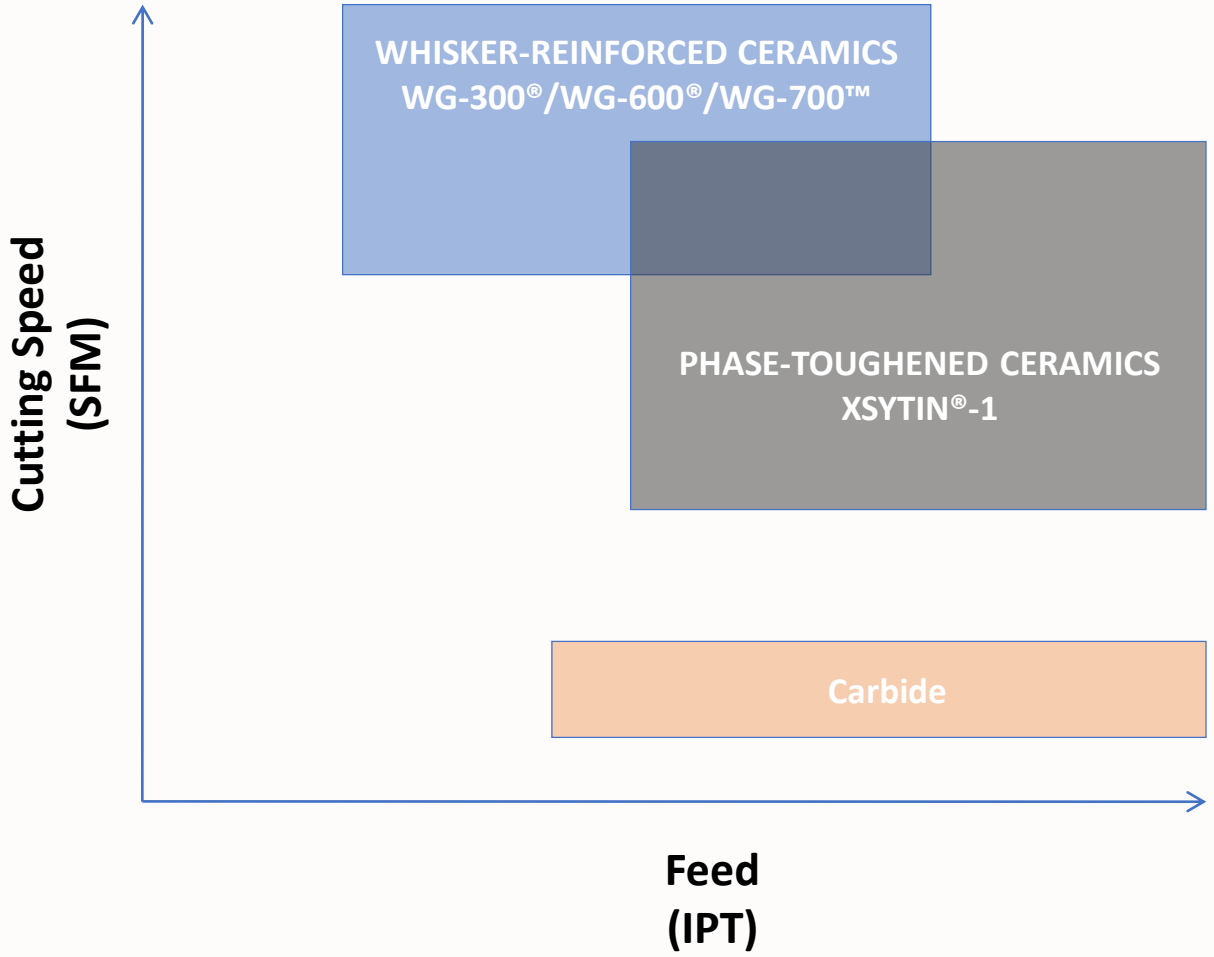


Phase-Toughened vs. Traditional Ceramics

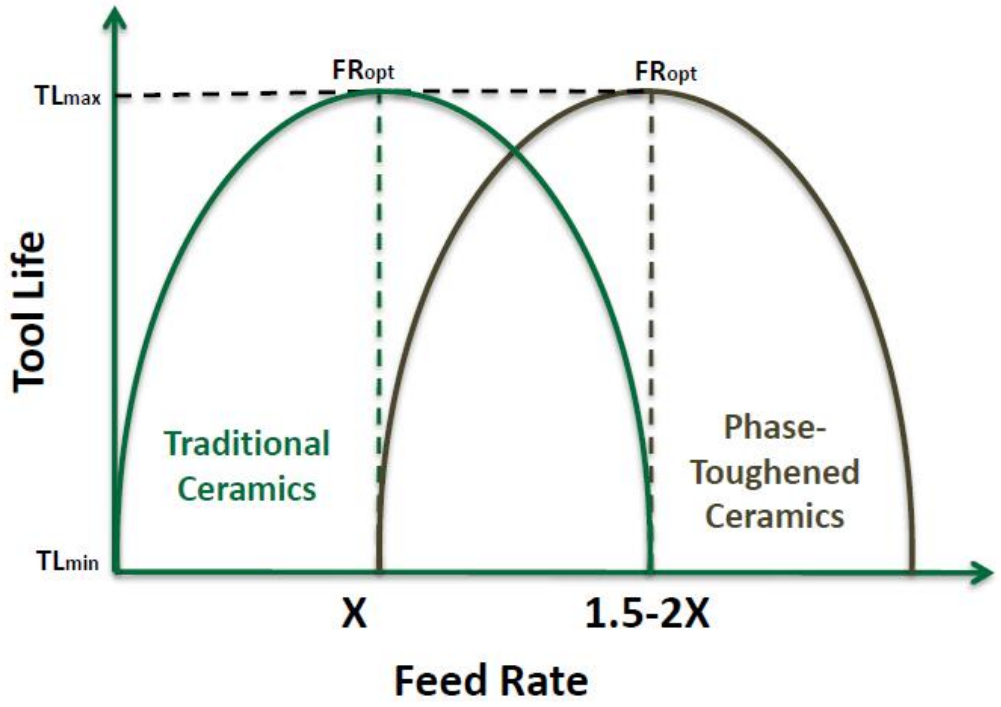


How Ceramics Work

Ceramic vs. Carbide Turning

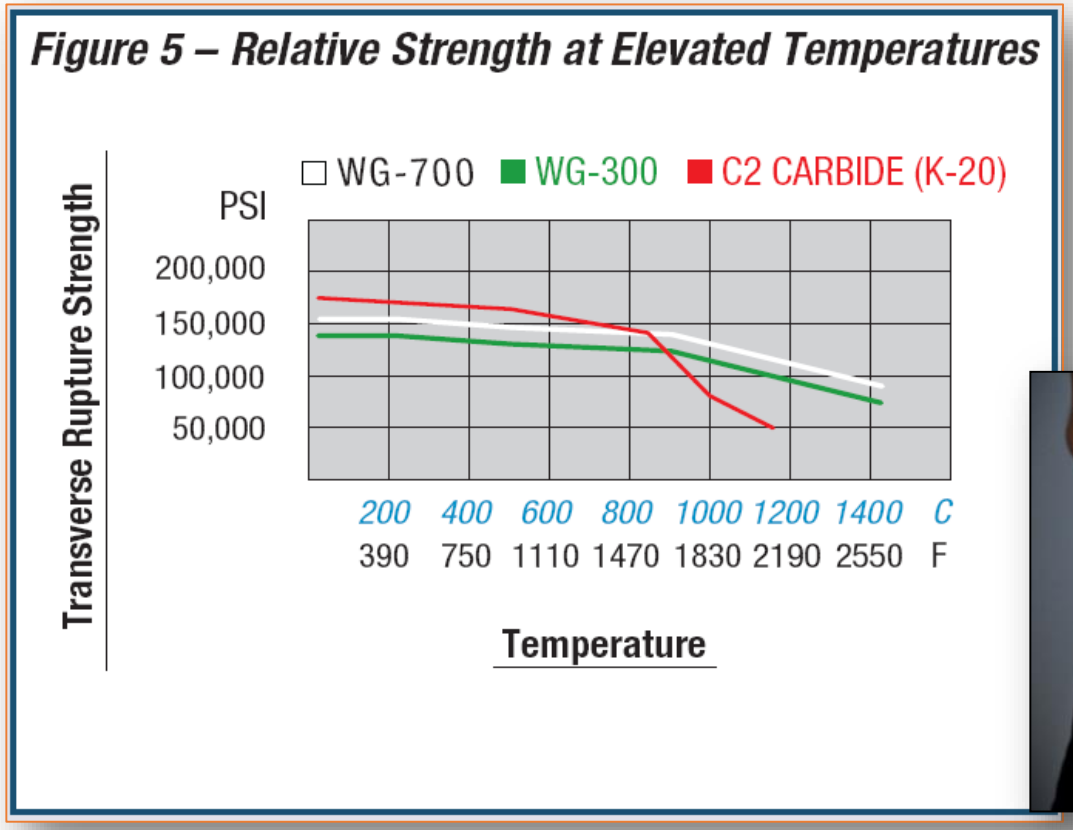


Tool Life vs. Feed Rate



*The **increased strength** of XSYTIN®-1 allows **much higher feed rates**.*

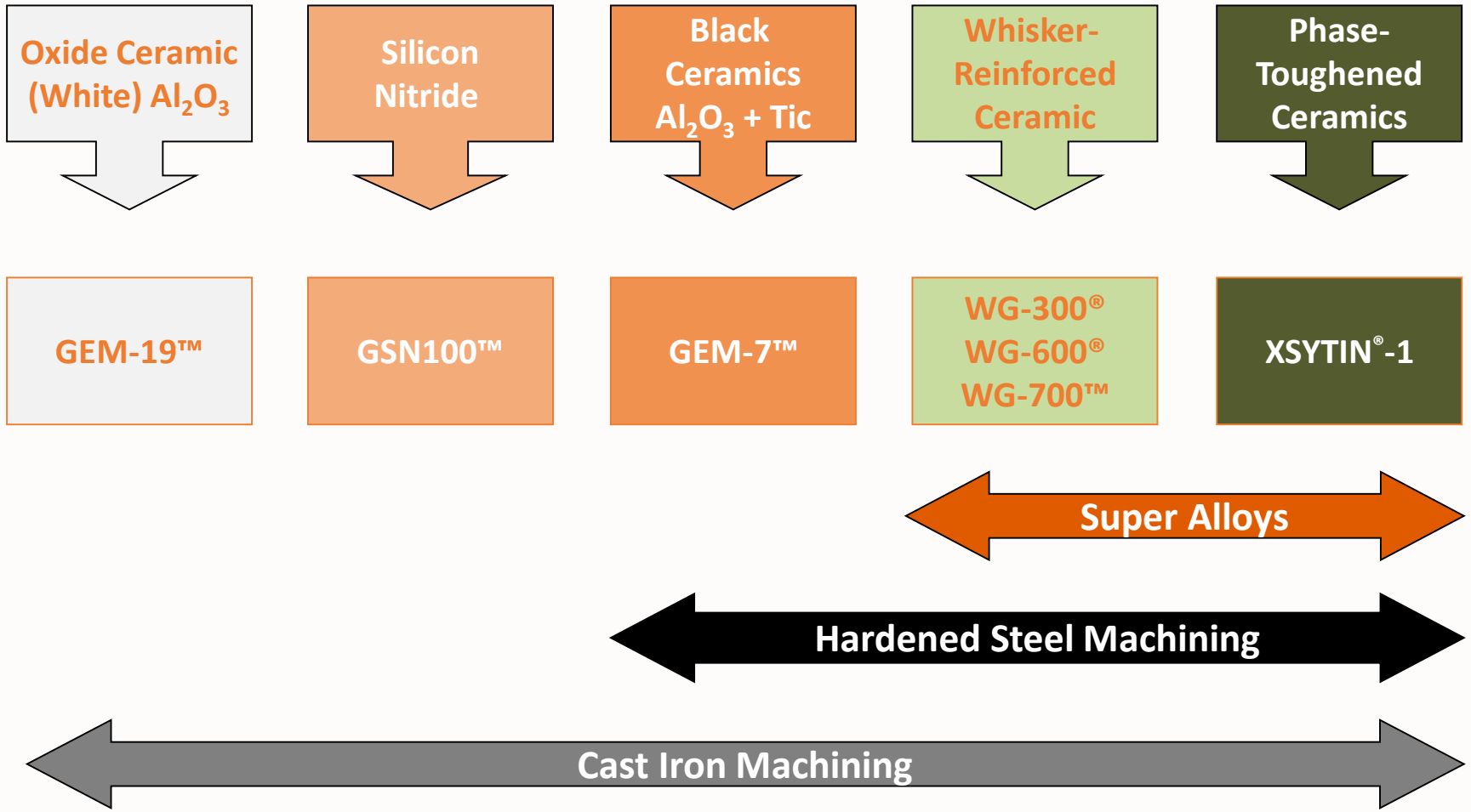
Heat Dissipation in Ceramic Machining



Whisker ceramics retain strength and hardness well beyond 1000°C

Carbide will turn to taffy at that temperature!

Greenleaf Ceramic Grade Profile



HRSA Materials

Nickel Alloys

Inconel

Waspaloy

Hastelloy

Cobalt-Based Alloys

Stellites

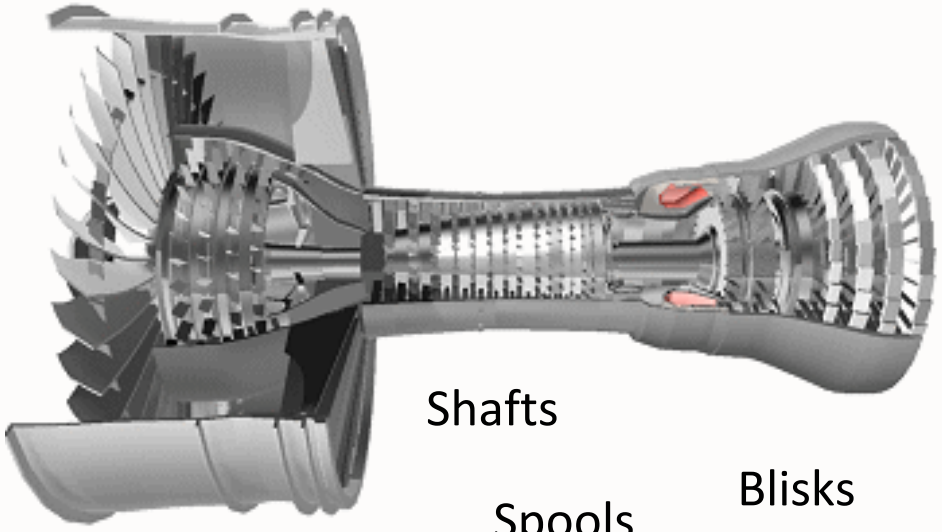
Haynes Alloys

Weld Overlays

Powdered Metals

HRSA Applications

Turbine Engine



Shafts

Spools

Blisks

Discs

Cases

High-Temperature Resistance

Oil & Gas

BOP

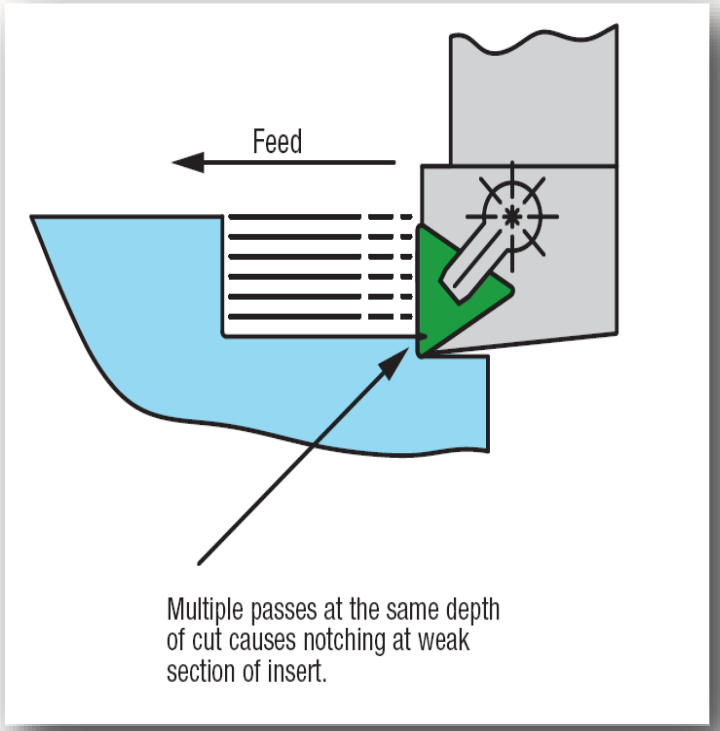
Adapters

Flanges

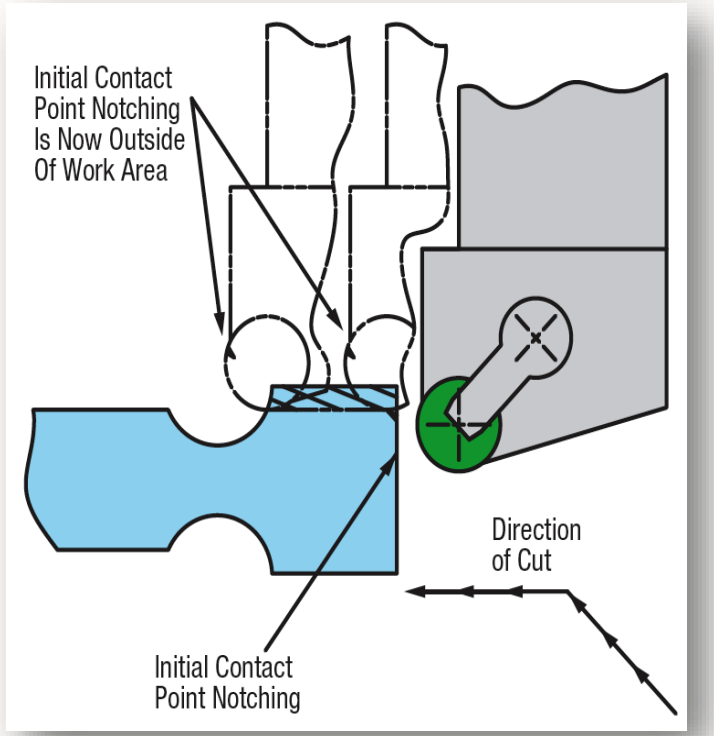
Valves

Wear & Corrosion Resistance

Programming Techniques

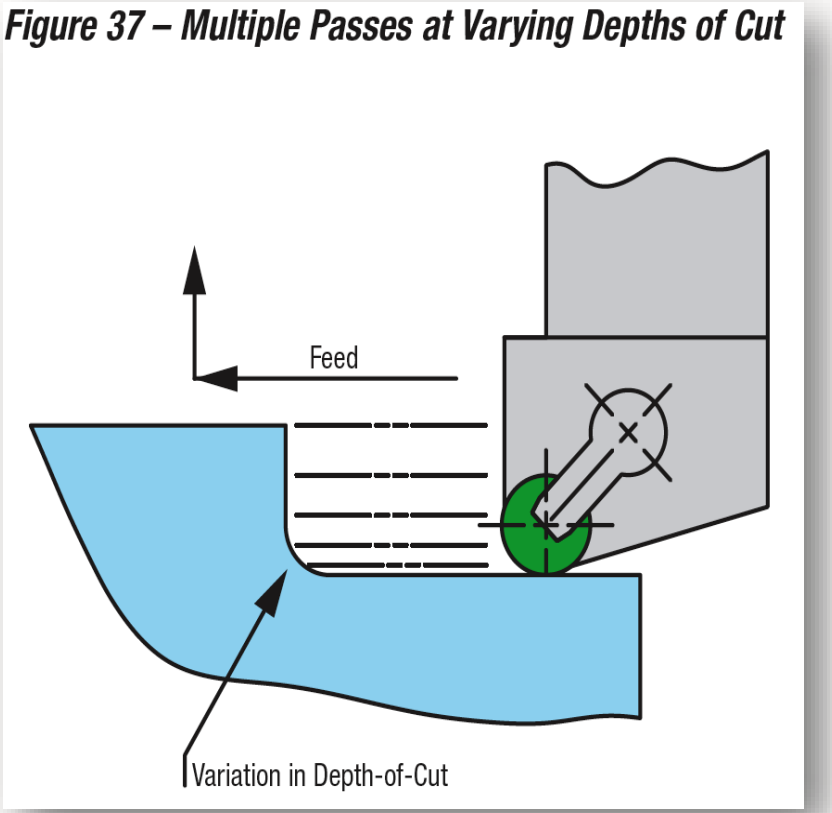


DOC Notching



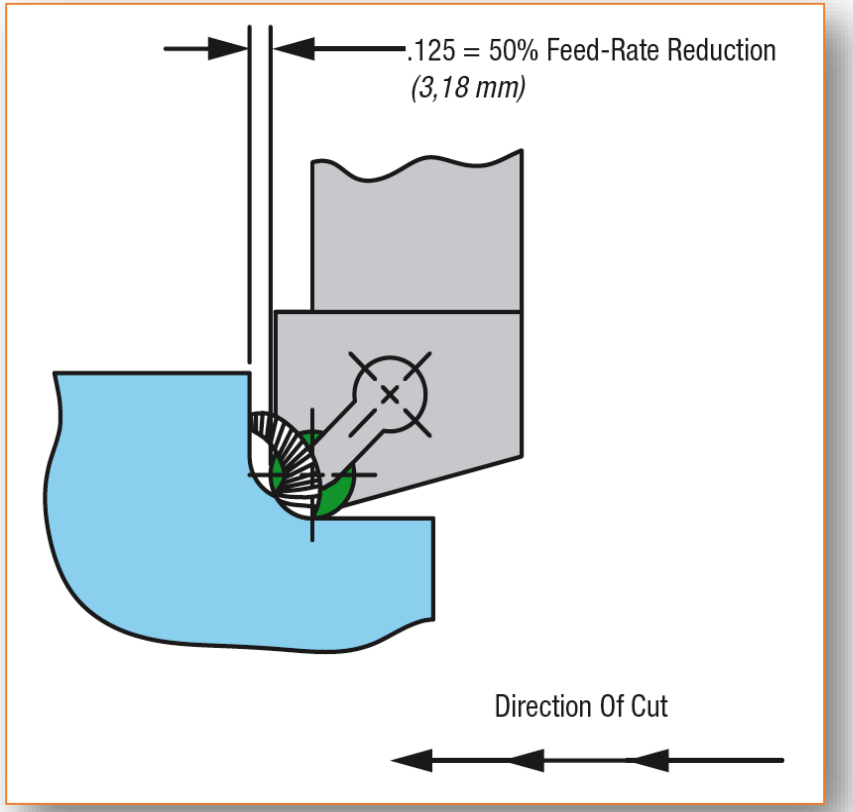
Pre-Chamfering

Programming Techniques



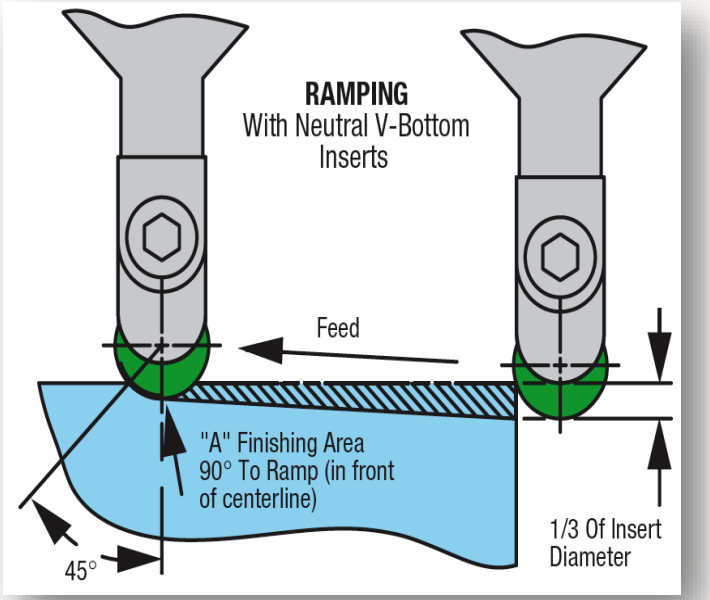
Varying the Depth of Cut

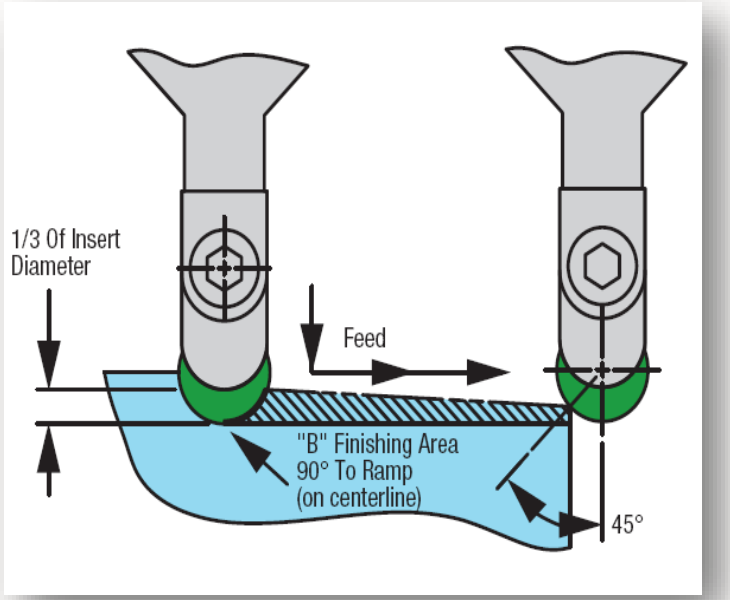
Chips being trapped against a shoulder



When machining up to a shoulder, reduce the feed rate by 50% when insert is within 0.125” (3,18mm) from finished wall.

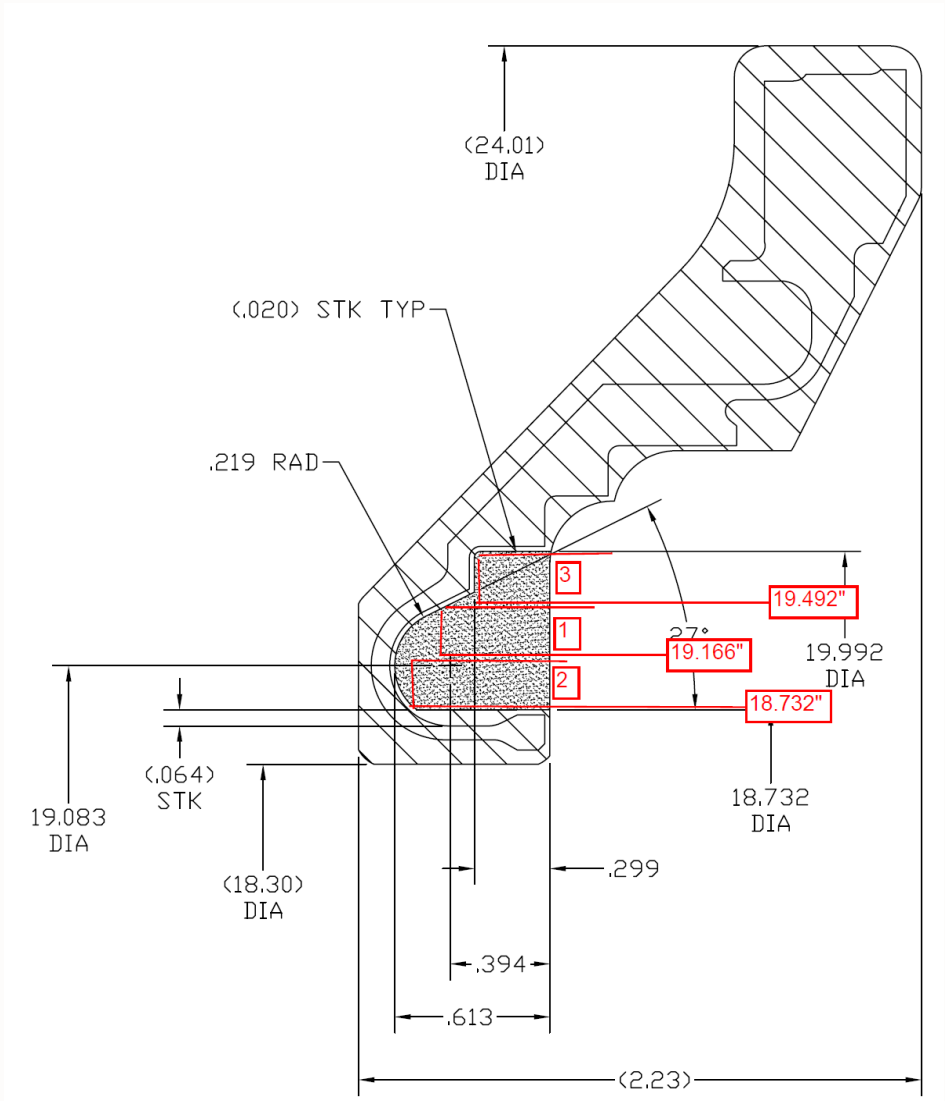
Programming Techniques

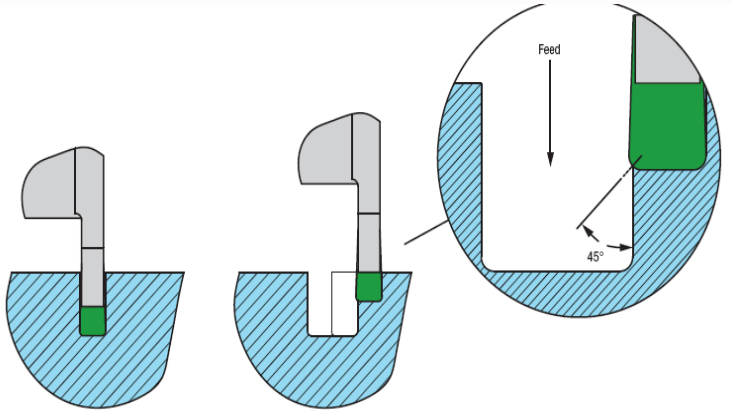




DIAMETER		"A"		"B"		"C"
inches	*mm*	inches	*mm*	inches	*mm*	minutes
.250	*6,3*	.080	*2,0*	.040	*1,0*	3
.375	*9,5*	.120	*3,0*	.060	*1,5*	4
.500	*12,7*	.160	*4,0*	.080	*2,0*	5

Ramping





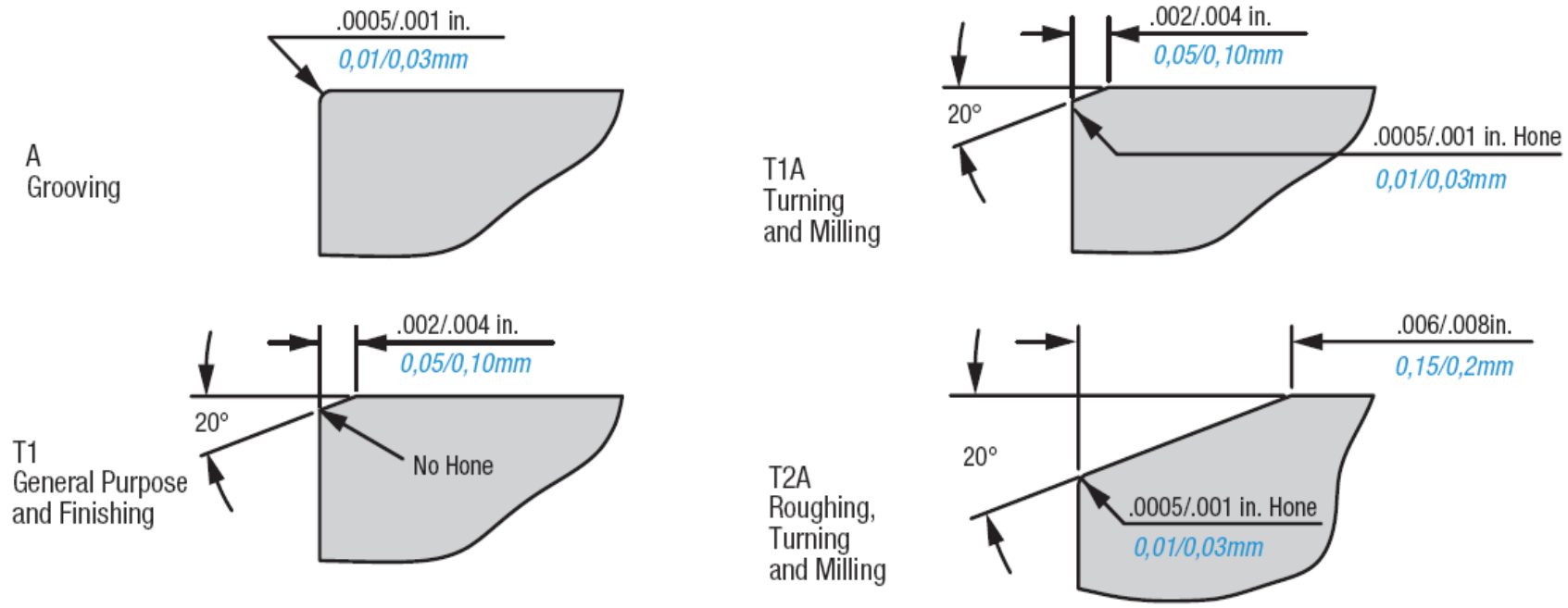
Greenleaf Solution

Layout optimal tool path and step over for WG-6250-3

- 900 SFM (274 m/min)
- 0.0025 IPR (0,06 mm/rev)
- 1 insert per part
- 3-minute cycle time

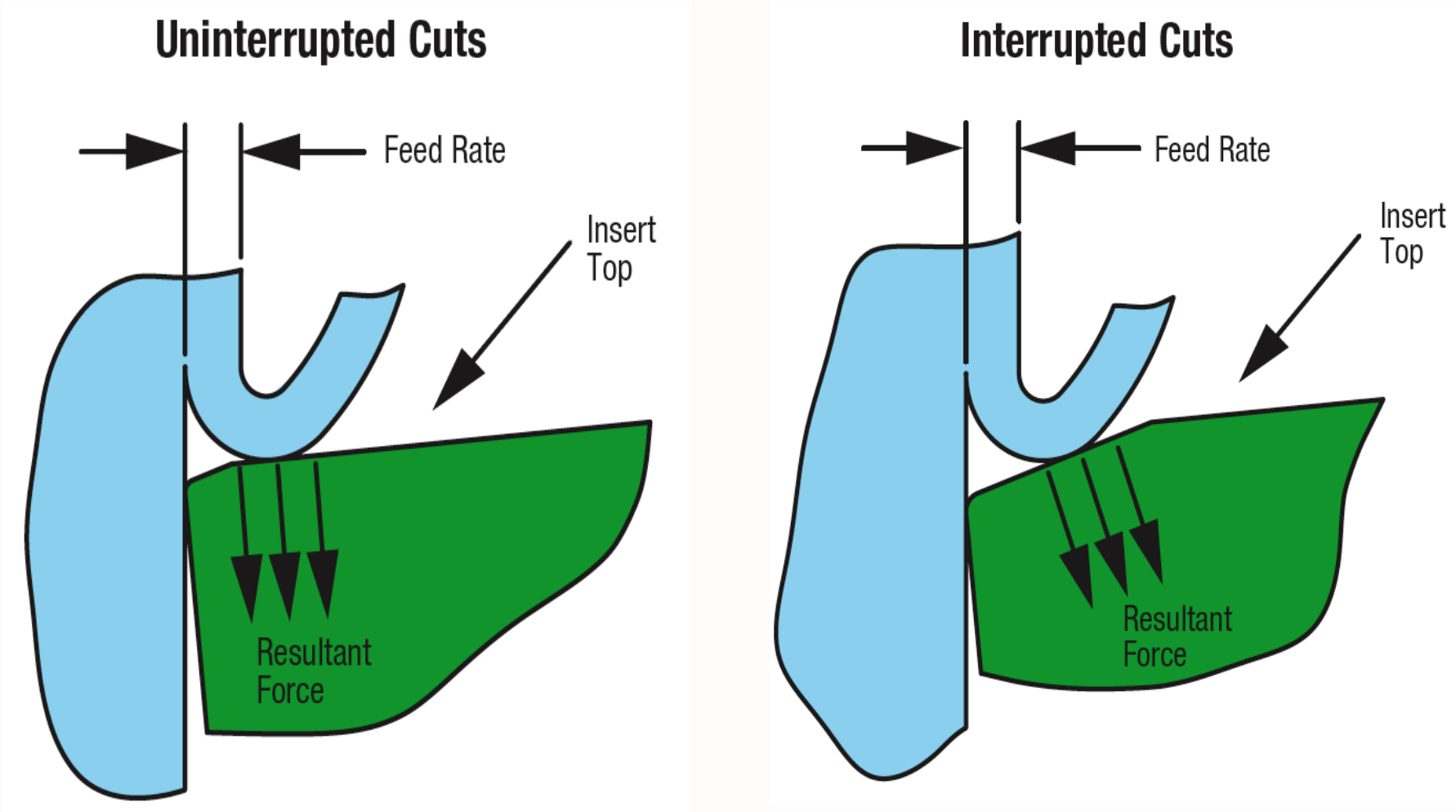
Standard Edge Preps

Figure 24 – Standard Edge Preparations



In ceramic applications, edge preparation is critical to tool life and surface integrity.

Edge Prep for Interrupted Cutting

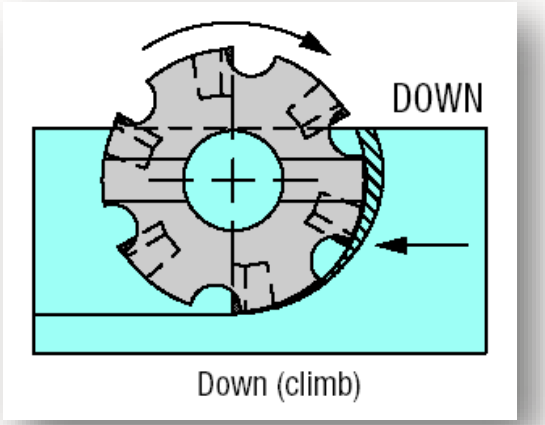


Use the land to redirect cutting forces.

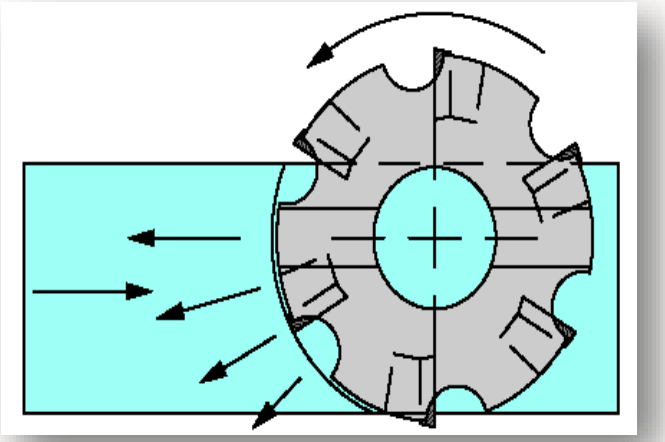
Programming Techniques

Keep cutter engaged in cut

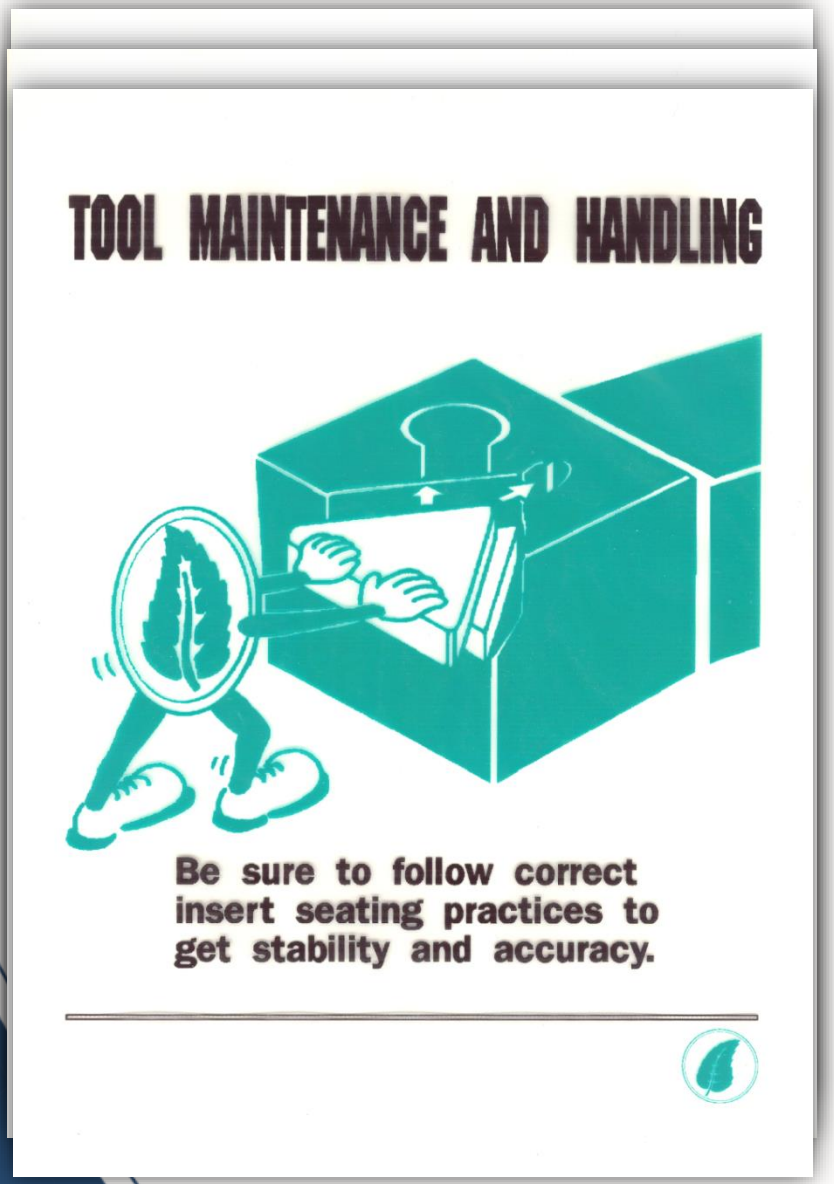
Climb (Down) Milling

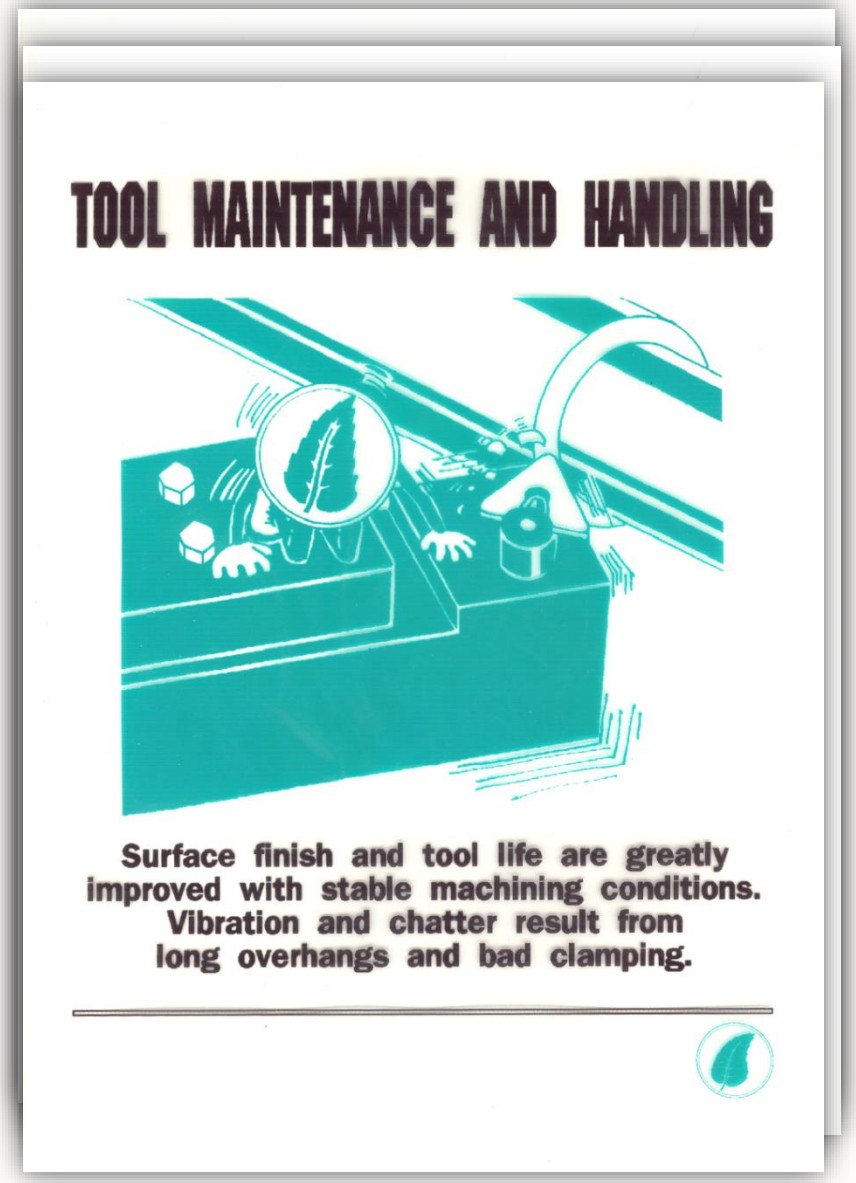


Cutter Positioning



Tool Maintenance

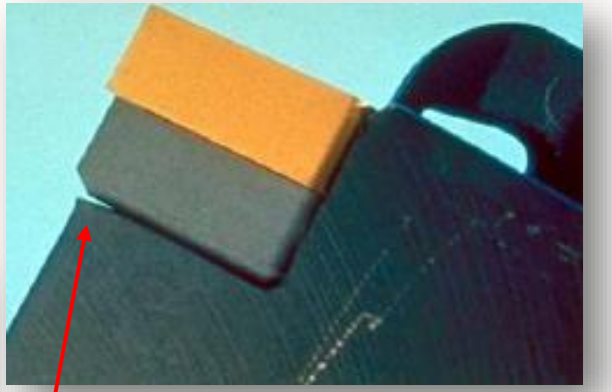




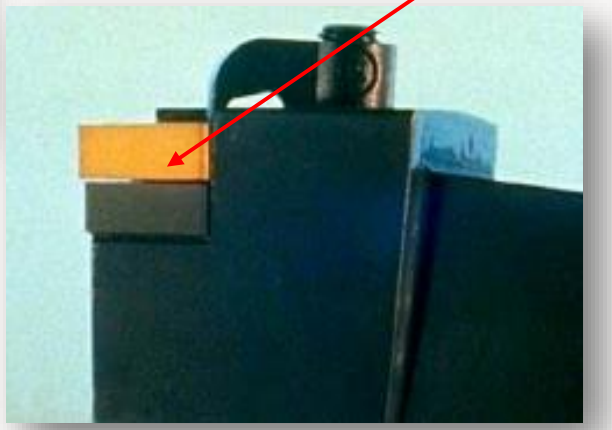
Tool Maintenance

Inspect the insert pocket, seating and clamping

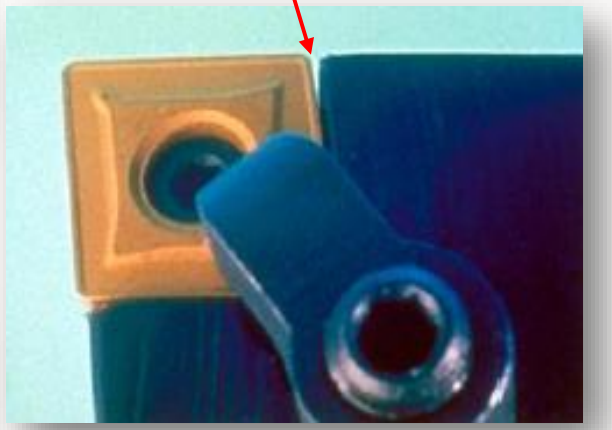
Damaged shim seat



Poor seating



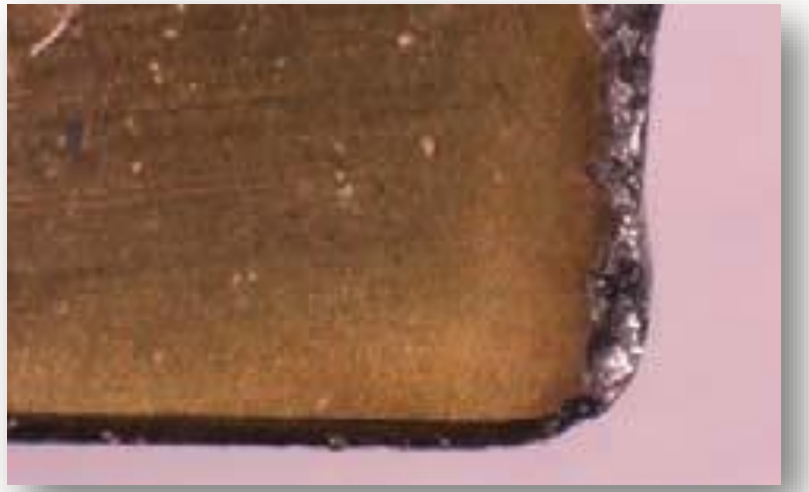
Bell-mouthed insert pocket



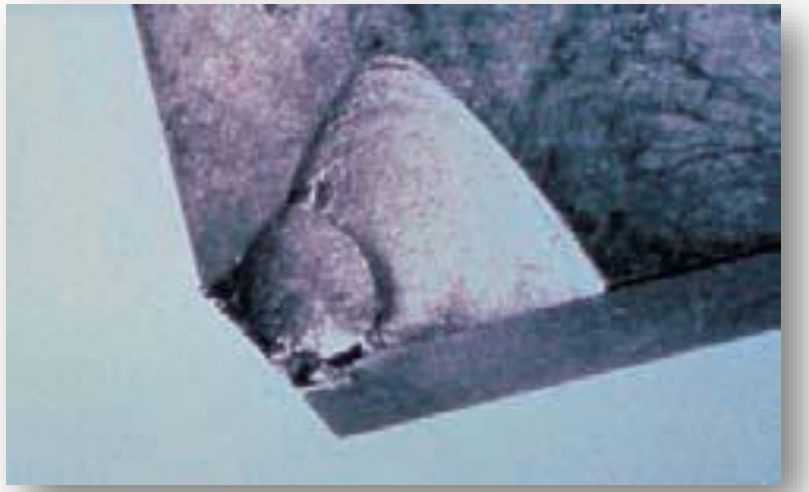
Ceramic Tool Wear

Undesirable Tool Wear

Chipping



Fracture

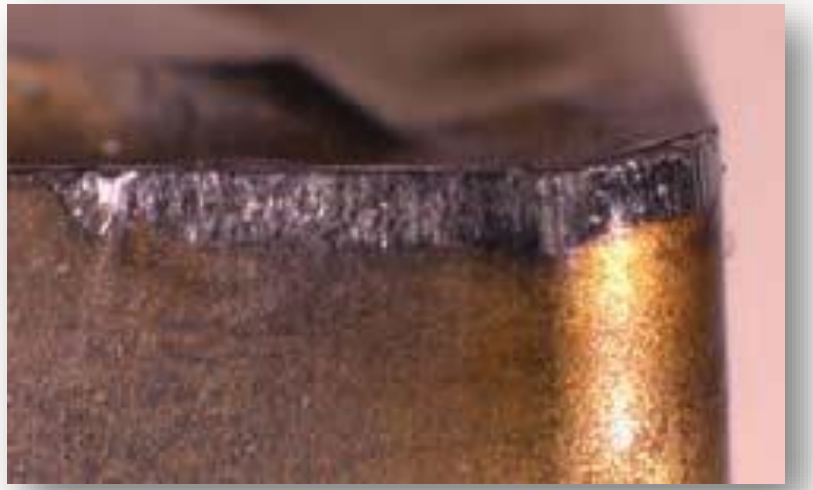


Almost always a mechanical issue

Ceramic Tool Wear

Typical Tool Wear

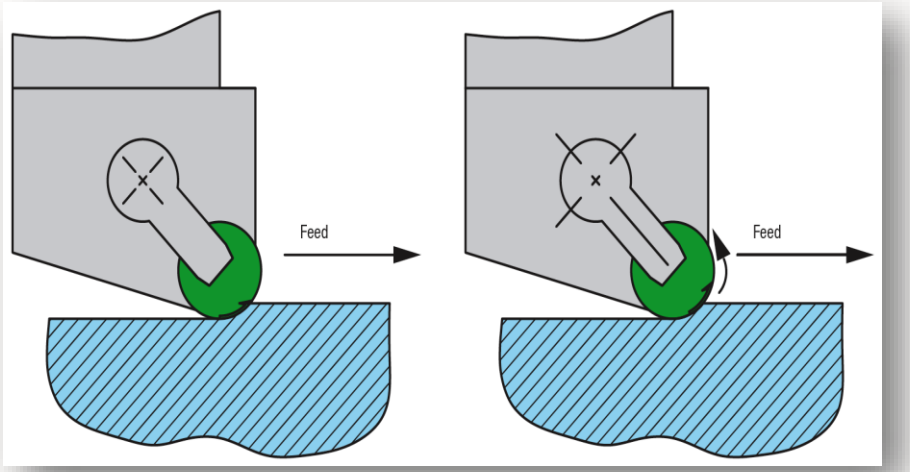
Flank Wear



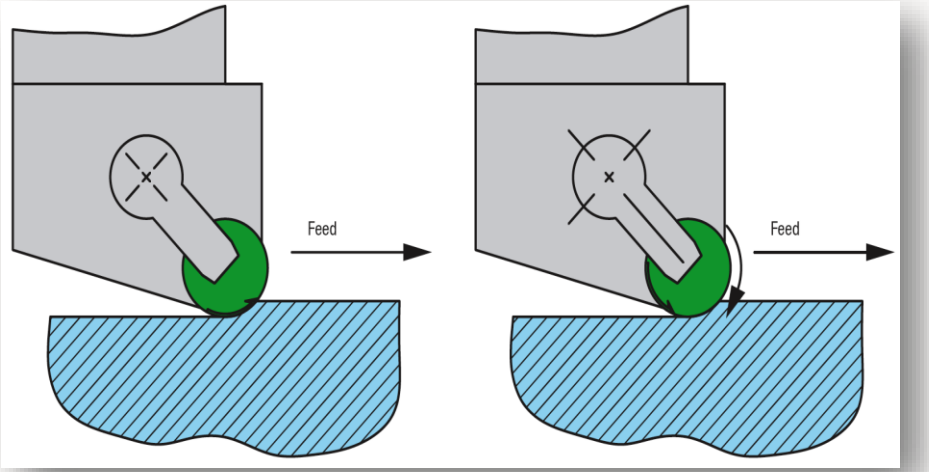
Notching

Cannot be eliminated but can be manageable to predictable

Proper Indexing Techniques

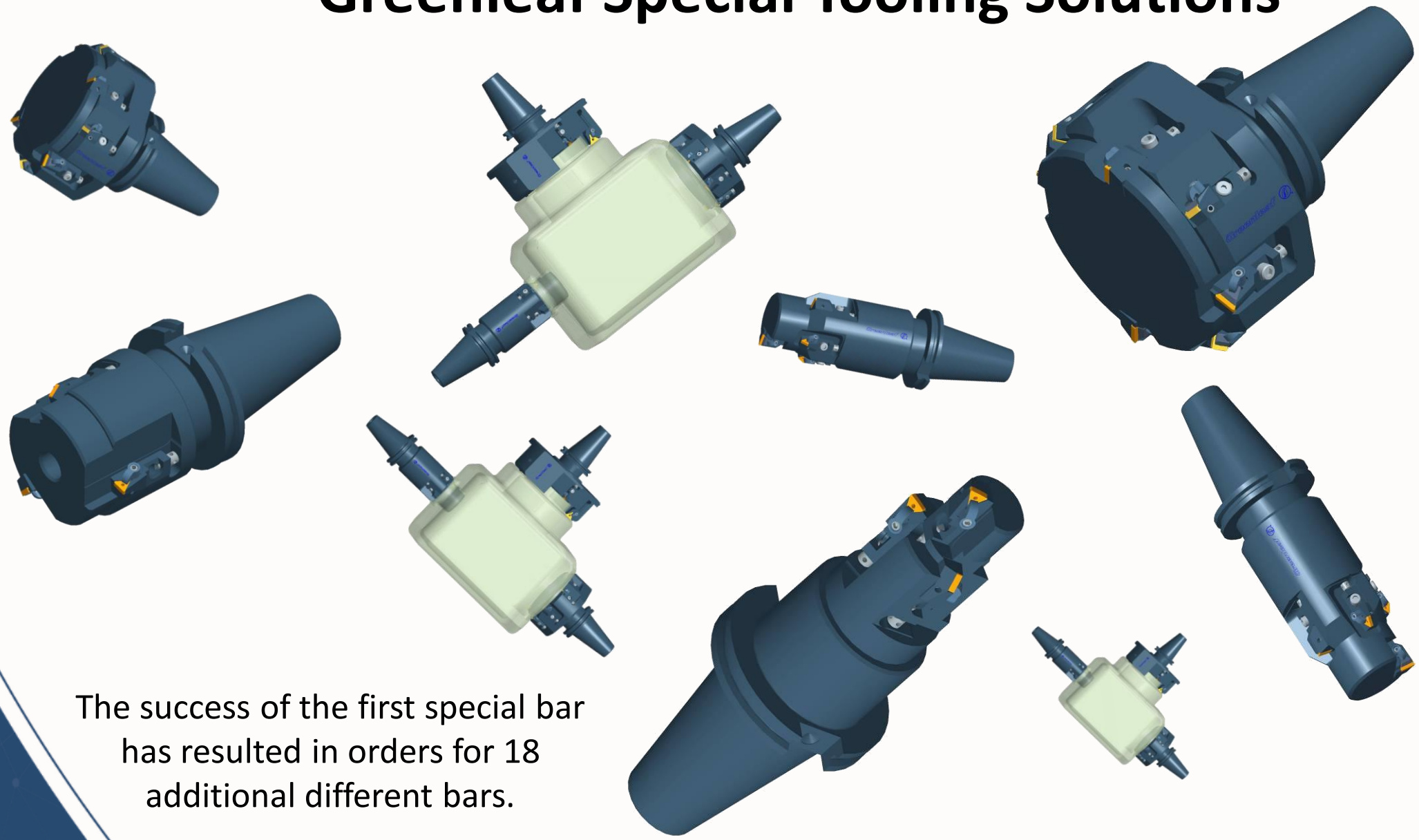


Heavy notch,
light flank wear



Heavy notch,
heavy flank wear

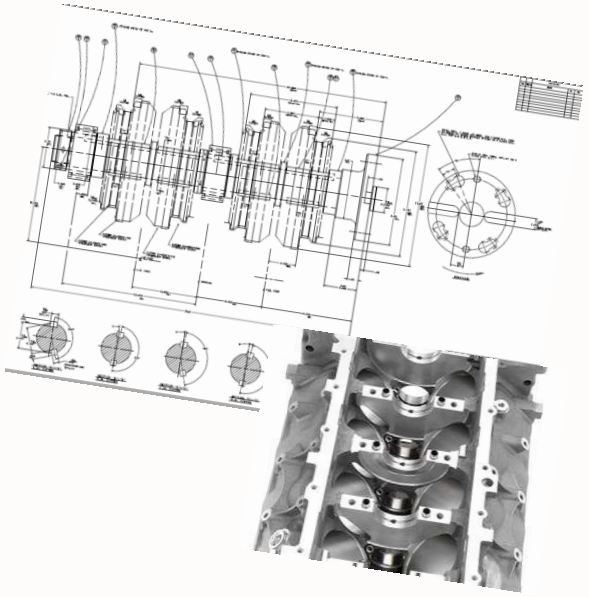
Greenleaf Special Tooling Solutions

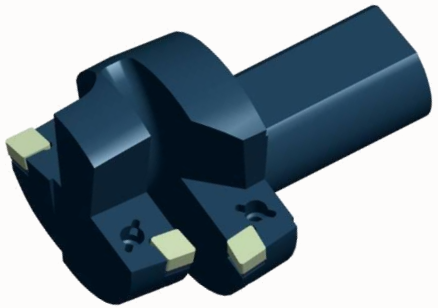


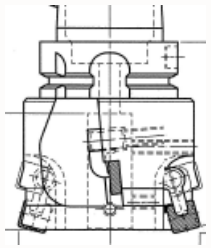
The success of the first special bar has resulted in orders for 18 additional different bars.

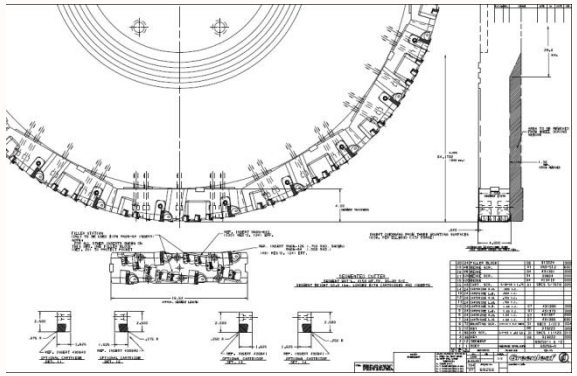
Automotive

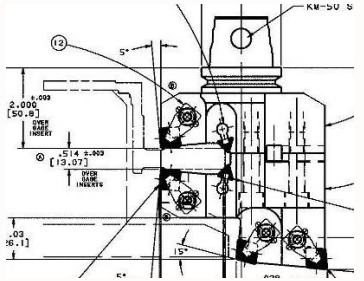

Greenleaf
600115 .812 WIDE
INSERT SCREW 25-30 IN-LBS.
MOUNTING SCREW 255 FT-LBS.











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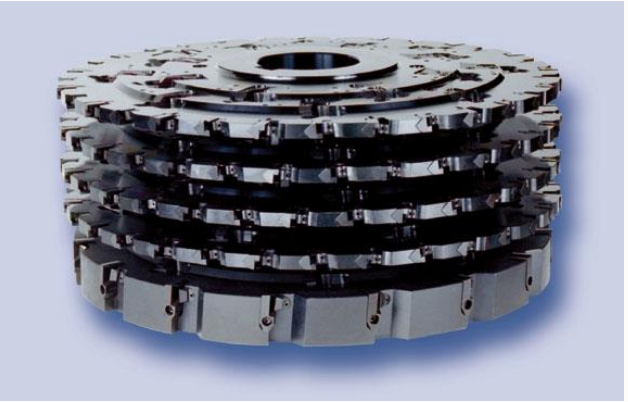
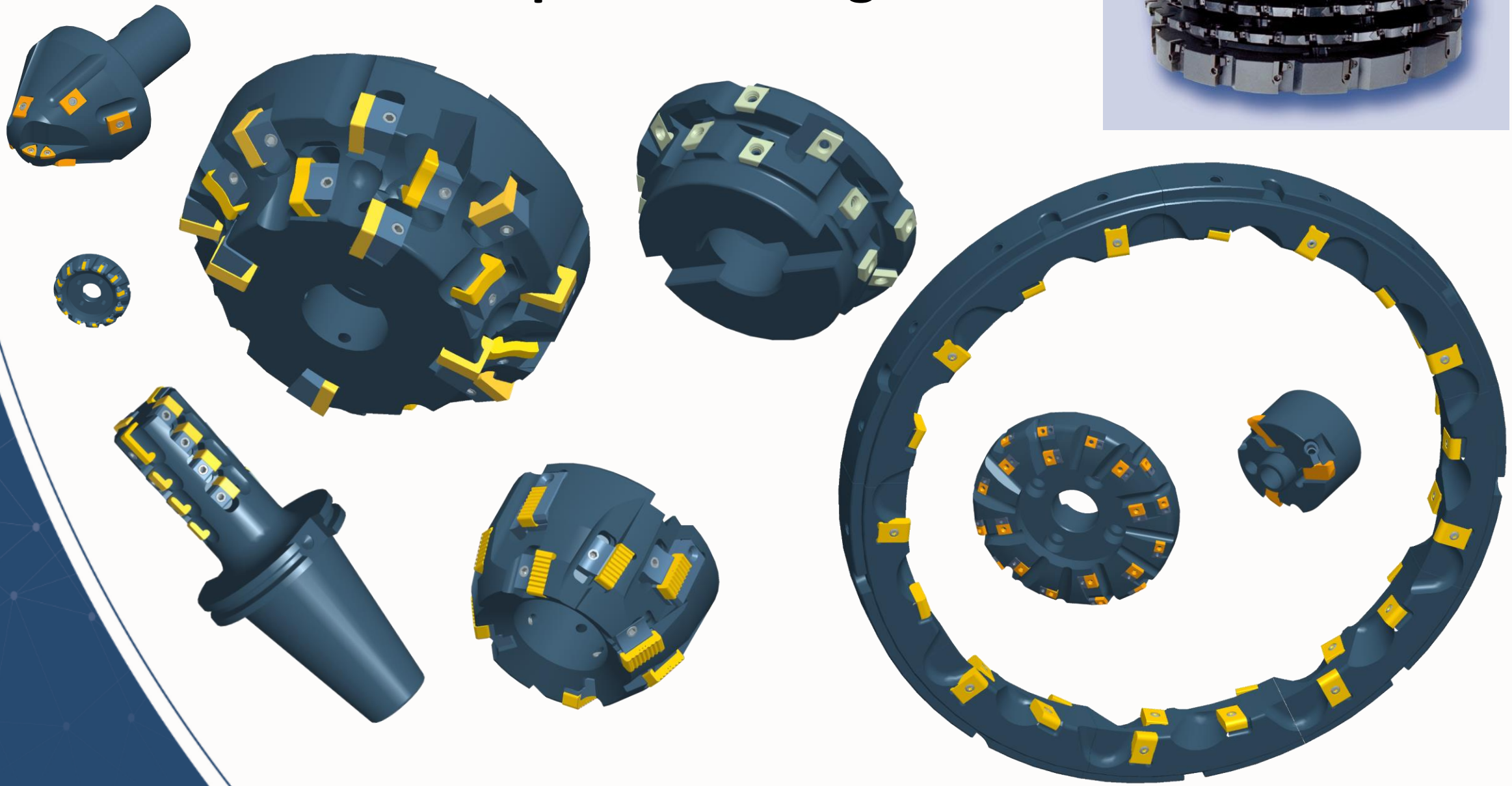
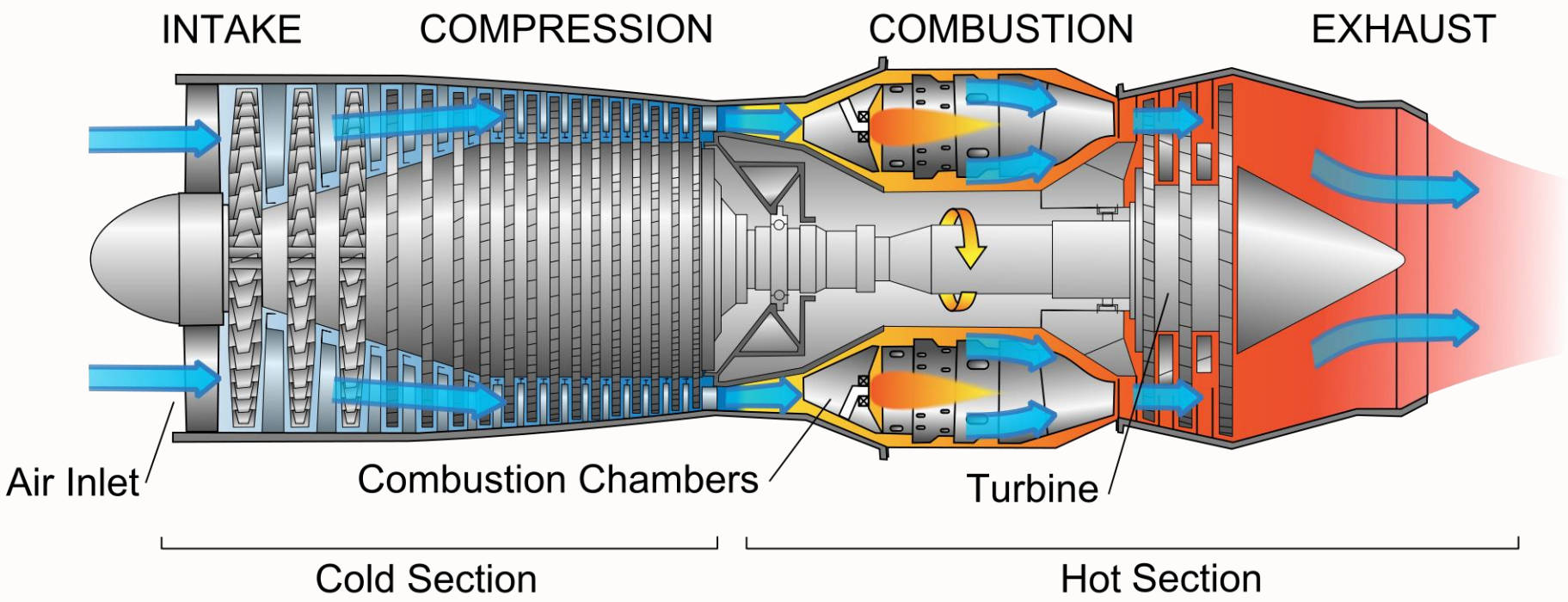
Special Milling Cutters

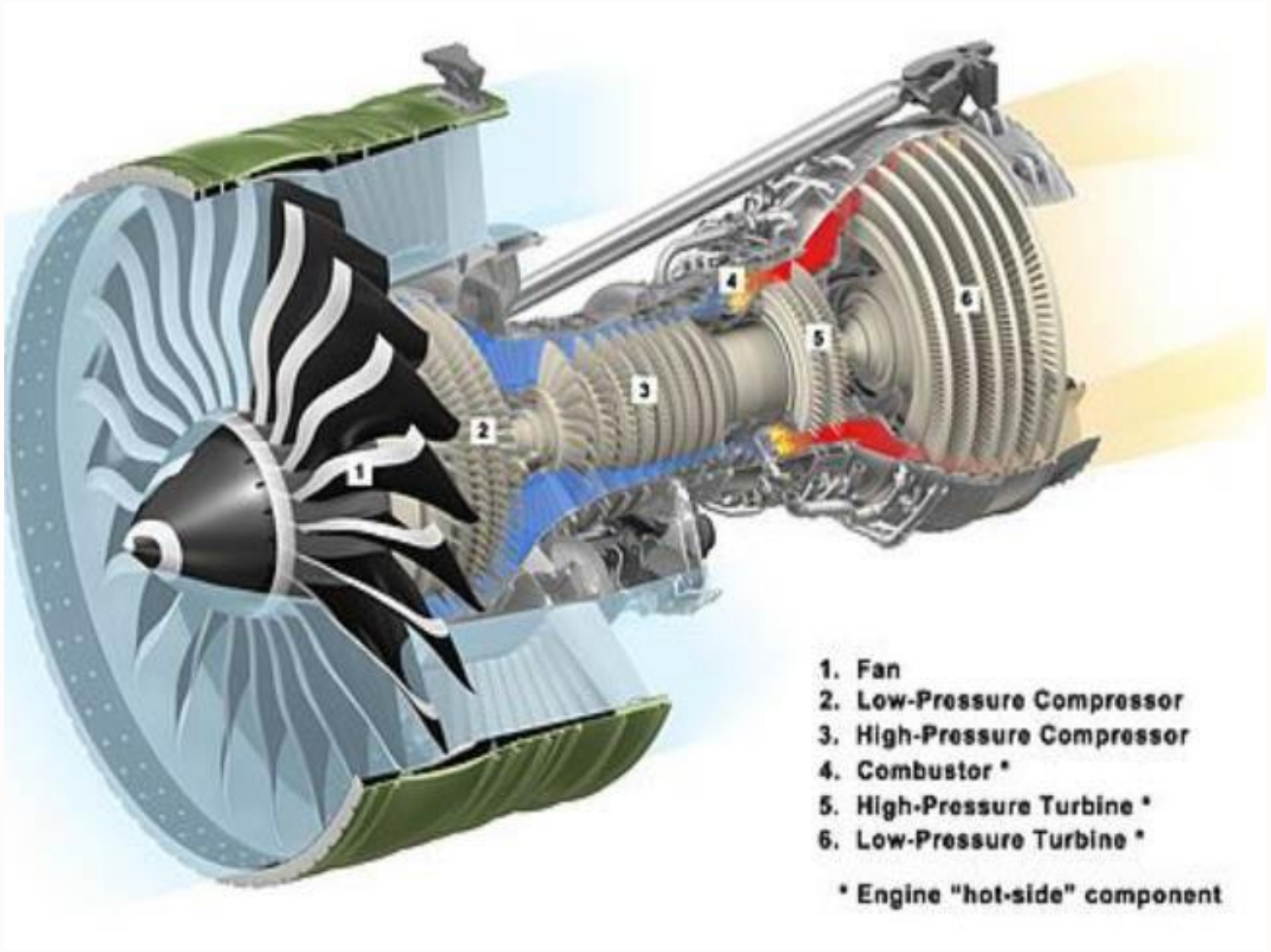




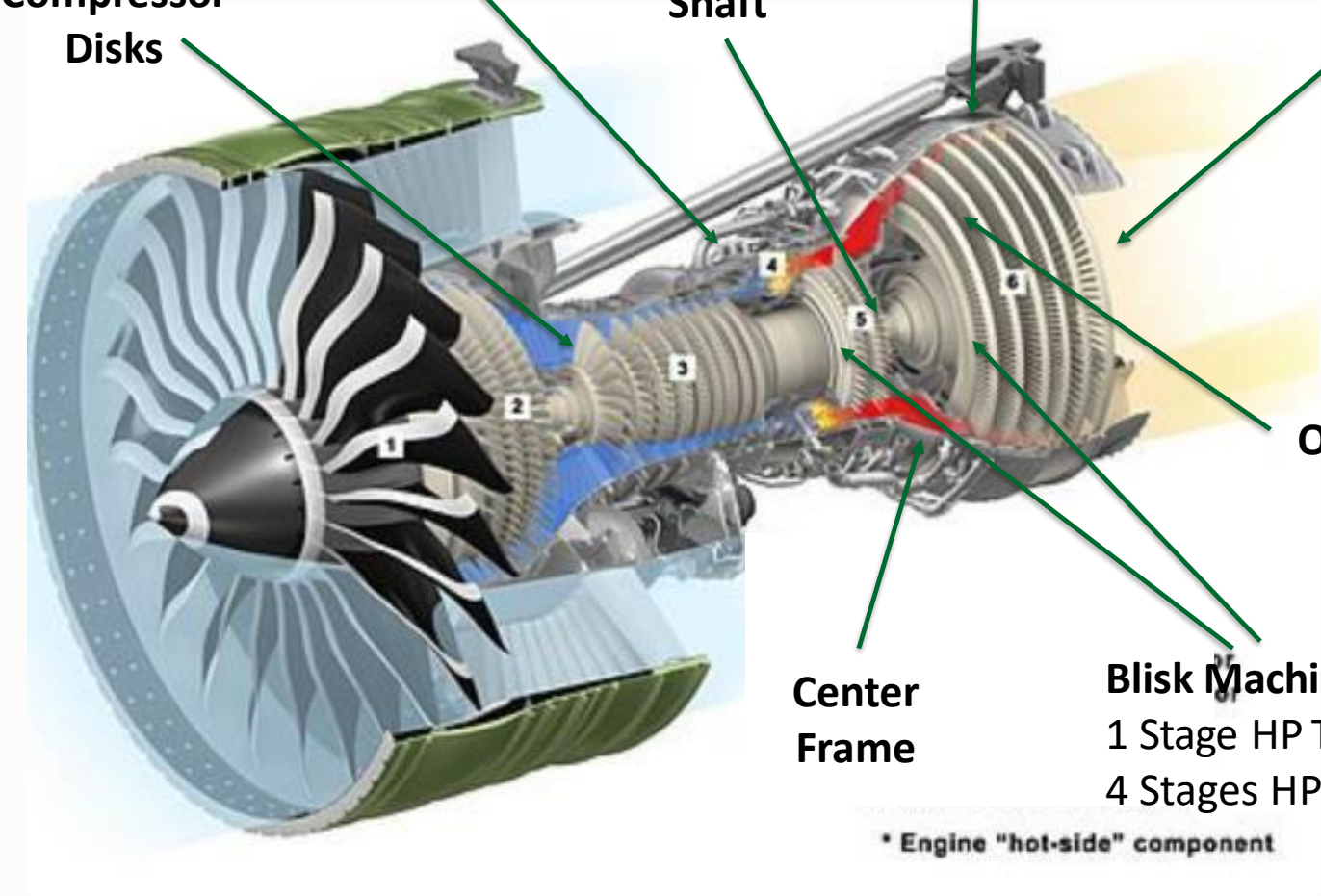
Aerospace Engines: Greenleaf's Comfort Zone



Aerospace Engines: Greenleaf's Comfort Zone

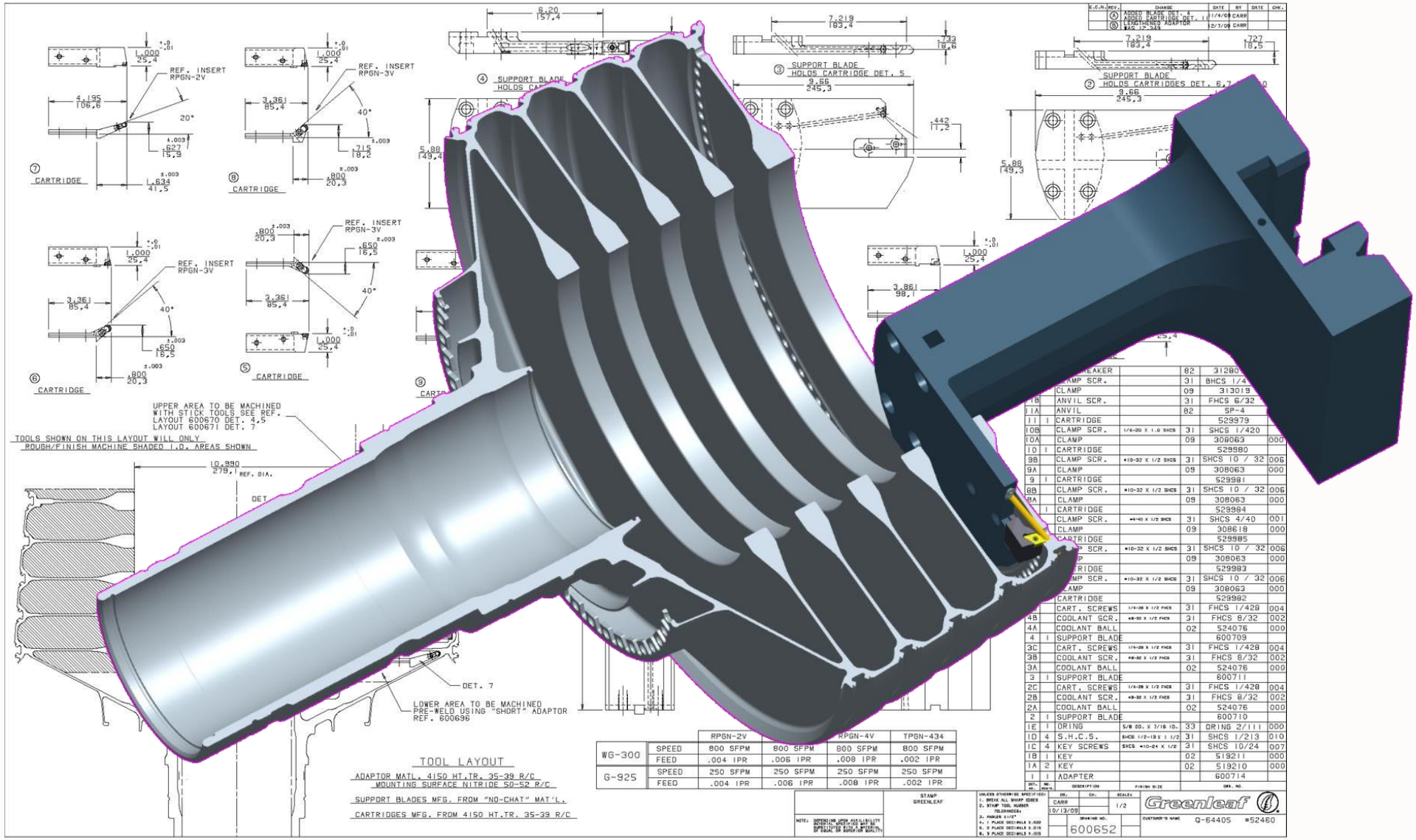


Aerospace Engines: Greenleaf's Comfort Zone



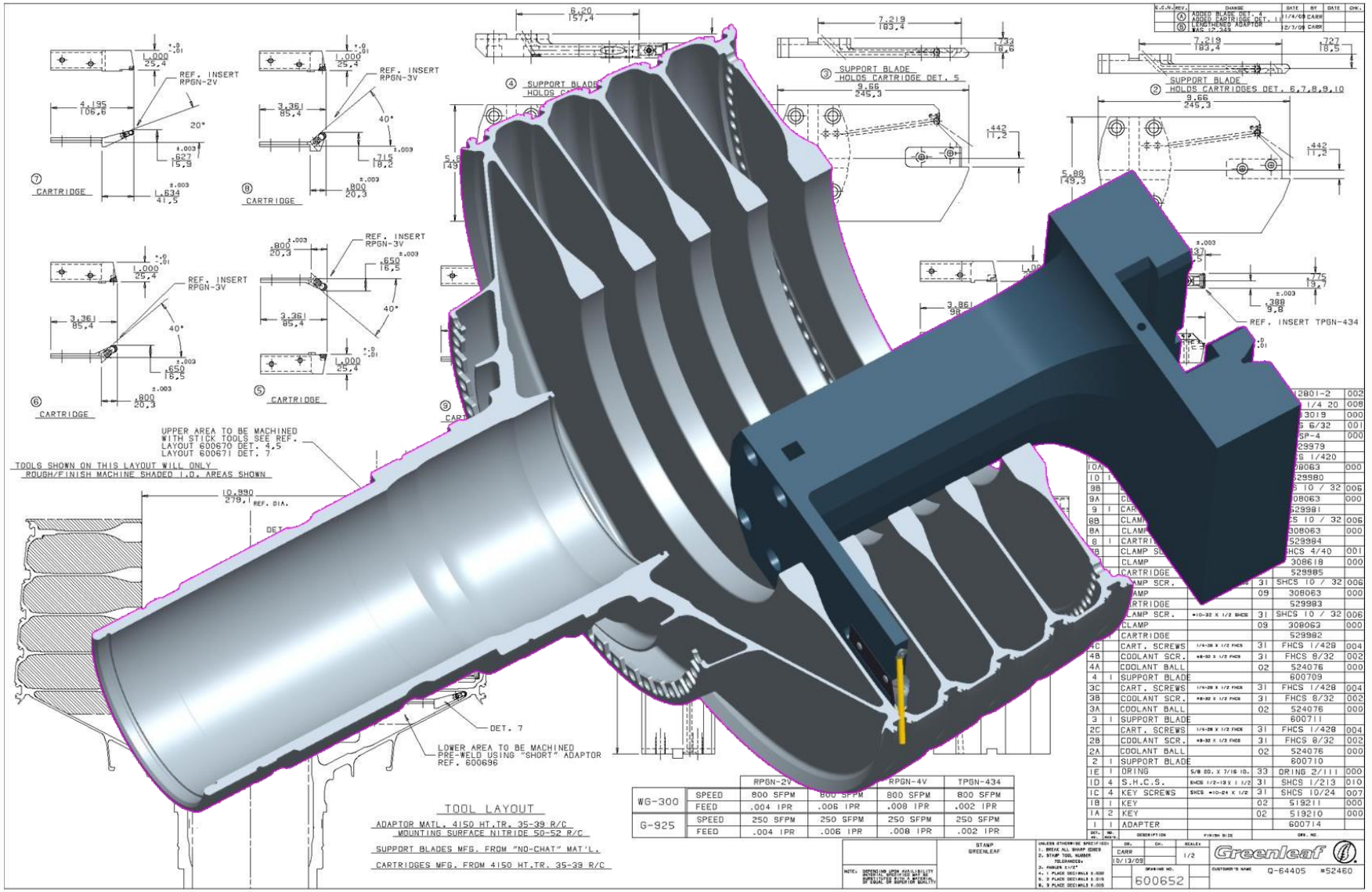
Tool Layouts

Tungsten Heavy-Metal Tooling



Tool Layouts

Tungsten Heavy-Metal Tooling



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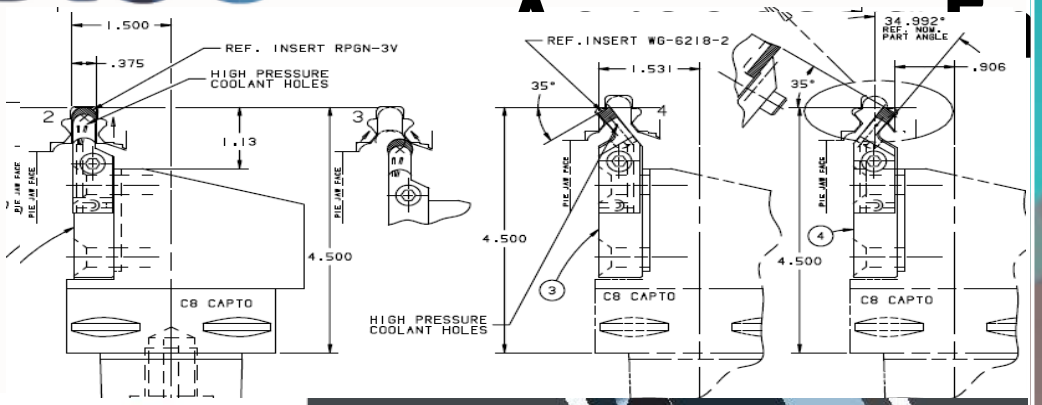
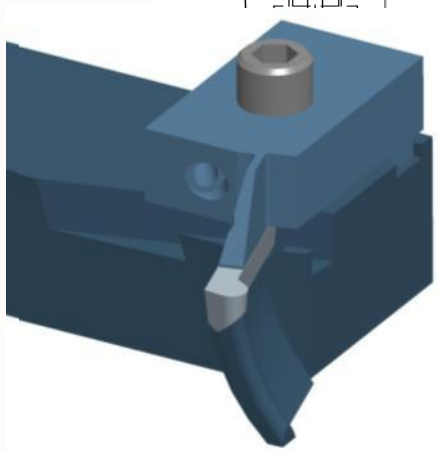
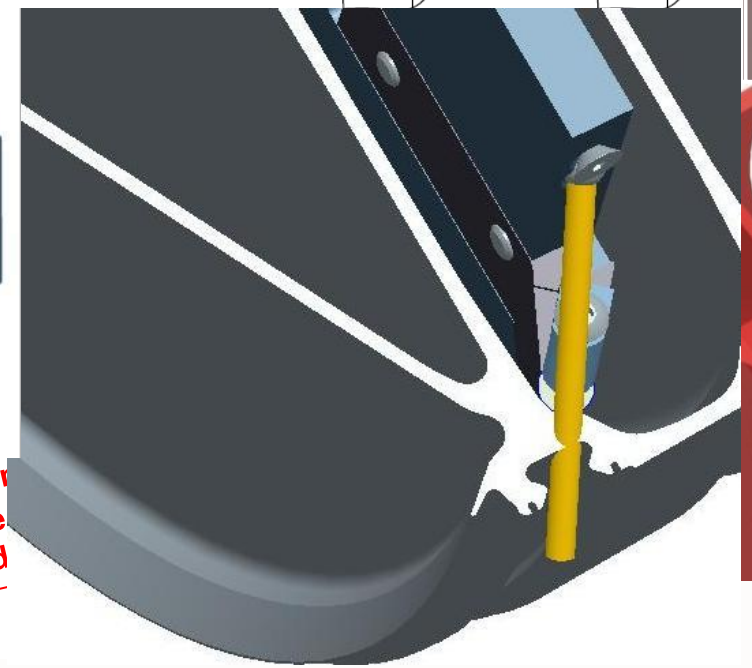
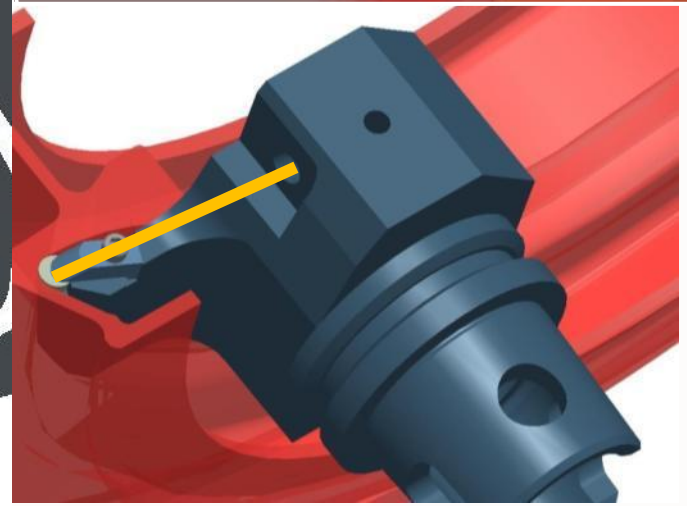




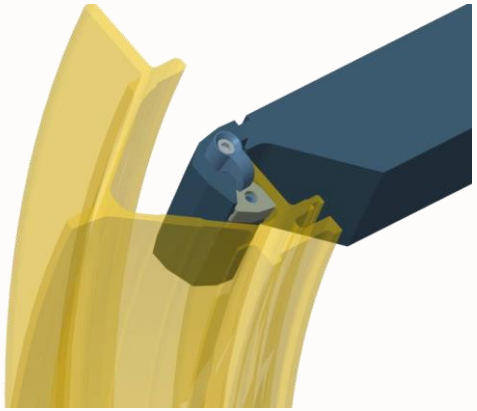


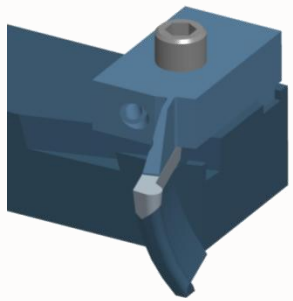
NEW custom design
using high pressure
are being developed

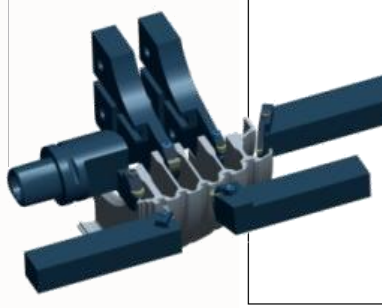


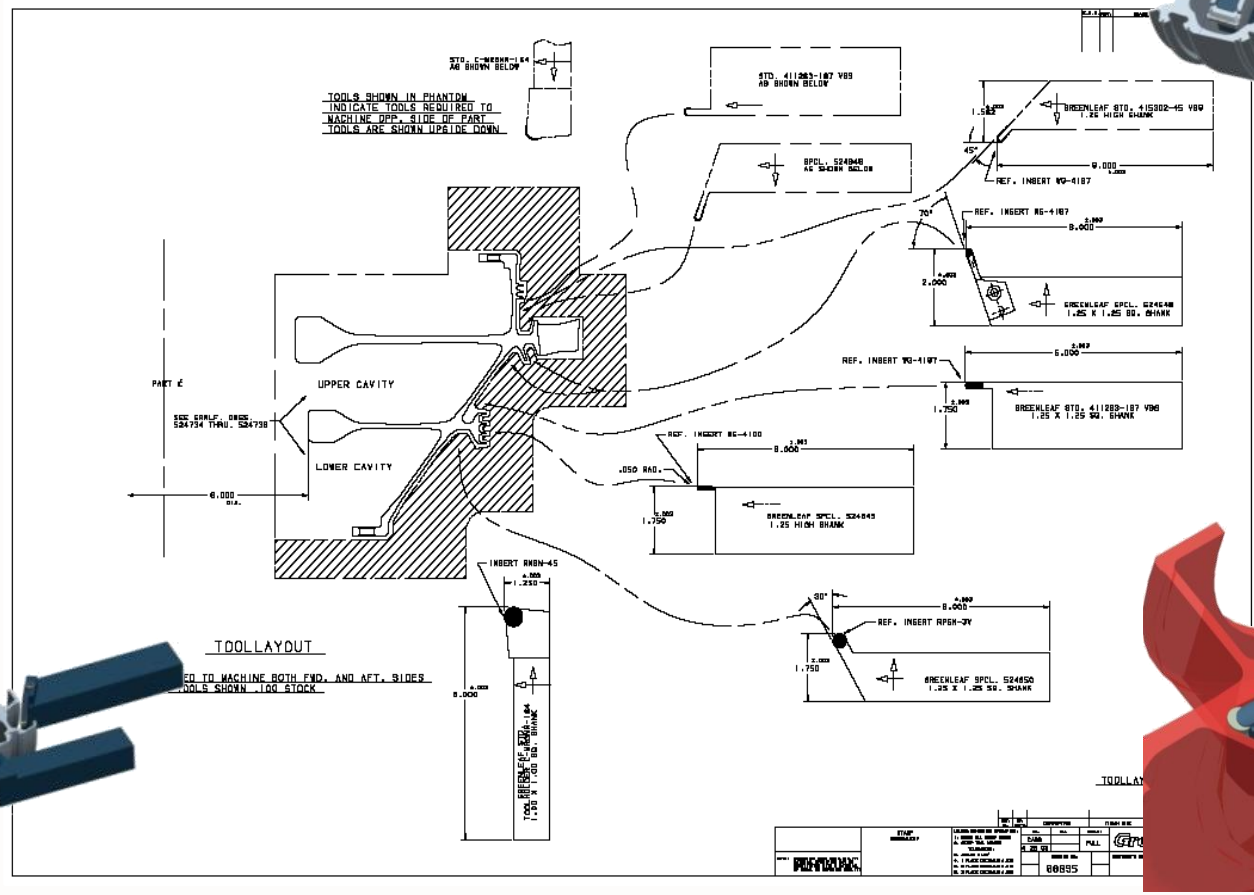
Greenleaf regularly custom designs tools to use both high- and mid-pressure coolant.

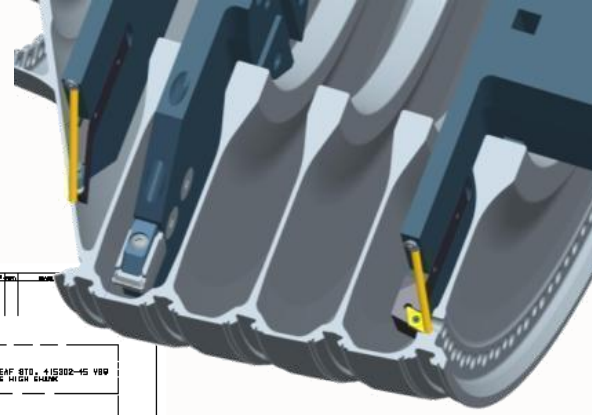
Aerospace Engineering

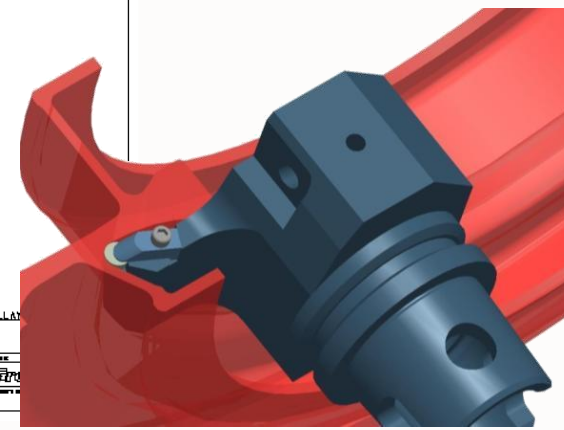












While Greenleaf has a full line of standard cutting tools, we have also custom designed and manufactured thousands of special inserts and tools for aerospace and power generation parts.

Priority Components: Compressor Section

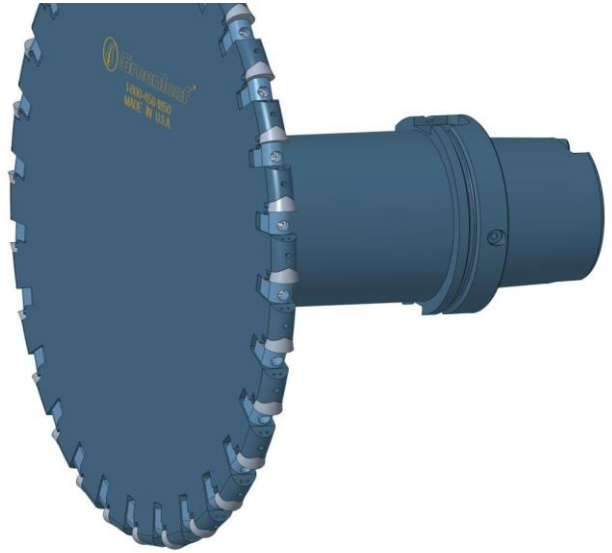
These stages are titanium blisks.

Greenleaf developed an innovative blisk mill solution for these parts.

Reduce cycle time rough milling slots in Blisks!

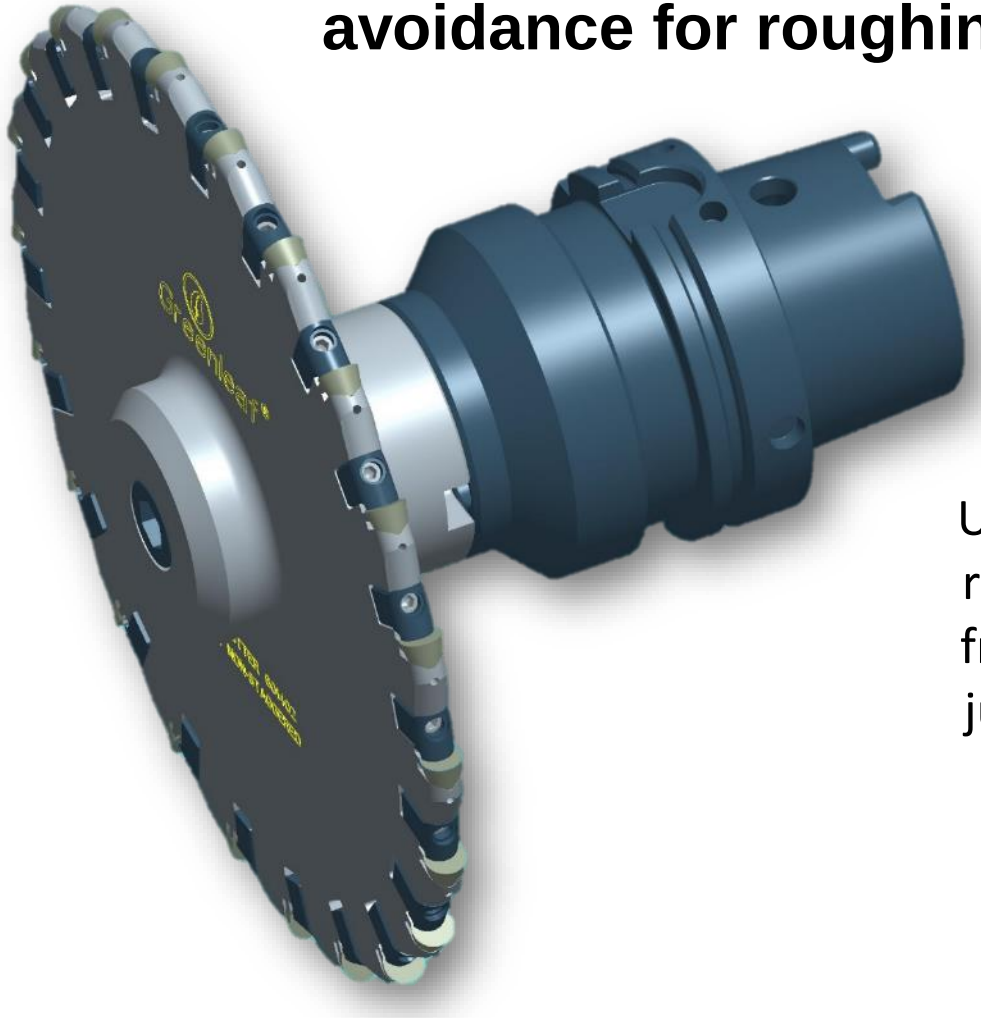
Current method for machining Blisks—Solid carbide tooling.

The new much faster method to rough mill slots in Blisks! Greenleaf custom designs and manufactures Milling Cutters and Inserts for your application.



Blisk Milling Cutters

Huge time savings and capitol equipment cost avoidance for roughing Jet Engine blisks.



Using a Greenleaf Blisk mill, roughing time was reduced from 30 minutes per slot to just 3 minutes with **G9230**!

Rough Milling Turbine Disk Slots

Greenleaf developed a cutter and inserts to rough machine dovetail slots in turbine disks and eliminate the rough pre-broach operation.

Finish broaching is still necessary.

Slotting Cutter & Inserts – *U.S. Patent Nos. 8,267,625 & 9,073,131*

Rough Milling Turbine Disk Slots

Material:
Rene 95, 48-50 HRc

Speed: 2874 SFM (876 m/min)
Feed: 53 IPM (1346 mm)
Chip Load: 0.0024 (0,06mm)

Part thickness: 1.13” (28,7mm)
Time to feed: 1.3 seconds

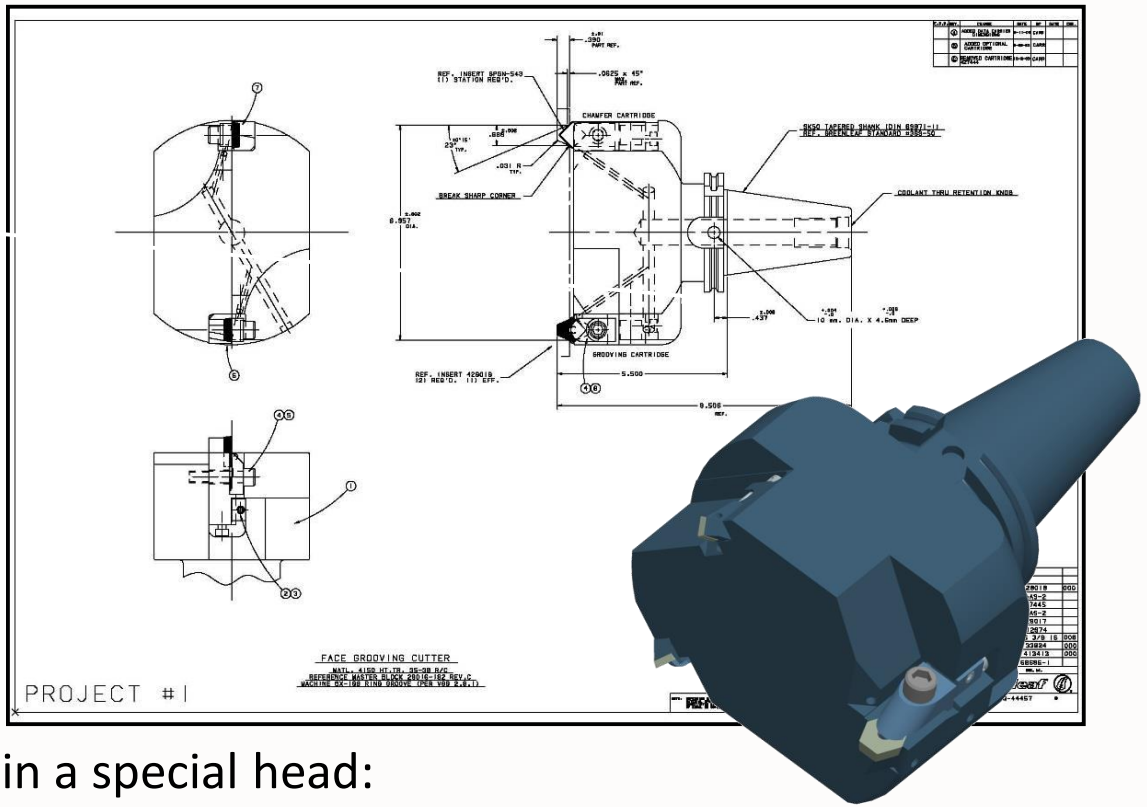
Overview of the Ring Max™ System

Two chamfer inserts

6.957” (176.71mm) cutting diameter

One grooving insert

Old method to machine groove:
Approximately 35-45 minutes
to machine BX-169 ring groove



New machining parameters using WG-300® in a special head:
Speed: 1,600 SFM (488 m/min)
Feed: 0.0012 IPR (0,03 mm/rev)

28 second cut time!

Concept sold to many companies around the world.

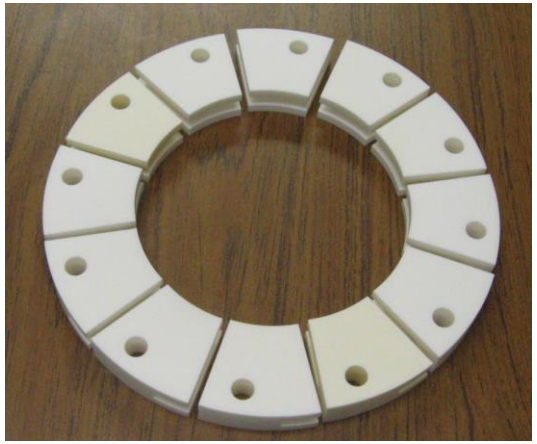
Finishes groove in 1 plunge with 1 edge!

Technical Ceramics

Technical Ceramics

- Cutting tools
- Metal forming
- Extrusion dies
- Can tooling
- Valves and seals
- Pumps
- Bearings
- Fluid flow control

- Electronics
- Microwave absorbers
- Semiconductor components
- Wear components
- Medical components
- Implants
- Battery dies
- Weld rolls



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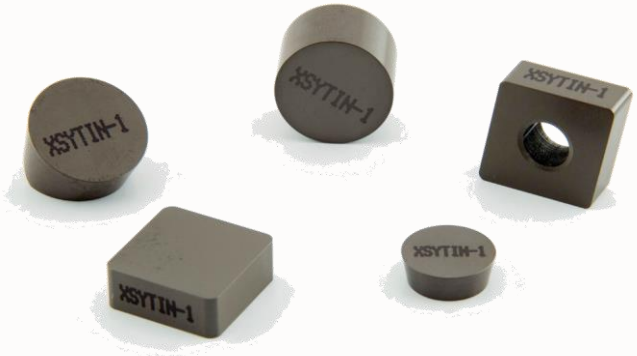

Greenleaf®
Tooling Solutions