AUTODESK. UNIVERSITY

Mastering Micromachining

Don Grandt

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About the speaker

Don Grandt, National Application Engineer

Don Grandt has over 32 years of experience in the cutting tool industry. Don started his career in the late 80s for Precision Twist Drill and eventually opened his own company that made and supplied cutting tools to the North American market.

Don has been able to hone and develop his experience in the use of cutting tools through his extensive knowledge of programming and engineering while running tools at the spindle daily. He now provides high level support to Harvey Performance customers by using his unique experiences and extensive knowledge to optimize performance and create successful machining processes.

About Us

HARVEY PERFORMANCE COMPANY

HARVEY TOOL

23,000+ Miniature and Specialty Cutting Tools

Helical

High Performance, Material-Specific End Mills

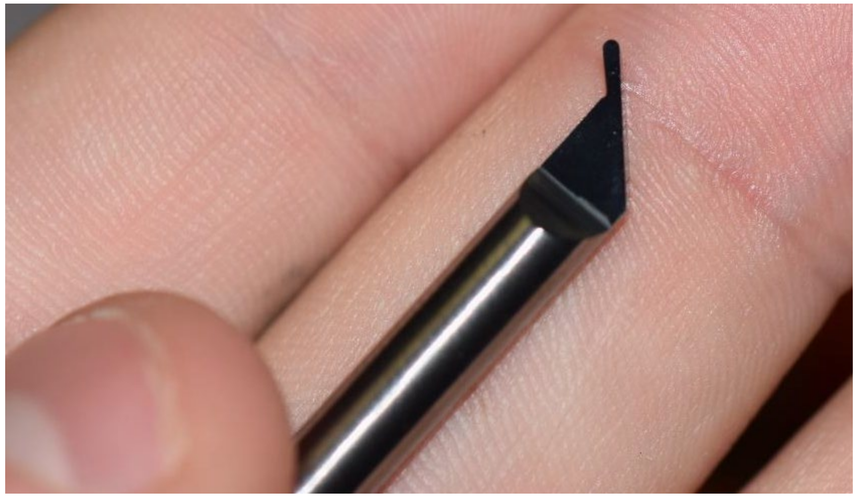
MICRO 100®

Miniature and Specialty Turning Tools

Micromachining: A Different World

When dealing with miniature cutting tools (under 1/8”), different rules apply than with larger diameter tools.

Let’s explore some of the differences in the world of micromachining.

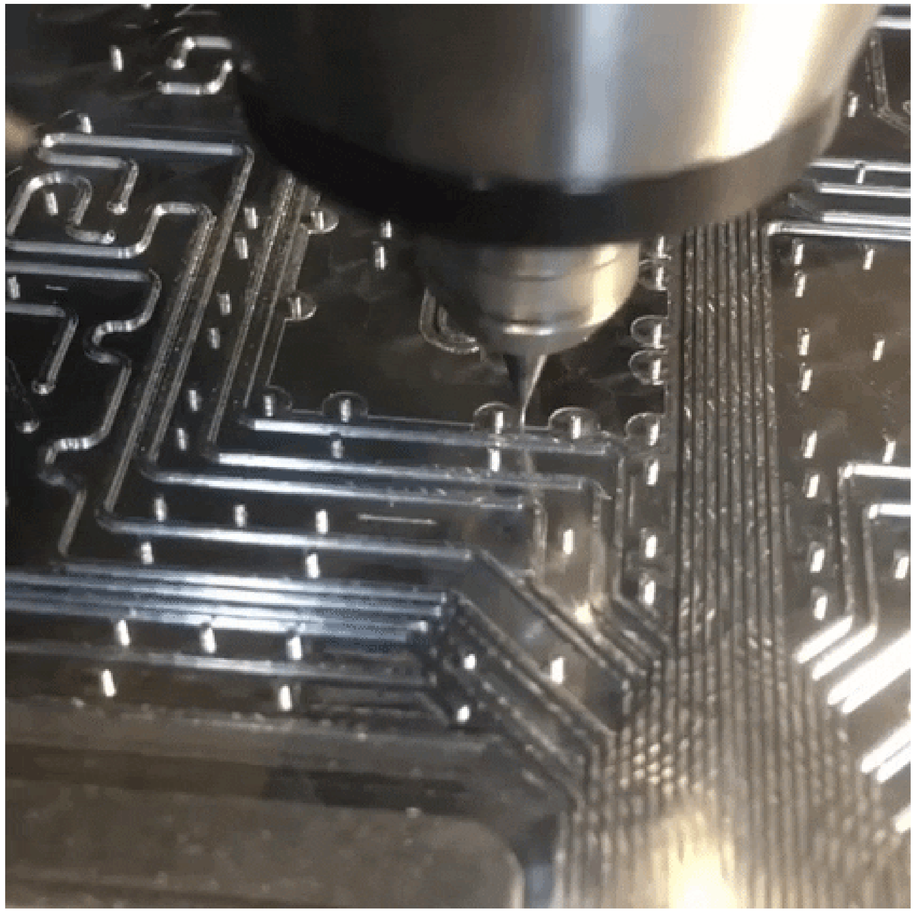


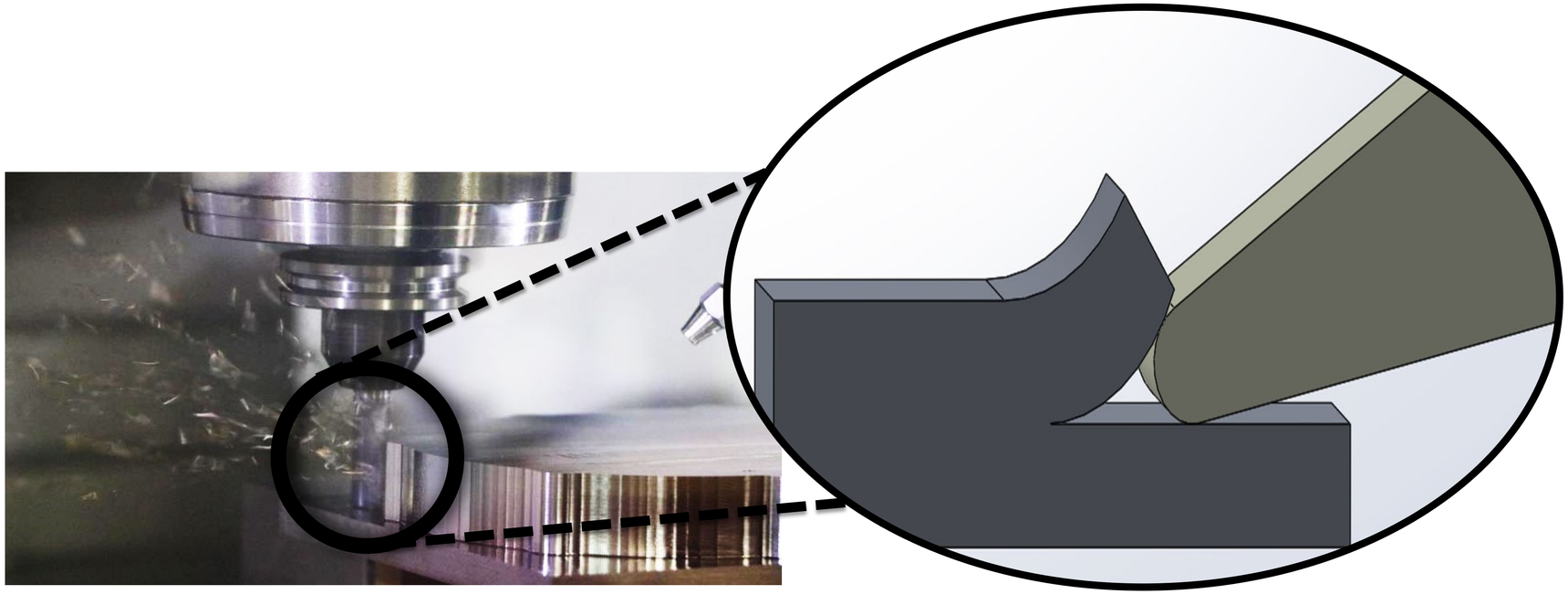
How Do We Measure Success?

Machining with miniature tools often comes down to one question: Did the tool break? If not, it is a success!

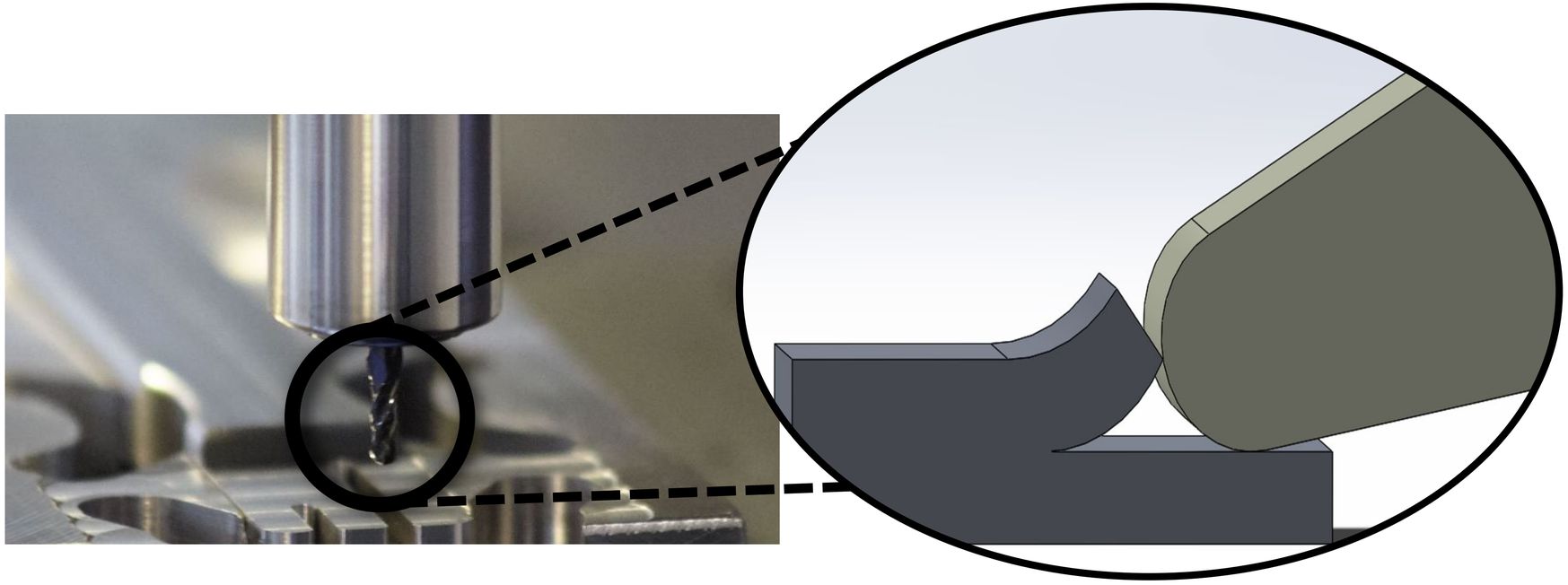
But we can do better…

We can optimize a 1/32” tool for increased MRR, better part finish, and longer tool life in the same way we optimize a 1/2” tool.



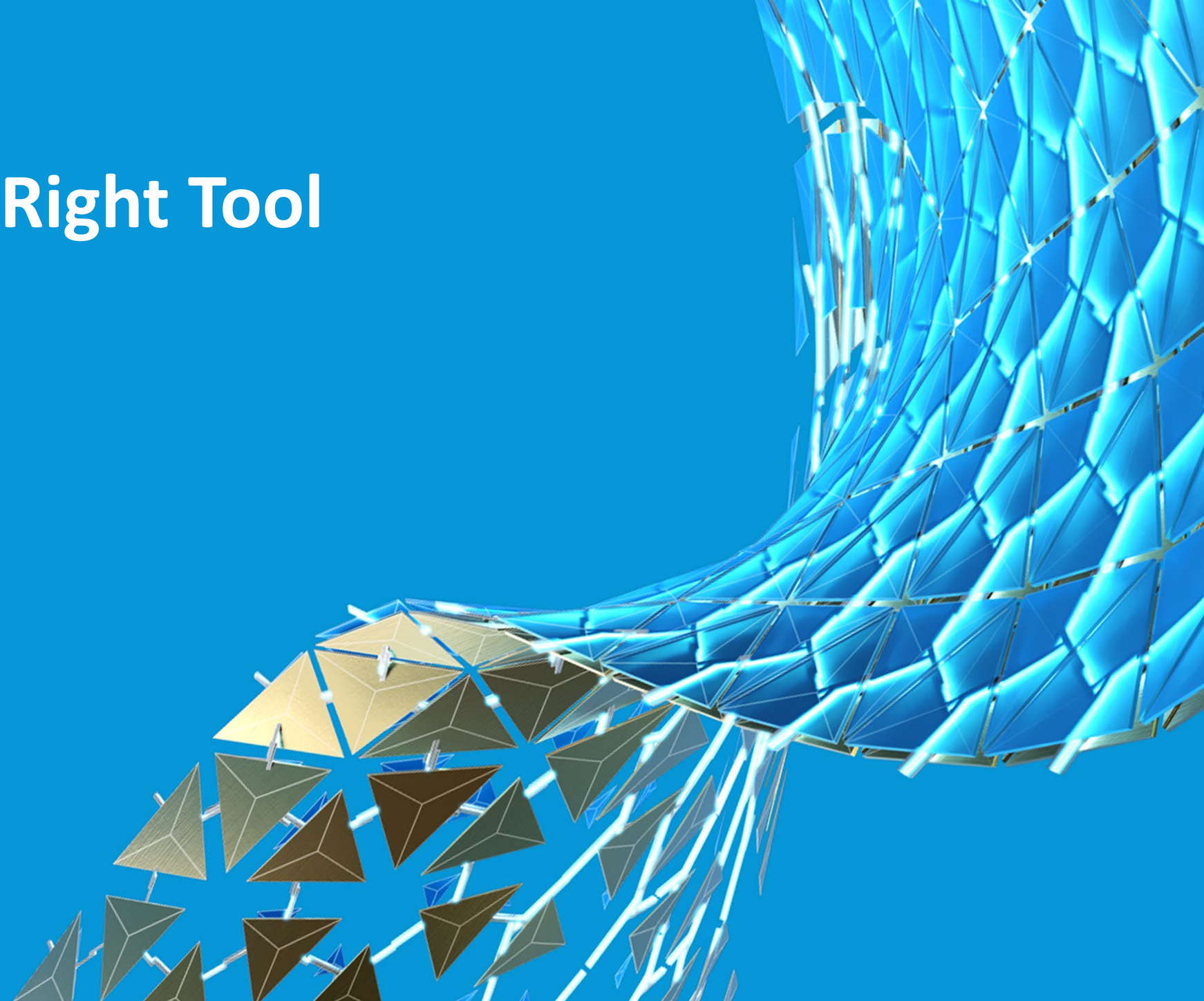


1/2” Tool
(Cutting Edge
Magnified)



.078” Tool
(Cutting Edge
Magnified)

Selecting the Right Tool

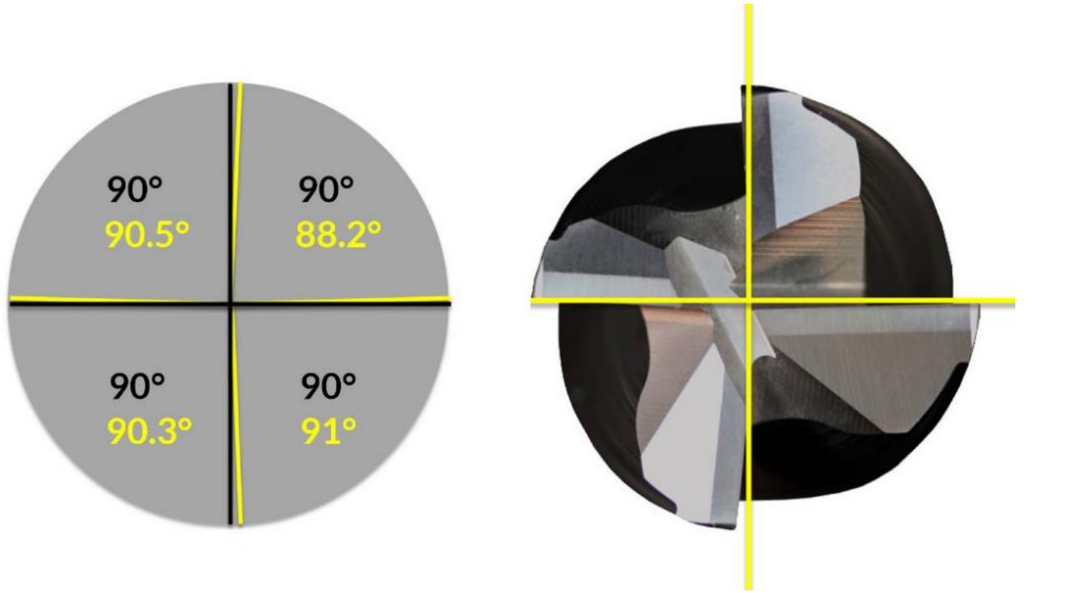


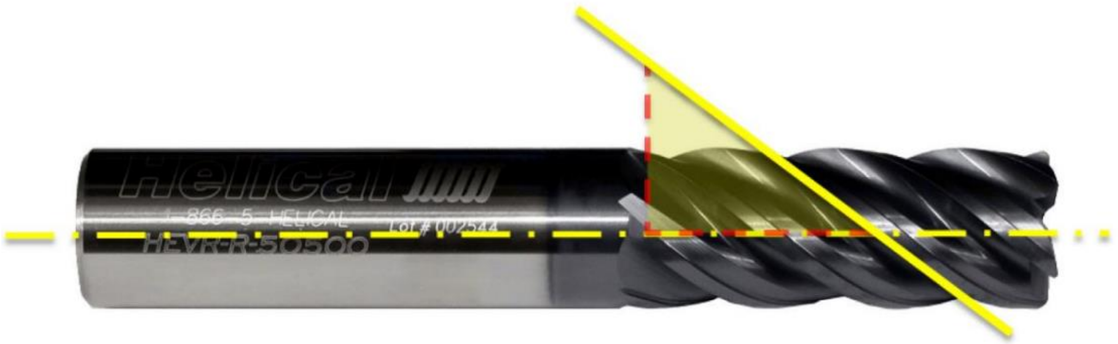
Micro Milling Geometries

When available, opt for variable helix or variable pitch end mills.

A variable helix creates irregular timing between cuts, while a variable pitch has non-constant flute spacing.

These geometries help to dampen reverberations that could otherwise lead to chatter.



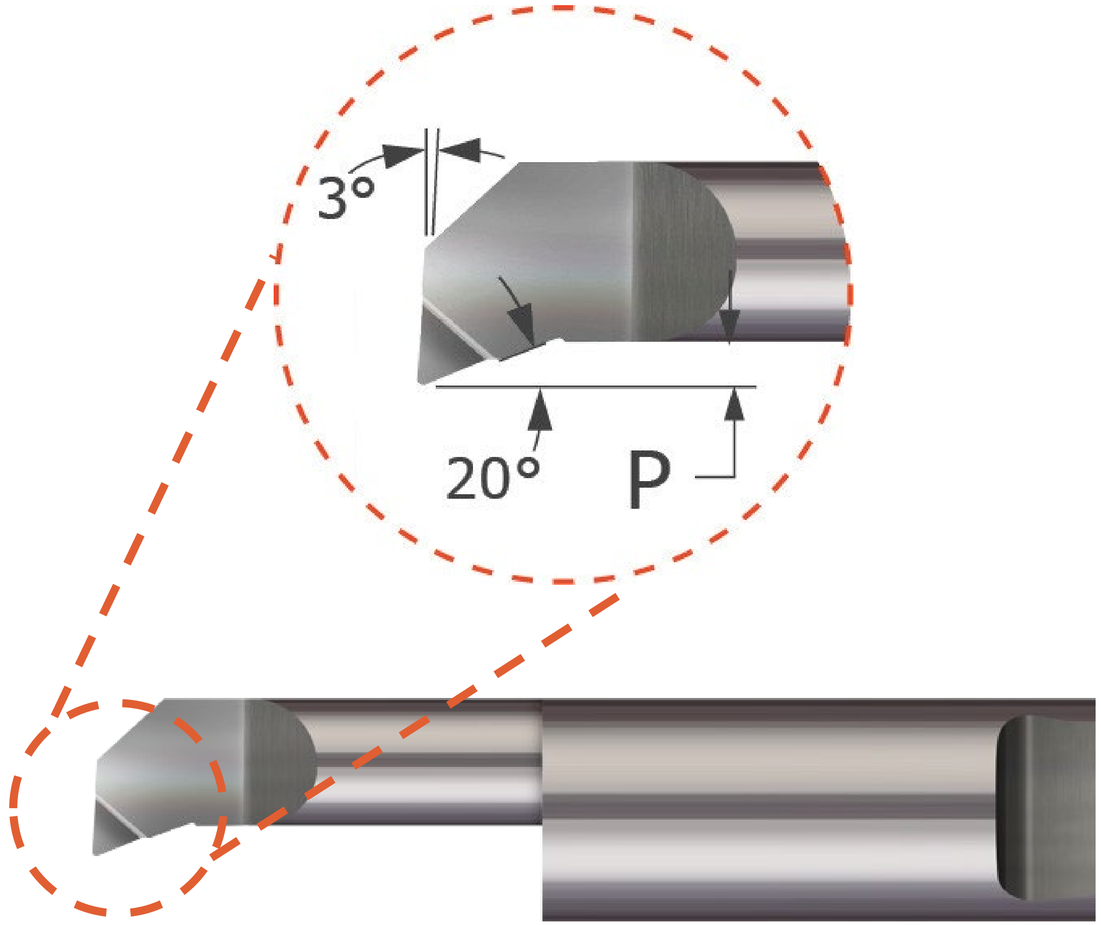


Micro Turning Geometries

Rake angle is key – too sharp a positive angle can decrease tool strength and performance.

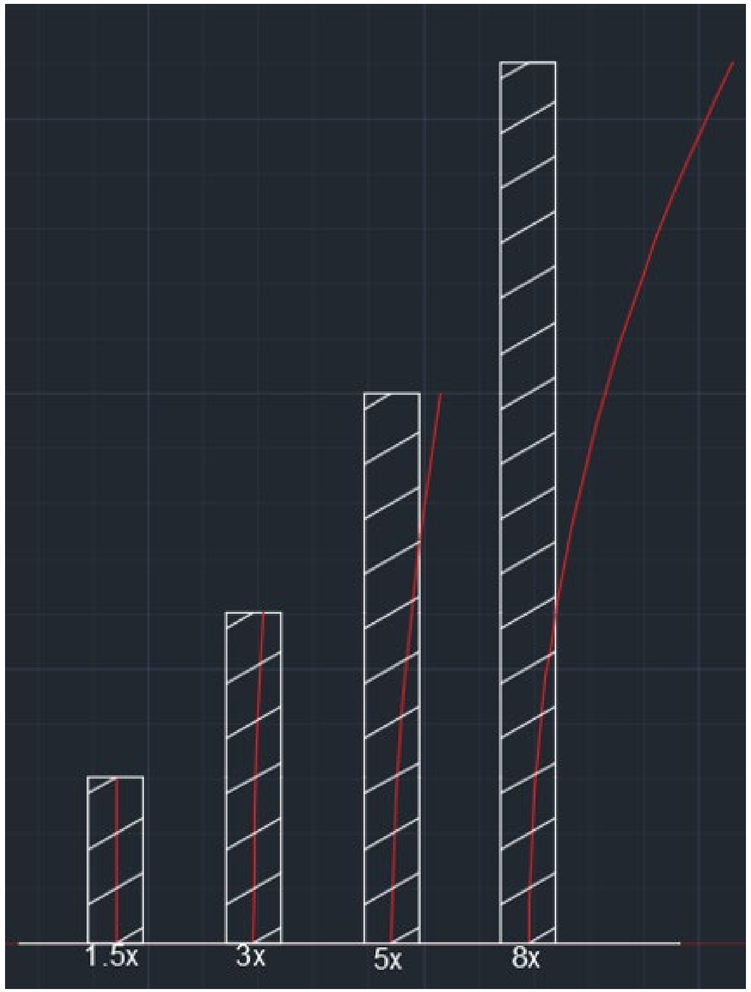
Solid carbide is preferred for strength and reliability in miniature operations.

Tools with a polished face reduce galling and improve chip evacuation – especially important for miniature tools!



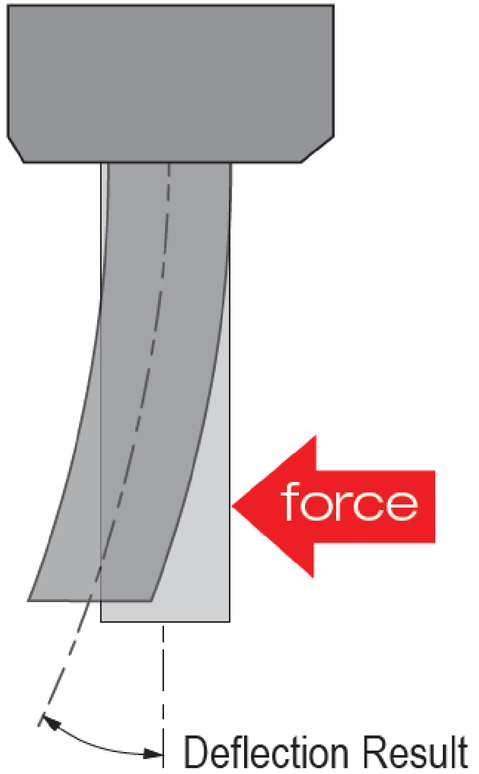
Micro 100's Top Rake Chipbreaker Boring Tool

Tool Deflection Is A Killer



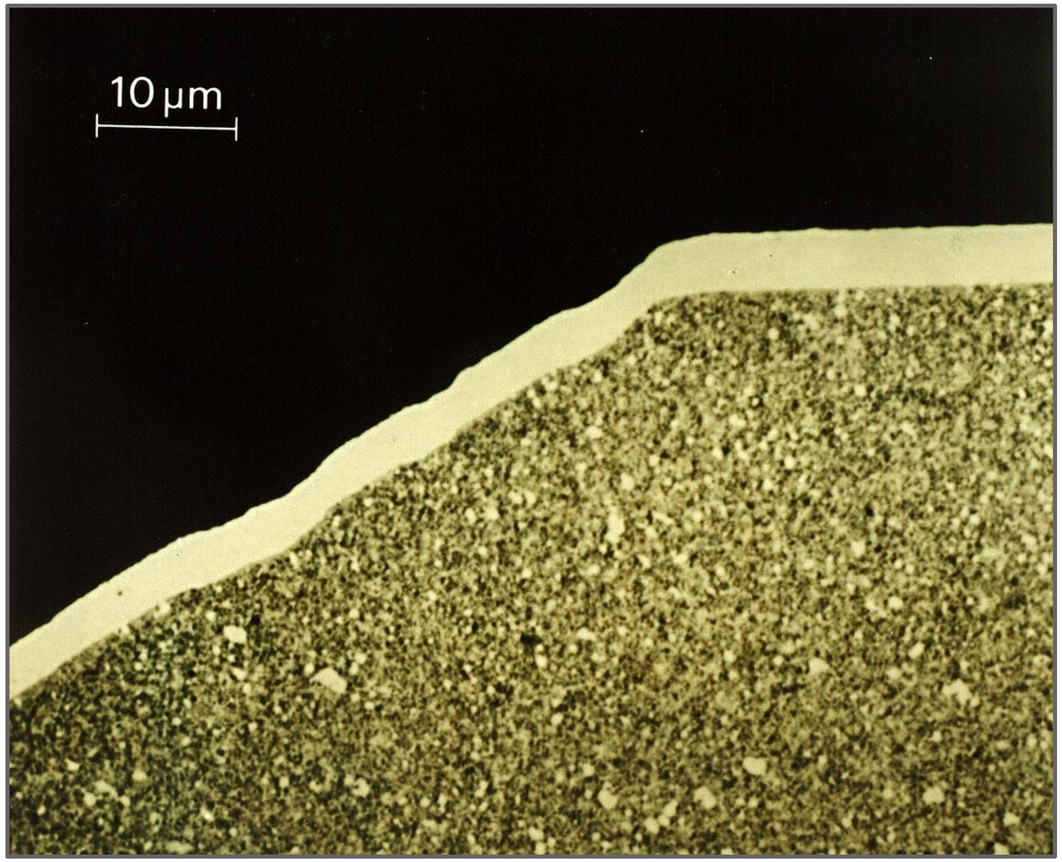
As tools get smaller, the force it takes to get the tool to deflect decreases.

- Double the diameter will result in 16 times less deflection
- Double the length will result in 8 times more deflection



Tool Coatings: Are They Worth It?

- Tool life increases 30% to 200%, depending on application
- Higher speeds are possible
  - Key for micro-machining
- Heat Resistance
- Surface Lubricity
  - Removes coarseness & irregularities on tool surface. Keeps tooling consistent.

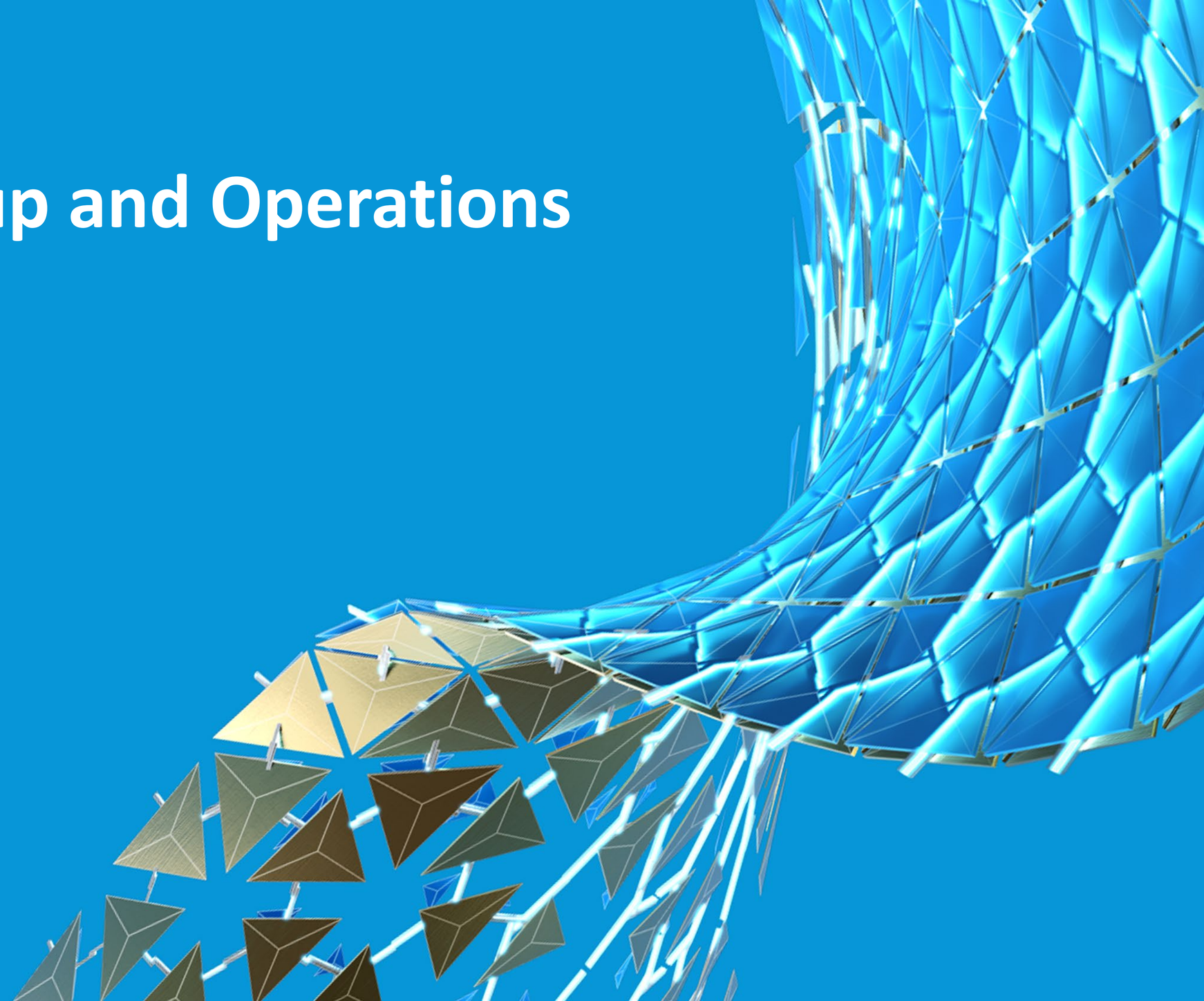


Material-Specific Tooling

Non-Ferrous Materials

Ferrous Materials

Machine Setup and Operations



Handling Micro Tooling

Handling of Micro Tooling is Critical

- As tool get smaller, they can break, chip, and fracture simply from poor handling
- Always keep tools in packaging until ready for use
- When mounting in a tool holder, make sure the tip is covered and protected

Touching Off Miniature Tools

Traditional touch-off methods risk tool breakage with miniature tools.

- Use non-contact systems for presetting miniature tools off the machine.
- Haimer, Zoller, Helicheck, Renishaw, Mituyoto, etc.
- Initial investment, but long-term cost savings avoiding tool breakage.

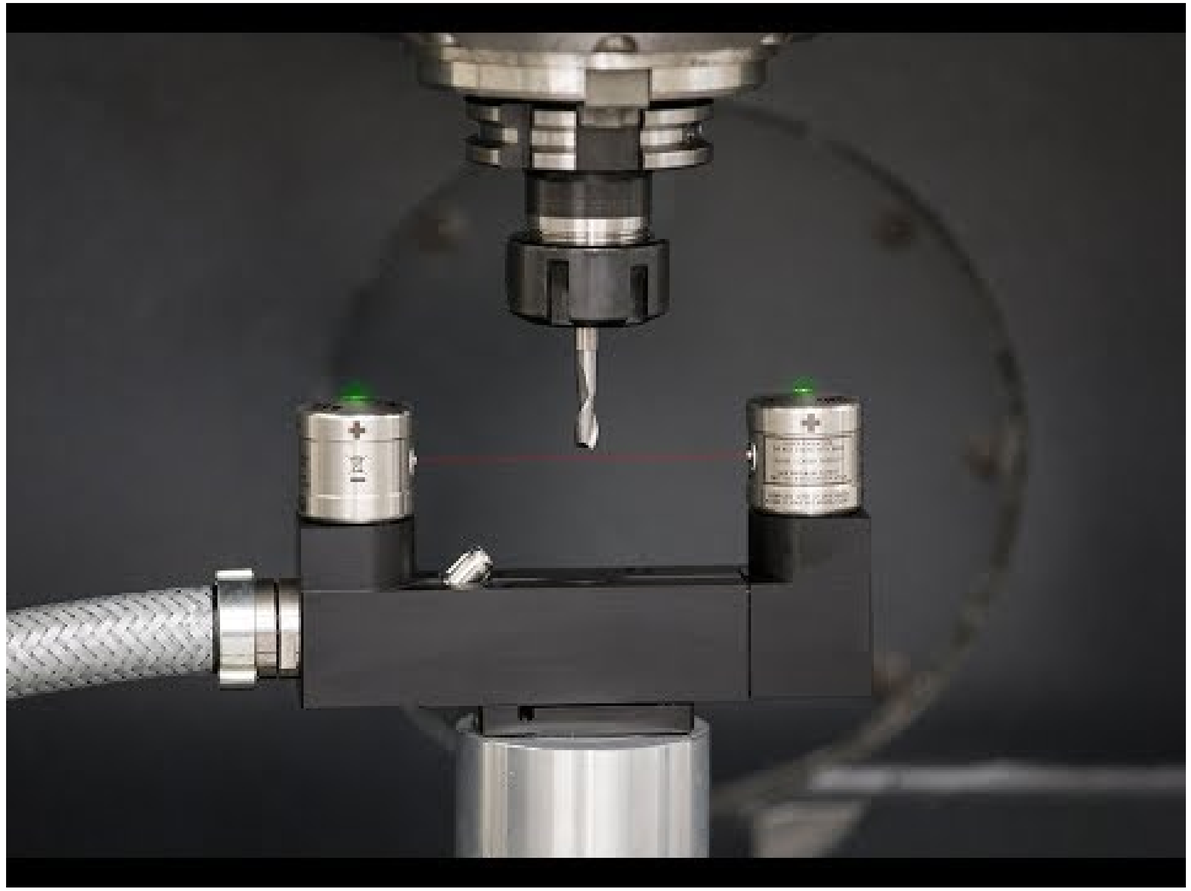


Image courtesy of Renishaw

Use High RPM When Possible

Surface foot is based off the diameter of the tool. As the tool gets smaller it wants to spin at an elevated RPM in order to control the heat at the cutting edge.

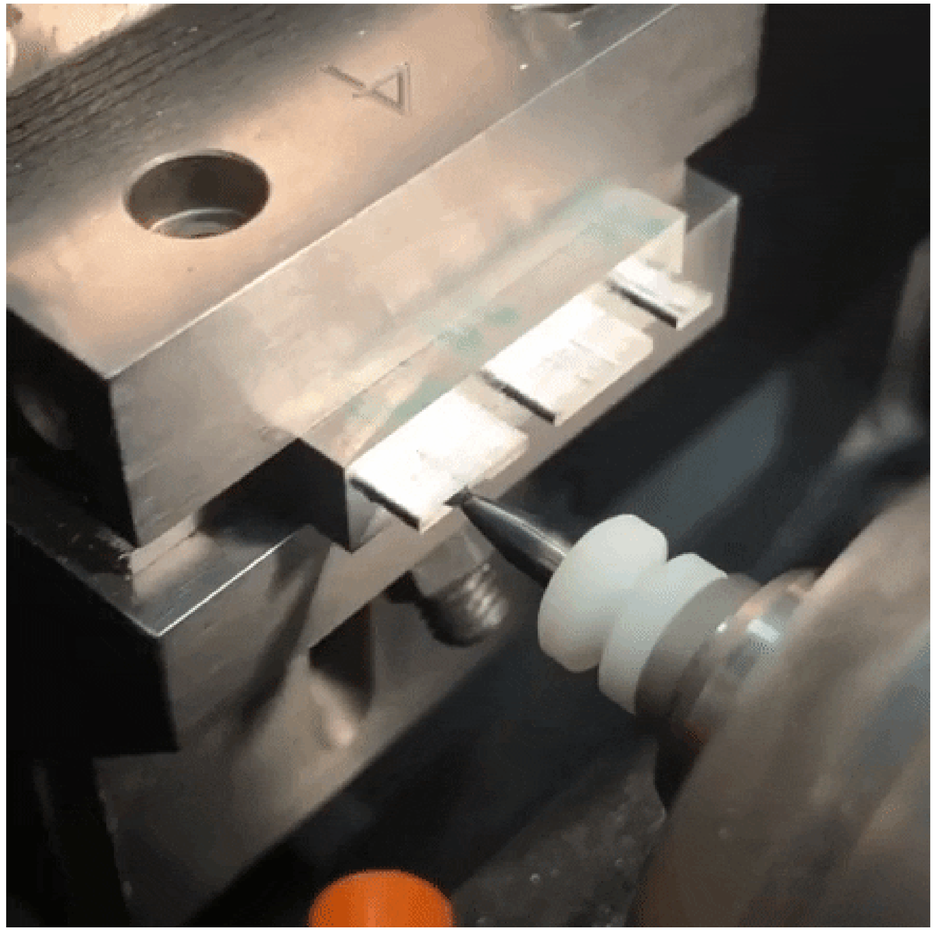
1/2 Tool or .500 Diameter

250SFM x 3.82 = 955 / .500 = 1,910 RPM

1/32 Tool or .031 Diameter

250SFM x 3.82 = 955 / .031 = 30,806 RPM

Tool life will be sacrificed if RPM or SFM is less than desired for the material group.



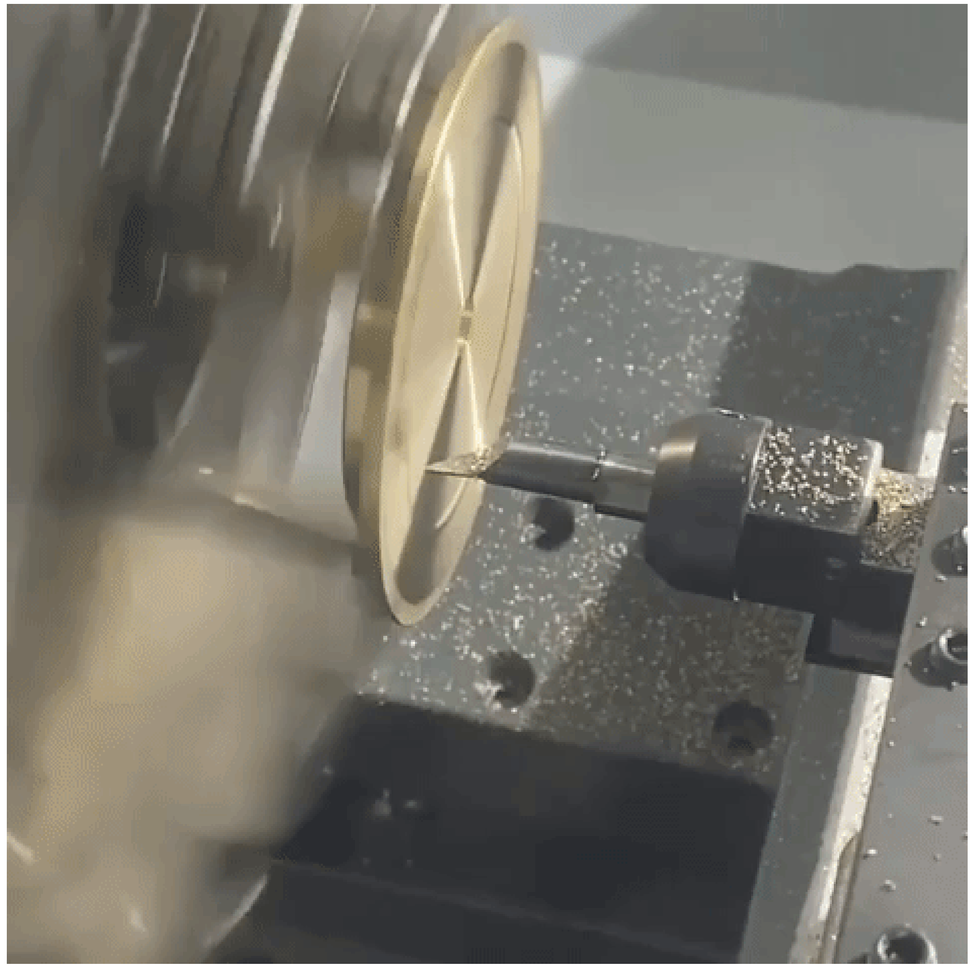
A .050” Harvey Tool end mill running at 50k RPM, 40 IPM in 50 Rc 420 Stainless Steel, using Fusion 360 adaptive toolpaths.
Video Credit: @MadsenMachine

Use High RPM When Possible

The same basic principles apply when turning parts, but calculations focus on the diameter of the stock, not the cutting tool.

As your stock size shrinks, you will need higher spindle speed to complete an effective turning operation.

Typical lathe machines will top out at ~2,000 RPM, but Swiss-style, high-speed machines that are optimized for micromachining can run upwards of 15k RPM.



Hear No Tool Wear, See No Tool Wear

**With miniature tooling, we cannot hear the tool,
and we cannot see the tool!**

With larger diameter tools, you can hear the cut change, and see the tool begin to wear.

Larger tools can still get the job done with some amount of wear. We don’t have that luxury with smaller tools.

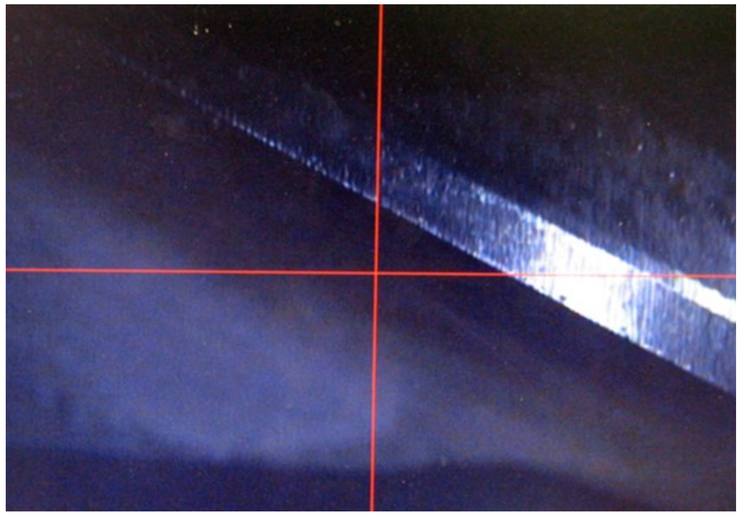
Sharp Tools = Success

Keep Your Tools Sharp!

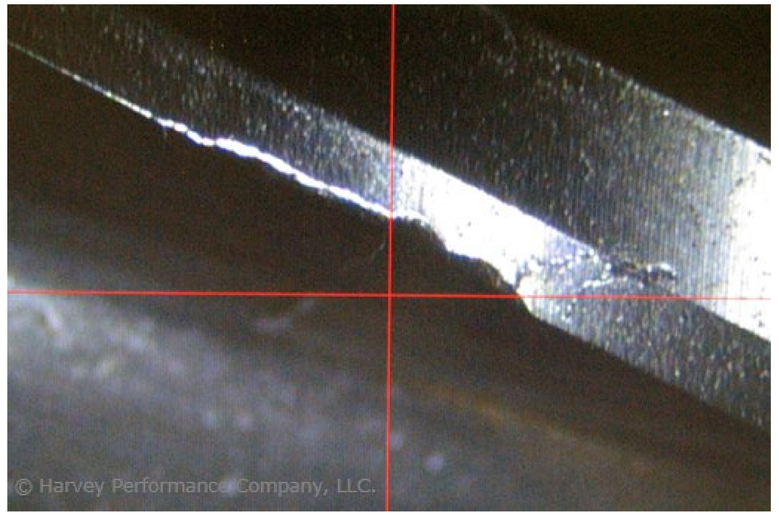
In micro-machining, something as simple as having a sharp edge can be the difference between success and failure. Always inspect your miniature tools between jobs!

This is another reason why material-optimized tools are key.

GOOD



BAD



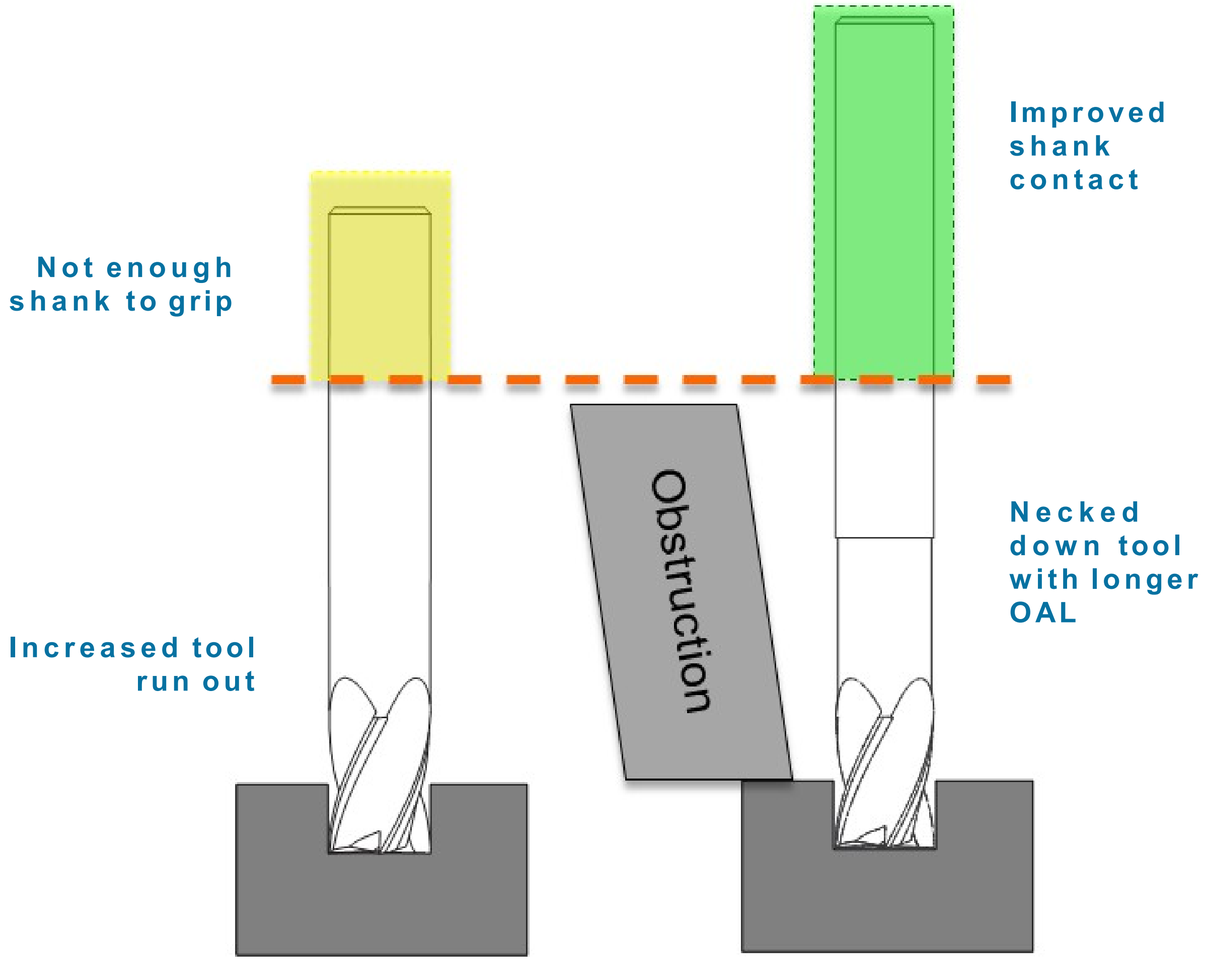
Tool Runout: A Tool Killer

Run Out

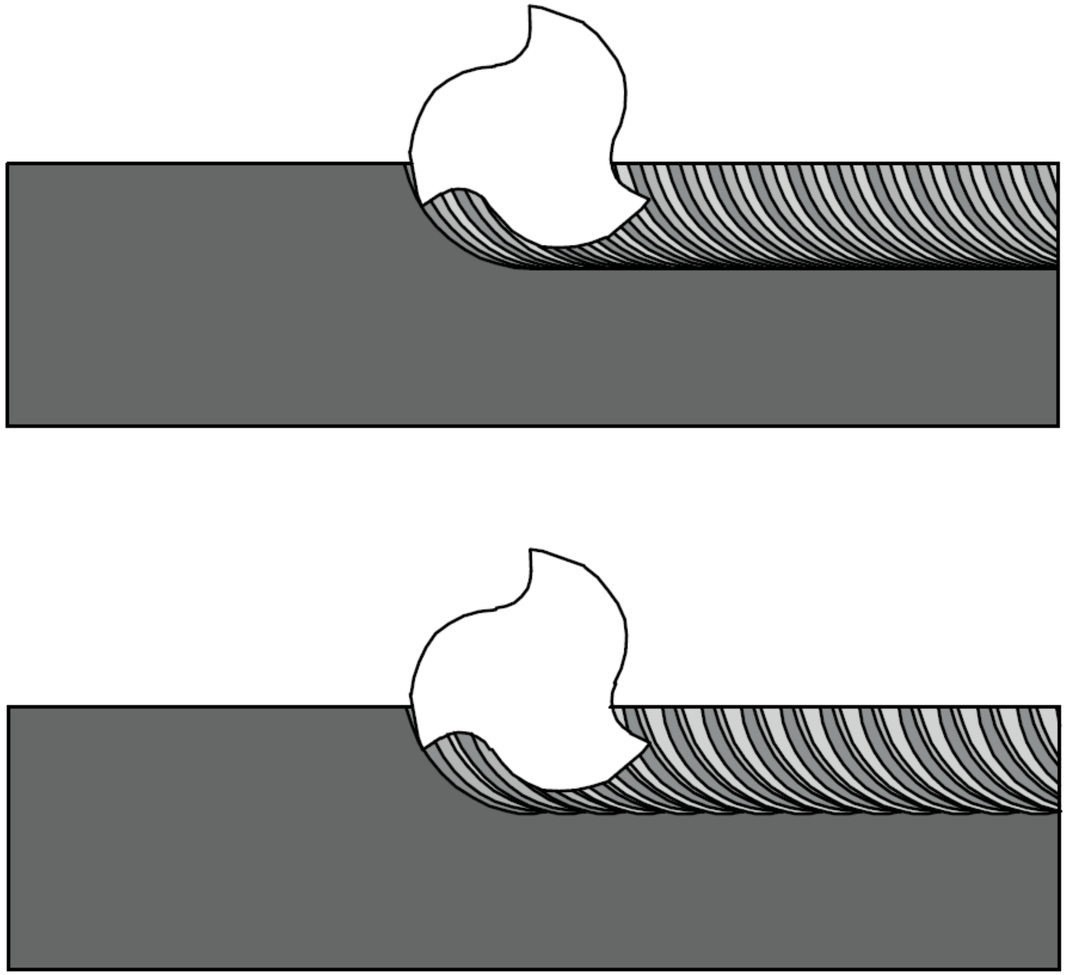
- Lowers tool life
- Decreases part finishes
- Tool life decreases 10% for every .0001 TIR

Usual Suspects

- Spindle/taper condition
- Collet
- Tool Holder (previous crash)
- Short tool shank grip



Tool Runout

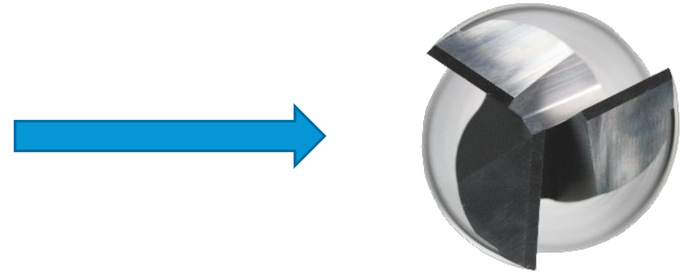


Tool Runout = Poor Surface Quality

Slotting or Making a Slot?

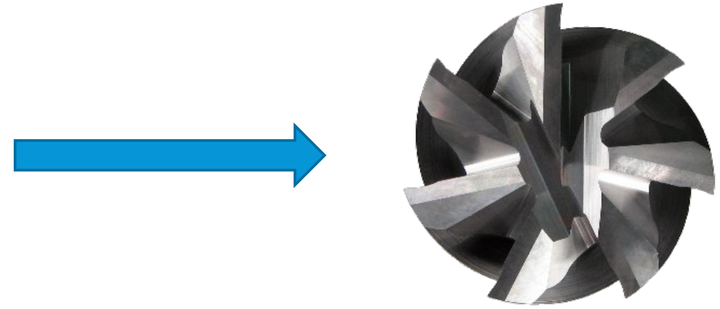
Traditional slotting is about chip evacuation and flute count

Traditional Slotting: Use the fewest flutes possible



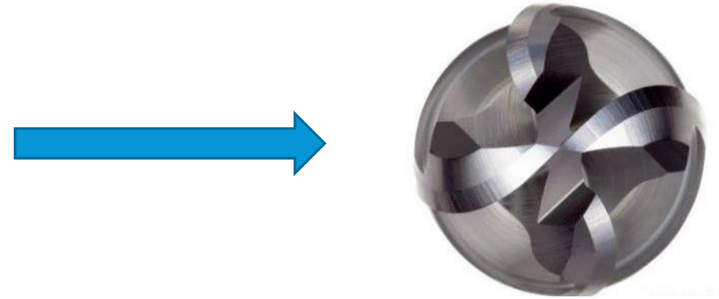
Micro slotting is about rigidity, deflection, and core strength

Put as many flutes in the cut as possible (TRUST ME)

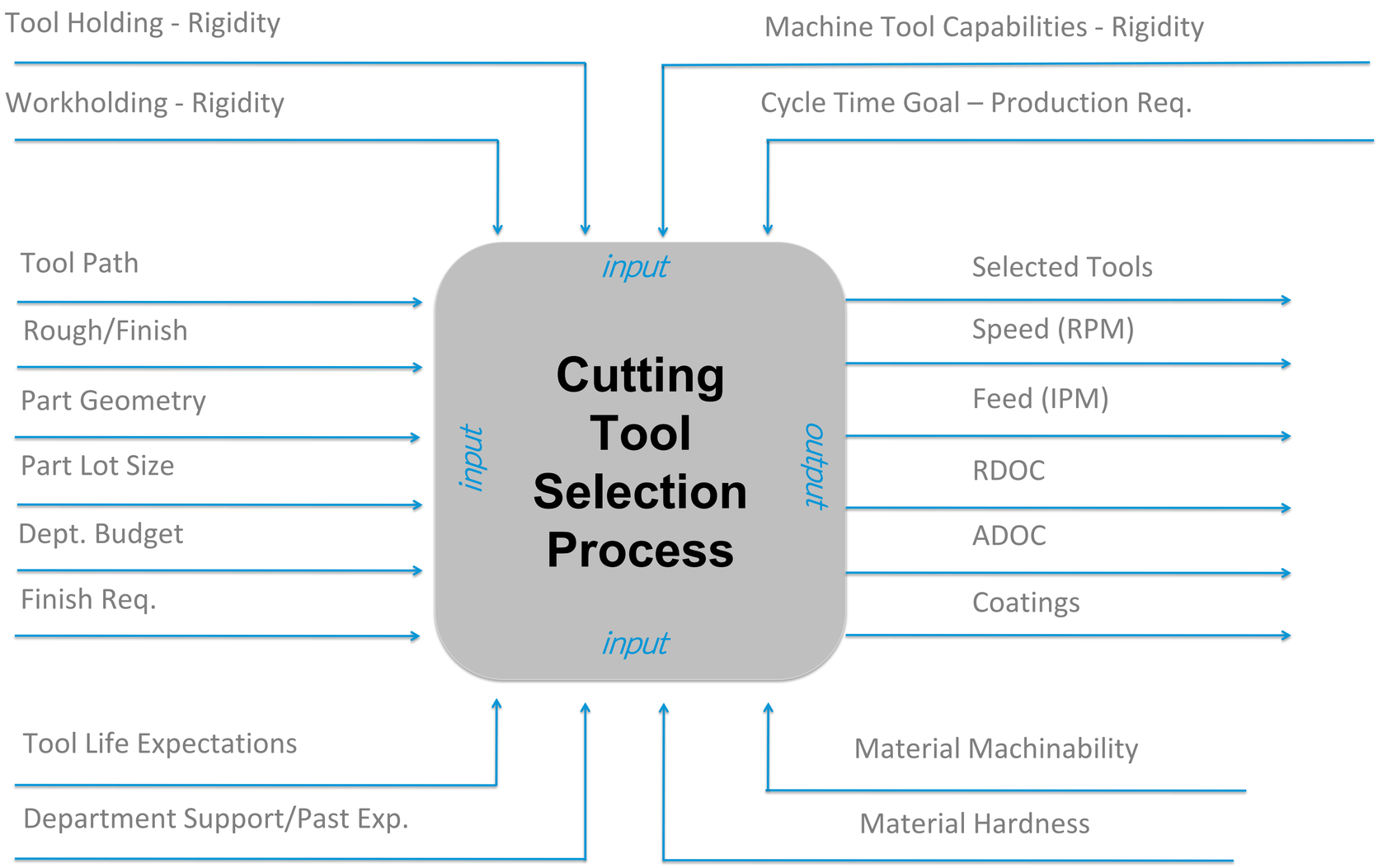


Use the **strongest corner** possible!!

Don’t be afraid to use a ball nose to rough out a micro slot.



Many Decisions To Make



Many Decisions To Make

Know your application, material, work holding, machine condition, tool holder condition, tool choices etc.

Know your surroundings, causes & affects, overall situation at hand and don’t be afraid of change, embrace it!

“Don’t waste time learning the ‘tricks of the trade’. Instead, learn the trade.”
- James Charlton

Thank you!

Please recommend this talk so others can view it!

Leave any questions or comments here and we will get back to you ASAP!