MFG466526

Mastering Micromachining

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Learning Objectives

- Discover the world of micromachining and learn how anyone with a CNC machine can enter this world.
- Learn about the major differences between micro-tooling and larger tools and how that affects programming and tool selection.
- Experience how new tool geometries can greatly improve your machining workflow and productivity in the micromachining space.
- Learn how to apply proper speeds and feeds and programming recommendations for microtooling and precision-machining applications.

Description

Micromachining is a notoriously demanding process that requires precision beyond levels that most machine shops are comfortable with. However, any shop can take on micromachining jobs with the right cutting tools, machines, accessories, and some knowledge on the differences between traditional machining and the nuances that micromachining brings with it. In this session, we will dive into strategies for successful micromachining, covering both micromilling and microturning applications. We will talk about cutting-tool selection and how it can differ from traditional machining standards, how miniature tooling reacts differently in the cut than larger tooling, and ways that you can take your machines to the next level with high-speed spindles and accessories.

Speaker(s)

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.

The World of Micromachining

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.

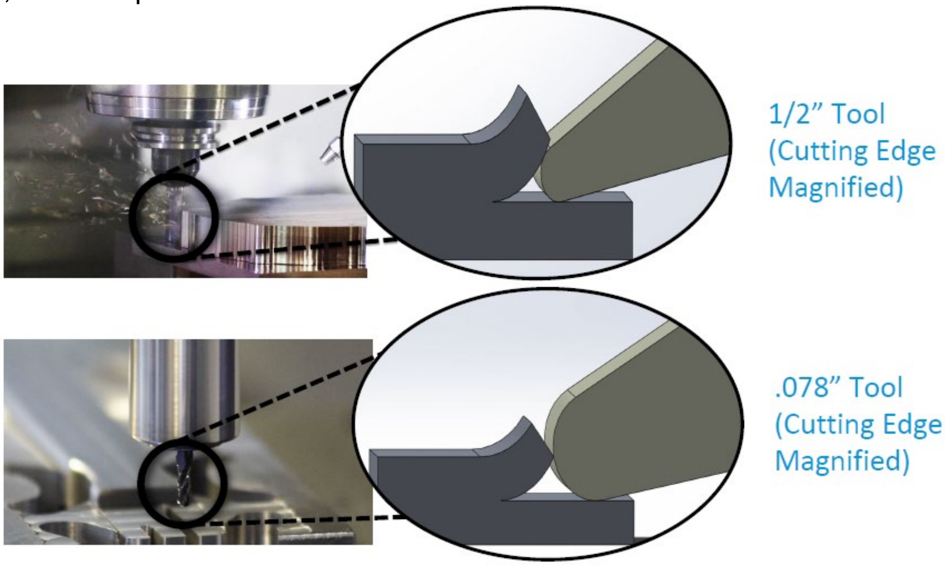
How Do We Measure Success?

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.

Magnifying the Cutting Edge

When we magnify the cutting edge on a ½" tool versus a .078" tool, we can see how the tool interacts differently with the material. On larger tools, the cutting edge can get under the material and grab the edge more easily. With smaller tools, the cutting edge cannot get under the material, and will "push" the material rather than "cut" the material.

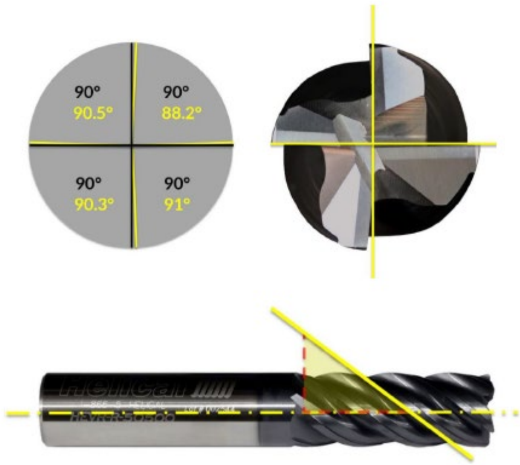


Smaller cutting edges interact with materials differently than larger cutting edges,

Selecting the Right Tool

Miniature Tool Geometries – Milling

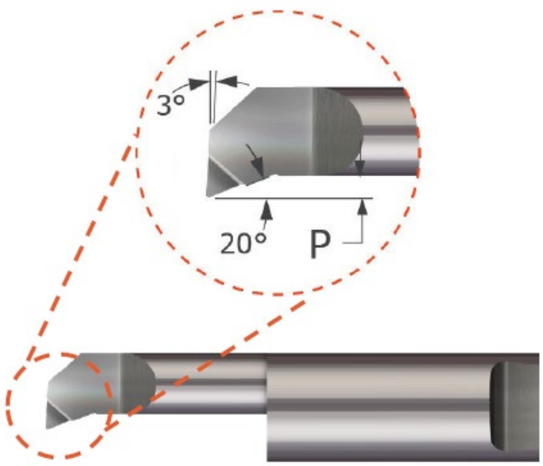
When available, opt for variable helix or variable pitch end mills. A variable helix creates irregular timing between cuts, while a variable pitch has non-constant flute spacing. These geometries help to dampen reverberations that could otherwise lead to chatter.



Variable Pitch and Varibale Helix Geometries on an End Mill

Miniature Tool Geometries – Turning

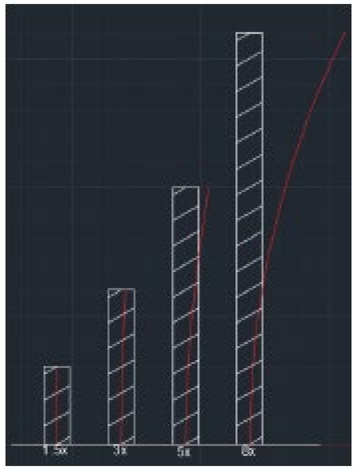
Rake angle is key to miniature turning tools. If you use too sharp a positive angle, it can decrease tool strength and performance. Solid carbide is preferred for strength and reliability in miniature operations, and tools with a polished face reduce galling and improve chip evacuation. This is especially important for miniature tools!



Rake Angle is a Key Dimension to Watch for When Selecting a Miniature Turning 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, and double the length will result in 8 times more deflection.



Selecting shorter lengths of cut when possible will decrease chances of tool deflection when milling. Excessive stickout of the part on a lathe machine will have the same effect.

Tool Coatings and Material-Specific Tooling

Tool coatings are an essential part of successful micromachining. The coatings can increase tool life anywhere from 30% to 200%, but they also allow for higher speeds due to the heat resistance and increase lubricity. This is key for micromachining, as speed is critical.

When selecting a tool, you should also opt for material-specific tooling when possible. Manufacturers like Harvey Tool and Micro 100 provide material specific tools with geometries optimized for your specific application. The performance difference is immediately noticeable when using these types of tools versus general purpose tooling.

Examples of material-specific tooling and different optimized geometries from Harvey Tool and Micro 100.

Machine Set-up and Operations

Handling and Touch-Off of Miniature Tools

As tools get smaller, they can break, chip, and fracture simply from poor handling. Always keep tools in packaging until ready for use.

Traditional touch-off methods risk tool breakage when working with miniature tools. Use non-contact systems for presetting miniature tools off the machine. There will be a initial investment, but long-term cost savings will add-up as you avoid breaking miniature tools before they even get into the operations.

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

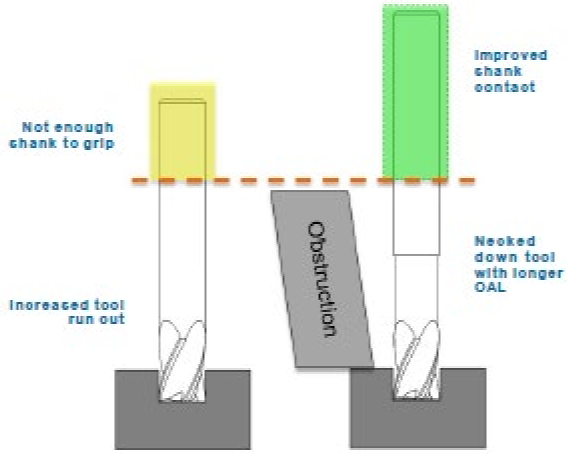
250SFM x 3.82 = 955 / .031 = 30,806 RPM

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

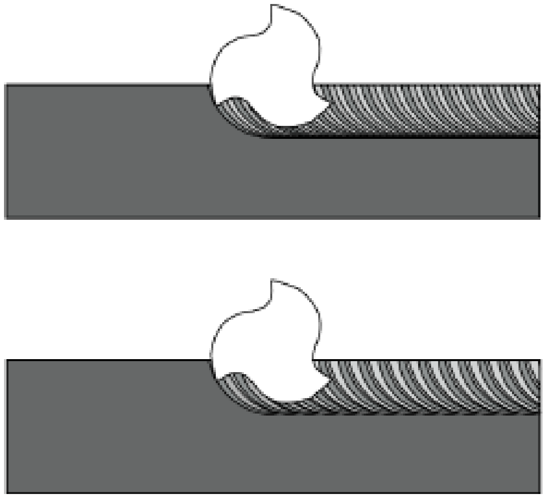
The same basic principles apply when turning parts, but calculations focus on the diameter of the stock, not the cutting tool. As your stock size shrinks, you will need higher spindle speed to complete an effective turning operation. Typical lathe machines will top out at ~2,000 RPM, but Swiss-style, high-speed machines that are optimized for micromachining can run upwards of 15k RPM.

Avoid Runout

Excessive tool/part runout is a key factor in the failure of micromachining operations. Excessive runout can cause lower tool life and poor part finishes. In fact, you will average about 10% less tool life for every .0001” of runout.



The usual suspects are the spindle condition, the collet, tool holder damage, or a short tool with not enough shank to grip. As the runout gets worse, the tool will begin to touch the material in an irregular pattern, which is what causing poor part finish. Each flute is taking a different cut, resulting in wavy finishes.



Tool Runout = Poor Surface Quality

Slotting, or Making a Slot?

When performing slotting operations with miniature milling tools, you need to adjust your thinking. Traditionally, slotting is about chip evacuation and flute count. Less flutes are ideal to evacuate the chips more easily. But that changes with miniature tooling!

Miniature slotting is all about rigidity, deflection, and core strength. You need to put as many flutes in the cut as possible to ensure you have the most rigid tool you can. You should also use the strongest corner possible, so using a ball nose end mill to create a minuature slot is not out of the question!

Many Decisions to Make

There are many decisions to make when starting a micromachining operation. You need to consider all of these factors in order to have a successful job.