



Technology

Optimize the Shop: Make the Move From 3-Axis to 5-Axis CNC Machining

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What You Need to Know

As part designs and materials grow more challenging, lead times and order quantities continue to fall with the advance of increased axes on machining centers.

The rationale for moving to a 5-axis machining strategy includes cutting down on lead times, reduced setup, less fixturing, improved quality and surface finishes-and longer tool life.

Just because you don't require 5-axis technology for simultaneous movement doesn't mean you won't benefit from 5-axis positioning, which is also known as 3+2.

Get familiar with 5-axis machine options like tool center point control, which keeps track of the tool center during complex movements and has automatic safe repositioning for easy retraction of tools buried deep within a tilted workpiece.

Whether you own a 3-axis vertical machining center or run one all day, you're probably quite happy with it. Given the right fixturing and some imagination, there's little you can't make with this technology. VMCs are less costly than comparably sized horizontal or 5-axis machining centers, and there's no need for special workholding or tombstones. Finally, there are more VMC-minded operators and setup people available than those familiar with 4- and 5-axis machine tools.

Why upset the apple cart by looking at something new? The main reason is to help ensure high production output, product quality and optimal machine and tool performance—and keep customers replenishing orders from your shop.

Maybe you heard that the shop down the street just installed a beautiful new *5-axis machine*, and you have a hunch that one of your customers has been talking to them. You may have also noticed over recent years that as part designs and materials grow more challenging, lead times and order quantities continue to fall. You may also wonder how your competition manages to stay afloat by quoting parts that inexpensively. Put it all together and the situation screams for an innovative and flexible machining solution.

We take a deeper look at how multiaxis machines are making an impact—and why it's worth investigating for manufacturers of all sizes.

Get Familiar with Multiaxis Output with a Rotary Table

Even if you have neither the time, the budget nor the inclination to rush out and buy a 5-axis machining center it doesn't mean you can't check most of the improvement boxes with a tool that takes minimal investment such as a *rotary table*.

Bolt a rotary table to your VMC table, mount a four-sided tombstone on its face, and learn how to increase your part output. Not only can you machine the tops and two sides of most workpieces in a single operation—eliminating two part handlings—but you can also produce four parts per cycle rather than the two you would get with the pair of 6-inch vises bolted to the center of so many VMCs.

Now take that a step further by investing in a tilt-rotary trunnion table and output will increase, quality will be controlled and lead times can be reduced. And if you do need full 4- or 5-axis-contouring capabilities, most machine tool builders will be happy to retrofit your VMC with the necessary hardware and control options. Granted, this setup is not as rigid or accurate as a dedicated 5-axis machining center, but it might just get you where you need to be.

The Argument for Complexity in 4-Axis and 5-Axis Machining Centers

This competitive scenario is increasingly familiar for a wide range of machine shops, but especially so for those producing—or hoping to produce— aerospace and medical parts, where complexity and difficult materials go hand in hand. Maybe it's time to trade in your traditional VMC mindset for one that offers additional axes, greater throughput and better part quality. If you are thinking about upgrading, a higher axis machine can save time and effort across a spectrum of repeatable areas that ultimately boost part production while preserving quality. Here's how

4 and 5-Axis Machines Cut Down on WIP and Lead Time

On a 3-axis machining center you often need up to six operations—one for each side of the part—to complete an orthogonal workpiece such as a hydraulic manifold or electronics housing. This means increased work in process and lead time, additional part handling, more opportunities that a part will become damaged while waiting for the next operation, and greater chances that a revision change or cancellation will occur.

4 and 5-Axis Machines Require Less Setup Time and Less Fixturing

After the initial operation on a VMC—usually performed in a machinist's vise—each subsequent machining step will require a workholding fixture of some kind. This approach is costly in several ways: There's the time spent designing and making each fixture, but there's also setup time associated with each individual operation, never mind storing and keeping track of all that tooling. Fixtures, quite simply, are costly.

Overall Part Quality Is Better

There's also part quality to consider. When parts are "done in one" there's no loss of accuracy due to tolerance stacking between operations, no variations in how one operator loads a part versus another, or opportunities that a part will be loaded incorrectly. Nor is there a need to hold tighter tolerances

than what the drawing calls for—the bore you were planning to use for positioning on the next operation, for example, can be treated like any other part feature.

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Improved Surface Finish, Longer Tool Life

Five-axis machining centers allow the part to be oriented in the most advantageous machining position. As a rule, this means cutting tool lengths can be made shorter, which in turn provides greater rigidity, longer tool life and improved surface finish. Speeds and especially feed rates can usually be increased as well, improving throughput. And because it's easier to keep the workpiece and cutter perpendicular to one another, tool life and productivity are further improved.

The bottom line? Additional machine axes mean higher profits and more opportunities for company growth. Yes, you will need to invest—there's the machine tooling to consider, as well as a **CAD/CAM upgrade**, some **new workholding**, training for the machine programmers and operators—and there may need to be some shuffling of responsibilities. At the end of the day, though, a 4-axis horizontal or 5-axis vertical center offers distinct advantages over the conventional 3-axis paradigm.

Want to more about the evolution of CNC machines? Check out "**What You Need to Know About Multiaxis CNC Machining.**"

Multiaxis Machining: Not Only for Aerospace or Medical Parts

Hold on, though: Everyone may agree that 5-axis machine tools are perfect for producing the sculpted surfaces found on turbine blades, knee replacements and mold cavities. The problem is that you may not manufacture any of that, so there's no need to invest in 5-axis simultaneous machining capabilities for the more straightforward work found in your job shop, right?

That may be true, but remember that just because you think you do not require 5-axis simultaneous movement doesn't mean you won't benefit from 5-axis positioning, also known as 3+2. Nor does it change the fact that having additional machine axes generally correlates to the benefits of less WIP, reduced part handling, shorter lead times, lower setup and fixture costs, greater tool life, and better parts—no matter what parts are being machined.

Interested? Prepare yourself. Several distinct styles of 5-axis machines exist, including trunnion style and swivel rotate configurations. Often the best way to determine which is best for your particular part mix is to insist on some test cuts. [Anchor4] You'll also want to become familiar with 5-axis machine options such as tool center point control, which as its name implies keeps track of the tool center during complex movements and has automatic safe repositioning for easy retraction of tools buried deep within a tilted workpiece. Finally, you'll want to rethink your parts processing—using a 3-axis approach on a 5-axis machine is unlikely to produce the desired results.

What has been your experience with multiaxis machining such as 4- or 5-axis centers? Share your experience.