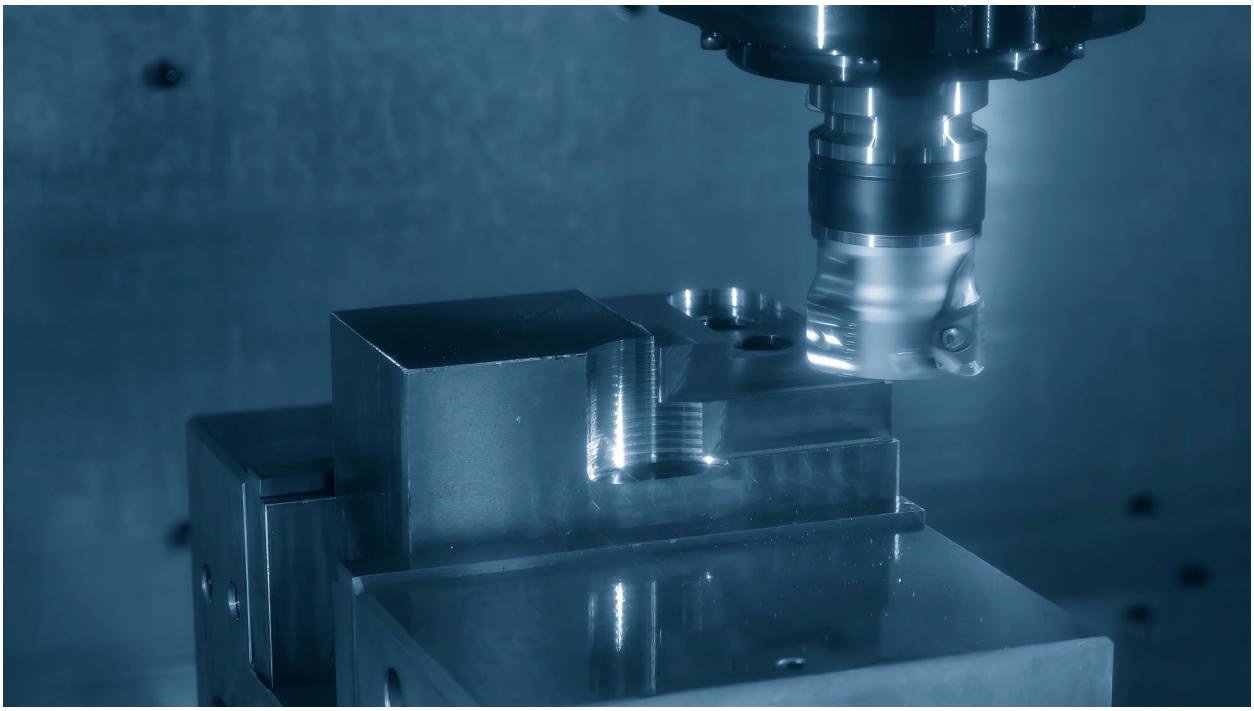
When Is Horizontal CNC Milling Better Than Vertical Milling?

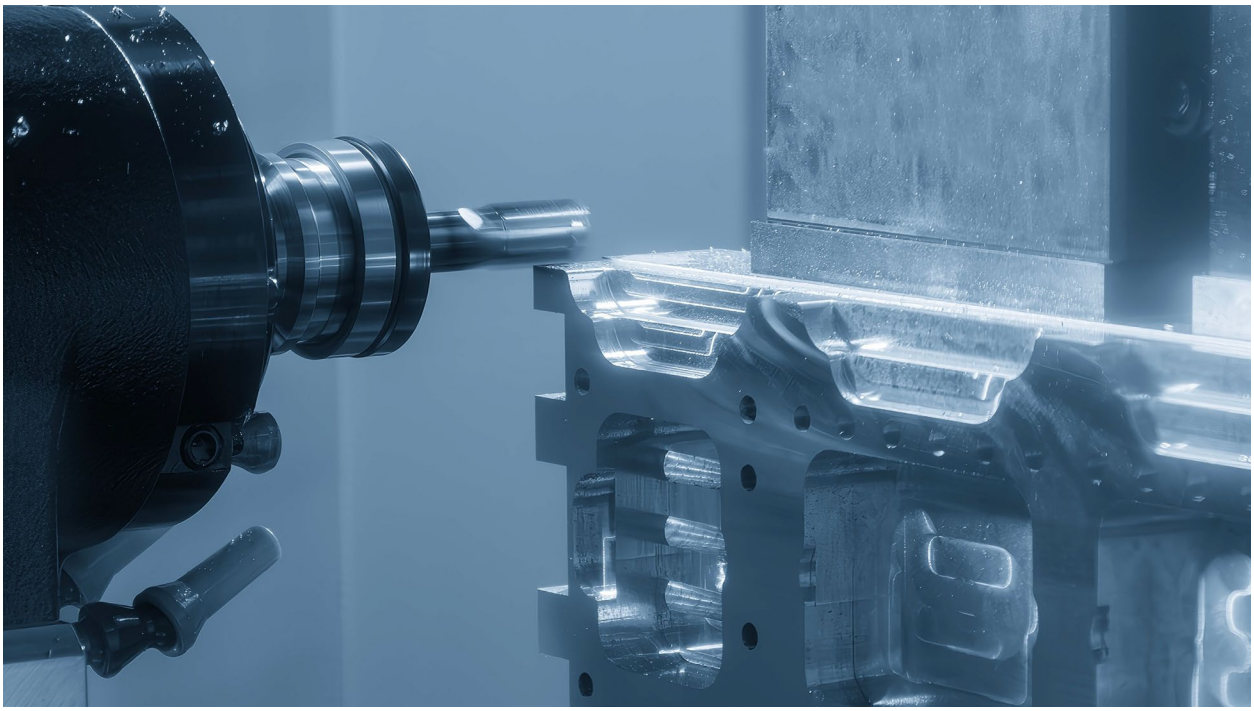
By Justin Kovscek and Gary Holcomb

Every CNC machine shop worth its salt has one or more vertical milling machines. Like its name implies, these machines have their spindles oriented in a vertical position (see photo below). Chips fly out horizontally and down. They sometimes collect on the work piece which normally is aligned perpendicular to the tool, that is to say, in a mostly horizontal position.



Some machine shops also have horizontal mills, which are the opposite of vertical mills. With these so-called horizontal machining centers (HMC), the spindle is oriented horizontally (see photo below) and the surface of the workpiece to be machined is in a vertical position.

Compass Precision, LLC
4600 Westinghouse BLVD. • Charlotte, NC 28273 • Phone 704-210-8600
www.compassprecision.com



Most customers don't care how their parts are machined as long as they are done economically, correctly, and on-time. But more sophisticated buyers do care because they understand the inherent differences between vertical versus horizontal milling. And they know that no one size fits all, meaning that the characteristics of a specific part will largely determine the optimal type of CNC machine for the job at hand.

So what are the important characteristics of a machined component that contribute greatly to whether milling should be done vertically or horizontally? Here are some of the most important considerations:

How Important Is Chip Evacuation?

By its nature, machining creates "chips", those little bitty pieces of material thrown off by the cutting tool when it engages with the work piece. With vertical milling, these chips sometimes accumulate on the surface of the work piece (remember, vertical machining means the workpiece surface aligns horizontally). If lots of chips pile up, the cutting tool may have difficulty properly finishing its job. Both surface quality and dimensional accuracy might suffer. In contrast, horizontal mills don't have this problem. Gravity is the friend of the horizonal machinist - chips normally slide right off the vertically aligned workpiece surface. Parts which have large flat surfaces or deep pockets are typically great candidates for horizontal milling because gravity takes care of chip evacuation. Parts with lots of flat surfaces that require extremely smooth finishes are even better candidates. Another positive effect of HMC's great chip evacuation is substantially improved tool life because no chips are recut. Better tool life saves costs in tooling and also leads to better quality, because now the process isn't adding another variable with changing to a new tool while machining a batch of parts.

Is Final Part Weight A Small Portion of Starting Material Weight?

Horizontal mills are constructed much differently, and have greater stability, than vertical mills. Without going into considerable minutia regarding equipment design, customers should know that horizontal machining centers almost always have more robust construction (and typically cost more). This more rigid machine structure results in considerably less cutting tool vibration while the unit is operating. This means horizontal mills can usually cut deeper and faster, removing more material in a given period of time than its vertical cousins can. The greater the percentage of starting material that gets thrown away, the more important higher rates of material removal becomes. If you have an initial-to-final part weight ratio greater than 10-to-1, milling horizontally should be something you consider. HMC's may also be a great choice for roughing operations requiring the removal of large amount of material quickly as a precursor to later ops that define final geometry and dimensions.

Are Part Tolerances Tight or Loose?

Horizontal milling may also contribute to maintaining tighter tolerances. This is another benefit of HMC's more robust construction leading to relatively less cutting tool vibration. The less the tool moves out of its perfect axis of rotation, the smaller the variability in the dimensions its cutting creates. Adding to the accuracy of the horizontal is the ability to share the axes between the table and the spindle more equally as opposed to a classic vertical mill. Typically, a vertical mill moves either the spindle or the table (usually only the spindle moves). But horizontal machines usually keep this equally distributed. Again, without delving into machinery design details, the more movement is equalized between the spindle and the table, the more accurate the machine.

How Important Is It To Achieve High Quality Surface Finishes?

Good-to-excellent shops know how to create high quality surfaces finishes using a variety of milling and turning machines. To a certain extent, the challenge is knowing how to program the machine, fixture the part, and select correct cutting tools. But everything else being equal, it is usually easier to machine very smooth, flat, and uniform surfaces using horizontal mills. As with obtaining high rates of material removal and/or maintaining high tolerances, having a very firmly constructed mill of a robust design (so to minimize all vibration including that of the cutting tool) just makes getting those high quality surfaces easier.

Will Final Part Weight Exceed 50 Pounds?

Generally speaking, heavier parts are usually easier to machine on a horizontal mills than vertical ones. Many vertical mills, even ones with a relatively large machining envelope, simply struggle to support the mass of parts whose final weight is measured in hundreds of pounds. Although a 50-pound final part weight is a somewhat arbitrary criterion,

customers should be more mindful of horizontal milling possibilities for parts that exceed this weight.

Do Final Part Dimensions Place It Outside a 36”x36”x30” Envelope?

Again, generally speaking, most of today’s vertical mills are quite adept at handling parts whose dimensions fall within a 36”x36”x30” envelope. The nature of typical vertical mill construction largely defines this parameter. So in the absence of any part characteristic previously mentioned, buyers are usually safe at sticking with vendors having vertical machining centers (VMC). But for larger parts outside this envelope, vendors with HMC’s may be a better choice.

Does The Part Have Deep Cavities?

Machining deep cavities with VMC’s can be a recipe for disaster. In additional to the usual complexity of milling this sort of challenging geometry, the inability to get rid of accumulated chips at the bottom of cavities when milling vertically can make holding tolerances and maintaining good surface quality nearly impossible.

How Important Is Versatility?

HMC’s can do things that are more difficult or impossible with a VMC. Almost all horizontals come standard with a B axis indexer, but we would recommend paying the little bit extra to get a full B axis. With this feature, a shop can set up a machine for contouring operations and use a fixture with as many sides as possible to increase part density, increase uptime, and enhance efficiency. Batch processing can be avoided by setting up multiple different operations for a particular part in order to get a completely finished part off every time. We have personally used an 8-sided tombstone on a pallet, that held two different part types, with two different operations allowing the machine to run for more than 8 hours unattended.

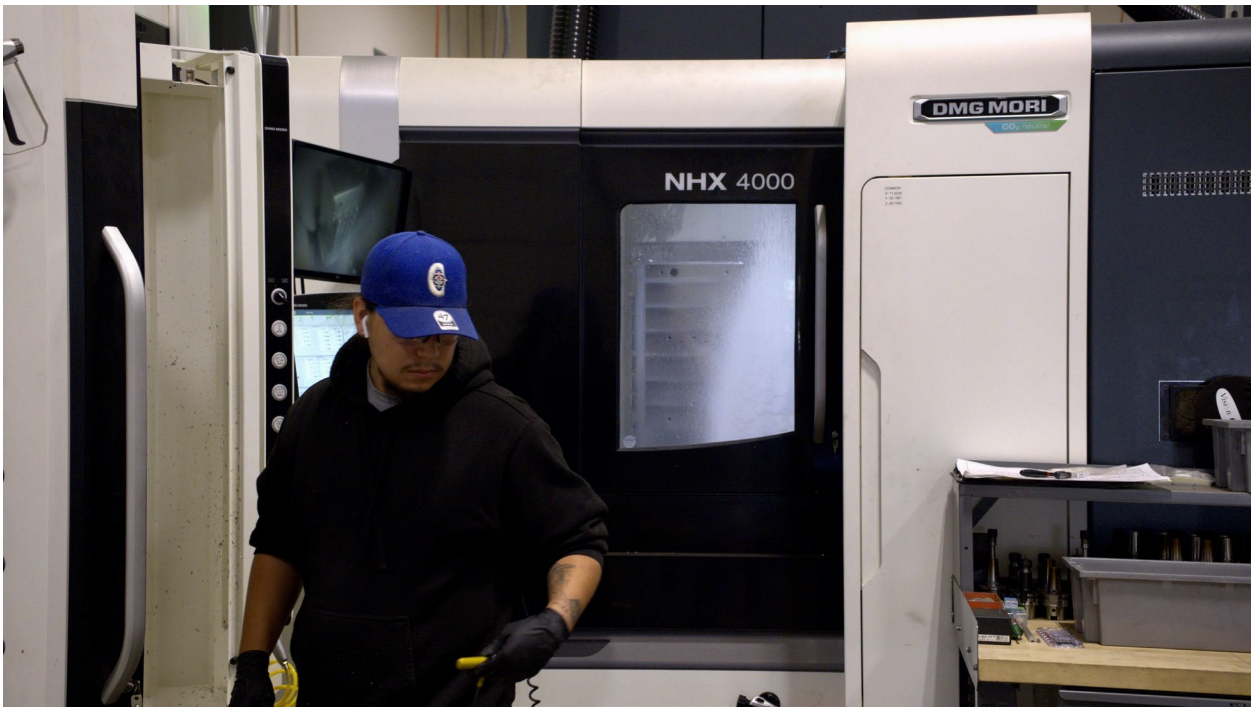
Want To Do Set-Ups While Machine Is Running?

Many horizontal mills will come standard with an automatic pallet changer, which allows the machinist to work outside the machining area, while the machine is processing another set of parts on another pallet. At the end of the day, that next pallet is ready to go in the machine. No operator intervention is required, the hallmark of true lights out machining. There is also an ability to add small cells of pallets, with multiple different workpieces which can be processed simultaneously unattended.

Do You Need More Than 100,000 Pieces Per Year?

Very high-volume machining, i.e., a low mix, high unit volume production orientation, isn’t what Compass aspires to, so customers like these probably aren’t talking to us anyway. But these customers should be exploring HMC alternatives to improve both costs and quality.

Compass has a wide array of 3, 4, and 5-axis vertical machining centers as well as numerous horizontal machining centers, all with available capacity. And we have invested in new machines of all varieties in the past five years. In fact, our largest investment in a single machine occurred in early 2023 when we purchased a DMG Mori NHX 4000 horizontal machining center at Strom Manufacturing in North Plains, OR (see photo below). This machine has 12 pallets and a sophisticated linear pallet conveying system. Our investment in this HMC totaled well in excess of $1 million.



When a customer comes to us with a new part and asks for a quote, we analyze all aspects of the design and requirement before presenting our quote based on running the job on the most optimal equipment.

About The Authors

Justin Kovscek

Justin joined R&D Machine as its Vice President & General Manager a few days after Compass acquired the company in April 2022. During the prior three years, he served as Plant Manager at Nemak's Sylacauga, AL works, a major machining vendor to the auto industry. Justin got his start in CNC machining at FPD Company, a precision machining and forging firm in McMurray, PA serving the implantable medical device and aerospace industries. While employed for nearly twenty years at FPD, he rose through the ranks from machinist to operations manager. Justin graduated from the PennWest University with a Bachelor of Science degree and completed Fayette Area Career Technical Institute's program in Machine Technology.

Gary Holcomb

Gary led the formation of Compass Precision in 2019 and serves as CEO. He was previously CEO of Coining, a Montvale, NJ-based precision stamping company whose revenue grew from $13 million to $65 million over seven years under his leadership. Earlier in his career, Gary was General Manager of Dynamet's Forged Products Division in McMurray, PA which later became FPD Company where Justin worked (their tenures did not overlap, but both were heavily exposed to vertical and horizontal machining there). After Dynamet, Gary served as CEO of Pittsburgh-based Dawar Technologies. He also worked in management roles at Air Products & Chemicals and Fisher Scientific plus an engineering position at Emerson Electric. Gary has a Bachelor of Science degree in Mechanical Engineering from Cornell University and an MBA from Harvard Business School.