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## OEM Moves From Five-Axis to Three-Axis for Improved Rigidity

After experiencing rigidity issues with a five-axis machine, Barbco moved its large parts to a three-axis bridge mill. So far, it has proved more reliable.



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Two years after [Barbco](#) — a manufacturer of trenchless boring equipment — bought a [five-axis](#) mill to machine its [monolithic parts from a single block](#), its machine shop has mostly reversed course. It is in the process of selling its five-axis machine, and instead relies on a double-column [Johnford](#) DMC-4100PH three-axis mill. Many of its one-piece constructions are weldments once again, and the shop has even needed to learn G-code after using conversational programming for most of its life.

Yet production is proceeding smoother than ever, according to Production Manager Matthew Wolf and Lead Programmer and Foreman Andrew Liston. Wolf is particularly cheerful about the change, saying, “There is life after five-axis.”

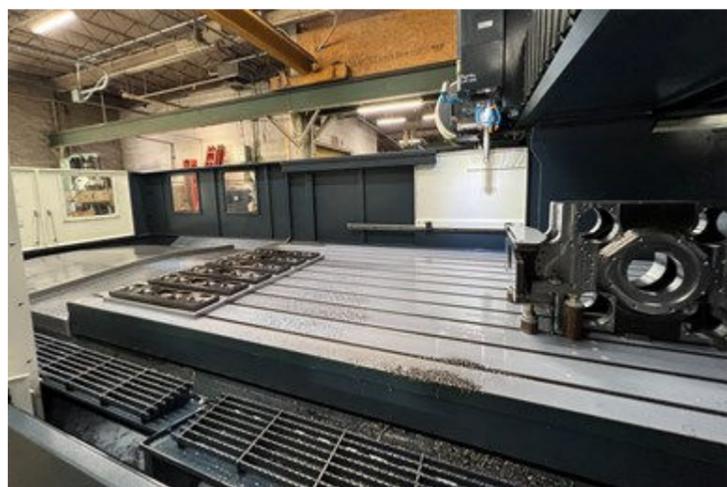
### Life After Five-Axis

The key selling point for this bridge mill was its rigidity. Barbco needed a machine that could perform both heavy-duty roughing and fine-tolerance work down to 0.0005 inch in A36 steel. When the shop’s aggressive cuts damaged the five-axis machine’s pivoting spindle head, repairs caused a delay that Barbco could not afford to repeat. Instead, Liston and Wolf looked into more rigid machines.

Nearby distributor [Absolute Machine Tools](#) soon introduced them to the Johnford bridge mill. While it lacks the positional five-axis capabilities of Barbco’s previous machine, its table is larger and its work travels longer, with 161 inches of X-axis travel and 90 inches of Y-axis travel. It can also hold heavier parts, and the machine’s construction is more rigid. Where Wolf says the five-axis machine would be well suited for aerospace work, the Johnford bridge mill “fits our industry better.”

As Barbco is an OEM for a high-wear industry and often needs to perform field maintenance, delivering repair parts in a timely manner is vital. Yet, with setup times reaching as long as half a day for larger metal weldments used in drills and track rails, unloading parts to meet a rush

order is not an option. This is when the size of the Johnford table comes in handy, as the machine shop can set up the repair parts on a different segment of the table and add G stops to the part program to ensure the machine only works in that area.



The table on the Johnford is large enough for Barbco to set up different projects on different portions of the table, using different G stops to indicate which section of the table the machine should work on at a particular time. This lets the company keep parts set up if it needs to change focus for a rush order, or if one project runs into problems that can't immediately be resolved.

Barbco's location in East Canton, Ohio. The distributor also worked to get ahead of any issues by creating a maintenance log with service dates to ensure Barbco knows the necessary service intervals for individual systems on the machine.

While the service plans are useful to Barbco, the Johnford machine has not required as much maintenance as the older machine. No major maintenance issues have occurred since the machine's installation in April, and the only regular maintenance the company has needed to perform so far are the regular maintenance tasks associated with machines, such as topping off coolant and way lube oil. Even filter changes are simple on the machine, as the DMC-4100PH is so large that some can even be changed while the machine is running on a different part of the table.

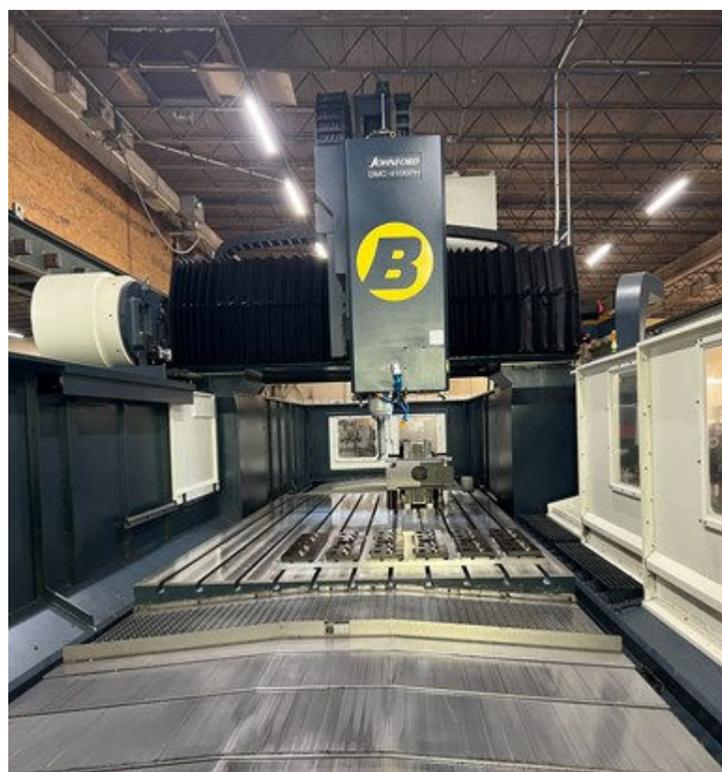
### Conversing About G Code

Less simple for the shop has been adjusting to the Johnford's [FANUC](#) control. Until it bought the DMC-4100PH, Barbco ran its machine shop on manual machines and CNCs with conversational controls. Moving to a more traditional control — one that lacked a touchscreen and presented lines of G code rather than graphics — created a tall order for the shop, with old hands feeling rusty and new hands initially baffled. Thankfully, the shop had already invested in [Mastercam](#) in 2019 to simplify coding for the five-axis machine, and many of the lessons Liston learned in programming that machine came into play with the Johnford. This includes high-efficiency machining strategies that use the full flute length of tools, which he says have led to higher productivity per tool and enabled the shop to achieve high-end tooling performance with less-expensive tools.

### Strong Support

Meeting these rush orders also requires swift support. When Liston and Wolf talked to Absolute Machine Tools, the representative from the distributor promised prompt service that would respond to any issues

in two days or less. So far, Absolute has remained true to its estimates. Wolf even says that Absolute has managed to provide same-day service on occasion, despite a 90-minute drive from the distributor's location in Lorain, Ohio, to



Barbco's Johnford DMC-4100PH is not the largest machine in Johnford's catalog — but it was the largest that could fit in Barbco's facility. The table can hold extremely heavy parts, supporting a total weight just over 11 tons.



Aside from the drill head, one of Barbco's standout new parts is the rotary gearbox for its Pathfinder guided boring machine. The rotary gearbox includes four pinions with 26,000 pounds of torque and can push nearly 500,000 pounds. As such, the gearbox must meet exacting tolerances to remain durable.

him.

When this all comes together, it works wonders for the machine shop. One example Liston points to is rail tubes for the company's Pathfinder rotary gearbox. These rail tubes can be 164 inches long and must remain straight. Through manual means, operators would need to use an indicator and take measurements all the way down the machine to ensure that the tube is properly set up. Errors would require infinitesimal adjustments and another round of measuring. With Mastercam, operators only need to probe each end to find the part's angle in comparison to the table. From there, Mastercam can skew an entire part program to match the part's orientation.



In addition to the Johnford mill, Barbco bought a [Hurco VM20i](#) three-axis mill earlier this year from [Reynolds Machinery](#) in Dayton, Ohio. With chip hopper and through-spindle coolant add-ons, the machine is fast and strong enough to match the output of the company's larger VMX 60. Now, the shop uses the Johnford for its larger parts while tasking the Hurco with smaller parts.

machined down to 5.5.-inches thick, then undergoes a two-day profiling process. The machine shop then mills the wipers and cutting heads from separate stock — potentially on another mill, but Wolf says the process is more effective on the Johnford — then welds them onto the frame.

The two operators for the Johnford have both started learning how to use the FANUC control, but most of the programming is down to Liston. In part this is because Liston has spent the most time learning FANUC's coding idiosyncrasies, but it is equally because altering programs from the control is more difficult than altering them from Mastercam and posting them to the machine. Having installed a data server alongside the Johnford machine, Liston can even use a VPN to revise programs from home, then send them to the machine via drag and drop — a major difference from the shop's old method of using flash drives to post programs. However, this reliance on Mastercam has required the shopfloor team to trust Liston more about the programs he sends them, and they must properly communicate any issues with the part program to

### Designing to Limits

The increased rigidity and more powerful cuts haven't necessarily reduced cycle times for the company the way they have tooling costs. The machine performs both roughing and tight-tolerance secondary operations, so an initial roughing pass will finish quickly only to give over to smaller, finer operations with longer cycle times. Instead, the rigidity of the machine has enabled Barbco's engineering department to design increasingly complex parts that pushes the Johnford's capabilities.

Most notable among these parts is a collapsible drill head for utility drills. Unlike previous challenging parts designed to be monolithic single-piece parts, this drill was designed to be assembled via welding. The part material arrives as six-inch-thick steel, with dimensions that would not have fit in the five-axis machine's enclosure. This material gets

This part is Barbco's answer to a long-running challenge in the industry: When a cutter breaks or dulls, how can a company withdraw the drill head without losing the hole? Liston and Wolf say demand for the drill head has been high, and as such the shop needs to make the parts as quickly as possible — the shop even plans to start keeping an inventory of the machined parts during lulls of orders, so that it can quickly weld the pieces together and maintain a quick turnaround time for fulfilling orders.

## Selling Points

The collapsible drill head has brought in job applicants for Barbco's machine shop to help meet demand. Liston and Wolf credit this to the company's appearance at a Utility Expo where Barbco showed off the drill head. "If you see the final product, it drives a different aspect than even just seeing the machine you get to work on," Wolf says. "Sometimes it's not about the work environment, so to speak. It's about what you get to build and what you get to be a part of."

That's not to say work environment doesn't play a role in employee retention, as Wolf and Liston say some employees have joined Barbco for the more open environment, even if it pays less than their previous job. As managers of the shop floor, Wolf and Liston say they keep their doors open for operators to suggest new ways of tackling problems and test out these theories. They say this autonomy helps boost staff members' self-worth, attitude and ambition, making the team work better alongside one another.

Also helping retention is the part variety moving through the shop. Even as an OEM, "We're not just making the same 10 parts," Liston says. "Engineering is constantly changing things. I see multiple parts hit the floor each week that I've never seen in my life." These can be revisions or wholly new designs, pushing the limits of the Johnford and the other

machines in Barbco's machine shop. But so far, all have come out successful.



Historically, utility excavators have needed to crawl into holes to repair dull or broken drill bits. Barbco's collapsible drill head eliminates this dangerous problem for soft rock applications, as pins within the drill bits rotate to shrink the diameter of the head when the drill is put into reverse.

### **Adding an Axis**

Another notable part the machine shop plans to produce on the DMC-4100PH is a rotary table. While the rigidity and reliability of the Johnford mill have greatly appealed to Barbco's machine shop, the flexibility of the five-axis machine was key to cutting setup time from many parts. Barbco researched the kinds of rotary tables on the market to see which could meet their rigidity needs while restoring a fourth axis, but ultimately decided to design and build one in-house to ensure it met requirements.

The machine shop hopes to further restore some flexibility by purchasing a right-angle head. Liston believes Mastercam should keep programming simple for programs using the head. As he puts it, the change in spindle orientation means "the machine needs to think that it's on its side," which traditionally requires a lot of translation work. Fortunately, Mastercam includes a postprocessor that can rotate the axes, and software is available for the control head to do the

same. Additionally, Wolf says, an add-on for the FANUC control can tell if the control is flipped, conclude that Barbco is using a right-angle head, and redisplay all the orientations in “a more operator-friendly environment.”

Still, the right-angle head will require some preparation, as the company will need to drill and tap a bar into the spindle nose to ensure the right-angle head will engage and maintain rigidity. So long as the company installs a stop, the spindle should continue to function with other heads as well, giving Barbco modular options in how it deploys its machine.

Liston and Wolf both say that the Johnford will retain its rigidity advantages with these upgrades. The flexibility they will add will enable the shop to consolidate part setups again — according to Liston, this could take some parts from six setups to two. It will also provide new axes for the engineering department’s experiments, helping the machine shop bring to life safer, more efficient trenchless boring equipment.