Bridge Mills: A Bridge to Success

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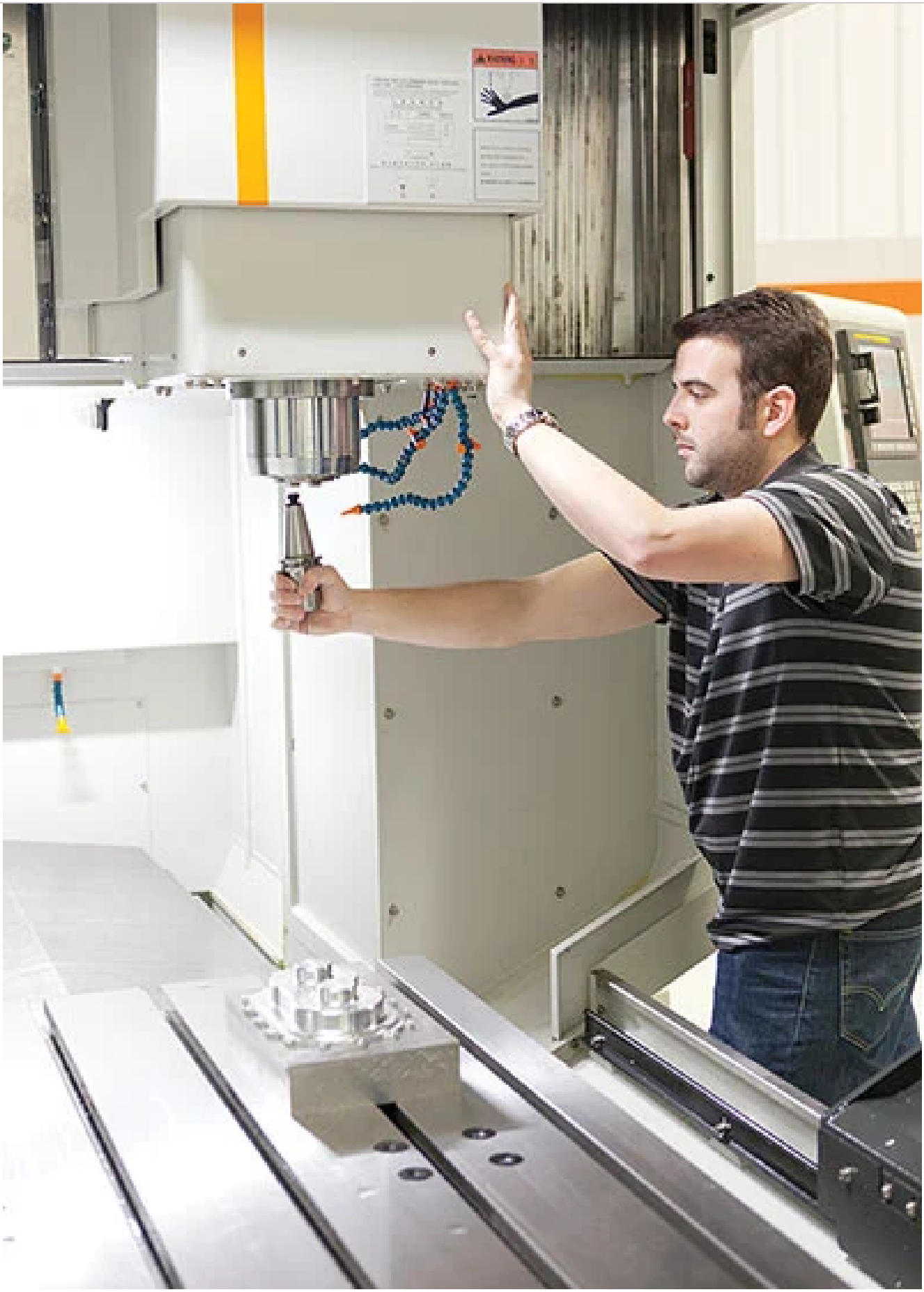
Think bridge-style machining centers are only for humongous parts? Think again. These rigid, highly accurate CNC machine tools come in a range of sizes and configurations.

Just as architects design homes according to their buyer's needs and budgets, so do machine tool builders produce equipment based on their customer's preferences. But just because a vertical machining center (VMC) does a decent job of milling and drilling, has a price tag that meets this year's CAPEX budget, and fits through the receiving door doesn't necessarily mean it will provide the best results.

What's most relevant? Predictable part quality and maximum metal removal rates from the machine tool's construction. Yes, optimal performance for any piece of CNC equipment depends on the use of high-quality spindles, servo motors, and other electromechanical components, just as it does on rigorous assembly practices and testing. But first on the list for any top-performing VMC should be its kinematic structure, and, for most buyers, this often comes down to one fundamental choice: go with a C-frame, or move to a bridge-style or double-column machine?

C U Later



So what's the difference? Scott Camloh, national sales manager for Indianapolis-based Hurco North America Inc. and Takumi USA, explained that bridge and double-column mills have a fully supported Y axis. The former usually consists of a one-piece inverted U-shaped casting the top of which is mounted to the Y-axis rail system and spindle head. Due to its larger size, a double-column machine uses three separate castings to form the U-shape, but provides the same level of support.

In either case, this assembly is bolted to a wide but relatively short base casting (not a weldment) responsible for carrying the table on a pair of X-axis guideways. This arrangement provides the stability and rigidity needed for large, heavy table loads, while the heavier casting absorbs the inertia of high rapid traverse rates and fast cutting speeds.

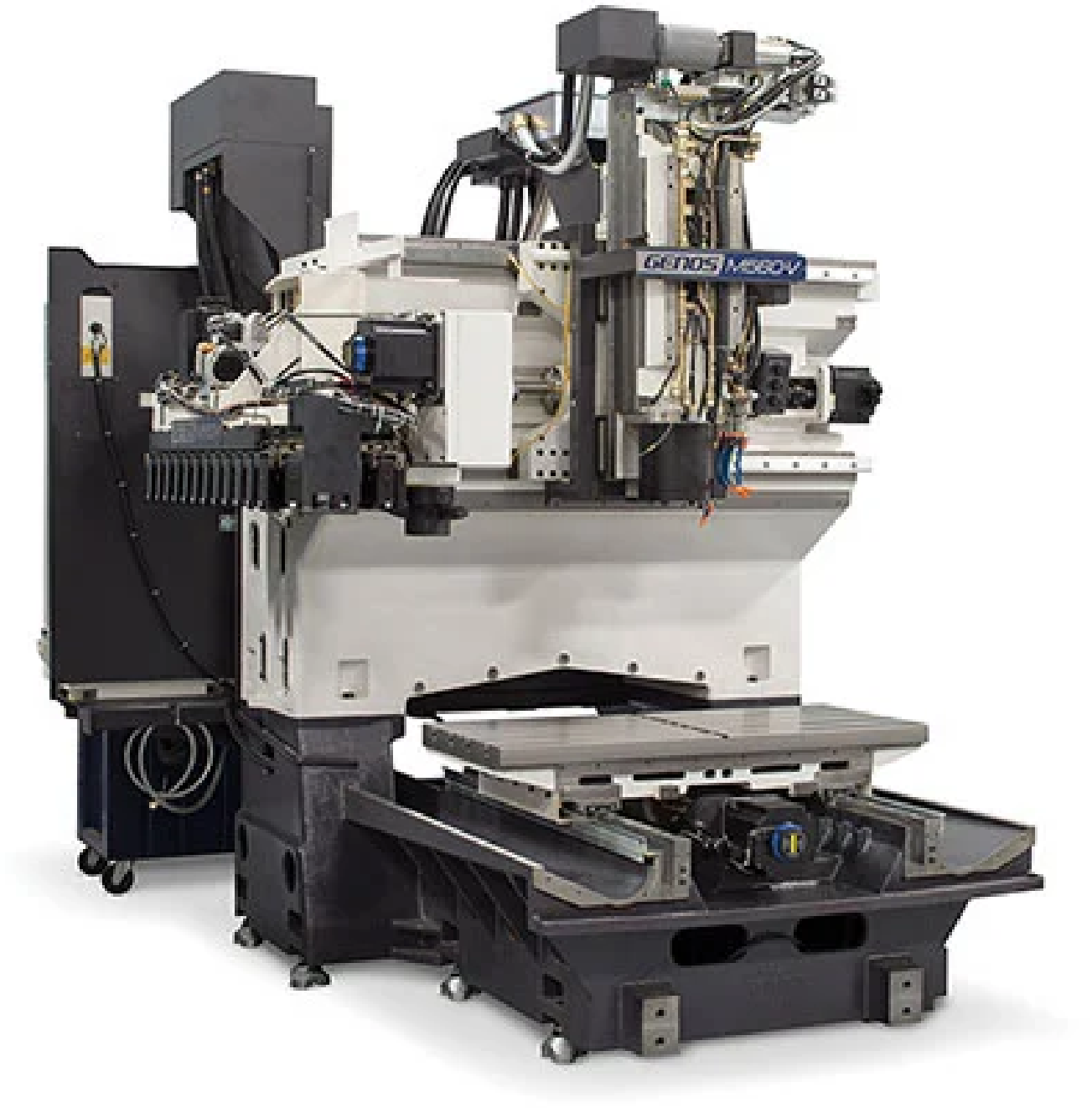
"The single-piece Y-axis construction also provides mass to absorb cutting vibration and increases the rigidity of the overall machine," Camloh said. "Further, having dual contact with the machine base—that is, the 'legs' of the inverted U—helps to eliminate pitch in the Y axis and reduces the effect of improper machine leveling or less-than-stable foundations. And since the entirety of X-axis travel is within the footprint of the base casting, there is none of the unsupported table overhang common in C-frame machines."

On the other hand, a typical C-frame VMC consists of three cast iron components: the machine base, a vertical column, and the spindle head. The table sits atop stacked X and Y axes that often have a 2:1 or higher ratio of longitudinal to cross travel. This arrangement means that the table is free to extend beyond the support structure in the X axis, resulting in overhang and "droop." Similarly, the spindle centerline-to-support distance is typically as long as the Y-axis stroke, making it more prone to thermal deformation.

Camloh added that, due to its greater rigidity and thermal stability, a bridge-style machining center generally outperforms a similarly sized C-frame VMC when machining parts that require tight tolerances, superior surface finishes, or both. They are also quite effective in high-speed machining applications. "For die-and-mold work, aerospace components, and even medical parts, a bridge mill or double-column machine like our BX-series is often the best choice, particularly with more challenging materials such as hardened steels and superalloys."

The Price is Right

even those who sell large numbers of C-frame mills—agree that bridge construction is a) more accurate and rigid, b) takes up less floor space, and c) provides greater tool life, part quality, and metal removal rates. So why are C-frame machining centers so popular, especially among shop owners who are just getting started? One word: price.



This Okuma GENOS M560V, with its sheet metal and control removed, illustrates the vertical machining center's bridge-style construction. (Provided by Okuma America)

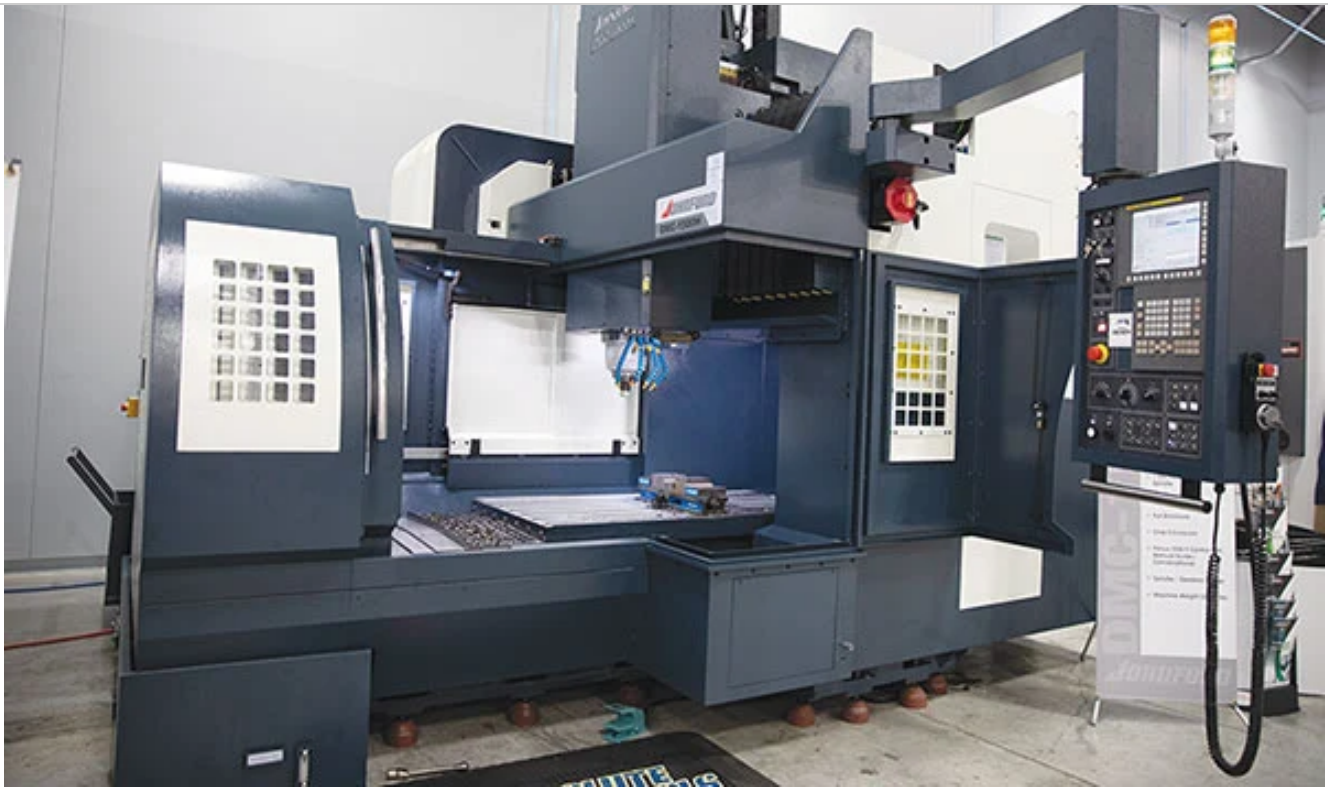
more than any other factor, is why there's such a big market. It's important to recognize, however, that by the time you load up a commodity VMC with all the necessary options, the price tag is often fairly close to that of a bridge mill. For these reasons, a bridge mill is a much better investment."

Still, for an entrepreneur with limited funds, any VMC is better than none, which is why many shop owners start with whatever they can afford and then upgrade to more capable machine tools as their business and revenue grow. "You're not driving the same car you had in high school, are you?" joked Burrell, adding that once a C-frame owner does make the switch to bridge-style construction, they're not going back.

"We have numerous customers who have swapped out a commodity-grade C-frame VMC for one of our GENOS M560-V machines," he said. "In every case, they saw improved tool life, part quality, and metal removal rates. Just as important, though, is machine uptime. Because C-frames are generally less rigid than a bridge or double-column machine, they suffer more wear and tear, especially on heavier cuts and consistently high feed rates. The result is an increase in maintenance costs."

Keeps on Ticking

Klaus Miller sees much the same thing. The vice president of sales for Absolute Machine Tools Inc. in Lorain, Ohio, distributor of Johnford brand CNC machinery, he noted that the higher vibration levels in a C-frame machine wreak havoc on tool life, as well as on the spindle bearings and other moving components. "I don't think most people recognize this. They try to take the same depths of cut and feed rates as they would on a bridge mill, which can take a far heavier beating. Because of that, we find there's a lot more maintenance on a standard C-frame type VMC [than on a bridge mill]."



Some machine shop owners say they will never go back to a C-frame machine after experiencing the improved ergonomics, lower maintenance costs, and overall rigidity of a bridge mill, such as this Johnford machine from Absolute Machine Tools. (Provided by Absolute)

Miller has his own customer success stories to share, including that of a job shop in Dayton, Ohio, with a dozen or so C-frame verticals. “The owner told me during a recent sales call that he would never purchase another one after investing in a Johnford DMC-2100H machining center,” he said. “From the standpoints of ergonomics, maintenance costs, and overall rigidity, [the owner] said there was simply no comparison.”

Miller ticked off the same list of bridge mill benefits as his counterparts at Hurco and Okuma, and added a few more. One of these is superior chip flow, a seemingly minor detail that can eliminate hours of manual shoveling and cleaning each week. Bridge mills are also more flexible, he said, in that an operator can mount parts anywhere on the table and still have easy access. He also claimed that the footprint on some C-frame machines is up to 40 percent larger than a comparably sized bridge mill, eating up valuable floor space.

Somewhat surprisingly, this last point is helping to close the price gap between the two styles of machinery. Said Miller, “The ocean container for a C-frame VMC is quite wide, which due to the recent increases in ocean freight means a significant increase on the sticker price over a double-column machine. In fact, for the first time ever, we’ve begun ordering small DMC-

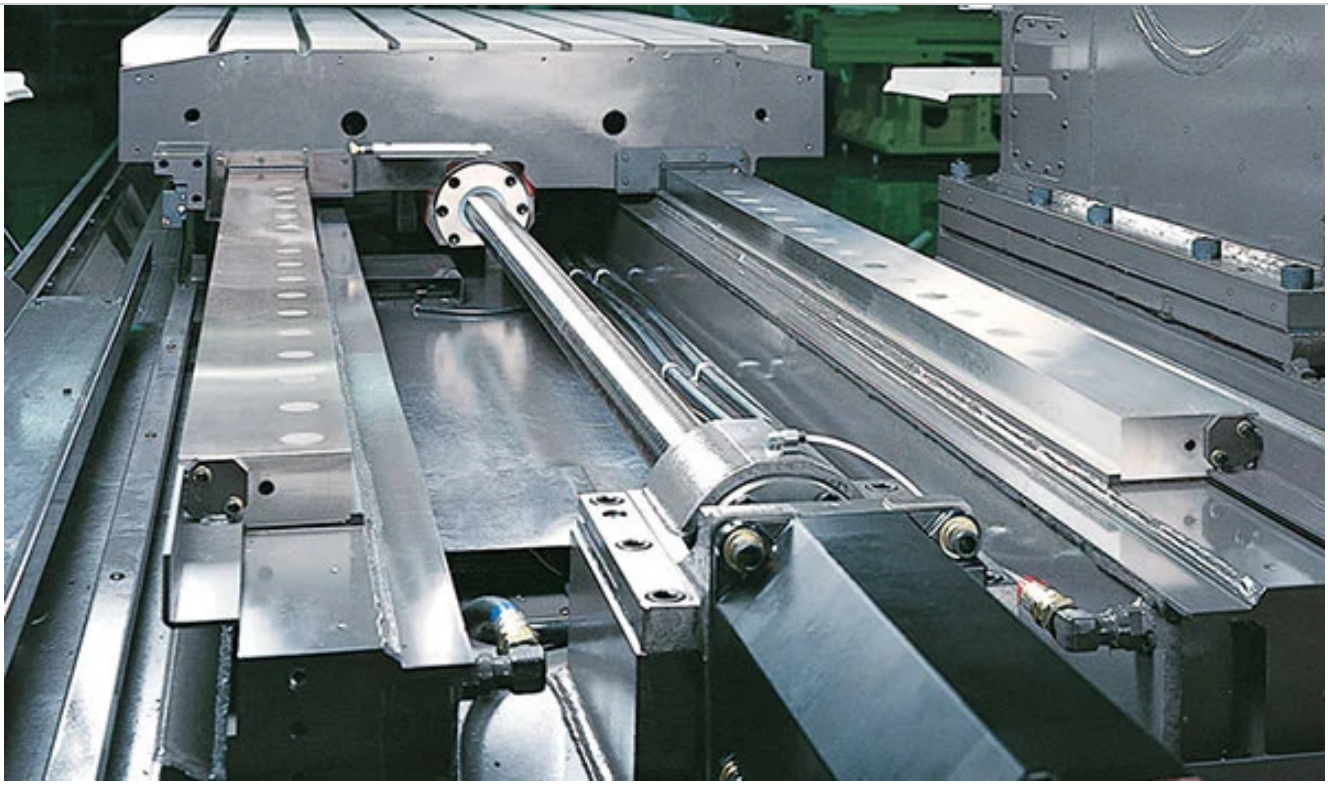
bridge-style machines.”

Die Hards

Another style of machine tool that’s seeing market share erosion is the boring mill. Where shops have long used these large horizontals with their extendable quills to reach deep inside weldments and castings, some are finding that a double-column vertical with a five-face attachment is not only more cost-effective, but can also machine a broader array of workpieces.

“Mold-and-die work continues to dominate the bridge and double-column market, but we’re also seeing great interest from shops specializing in aerospace work and those making large components for the military,” said Miller. “Johnford offers a head that’s fully programmable in one- or five-degree increments and supports automatic tool changing, both horizontally and vertically. The whole headstock travels over, picks up the head, and now you can hit five sides of the part in a single handling. It opens a lot of doors.”

It’s the mold-and-die work that Kevin Lichtenberg, YASDA product manager at Methods Machine Tools Inc., Sudbury, Mass., is targeting with the YBM series, all of which are bridge-style machines. Micro centers and small-to-midsize bridge-style machines will always have a home in mold and die shops, he noted, but to keep the revenue streams flowing, a growing number of shops are taking on bigger jobs, necessitating bigger work envelopes.



This 1218V bridge-style machining center from YASDA features precisely-ground guideways fastened to a hand-scraped mounting surface after lapping. (Provided by Methods Machine Tools)

“That’s where YASDA shines, as you get the accuracy of a jig borer even in high-capacity machines,” Lichtenberg said. “With an X-axis travel up to three meters and 1,200 mm in the Y, the YBM 1218V jig borer is a relatively large machine, but it can still maintain tolerances of two microns or better across its entire envelope.”

Granted, there’s a price tag for this level of performance, but it’s one that some shops are willing to pay if it means eliminating EDMing, grinding, and other secondary operations. “Whatever your shop makes, if you’re consistently striving to meet tolerances within one-thousandth of an inch—especially true position tolerances—then you should really consider investing in a more accurate machine tool,” Lichtenberg said.

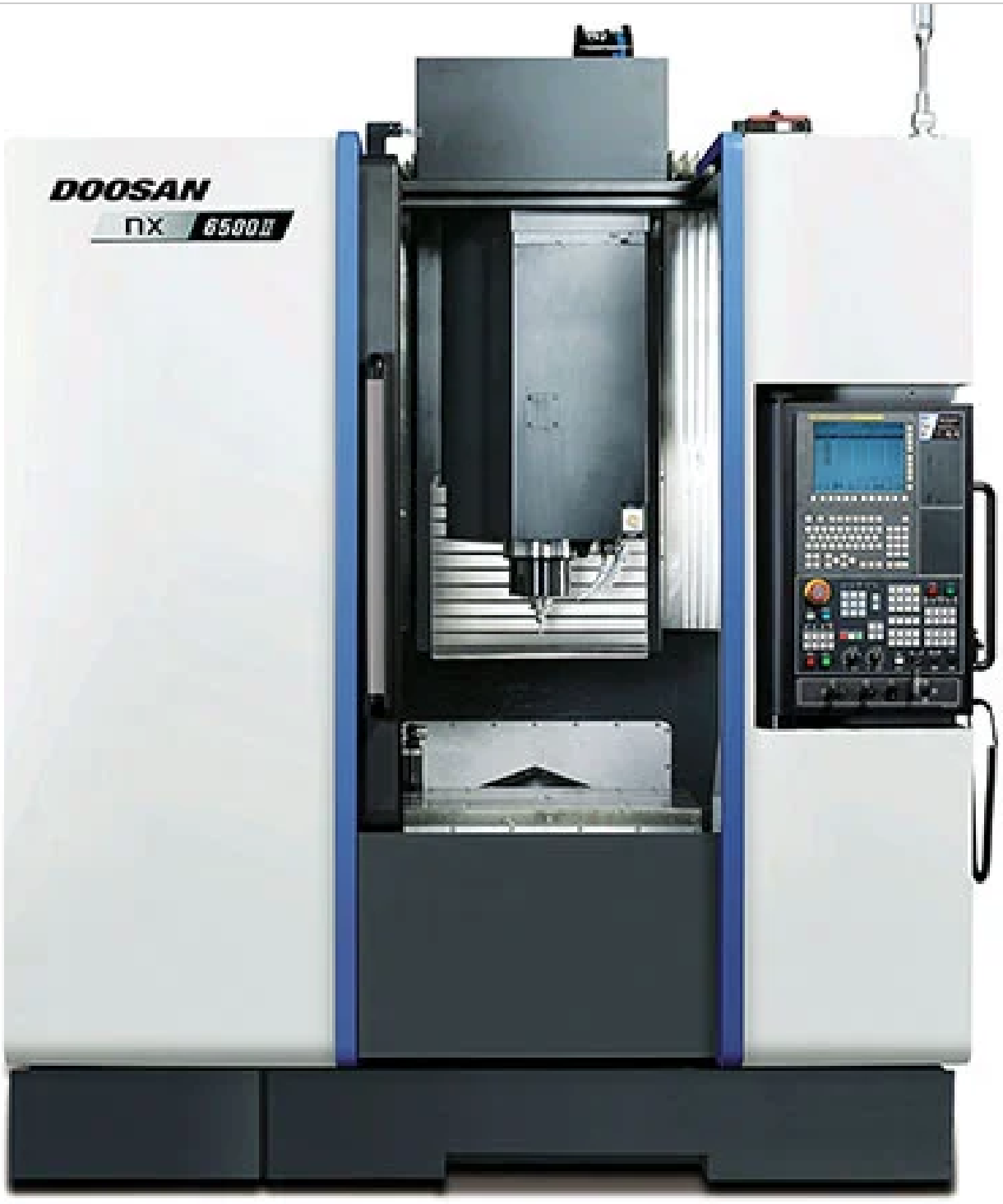
Despite his enthusiasm for high-end milling and boring machines, Lichtenberg admitted that there are plenty of shops out there that are quite successful operating equipment that he labels “middle-of-the-triangle” brands. And while he won’t gainsay these or any other shop’s choice of machine tools, he did suggest that the industry is beginning to realize that investment in low-cost machinery rarely provides the lowest cost per part.

one with rigid construction. Tool life is also shorter, so you incur more downtime. And if your parts are less accurate than they should be, they require more handwork, more inspection time, and more rework because they weren't right the first time."

All of this costs money, Lichtenberg added, but you get what you pay for. "High-end machine tools have staying power," he said. "They produce the same, reliable cut for generations. There's a group of machine shops that understand this, and have become very profitable as a result of their decision to invest in the best equipment."

Choices, Choices

Despite all this C-frame nay-saying, there are some applications where a bridge mill might not cut the mustard. For example, oversized workpieces are easier to fit onto a C-frame machine. Due to their historical popularity, there might also be more automation options, and many operators are quite familiar with certain commodity brands of VMCs, making it easier to keep one manned. And even though bridge mills require a smaller chunk of production floor real estate, they are generally a fair bit taller than their C-shaped cousins, spelling trouble for shops with undersized loading doors. None of these are insurmountable problems, but they do play a role in the purchasing decision.



Doosan's NX II series vertical machining centers are designed with a thermally symmetric, bridge-type structure to optimize precision and workpiece quality. (Provided by Doosan)

Andrew McNamara, director of sales at Doosan Machine Tools America, Pine Brook, N.J., hopes to move those purchasing decisions in his direction soon. The company has just introduced the BVM-series bridge mill, an alternative version of its well-known DNM lineup,

“We’ve had a similar machine available on our global site under the NX II brand but never brought it over, as we felt it was too expensive for the North American market,” he said. “Given the demand, Doosan has been able to package the BVM 5700 with similar specs to the NX model and offer it more competitively into the Americas region.”

Like his competitors, McNamara said far too many machine buyers are focused only on price. These are among the “it’s good enough” crowd of shop owners and purchasing managers who might not realize all that they are sacrificing with this attitude. And as others in this article have suggested, the long list of productivity-enhancing features that cost extra on a commodity machine generally come standard on a bridge mill, helping to level the playing field.

Price tags and machine options aside, McNamara raised another important point, one that’s especially relevant in today’s world of trochoidal, lower-force toolpaths: sometimes you just need to hog. “I watched a machining demonstration recently where they compared five different programming techniques,” he said. “It was clear that, in many cases, more traditional roughing approaches are more efficient.”

The problem, he explained, is that lighter-duty C-frame machines don’t always support these “get in and plow” methods of metal removal, so programmers are forced to use toolpaths that increase the amount of axis motion necessary to machine a given part feature, which in turn generates additional heat in the ballscrews and drive systems. It’s a vicious cycle, one that ultimately leads to premature component failure in some machine tool brands.

In the end, bridge mills provide greater flexibility, said McNamara. They are both stiffer and, as mentioned previously, much more accurate. Aside from a slightly higher price tag, the only negative, he noted, is that a bridge mill’s Z axis suffers more “cantilevering” at full extension, although it’s easy enough to minimize this by lifting shorter workpieces closer to the spindle via workholding risers. “Any negatives are easily offset by the bridge mill’s greater mass and therefore reduced harmonics; its higher thermal stability, accuracy, and tool life; and all the rest. Simply put, they offer some huge advantages over C-frame machines.”

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