If machine tools were dinosaurs, horizontal boring mills would be brontosaurus. Even the smallest of these brutes have axis travels best measured in meters, and spindle horsepower sufficient to drive a small car. But what is a boring mill? Isn't it just a gigantic horizontal machining center?

Boring mills do share many of the same characteristics as HMCs. They have X, Y and Z axes, are frequently equipped with rotary tables for multiple-sided machining and generally have large-capacity tool magazines. But the defining characteristic of a boring mill is its bar spindle, or W-axis.

Similar to a quill, the bar spindle is an extension of the Z-axis. With conventional machining centers, the ability to reach deep into a workpiece is limited by the size of the spindle housing and the Z-axis travel. Manufacturers can sometimes get around this by using an extended-reach toolholder, but this can cause chatter, tool wear and loss of accuracy.

On a boring mill, however, once the Z-axis, or ram, is in position, the W-axis can extend to machine features that would otherwise be inaccessible—without the need for long-reach toolholders.

Also, a bar spindle is inherently more rigid and accurate, according to Bob Conners, vice president of sales and marketing for United Precision Services Inc., Cincinnati. “The W-axis allows for better access into..."
tight areas, greater rigidity as well as overall parallelism of the spindle to the machine axes,” he said.

Parallelism is key. Conners noted that the fixed spindles on traditional machining centers are relatively short. Of course, builders strive to perfectly align those spindles, but depending on a number of factors, including less than perfect installation, improper machine maintenance and wear, slight misalignment may occur. “But in a boring mill, a spindle might be 10’ long,” Conners said. “Compared to a traditional machining center, the spindle on an HBM has wider support and a shorter lever arm. This makes it easier for the builder to dial-in and maintain proper alignment.”

He should know. United Precision represents five brands of machine tools, and all of them are big. Union, United Precision’s boring mill line, claims to be the oldest machine tool builder in Germany, being in business more than 150 years.

Like most boring mill builders, Union offers several iterations of its equipment, each suited to a particular type of work. A table-type boring mill uses a conventional compound-saddle design similar to most HMCs, but with the addition of the W-axis. These machines are for smaller workpieces, but take that with a grain of salt: You can still machine a block of steel the size of a Smart car on one of these machines.

“In general, the limit for a table-type design is a 100” cube weighing 30 tons,” Conners said. “But you still need to consider how much of the load is going to be hanging out beyond the support of the guide ways.”

For anything bigger than a 100” workpiece, a T-style, or planer, machine should be considered. In this design, there is no saddle—the X-axis is separate from the rest of the machine and slides on its own set of guide ways, making heavy loads less of a consideration. The column, which contains the spindle as well as the quill, rides on a perpendicular set of guide ways, providing Y- and Z-axis movements.

It’s like a car wash. You drive your car onto a track (the X-axis) while the spray head moves up and down the rocker panels (the Y-axis) and across the hood (the Z-axis). And this car wash is even equipped with a deep-clean W-axis, for getting inside those tough-to-reach wheel wells.

Planer-style boring mills, because they do not rely on a saddle design, have higher weight capacities and X-axis travels than their smaller-table brethren. Think large equipment frames and housings or components for earthmoving machines, parts up to 20’ long and weighing as much as 60 tons.

Looking to machine something big-
ger, say the size of a railroad trestle? For mammoth parts, you'll need a floor-type boring mill, or traveling-column machine. With virtually unlimited X-axis travels and weight capacities limited only by the foundation on which the machine sits, there's not much these big guys can't handle—aircraft frames, rock crushing equipment, military products and even other machine tools.

As its name implies, the business part of a floor-type machine—the traveling column—moves the entire length of a fixed bed, which is typically sunk into the shop floor. And because the bed is at floor level, you don't need to climb a ladder to check a cutter or measure a just-milled counterbore. You can even drive a forklift on to the bed to load and unload workpieces.

**Monster Builders**

There are a number of horizontal boring mill builders. One is the Italian company PAMA s.p.a., which has been supplying horizontal boring mills for more than 80 years. According to Sergio Scotti, general manager for PAMA Inc., Elgin, Ill., the company tends to cater to larger corporations such as GE, Caterpillar and other companies in the energy and mining industries, but sells machines to smaller companies, including machine shops.

PAMA offers two horizontal boring mill versions: the floor-type Speedram and the table-type Speedmat. Each machine comes in a number of configurations, but all have cast iron construction throughout and offer spindles rated from 70 to 250 hp. PAMA can also equip its machines with pallet changers, rotary tables with capacities up to 600 tons and swappable multiaxis, programmable indexing heads.

While Grandpa probably never had them on his boring mills, programmable indexing heads give the ability to rotate the cutter in multiple directions. The benefit is obvious—an indexing head lets a user machine up to five sides of a workpiece without repositioning. They also make it possible to drill angled holes or reach inside a workpiece to mill internal features.

A more-costly full-contouring version permits milling of complex 3-D surfaces, such as those seen in die and mold work. Better yet, many builders offer an automatic head-changing option, which permits faster changes between different jobs. Said Conners of United Precision, "There are a number of options, including number of axes, attachment methods, motor type and through-spindle coolant. You might spend anywhere from $30,000 all the way up to $400,000 on a spindle head."

Another builder offering this technology is Soraluce. A member of the Spanish Danobat group of machine tool builders, Soraluce was founded in 1962. Steve Richards, sales director of Soraluce America Inc., Rockford, Ill., said: “An articulating head makes a really big impact in reducing setups, due to the ability to rotate the head to whatever angle is needed. This also reduces the expense of multiple fixtures. And with today’s CAD/CAM systems, it’s much easier to program up to seven axes than it was in the old days.
when programs were written by hand.

“A lot of people consider this style of machine, but when they look at the head it scares them because of the problems inherent with everything that moves inside of that head,” Richards continued. “But Soraluce has addressed the lubrication and maintenance issues, employing special cooling methods to keep the bearings lubricated and the spindle chilled for longevity.”

**Machine Choice**

The appropriate boring mill depends in large part on the jobs at hand. For example, machining wind turbine bases with reduced setup and handling might require a table-type boring mill with a pallet changer and a 1° indexing head. You ask your friendly horizontal boring mill salesman, “How long will it take to get, and how much will it cost?” The typical answer would be, “Well, that depends.”

Due to the number of available options—such as different travels and load capacities, spindles, rotary tables and articulating heads—these machines are not kept in stock. If you need to be machining windmill parts before next spring, you’d better place an order now because lead times run 8 to 12 months.

And they’re not cheap. A small, basic machine may cost as little as $500,000, but a well-equipped monster capable of machining earthmoving equipment might cost 10 times that.

And don’t forget about the hole. Due to their humungous size, you can’t just truck one of these things in, set it on the floor and go to work. First, you’ll need to design and pour a reinforced concrete foundation, which means digging a hole in the middle of your shop big enough for a family swimming pool.

But it’s not that simple. “There are environmental considerations, such as soil properties and water tables,” said United Precision’s Conners. “And once you dig 10’ or 15’ down, you never know what you might find. Sometimes, we go into buildings that are 100 years old. You can run into underground streams, changes in soil type, even old foundations. We’ve had customers that have spent $500,000 just on the foundation.”

John Matysiak, manufacturing engineer for Bucyrus International Inc., Oak Creek, Wis., has experienced many of these issues. For more than 100 years, Bucyrus has been making excavators, drills, trucks and mining equipment. [Editor’s Note: Caterpillar Inc. completed its acquisition of Bucyrus International Inc. in mid-July and is eliminating the Bucyrus brand name.] Matysiak said when a PAMA Speedram 2000 was installed at the company’s Milwaukee facility: “We poured 4 million pounds of concrete for the foundation. We have a 7-axis machine holding positional tolerances of ±0.001” and bore tolerances to +0.001/-0.000” on medium-sized components for electric mining shovels and draglines. Machine alignment is very important.”

Aside from a solid foundation, temperature is crucial. “Look in your physics book for how much steel moves per degree,” Conners said. “Ambient temperature plays a big factor when machining big parts.” As the temperature increases, so does the size of the machine, as well as the workpiece, but they may not grow at the same rate. Many builders use glass scales and temperature compensation in the machine control to deal with some of this, but there are limitations. In a machine with X-axis travels as long as a basketball court, traditional glass scales are not feasible, so a metal tape or rotary encoder is used instead.

Steve Richards of Soraluce agrees. “Our machines are glass-scaled and thermally compensated for things like ram droop and spindle growth, but it’s like any machine tool of this size—if it’s possible to keep the machine at a constant temperature, life’s going to be a lot easier. If you have a 20’×40’ machining center in your garage, it’s not that expensive to keep that space air conditioned. But when you’re talking about an entire plant, it’s generally too expensive. That makes machining on this scale a whole different animal.”

Aside from these challenges, there’s also
setup and programming. The thought of programming not just three or four axes but also a 2-axis contouring head together with a rotary table, well, it’s enough to give you a headache. But one shop with a good handle on the complexities of boring mill programming is Aeromet Industries Inc., a job shop in Griffith, Ind. Fred Wahlberg, president, said, “Fifteen or 20 years ago, this might not have been possible. But with modern CAM software, the computer takes care of the whole thing.”

Aeromet has three programmers using Mastercam CAM software for jobs on the shop’s Union PC-150 floor-type boring mill. That includes everything from 20’-long coiling mandrels for sheet-steel makers to gear cases, machine fabrications, gas turbine parts for GE, and engine frames for Caterpillar Model 994 end loaders.

Wahlberg explained that, because programming is done ahead of time, less-experienced operators can be at the machine. “A 2-or 3-year apprentice can load the program, set the tools and go.” This is especially important to shops like Aeromet that run a horizontal boring mill around the clock.

“We’re real busy right now,” Wahlberg said. “The economy was pretty tough in 2009, but last year was a lot better and this year has been one of our best ever.”

Most people associate big machine tools with big manufacturers, like John Deere and Pratt Whitney. But as Aeromet shows, smaller shops can effectively use boring mills. Of course, you have to do your homework before draining $1 million or more from your bank account to buy a machine, prep your shop and learn how to set up and program one of these beasts. But when you consider the flexibility and productivity these giants bring to the table, a horizontal boring mill is hard to beat.

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