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Milling Large

Large-diameter facemills are affected by weight and tolerance issues.

▶ BY SUSAN WOODS, ASSOCIATE EDITOR

Everyone has a slightly different idea about what constitutes a "large-diameter" facemill, but everyone agrees that a large diameter can create problems. They also agree that the biggest advantage of using a large-diameter cutter—removing more metal with fewer passes—means there will always be a need for them, especially in the automotive industry.

So what is large diameter? The general consensus is anything 8" and larger.

One of the concerns with large-diameter facemills is spindle speed. According to Dr. Bert Erdel, president of Ingersoll Cutting Tools' Innotool Division, Rockford, Ill., "The higher the speed, the more centrifugal force you generate, the more balancing becomes a real issue."

Erdel has performed tests to determine how high speeds can go. He noted that on the smaller facemills, it is the body that breaks apart. On the larger facemills, it is the inserts that fly off the body before it breaks apart. Therefore, safety is a factor, but "only at extremely high speeds—up to 50,000 rpm," Erdel said.

To ensure operational security, especially at high spindle speeds, Walter Waukesha (Wis.) Inc. recommends observing maximum safe running parameters. "The body material and the components that make up the tool determine the maximum safe rpm for a facemill. Larger-diameter tools and tools with cartridges typically run at lower spindle rpm," said Patrick Nehls, product manager at Walter Waukesha.

Walter Waukesha

This close-pitch facemill from Walter Waukesha is fitted with 48 inserts and has a 355mm diameter.

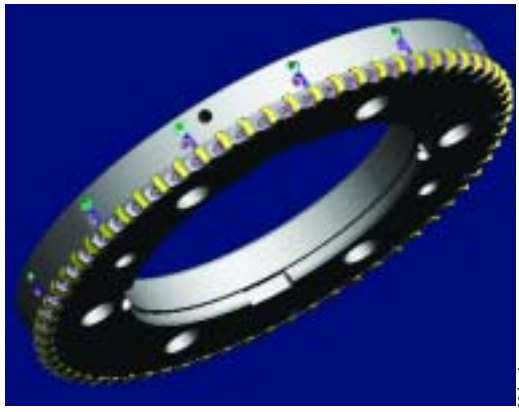
Weighty Issues

The weight of large-diameter facemills is a big consideration, especially when used on machining centers. According to Don Hughes, manager of engineering at Greenleaf Corp., Saegertown, Pa., "Sometimes, there are weight restrictions within the machine and the toolchanger will not allow the lifting or the changing of a large, heavy tool." In these cases, the design of the facemill has to be modified so that a certain weight limit is not exceeded. "We may have to look at some alternate cutter body materials or changing the configuration of the cutter body itself to try to reduce the weight," said Hughes.

According to Tim Marshall, product manager, milling products, Kennametal Inc., Latrobe, Pa., tool weight is an issue because as the diameter increases the mass increases, making weight a concern. "Customers sometimes modify milling cutters to try to reduce the weight, but caution must be used. If too much mass is removed, the performance of the cutter is reduced," he said.

A better way to lighten facemill bodies is to make them out of aluminum instead of steel. There are pluses and minuses to aluminum bodies. One benefit is they can be run at higher speeds. "Most of the facemill bodies fitted with PCD inserts are now being manufactured out of a high-strength aluminum alloy, which is very stable at extremely high speeds," said Tim Johnson, director of applications and engineering, H.A.M. Precision Tools, Pewaukee, Wis.

However, because of the high chip load generated during facemilling, there is an erosion effect on the aluminum bodies. According to Ingersoll's



Valenite

Valenite's M-750 iron milling system cutter has "ring-style" mounting to reduce weight and facilitate changing the cutter. The diameter is approximately 26".

Erdel, "Most modern facemilling cutters with aluminum bodies have a steel plate behind the cutting edge to prevent erosion." But, this plate complicates balancing.

One solution may be to use lightweight stainless steel bodies, which do not erode. Stainless steel's weight "is right in between the original, regular steel body and the aluminum body," said Erdel.

Another weight-reduction option is to switch to a smaller-diameter cutter and take multiple passes. "Instead of going with a 12" cutter, you might have to use an 8" cutter and take two passes, for example," said Kennametal's Marshall.

Another solution is to use a modular, or ring-style, cutter. "You certainly don't want people lifting and carrying a 75-lb. to 100-lb. milling cutter. With the ring-style cutter, the mass is reduced so changing the cutter becomes easier," Marshall said.

Balancing Act

Most toolmakers address balance issues with the actual design of the facemills. Bob Coleman, milling manager at Valenite, Madison Heights, Mich., said, "We try and make the cutters symmetrical; balancing is one of the advantages that CAD has finally let us realize."

He noted that Valenite does all its engineering in solid modeling, which allows the designers to balance tools during the design stage. "When it comes to balancing at the final assembly of the tool, only very small balance adjustments have to be made," said Coleman.

Johnson said H.A.M. Precision Tools balances its facemills for a maximum rpm, which depends on the diameter of the facemill. It ranges from 6,000 rpm for a 315mm cutter to 25,000 rpm for a 50mm cutter. "Balancing to a maximum rpm is an issue of safety. This is common practice for all large-diameter indexable tooling," he said. Also, the company uses a "balancing ring"—an adjustment of screws on the tool's OD—so the tool can be balanced accurately.

The balance grade is also important. "The balance grade for precision facemilling has to be G2.5 to make sure everything runs smoothly," said Ingersoll's Erdel. "Most toolholders are prebalanced to a grade of G6.3, which is good enough at conventional speeds, but not adequate for high-speed machining. And even a perfectly balanced toolholder can be thrown out of balance by an unbalanced cutter," he added.

Holding Tolerance

Maintaining close face and OD runout on large-diameter facemills can be a challenge if the tool manufacturer does not have the appropriate experience and equipment. According to Greenleaf's Hughes, "The face and OD runout is the small axial and radial variation between the insert's cutting edges. A better part finish can be achieved if the face runout tolerance is controlled closely."

Greenleaf uses CAD/CAM software to allow a solid model of a facemill to be electronically sent to its 5-axis machinery. "We actually generate toolpaths right off the solid model. This allows us to maintain extremely close tolerances throughout the cutter," said Hughes.

Diameter tolerance of the facemill is

Ingersoll Cutting Tools

The Power-Max high-density facemill from Ingersoll is designed for roughing and semifinishing.

Greenleaf

Greenleaf manufactured this 24"-dia., 750-lb. cutter for a 300-hp machine.

Saving facemills

Carbide Tool Services

A 10"-dia. facemill before (left) and after repair.

Because large-diameter facemills can cost thousands of dollars, many companies use a repair service to rebuild damaged or worn tools.

"Tool repair often can provide savings of 50 to 90 percent over purchasing new tools," said Olaf Klutke, president of GKI Inc., Crystal Lake, Ill.

There are several reasons a large-diameter facemill might need repair. Many times, they are simply worn out. According to Tony Szafraniec, president of Antech Tool Inc., Canton, Mich., running the tool too long, not mounting the insert correctly or not fixturing the workpiece correctly and having it move around can all cause problems for large-diameter facemills. Other reasons include incorrect machine programming or an extremely hard material being cut, which can damage the tool.

"It tends not to be the tool itself," said Julie Reiling, president of Carbide Tool Services Inc., Anoka, Minn. "Typically, it is an application issue."

What is involved with repair? If the insert breaks and damages the steel body pocket, for example, that pocket, or the body itself, is repaired so that the insert can be secured again. "We grind off the damage, weld up the pocket and remachine the pocket. Then we 100 percent-inspect the cutter to the manufacturer's tolerances for proper insert location per our ISO requirements," said Reiling.

The biggest concern with repairs is making sure that all the pockets are properly located. "If we have a 20"-dia. cutter that has 56 pockets," Reiling said, "it becomes critical that all of the pockets are aligned correctly."

According to Klutke, "Repair houses come a-dime-a-dozen, but few companies actually provide a tool that will perform as well as a new tool. Many sources merely 'touch up' damage on a manual knee mill." GKI uses 4- and 5-axis equipment to rebuild most of the tools it services.

Repairing large-diameter facemills takes sophistication. It "requires special equipment and expensive fixtures that most rebuilders simply don't have, which leads to substandard work," said Klutke.

Some facemills are beyond repair. According to Reiling: "We repair the tool off of the existing pocket material. Therefore, the tool needs to have a portion of the original material remaining in order to rebuild the pockets economically. If the cutter is missing entire pockets, it would be uneconomical to rebuild it."

—*S. Woods*

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(734) 207-3622
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Valenite
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Walter Waukesha Inc.
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not as critical as insert-height tolerance, according to Walter Waukesha's Nehls.

Depending on the application, one solution is to use a cartridge-style facemill, instead of a fixed-pocket facemill, where the height of the inserts can be adjusted so they are all on the same cutting plane. The trade-off is that the facemill is more expensive because of the additional components.

Toolmakers can also grind the periphery of the inserts after sintering. But, this adds cost as well because it is an additional production process.

Finishing inserts are a third solution. A fixed-pocket facemill could be fitted with standard inserts except for one or two finishing inserts. Theoretically, this should take up all the variation in the inserts and produce a nice surface finish.

Another factor to consider is whether a large-diameter facemill will fit in the tool magazine on a machining center. The large diameter may interfere with other tool slots, so they may need to be left open.

This and other challenges occasionally arise because of a large facemill's diameter. But size is also the source of its greatest appeal: The ability to remove metal more quickly than its smaller counterparts.