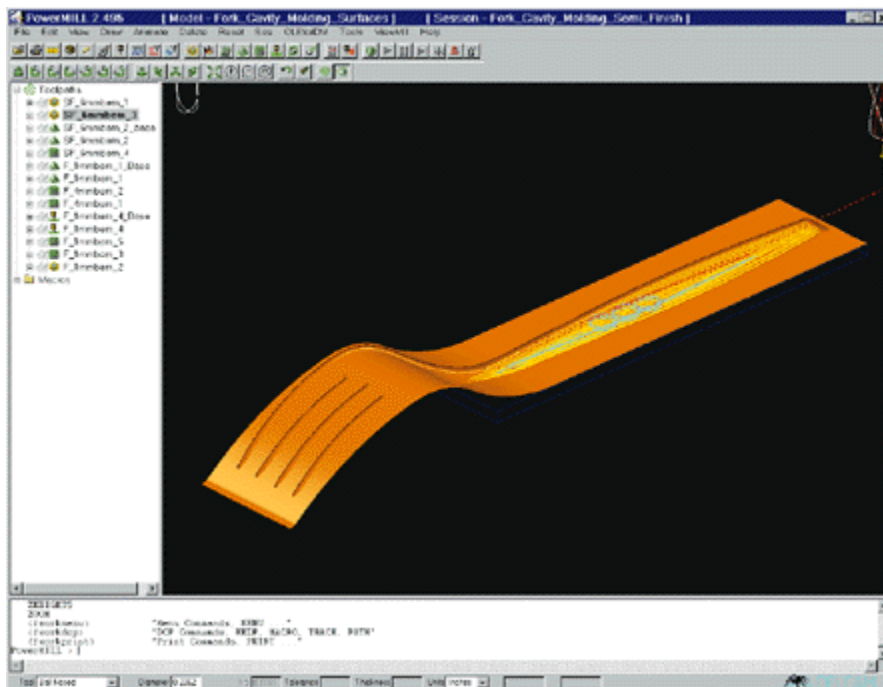


CAM, high-speed machining combine to speed delivery of stack mold for plastic tableware

## Complex Tooling, Simple Product

Few injection-molded items are more taken for granted than plastic tableware. Yet making the tooling for economic production of plastic knives, forks, and spoons is an extremely complex undertaking. As with any high-volume, low-cost plastic product, the toolmaker is challenged to come up with a highly productive and highly accurate set of molds.



*CAM toolpaths for 6 mm ball-nose end mill are for Z level roughing cuts performed after heat treating to remove stock below parting line. Note the circular ramping into cuts for efficient high speed machining.*

The toolmaker in this case, Helm Tool Inc. (Elk Grove Village, IL), overcame these challenges with high-speed machine tools and a state-of-the-art CAM system that helps keep them running. "Helm Tool does things when the customer can't figure out how to do them," says Helmut Mueller, president and owner of the 18-employee moldmaker. Though still small, the company doubled its size in 1997 and 1998, investing more than \$1 million in three new high-speed Makino machining centers.

"It's very important to understand that even though people don't think much about plastic tableware, the companies that make it think about it a great deal," says Mueller. "Tableware is a very low-margin business, so the tooling cost and the plastic resin used per piece have to be very tightly controlled."

The need for accuracy in the mold stems from the customer's demand that resin be controlled to the tenth of a gram per piece per shot. Since Helm Tool's molds make 144

pieces at a time, the total tolerance adds up to less than half an ounce--including gates and runners. The stricture also means there can be no flash.

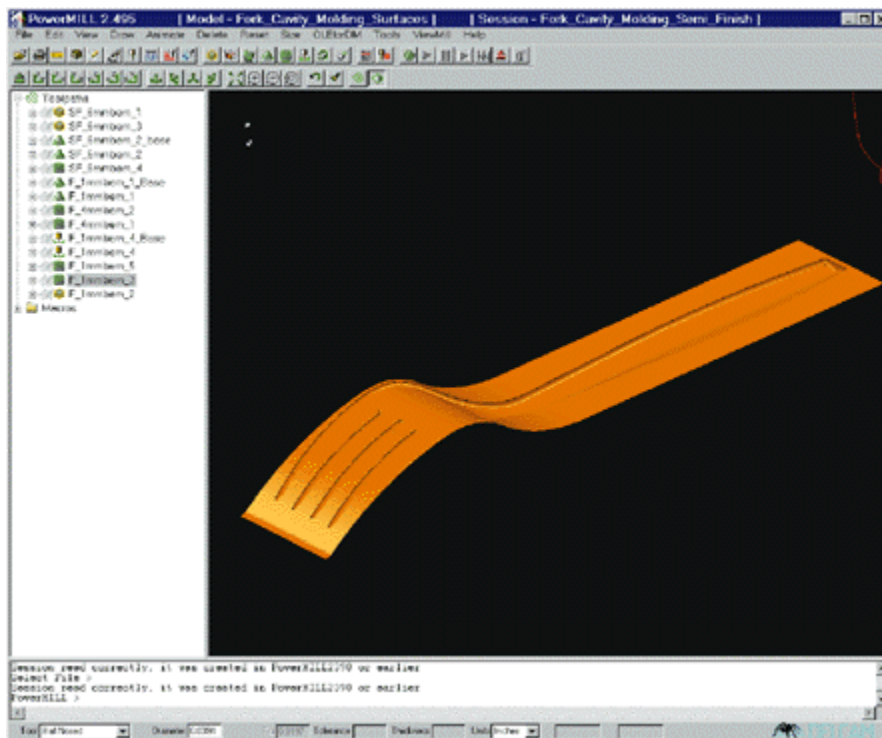
The tableware job was the first to use the new Makino machines. For Helm Tool, this alone was a big step. Many other toolmakers would have used electrical discharge machining (EDM) instead, machining dozens of graphite electrodes and slowly burning the shapes of the tableware pieces into the tool steel. Mueller thought that approach was too slow, too costly, and required too much hand finishing.

Another alternative would have been duplicating or tracer milling from a model. A problem with that is distortion during subsequent heat treating operations and resultant decreased accuracy. In addition, duplicating is relatively costly and slow.

To cope with jobs like the tableware molds and make a profit on the work, Helm Tool jumped into high-speed machining with three new machines from Makino (Mason, OH). Two of the machines have 32,000-rpm spindles; the third features a 20,000-rpm unit. Maximum feedrates are 350 ipm.

### Critical CAM

One of the keys to wringing all the potential productivity benefits out of the high-speed machines is a computer-aided manufacturing (CAM) system that can handle programming. Although Makino recommends packages from other software vendors, Helm uses PowerMill CAM software from Delcam International Inc. (Windsor, ON).



*Fork cavity parting line is shifted 0.003" so that only the molding area is cut.*

"The other packages cost more," Mueller says, "and they are harder to learn and harder to use. That cuts into our productivity.

With PowerMill we were able to create good programs after only a few hours' work with the software. Our programmer has had only half a day's training total, and that was on how to use updates.

"If you're a machinist, even without CAM training, the package is very quick to learn," he continues. "The combination of PowerMill and high-speed machining lets us get the most productivity out of the fewest number of people."

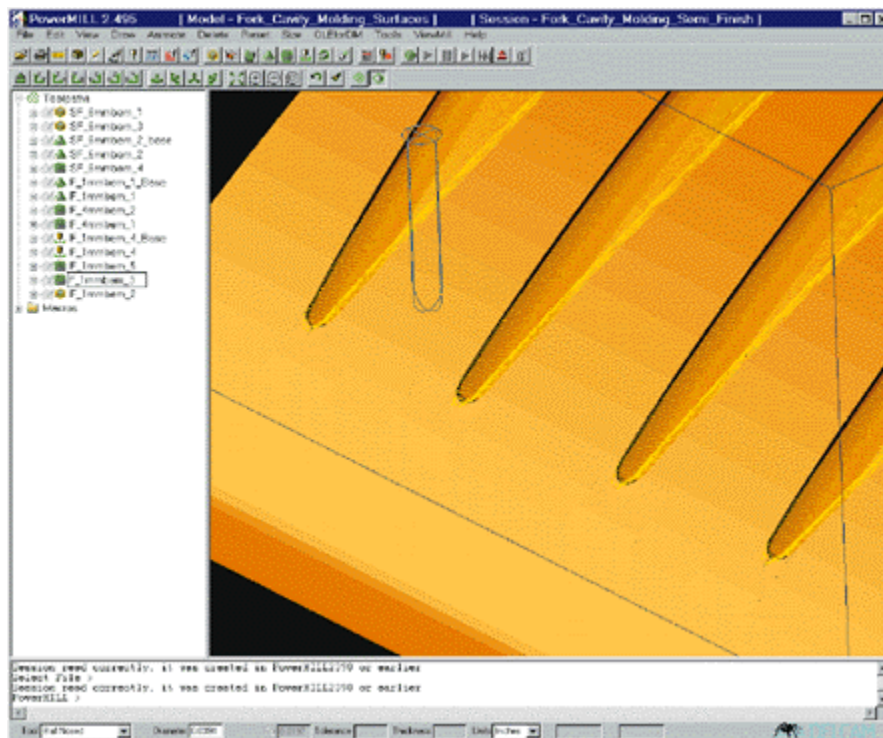
That sentence pretty much sums up Helm's overall production philosophy, according to Mueller. "We always try to do as much as possible without operator intervention, even to slowing down for curves," he says, explaining how directly CAM programming relates to productivity. "That has to be in the CAM program. The machines run too fast for the operators to work that way, slowing down and speeding up the machine tools with manual overrides."

Helm programmer Jason Swackhamer concurs. "With these high-speed machines, the operator can't slow the machine down if he doesn't like the way it's hitting the corners," he says. "It's all in the program. So programming is much more intensive."

## High Cavitation

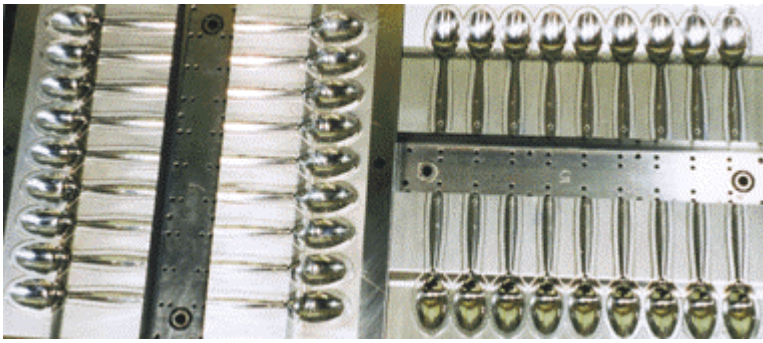
The 144-cavity stack mold--for a fork, knife, spoon, and toothed spoon-- was one of the more complex jobs Helm took on, according to Mueller. "We cut on this for months," he says. "We roughed, semi-roughed, semi-finished, and finished. The programs even had cutter changes and surface blends in them. There was not a single machining error."

That's a good thing. "We just cut right to the nominal dimensions, even when they are 0.001"," says Swackhamer. "No benching. No hand fitting. No EDM etching of parting surfaces. All those surfaces were machined."



*Toolpaths for 1-mm diam ball-nosed end mill finish cuts in the tine area of the fork mold.*

Helm built the two-level stack mold for use on a 500-ton molding machine. The stack mold technology complicates tool design, as Mueller explains. "Levers and cams open and close these molds, and the arrangements make the gating very tricky," he says. "These molds have interchangeable runner inserts, sub-gates, and edge gates, for example."



---

*A section of the finished mold. Part of a 144- cavity stack mold, the core and cavity set shown here produces 18 spoons per cycle.*

---

Stack molds are commonly used for can and bottle closures and similar high-volume, long-running jobs. Though more complicated and costly than conventional tooling, stack molds can increase productivity without requiring a higher-tonnage machine. (For more on stack molds, see the article "[Stacking Up Productivity](#)" on page 30 of the March 1999 issue of *Molding Systems*.)

Helm used 0.030" diam end mills for last cuts and fine finishing after heat treating and hardening to 5860 Rc. "Some Z-axis cuts are just a tenth (0.0001"), and we get better surface finishes," Mueller said. "All the corners get done by machining too, which is much faster and more accurate than hand work.

"Because we do less EDMing, we need more toolpaths for cutting the mold details," Mueller continues. "And each of those toolpaths is longer because it has so much more information in it." Handling the big program files required modification of the machine controls for faster networking, he adds.

Although Makino warned that programming the high-speed machines could take far longer than actual machining, that turned out not to be true in this case, according to Swackhamer. "Makino told us that programming would take twice as long as machining time because of the longer toolpaths and because so many of them are needed," Swackhamer said. "But it turned out to be less than one-to-one."

Mueller says the relatively fast toolpath generation and high-speed, unattended machining enabled Helm to produce the tableware mold in 12 to 14 weeks. He estimates it would have taken 22 weeks using other means.

Mueller says the ability to run machining centers unattended was a big factor in cutting delivery time, but the CAM system's circular lead-in feature also helped. "When we want surfaces, especially inside ones, to have rounded corners rather than sharp ones, we have to machine in a long series of arcs. The circular lead-in feature gets us down to each successive Z level very easily."

### **From Round to Oval**

Another early PowerMill/high-speed machining job, a special bushing with two mating tools, demonstrates just how far CAM and computer systems have come in doing close-tolerance work. "After mold sampling, we found that the tube diameter of the plastic part shrank out of round," Mueller recalls. "We machined the bushing to an oval cross section by an additional 0.004" plus the draft, then found after a second sampling that we still needed to open up the bushing another 0.001". All this was done easily and without a problem," he says.

Swackhamer accomplished the reprogramming with some quick edits to the CAM session file, then used the modified file to recut the tools' inside and outside diameters. "We made the tools slightly wider side to side than front to back," Swackhamer says. "The CAM system let us machine them that way and blend the surfaces with the slightly different tangents. After these new tools were heat treated, they were in perfect concentricity."

Yet another example is a smoke detector housing. Helm produced tooling that successfully molded in stiffener ribs with 1-deg draft angles. "Some of these ribs are as thin as 0.030", and in some cases five-eighths of an inch deep," Mueller points out. These were machined after hardening the tool to 50-52 Rockwell C.

Unlike many mold shops, Helm still performs CAM programming and toolpath generation in the CAD department. "We would prefer at-the-machine programming for high-speed machining," says Mueller. "The machinists know best how to program these jobs. We just haven't had time to move this to the shop floor yet." But, he adds, most 2D programming for things like mold bases and components is done on the shop floor using modifications to the G and M codes in the post-processed programs.

PowerMill's lack of true surfacing capability has not presented problems for Helm, even though Mueller thought it might. "We found that we can very quickly create the surfaces we need in SolidWorks and read them right into the CAM package," he says. "We could also create surfaces by jockeying around with the G and M codes, but that's not a good way to do it. PowerMill takes us right to the toolpaths, and that's what we want," he concludes.

The reliability of toolpaths generated by the software also helps Helm run its high-speed machining centers overnight, unattended. "That gives us an opportunity to do more tools for a given job," Mueller says, noting that large projects are sometimes split up among two moldmakers. Sourcing an entire mold package with one shop often produces cost savings for the customer, too, he adds.

---