focus: moldmaking

▶BY BILL KENNEDY, CONTRIBUTING EDITOR

Virtually Competitive

Advanced software gives moldmakers a boost.

Producing injection molds is challenging. A typical mold is a complex structure made up of a highly contoured core and cavity housed in an intricate mold base, gate and hot-runner system. Moreover, since one mold often constitutes a "run," there is no room for trial and error.

Key to moldmaking survival and success is application of technologies that permit maximum utilization of employees and resources. Such technologies include advanced machine tools and part-handling equipment that permit unattended operation, and cutting tools that facilitate high-speed machining.

Another major contributor to competitiveness is moldmaking software. It augments the mold-design phase, facilitates the automation and optimization of machining processes, and enables the user to simulate and verify mold manufacture and operation.

Design Development

Mold design begins with designing the part that the mold will eventually form. Today, part design usually exists electronically as a 3-D CAD model.

John Callen, vice president of marketing at CAM software developer Gibbs and Associates, Moorpark, Calif., said most moldmakers "couldn't imagine creating the parts they make outside of a digital environment, and many can't conceive of doing the parts without using 3-D solid models."

After the customer provides a 3-D model of the part, the moldmaker uses CAD software to create the mold core and cavity, as well as the mold base and the mechanical components required to operate the mold and transport the plastic into it. CAM software generates toolpaths for machining the cavity and mold components, as well as the toolpaths for cutting the electrodes needed to electrical discharge machine fine mold details.

Challenges often appear immediately. Designers may conceive of parts that would be expensive—or even impossible—to mold. A certain feature, for example, may prevent a part from being removed from a mold.

Matt Wallace, owner of Accelerated Mold Technologies, Monroe, N.C., makes molds for inventors and entrepreneurs who want to bring new products to market. Often, he said, "we wind up doing product development before we go into the actual mold design. We [can keep] the cost down on the mold by designing a part that is manufacturable."

This is achieved with software that allows a moldmaker to import a CAD model from a customer's design system and, if necessary, alter it. The more direct the path from the customer's model to the moldmaker's software package the better. It's possible to convert models into the least-common-

Delcam

Five-axis machining of an automotive bumper mold is accomplished with toolpaths created in Delcam's PowerMILL CAM software.

denominator IGES file when transferring data between software packages, but some information may be lost. Accordingly, software programs include direct translators that are capable of reading proprietary CAD-data formats, circumventing the need for a shop to buy a copy of the exact CAD program that produced the data.

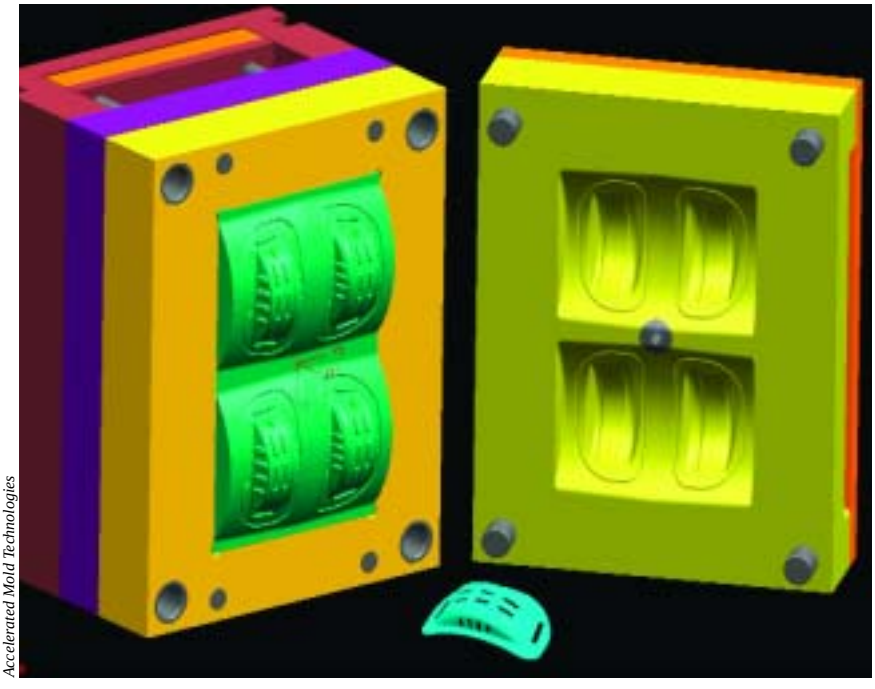
To further facilitate direct translations, CAM packages are starting to come with plug-ins for transferring CAD data. For example, to enable the exchange of design data from mainstream, PC-based CAD systems, Gibbs and Associates' GibbsCAM software features custom plug-ins for popular CAD systems, including Autodesk Inventor, Mechanical Desktop, Solid Edge and SolidWorks. The plug-ins allow users to seamlessly transfer designs from their CAD systems directly into GibbsCAM for programming.

Translation between a moldmaker's internal CAD and CAM software can also be an issue. For mold design, Wallace said he uses Unigraphic's MoldWizard software, while one of his colleagues prefers CADKEY. "I have to export from the CAD software in an IGES, DXF, Parasolid or STEP file," Wallace said, "then pull it into my SURFCAM [to program toolpaths]. If I make a revision in the part, add a boss or something, it is updated in my mold design. But when I go to [revise] the program for machining, I have to export it again and import all the information. It's almost like starting over."

As a result, Wallace is looking to move to a single "fully associative" software package, in which changes in the part model are reflected automatically in the CAM toolpaths.

Peter Dickin, marketing manager for software provider Delcam International Inc., Windsor, Ontario, agrees that across-the-board integration is desirable.

He warned, though, against assuming that associativity always exists between a design and machine toolpaths. "Automatic associativity will probably give the correct result for simple geometric changes, such as moving the position of a hole in a plate," he said. "However, when making any changes to the core or cavity surface, it is dangerous to rely on an automated regeneration of the toolpath. Particularly with larger molds, there will usually be a need to change the size of the cutter or the strategy to be used to give the most efficient machining. Associative systems will not make these changes."



Accelerated Mold Technologies

Matt Wallace of Accelerated Mold Technologies designed this mold for a police helmet chin guard with Unigraphic software, using a standard mold base from D-M-E Co.'s CAD files.

Delcam offers a "Power Solution" package that includes PowerSHAPE CAD and PowerMILL CAM software. The package enables direct data import from design systems, including CATIA, UG, Pro/E and SDRC. Within PowerSHAPE are tools designed to correct any problems with the part design and modify features in order to facilitate efficient mold production.

Delcam's PS-Moldmaker incorporates DieWizard, which automatically designs the core and cavity halves of a mold, the mold base and other components. Data on specific mold features can also be extracted and used to design EDM electrodes.

At Concept Models Inc., a shop in Livermore, Calif., owner Bob Hallock produces molds and prototype parts. He said he brings customer files into PowerSHAPE to modify them for machining. "I look at the part's design and things like moldability and wall thickness," he said. "If you don't have a constant wall, you could have sink." A perfect IGES file, he continued, can "go right into the CAM program, but if you need to create any kind of geometry, it's easier to do that in PowerSHAPE."

When it is ready to cut, he moves the CAD file into the CAM program. "Anything you do in PowerSHAPE can be sent over to PowerMILL for toolpath generation by selecting it and then clicking on the PowerMILL icon," he said.

Dickin said an important trend in mold design is the move to designing entirely with 3-D models rather than using 3-D just for the core and cavity and making 2-D drawings for the rest of the tool.

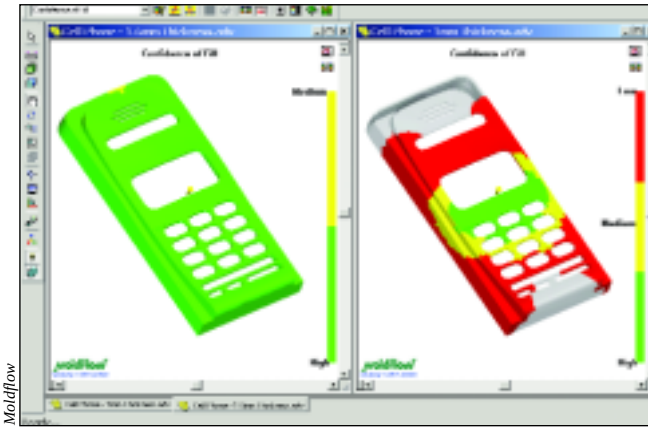
"Moving to 3-D design offers some time savings in the creation of the mold design, and even more significant improvements can be made through eliminating mistakes, and therefore rework time and costs, during both design and manufacture," he said.

Dickin added that performing all design work in 3-D also enables a mold to be designed in its entirety by one group or one individual in an organization, saving time and reducing the chances for error.

Regarding the actual machining of

the mold, Dickin said the small lot sizes typical of mold manufacturing put pressure on moldmakers to program toolpaths correctly. "Many molds are 'one-offs,' so they must be right the first time," he said.

The machining part of the software must, therefore, have the ability to quickly compare the different machining strategies that could be used, so that the most efficient combination is selected. Even more important is eliminating the possibility of the mold being gouged. In a production run, gouges only affect the first of many parts (assuming that the operator notices and stops the machine). In moldmaking, a gouge during the finishing of the mold can lead to many weeks of work being scrapped.



Moldflow

Color-coded simulations enable users of Part Adviser software to determine the manufacturability of plastic part designs early in the design process.

Automation and Simulation

Increasingly, mold-design software is incorporating automation-related functions, including basic core and cavity creation, selection of the mold block and choosing the requisite mechanical components from suppliers' catalog databases. Automation is not, however, merely a way to reduce labor costs. Ideally, the capabilities of the software increase employee productivity.

Ray Seeley, president of moldmaker and parts producer PTA Corp., Oxford, Conn., said software "doesn't replace the knowledge that is walking around the plant in the head of a moldmaker, but it is a tool that can help reduce lead times and bring value to the customer. It permits the best use of skilled employees, letting them do what they do best, and eliminates redundant, repetitive tasks."

As lead times compress and molds become more complex, the luxury of mold development by trial and error has disappeared. Throughout the moldmaking process, software simulations enable mold designs and machining processes to be tested and changed before any metal is cut.

Producing molds is expensive, said Terry Wohlers, principal consultant and president of the industrial consulting firm Wohlers Associates Inc., Fort Collins, Colo. "In fact, it can prevent a product from succeeding if you can't sell enough product to amortize the tooling cost." Simulations allow a manufacturer to determine a product's manufacturability and, thereby, its cost, and "reduce risk by being fairly certain that the investment in tooling is going to provide a payback," he said.

Moldflow Corp., Wayland, Mass., offers software that simulates the flow of plastic into a mold. Peter Rucinski, the company's director of product marketing, said, "You want to run these simulations before you cut the steel."

Moldflow's Part Adviser software is its most basic simulation tool. It provides designers with a quick manufacturability check—i.e., whether a part can actually be molded. The next level up, in terms of capabilities, is Moldflow Mold Adviser. It's designed for mold shops that have inherited a customer's part design and must determine and test the positions of the gates and runners that direct plastic into the mold.

The most advanced package, called Moldflow Plastics Insight, simulates all phases of injection molding, including exotic processes such as gas-assisted molding and co-injection of more than one type of plastic into a mold cavity. The software can also predict the post-molding properties of a part.

Such analysis, Rucinski said, "can eliminate the need to make a prototype mold to see if it will really fill." In addition to testing the manufacturability of complex geometries, the software can also be used to optimize the processing of even simple geometries. It can predict cycle times, too.

Rucinski said, "If you molded a part today that took you 60 seconds, how do you know you can't make it in 40 seconds? If the volumes are high enough, very small percentages in cycle time savings or material savings can add up to tens, or hundreds, of thousands of dollars a year."

Conveniently, Moldflow software works directly with the user's 3-D solid model program. Other simulation software requires the 3-D model to be translated into an FEA (finite element analysis) mesh model, a process that can take days or weeks.

For infrequent and first-time users, Moldflow offers an Internet-enabled analysis program called iMPA. This is a pay-per-model licensing program for assessing plastic-part designs. For about $350, users can analyze a model to determine its manufacturability. Flow analyses can be conducted on the 7,500-plus materials in Moldflow's database.

Verification

Most CAM software offers simulation capabilities that permit verification of the toolpath to ensure the mold is being cut as designed, and to recognize and prevent problems such as gouges and tool collisions.

For example, ESPRIT software from DP Technology Corp., Camarillo, Calif., presents the tool, fixture, stock and workpiece as 3-D dynamic solids and enables users to pan, zoom and rotate the workpiece. As a result, said DP Vice President Chuck Matthews, "users can inspect the 'as-machined' part vs. the 'as-designed' version and proceed accordingly."

Some high-end manufacturing software packages also enable users to optimize cutting parameters. CGTech, Irvine, Calif., offers VERICUT software, which provides simulations that

The following companies contributed to this report:

Accelerated Mold Technologies
(704) 764-8878
www.quickmolds.com

CGTech
(949) 753-1050
www.cgtech.com

Concept Models Inc.
(925) 606-6743
www.cmodelz.com

Delcam International Inc.
(800) 664-3506
www.delcam.com

DP Technology Corp.
(805) 388-6000
www.dptechnology.com

Gibbs and Associates
(800) 654-9399
www.gibbscam.com

Moldflow Corp.
(508) 358-5848
www.moldflow.com

PTA Corp.
(203) 888-0585
www.ptacorp.com

Wohlers Associates Inc.
(970) 225-0086
www.wohlersassociates.com

identify toolpath errors and also processes data to optimize machining. After the user inputs information about the machine tool, workpiece material and cutters, the software simulates the cutting process and analyzes the toolpath, including depth, width, angle and volume of material removed by each cut segment. This information is used to build a knowledge database from which the software automatically determines optimal feed rates that match the varying cutting conditions encountered.

"This goes well beyond a simple visual check for interference—to the level of true knowledge-based machining that enables the user to improve the quality of the NC program by machining with the ideal feeds and speeds," said CGTech's marketing communications manager, Jeff Werner.

In addition to machining more efficiently, optimized cutting parameters produce a constant chip load, which reduces stress and wear on the milling machine and cutting tools. Another result is more uniform surface finishes, which can decrease mold-polishing time.

VERICUT software also provides a way to send a solid model of a partially machined part back into the CAD/CAM system. This is helpful when programming subsequent operations, because it can be difficult to confidently program accurate toolpaths without a true representation of the "as-cut" part. Consulting a correct solid model at each manufacturing stage helps avoid machining errors. The software enables users to "virtually cut" the mold, then export the in-process part as a solid model that can be imported and used in the CAD/CAM system.

Werner noted that CGTech offers a VERICUT package with a dedicated interface that's specifically for moldmaking. A streamlined version of the full-featured software lets the user "more quickly and easily perform verification and NC-program basic optimization functions," he said.

Optimizing processes is critical to competing in today's global market.

PTA Corp.'s Seeley said competition in moldmaking is tough but manageable. "In this country, our industry has some of the most talented people in the world. We've got the people. We have to invest in the technology that will allow us to be a hell of a lot more competitive." Moldmakers need to look at different ways of approaching the build cycle and invest in "a whole different type of process to build the mold," he said.

That approach includes software that can significantly expedite the design, analysis and manufacture of injection molds.