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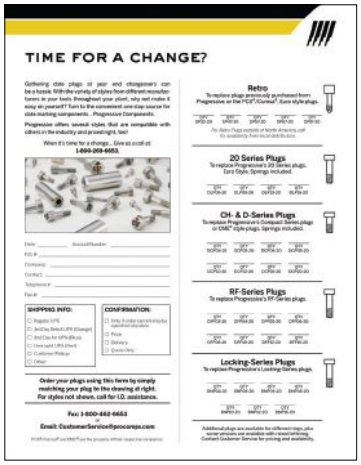

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MoldMaking Technology (ISSN 1098-3198) is published monthly and copyright © 2019 by Gardner Business Media Inc. 6915 Valley Ave., Cincinnati, OH 45244-3029. Telephone: (513) 527-8800. Printed in U.S.A. Periodicals postage paid at Cincinnati, OH and additional mailing offices.

POSTMASTER: Send address changes to *MoldMaking Technology* Magazine, 6915 Valley Ave., Cincinnati, OH 45244-3029. If undeliverable, send Form 3579.

CANADA POST: Canada Returns to be sent to IMEX Global Solutions, P.O. Box 25542, London, ON N6C 6B2. Publications Mail Agreement #40612608.

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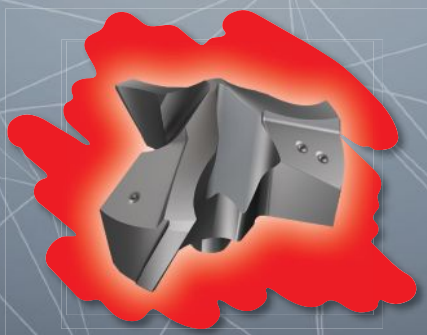

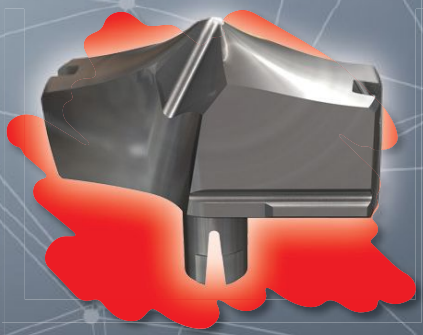

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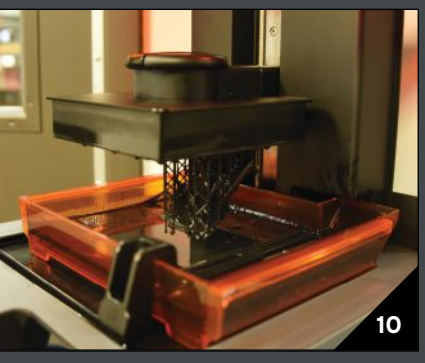

Features

Departments

ON THE COVER

Cover photo courtesy of Walter USA, LLC. This month's cover shows a circle segment cutter, which is growing in popularity because of its ability to finish parts in a near to net size with a reduced number of tool paths. These cutters machine with a cutting edge that uses a large radius oriented at an attitude that matches the part feature. See related feature on **page 14**.

Images courtesy of (left to right) M&M Tool and Mold Inc., Mitutoyo and Evco Plastics.

VIDEO ACCESS

TRICKS OF THE TRADE

5 Great Tips from This Issue

1. Can't We All Just Get Along
Mentorship, which creates a personal relationship between two humans where they feel comfortable enough to engage over a problem, challenge or issue, is vital to easing the current workforce generational shift.
PG. 6.

2. Get Your Full
A dynamic adjustment to the contact point with circle segment cutters ensures that the advantages of each contact point are used to the fullest and incorporates the entire cutting edge into the process.
PG. 14.

3. Measuring Up
Flexible, automated measuring equipment gives mold builders flexibility in part adaptation, consistent measurement *without* operator influence, greater speed, improved data management and tighter process control.
PG. 18.

4. Assembly Required
Electrically-actuated hot runner systems reduce mold assembly time because the electric motors plug into the junction box, eliminating any necessary plumbing to run air or hydraulics.
PG. 24.

5. Money Matters
Keeping currencies artificially low to gain a trade advantage is known as "currency manipulation" and this has very harmful effects on American manufacturing jobs.
PG. 29.

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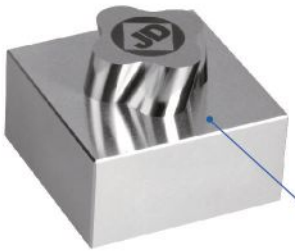

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Fitting Allowance ⩽ **5μm**

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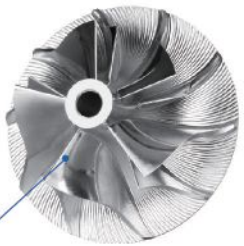

Optical Mold

Surface Roughness ⩽ **5nm**

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What About Mentorship?

We discovered a specific generational workforce challenge beyond that of not being able to find skilled workers—once the next generation enters the workforce, the two generations are struggling to get through to the other or understand each other's perspective. Both seasoned and new moldmaking professionals voiced this dilemma during our Amerimold 2019 30 Under 30 Happy Hour. And we believe that mentorship can help to get the conversation started.

Let's step back and take a broader look at the value of the proposition of mentorship. In a nutshell, we are suggesting that all generations take the opportunity to mentor each other because there is something to be said for the experiential learning that can come from developing a relationship between a mentee and a mentor.

This personal relationship between two humans through which they feel comfortable enough to engage over a problem, challenge or issue is vital to easing the current workforce generational shift. Mentorship allows participants to share different perspectives and learn from each other perhaps something that they didn't know before.

Cross-generational mentoring starts with an understanding that generations differ from each other in their strengths, preferences, working styles and ways of thinking, and it serves to make those differences an advantage rather than a detriment in the workplace, in part by creating an opportunity for members of those different generations to share their knowledge with each other.
–Marion Wells, HAM

The mold manufacturing industry has a lot of young people who are full of energy and ideas, but they do not have an incubator to grow those ideas. We also have plenty of older people (or seasoned, as I like to refer to them) with a great deal of knowledge and ideas, and they also do not have an incubator to grow those ideas. We are on a mission to create that incubator to harness ideas and allow the conversations to continue under the auspices of the *MMT*'s Pilot Mentorship Program with the expert council of *MMT*'s newest EAB member and talent development consultant, Marion Wells of Human Asset Management.

MMT has identified the pilot group and initiated this informal cross-generational mentoring program last month. We will follow and document their journeys through print and digital coverage, as well as a special panel discussion at Amerimold 2020, June 10-11 in Novi, Michigan. I invite you to take this journey with us, if for nothing more than to witness how mentorship can help bridge the great generational divide, and work with us to broaden the program's reach. MMT

Christina Fuges

Christina M. Fuges
Editorial Director

Follow MMT on: Follow @MMT_ChristinaF

THIS MONTH ON moldmakingtechnology.com

VIDEO: ALBA Demo at Amerimold 2019

At Amerimold 2019, ALBA Enterprises introduced the moldmaking world to the freeform injection molding process, combining the proven injection molding process with the freedom of part design.
short.moldmakingtechnology.com/AlbaDemo

PODCAST: A Campus and Culture of Capabilities and Solutions

MGS Mfg Group displays passion for mold manufacturing, as well as commitment to their next generation workforce and their experience with a campus of capabilities during this *MoldMaking Technology* and The Manufacturing Alliance Podcast episode.
short.moldmakingtechnology.com/MGSMfgPod

BLOG: Mold Builders Are Leading the Way

MMT is still accepting entries for our 2020 Leadtime Leader Awards competition, so put your hat in the ring today!
short.moldmakingtechnology.com/LeadtheWay

WEBINAR: How Industry 4.0 Will Impact Moldmaking and What You Can Do Today to Maximize Production

Industry 4.0 is coming to all of manufacturing. It's time for moldmaking companies to seriously address benefits of networked production and how to implement it in their operations with this webinar from Tebis America.
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EAB Picks: Cover Stories

To top off 2019, and to close out their three-year term as *MMT's* Editorial Advisory Board, we asked members to share their favorite cover stories for the year. As *MMT* works about two months ahead, their choices did not include November or December. Still, they weighed in with the following features.

The number one pick was featured in the January issue: "Training Redefined: A Three-Pronged Approach to Solving the Skilled Labor Shortage". One EAB member said, "Of course I am always interested in workforce development and training strategies and this feature was very in-depth." Another EAB member commented that, "It is incredible what they are doing with employees, and I would love to see more shops take this approach."

Editorial Advisory Board members weighed in on their favorite *MMT* cover stories. To read their choices and more, you can access our Digital Issue each month on moldmakingtechnology.com.

Tied for second was "Higher-Level Laser Mold Texturing", which ran in the February issue and "How to Better Balance Family Molds", which was the April cover story. EAB members told us that each feature represented a technology they were either not familiar with or that they knew little about. Regarding the latter, one EAB member said, "It might be a possible approach for a two-shot mold that we are looking at making, where the over-molded part is basically four separate parts, similar to this family mold application."

Finally, a third top pick was our June issue feature about X-Cell Tool and Mold, *MMT*'s reigning Leadtime Leader Award winner. One EAB member said he enjoys learning about the shop that wins these honors, while another said, "I always read the LLA articles to see what makes the winner tick. It is always interesting and makes me feel happy for them and all the teamwork they put in to win!"

Honorable mentions included "A European View on AM: Rethinking Injection Molds", which appeared in March, and the September issue's "Tooling 4.0: Connecting Industry 4.0 Technology to Your Molds and Molding Process". As expected, our readers are always looking for educational content about technologies that can help them improve their operations, and workforce development is an ongoing challenge for every shop. When you can get a glimpse of another moldmaker's strategy, it can spark new avenues for development. MMT

EDITORIAL ADVISORY BOARD (EAB)

The EAB enhances the standing of the publication and strengthens its professional integrity through the active involvement of its members.

The Board represents all aspects of the mold manufacturing industry with a balance of moldmakers, molders, OEMs and academia, and various moldmaking segments and job functions. A member is selected based on his or her experience and knowledge of the moldmaking industry to serve a three-year term.

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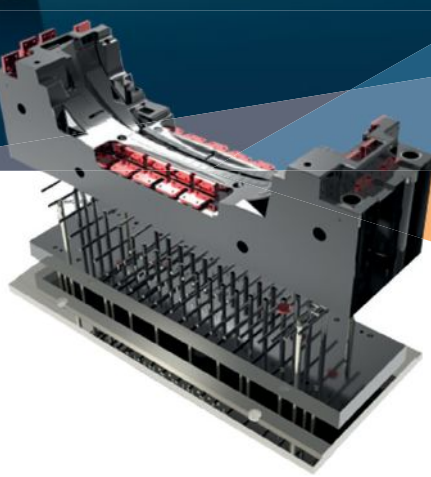

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A Conversation with ...
M&M Tool and Mold Inc.

Images courtesy of M&M Tool and Mold Inc.

New this year at M&M Tool and Mold is an Alliance ID1 Fiber Laser Welding System from Alliance Specialties. It is used to perform in-house mold repairs and engineering changes, not only for M&M Tool customers, but for its recently added sister companies, Forest Tool Inc. in Crandon, Wisconsin, and Rowley Tool & Die in Green Lake, Wisconsin. Together, the companies offer strategic tooling capabilities with the capacity for full project management from design to production.

What notable technology changes have occurred since M&M Tool's last Leadtime Leader Award in 2012?

Carl Jacobsen, tooling engineer/estimator: Our company added a quality lab four years ago. Anytime you're building a part for the customer, you want to be able to make sure that your steel matches your design file and be able to document it. If there are adjustments or windage that must be added to a part due to differential shrinkage, again, document where you started from and where you ended up on the steel measurements. By having a dedicated Zeiss Duramax coordinate measuring machine (CMM) in a quality lab, it allows us to keep this inspection process off the shop floor. We have another CMM, also a Zeiss Duramax, that is integrated in our electrode cell. In order to use it for anything else, we would have to break into the cell, pausing anything that may be going on at that time, which is undesirable. The company made a considerable investment to build this room, which is temperature controlled, and then they filled it full of inspection tools, including a Micro-Vu Sol 161 Manual Vision Measurement machine, so now we have a dedicated quality lab where we can do final inspections and record those critical numbers. For a company of our size, it is one of the nicest labs I've seen in the area. Our general manager, who is extremely talented in quality management, oversees the lab, plus we have three moldmakers who are trained on running the CMM. We want a fresh set of eyes on every project. Sometimes you can be too close to it and miss things. By having others who can inspect it for you who have not worked on the job, they will detect any issues.

In addition, our new Formlabs Form 2 desktop 3D printer also plays a key role in our quality program. Whenever possible, we 3D print the part, actual size or scaled down, based off the model, and we have found that having that printed part helps in the inspection process, especially if something doesn't look right. For example, the printed part will tell us that there is a wall missing or a radius is off. Maybe there is a hole that is not in the tool, but it is in the part. Sometimes it's difficult to see every detail by rolling a CAD model around on the screen, but if we have a part in our hands, that's huge.

We have also invested in an Alliance ID1 Fiber Laser Welding System from Alliance Specialties. This system enables us to per-

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mmtoolandmold.com

- Founded in 1995 by co-owners Marty Ciriacks and Mike Richard. In 2008, acquired by North Central Equity, LLC., then, in February 2019, acquired by an undisclosed manufacturing group as part of a strategic tooling business unit.
- Captured *MoldMaking Technology*'s Leadtime Leader Award honors five times: Three as Leadtime Leader winner (2003, 2004 & 2005) and twice as Honorable Mention (2007 & 2012).
- Specializes in engineering and building small- to medium-sized injection molds, up to 500 tons, including insert and multi-shot molds and prototype tooling. Added the manufacture of LSR molds and die cast dies in 2012.
- Currently employs 20 full-time team members, including 1 apprentice, plus three part-time drivers.
- Industries served include automotive, medical, agricultural, defense, recreational vehicle, consumer products and electronics industries.
- ITAR registered and QMED approved.
- Member of the American Mold Builders Association (AMBA).

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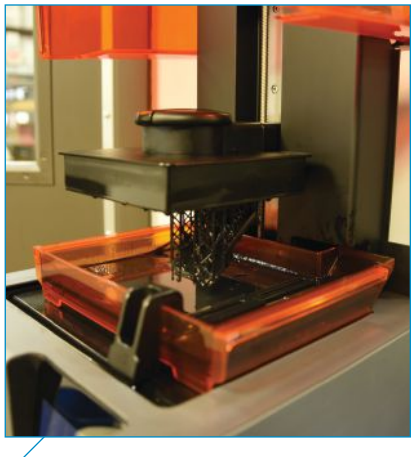
form mold repairs and engineering changes in house, for M&M Tool as well as for our sister companies, quickly and efficiently.

During the 11 years that an equity company owned M&M, how did that work out? Did they understand or have experience in the moldmaking industry?

Jacobsen: They had a person who had a sound background in machining and manufacturing. He did not know much about the intricacies of moldmaking, but there was also a general manager who was a tool and die maker and he was able to keep operations on the straight and narrow for them. They provided training for him and then also for the new management team after he left M&M Tool. We learned how to look at and query the financials of the business to see how we were doing, where improvements could be made and needed to be made. We monitored workflow month to month, too. We have heard some horror stories about moldmakers closing up because equity owners didn't understand the nature of our industry, and that could have happened to us if it had not been for our general manager and the tool and die maker overseeing things at the time.

M&M Tool recently became part of a strategic tooling business unit and now has two sister companies. How are you working together to serve customers?

Jacobsen: Our sister companies are Forest Tool Inc. in Crandon, Wisconsin, and the other is Rowley Tool & Die in Green Lake, Wisconsin. Forest Tool specializes in custom job shop machining and plastic injection molds. Rowley Tool specializes in progressive press tooling, weld fixtures, assembly machines and special material



This Formlabs Form 2 desktop 3D printer is among the many tools used by M&M Tool and Mold Inc. in its quality lab to ensure exactness in the moldmaking process. Whenever possible, the company 3D prints the part in actual size or scaled down, based on the model, to use as part of its inspection process.

A Zeiss Duramax coordinate measuring machine (CMM) is the centerpiece in M&M Tool's temperature controlled quality lab. It is the second Duramax the company has invested in. While this machine is dedicated to inspection of steel parts for molds to ensure every critical area matches the customer's design files and is documented, the second CMM is integrated with an EDM cell. The company, a five time Leadtime Leader Award winning shop, built its quality lab four years ago. Among many other pieces of inspection equipment is a new Micro-Vu Sol 161 Manual Vision Measurement machine.

handling. The objective with these acquisitions was to consolidate our strengths to create a dynamic force in the tooling industry and provide our customers with the capacity for full project management from design to production.

With each of the three companies in proximity, we can assist each other as needed. For example, at Rowley Tool they have a new, Makino V80S five-axis vertical machining center with travels of 59 by 47.24 by 21.65 inches. It is not a trunnion-style machine; the trunnion is in the head, so there are no clearance problems for working on larger workpieces, and we can benefit by having access to that. They have also purchased a new carbon-cutter and a new sinker EDM that are also great for larger jobs we cannot cut here. Rowley also has a certified welder on staff who can do things the other two shops can't. The alliance also gives us access to end-of-arm tooling design expertise, opening up a new service that we can provide for our customers. It's a collaboration. Each shop has certain strengths. Each shop has certain weaknesses or challenges, and with the three shops working together, those issues tend to get resolved. MMT

By Luke Pollock

VIDEO Access the related video under the Videos tab at *MMT* online.

Improving Finishing Operations with Circle Segment Cutters

Circle segment cutters are a concept in cutting tool design that allows for maximum production rates while still achieving excellent surface finish.

As machining capabilities become more and more sophisticated, mold manufacturers are moving toward machining parts as close to near net shape as possible in the milling process. Grinding and polishing can be time-intensive and expensive operations. The more we can shorten these processes, the more we drive manual work and cost out of an operation.

Traditionally, ball nose tools have been used to try and finish parts as close to near net shape as possible. This is accomplished by using the radius at the end of the tool and taking small stepover tool paths to minimize the scallop to an amplitude that fits within the surface finish specification. The advantages of this approach are that it eases programming, makes it possible to reach deep into cavities and allows the inclination angle to be versatile. The main disadvantage of using this process is that it requires many tool passes, resulting in very high cycle times.

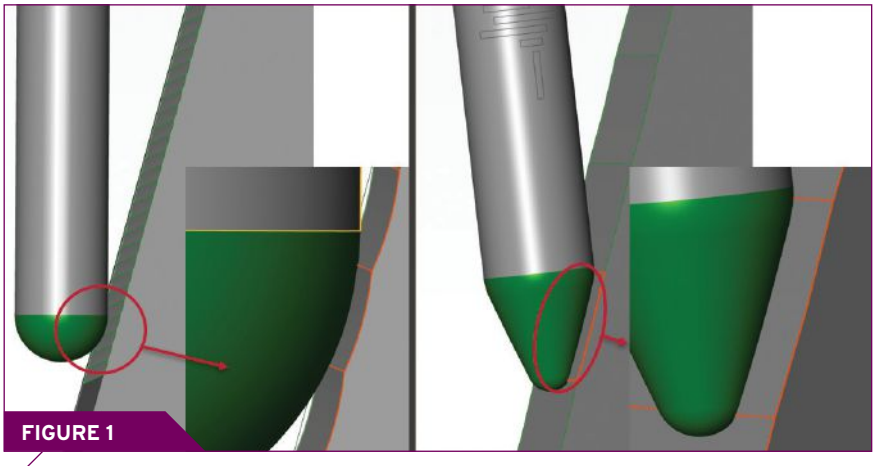
Another strategy is using a circle segment cutter (**Figure 1**) that comes in several different designs. The basic concept involves matching the tapered angle of the tool to the inclination angle at which the part is machined. This allows the use of a larger radius in the tool, which then machines a larger area while producing the same scallop size.

Circle segment cutters require a CAM software package that can program their complex tool paths and allow the tool path to work with the tool design. Many of today's most popular CAM systems already include packages for this machining strategy. It is also necessary to use a machine with at least five-axis capability that can incorporate the necessary tool paths.

Cutting It Down to Size

Here is a breakdown of the four main tool design concepts (**Figure 2**) that fall within this cutter category.

- **Barrel cutter.** A cutter with a barrel shape is considered the first concept developed for this new machining strategy. The barrel shape allows a mold builder to machine surfaces that must be undercut and that do not require a finished cavity floor.
- **Tangential form.** A tangential form circle segment cutter incorporates a taper built into the tool and a ball nose style point. However, the taper is not a straight cutting edge; instead, it incorporates a radius of up to 90 mm. These tools are ideal for contoured surfaces.
- **Lens form.** The lens form tools have an extreme angle geometry on the end of the tool that allows a mold builder to machine contour shapes that are flat as opposed to pocket shaped.



Figures courtesy of Walter USA.

FIGURE 1

A circle segment cutter allows a larger step over compared to a traditional ball nose tool while still producing good surface quality.

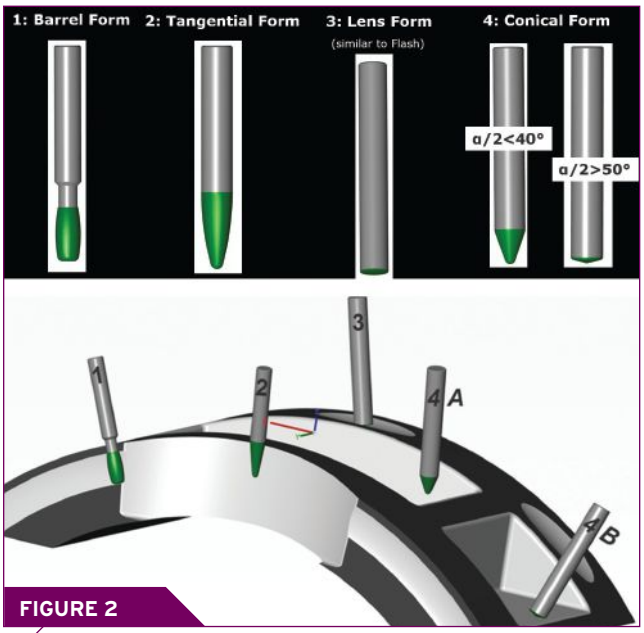


FIGURE 2

Barrel, tangential, lens and conical are four styles of circle segment cutters used in different applications.

- **Conical form.** Conical form cutters come in two types. The first type is for an inclination angle of fewer than 40 degrees. This tool is better suited for deep pockets and sloped surfaces. The second is for the larger inclination angles above 50 degrees. These tools are better suited for pocket floors and flatter surfaces. While the conical form tool may resemble tangential shapes, it can incorporate a much larger radius. These tools have a maximum effective radius of 500 mm versus the 90 mm of the tangential tools.

Point of Contact

The contact point between the tool and the part it typically in three different locations, with each one offering advantages and disadvantages (**Figure 3**).

- The contact could be at the tangent point on the tip, the point where the ball nose intersects with the taper. This produces the lowest cutting forces during the finishing operation. However, it is also the weakest point and will tend to wear quickly or possibly chip, reducing tool life.
- The contact point can also be in the middle of the effective radius. In this position, the tool provides the most stable cutting edge but increases the cutting forces and prevents finishing of the sidewall to the bottom of the pocket. This contact point position will require additional rework in the pocket corners.
- The third contact point is the location where the effective radius transitions to the straight part of the cutting edge, or the *end.* This contact point reduces the amount of material at the transition point, providing excellent surface finish. It also allows complete engagement of the cutting edge on the first pass. However, additional offsets may be necessary.

The ideal contact point is a combination of all three, which utilizes a dynamic adjustment to the contact point. When the tool contacts the part, the *end* location is used; then as the tool feeds to the bottom of the contour, the contact point transitions to the middle. And, as the bottom of the contour is reached, the *tip* contact point is made.

A dynamic adjustment to the contact point ensures that the advantages of each contact point are used to the fullest and incorporates the entire cutting edge into the process.

A dynamic adjustment to the contact point ensures that the advantages of each contact point are used to the fullest and incorporates the entire cutting edge into the process.

Cutter in Action

The chart compares a ball nose tool with tangential and coni-

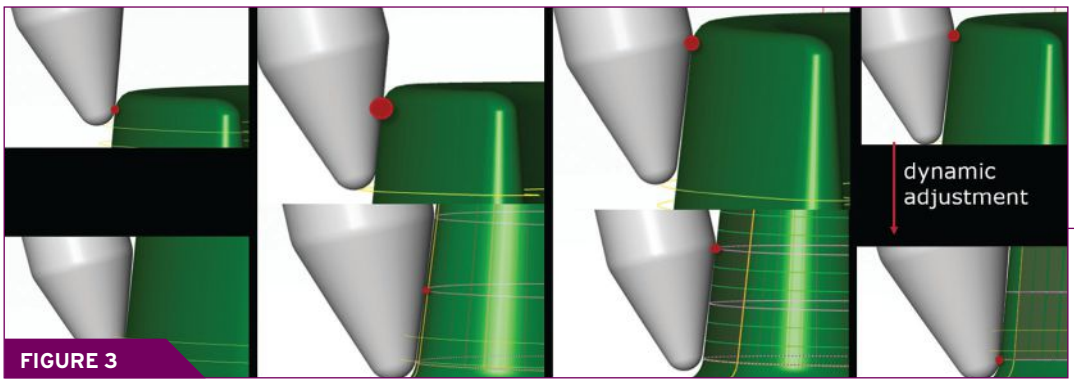


FIGURE 3

Although incorporating a dynamic contact point provides the best results, there are different options for using a contact point.

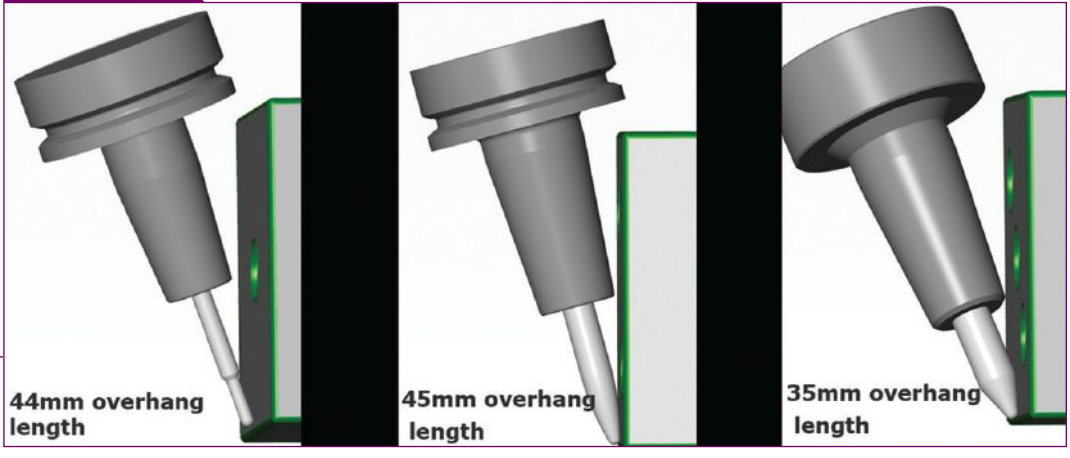
CHART

	Ball nose	Tangential	Conical
a_p	0.18 mm	1.2 mm	2 mm
Tool Rad	2 mm	90 mm	250 mm
Inclination Angle	20 deg	15 deg	α/2*
Hangout	44 mm	45 mm	35 mm
Tool Path Distance	55,916 mm	8,333 mm	5,000 mm
Cycle Time	20:56 min	3:07 min	1:52 min
Actual Rz	3.203	2.689	3.075

α = the included angle of the cutter body taper
α/2 = The approach angle of the cutter body (aka angle of attack) so the machining is positioned in the center of the large radius.

Larger tool radius increases the stepover distance (ap) and significantly improves cycle time.

FIGURE 4



The shape of the cutter effects the inclination angle and overhang length.

cal form circle segment cutters. The machined area was 10,000 mm² (100 by 100) with a required surface finish of Rz=2 mm.

The results show that the larger corner radius allows for a much larger stepover. In this case, the conical form tool had a stepover distance (ap) over 10x compared to the ball nose tool. This means more than a 10-time reduction in the overall tool path distance. Shortening the total tool path distance cut the cycle time by about 90% while still achieving a slightly better surface finish. The cutter shape also helped shorten the overhang distance, which helped improve rigidity and surface finish (**Figure 4**).

Circle segment cutters require the mold builder to match the cutting tool design to the parts he is machining and to understand which inclination angle he will use to machine the parts. However, when it all comes together, a shop can dramatically reduce cycle times and production costs. MMT

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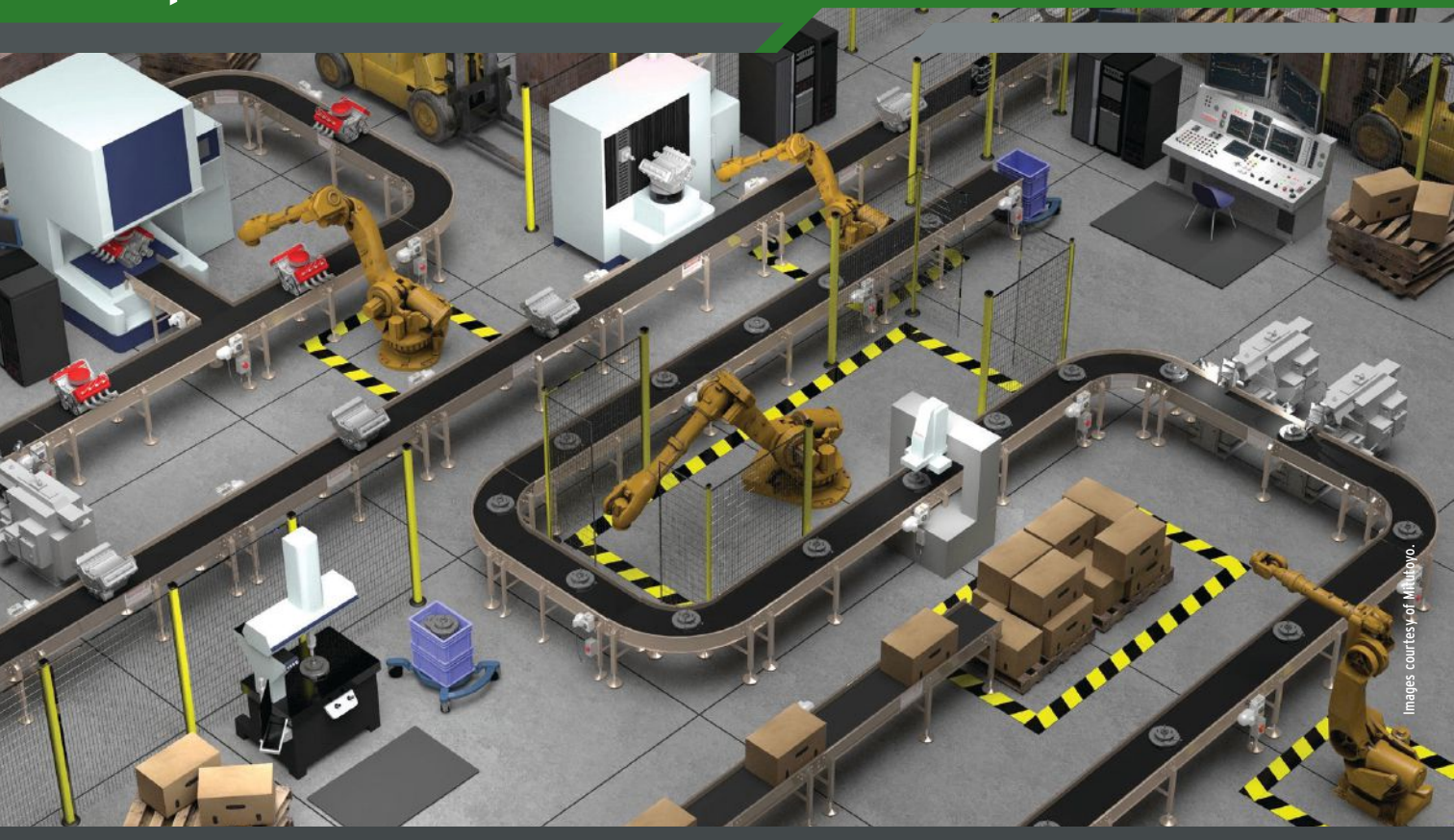
By Gene Hancz



Images courtesy of Mitutoyo.

Get Smart with Automated Measurement

Automated shop floor inspection and measurement technologies are leading mold builders to smart manufacturing.

Shop floor inspection can be a tedious or relatively innocuous part of daily operations, depending on the measurement and analysis methods shops use. However, automated measurement equipment solutions, comprising a CNC coordinate measuring machine (CMM), flexible part fixturing, and automated part handling systems, enable operators to quickly and easily change the configuration in hours versus days to accommodate completely different or redesigned parts on the shop floor during production.

The automation also eliminates the need for dedicated measurement equipment for each mold, mold component, or even molded part, while simultaneously streamlining the analysis and storage of measurement data into smart systems. A smart system combines computer-integrated manufacturing, high levels of adaptability, rapid design changes and digital information technology to achieve a system that monitors the entire process.

For example:

- Equipment status
  - Working time
  - Idle time
  - Maintenance
  - Process stopped, the attention required
- Equipment condition
  - Preventative maintenance
  - Potential component failure predictability

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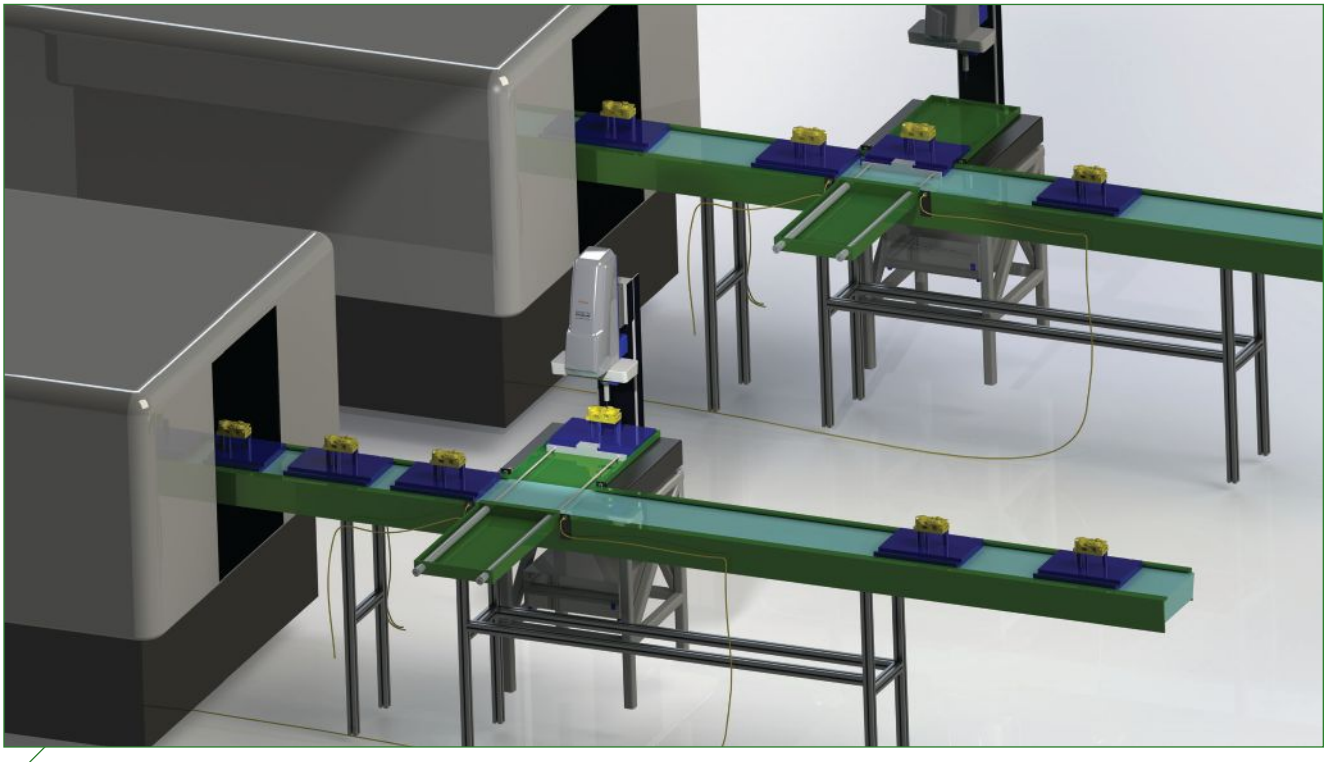


This fast, compact, lightweight and easy-to-mount CMM installs inline or near-line and provides fast, highly accurate measurements on small parts.

- Measurement data management
  - Monitoring for compliance with manufacturing design
  - Process control for constant adjustment feedback
  - Historical data archiving

Flexible, automated inspection solutions are integral to smart manufacturing for keeping up with efficiency and productivity demands placed on the modern mold builder.

Shops do not necessarily need to invest in a measurement machine on the shop floor, as some may have a minimal number of required dimensional inspections or a lower level of tolerance precision. However, for those shops that do, they should consider automated systems that have both easy setup and easy parts changeover capabilities.

Here is a breakdown of each benefit to help mold builders better understand how measurement equipment can coexist on the shop floor next to production equipment and improve the overall inspection process.

Flexible Inspection

Inspection is integral to providing part verification against design specifications based on product functional requirements. For mold builders, being able to accomplish measurement inspections on the shop floor instead of in a separate quality room eliminates part measurement backlogs, yields rapid turnaround of first article inspection for faster entry into production and avoids the need to physically take a part to measuring equipment not located near the production areas.

Using flexible inspection solutions for mold measurement instead of gauges that are dedicated to one specific mold or one machine to handle all parts, will reduce part changeover costs and save time in gauge modifications and measurement backlogs. These results are possible because it is not necessary to invest in new, dedicated gauges once "old" gauges become obsolete due to part redesign or replacement. Flexible inspection solutions that can be repurposed require only a fraction of the cost of dedicated gauges.

Flexible, automated inspection solutions are integral to smart manufacturing for keeping up with efficiency and productivity demands placed on the modern mold builder.

When investing in a flexible measurement machine, consider a system that can easily change from one part type to another in an hour or less, store inspection results and monitor its process and the machinery's condition. All of this is

accomplished by measuring multiple dimensions, typically 90% or more of the part's total dimensions as compared to dedicated gauging that usually measures considerably less.

When an operator can see real-time machine status (busy, idle, stopped, down) and real-time machine conditions (hours of use on components, planned maintenance alerts, potential failures from weak components), he or she can improve production planning and use of the measurement equipment's full capabilities. This data also reveals preventative maintenance needs, which heads off costlier repairs down the line and eliminates the unexpected downtime and loss of production associated with sudden machine breakdowns.

Elimination of Human Error

Mold builders run the risk of lost productivity when measurements are inconsistent due to human error and result in elevated costs per part. Flexible measurement solutions for parts inspection can help avoid any monetary repercussions as a result of this risk.

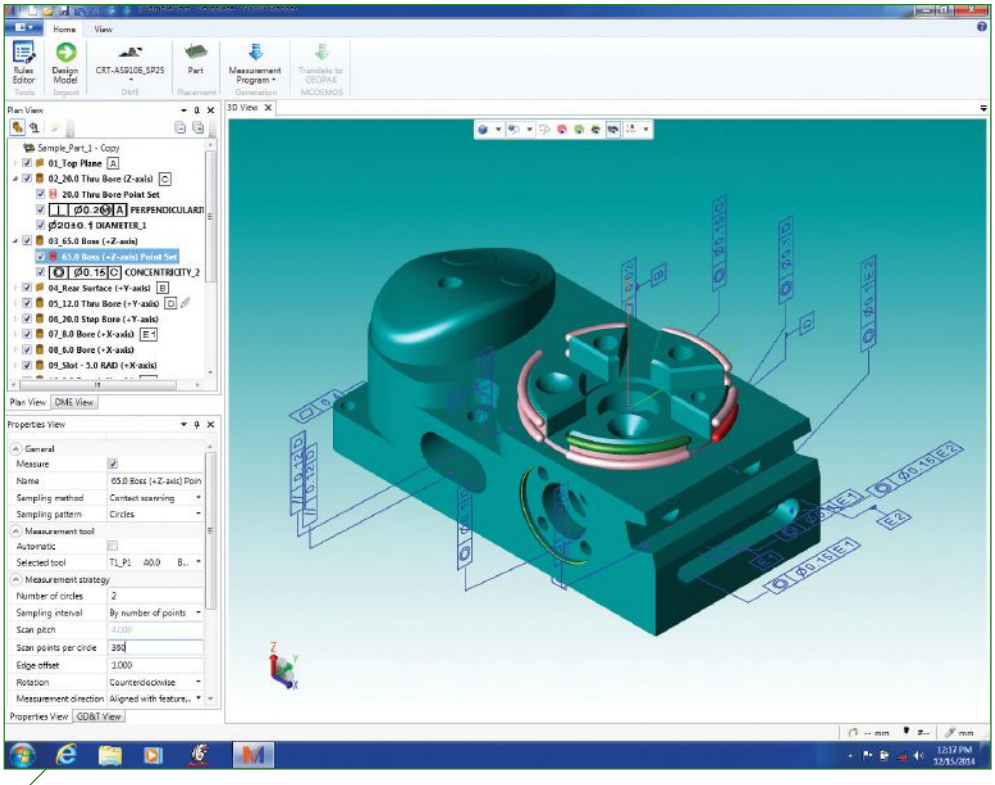
By adopting flexible, automated measuring equipment for inspection (such as a CMM with multiple sensor capability and programmable software), a mold builder can establish a measurement plan one time, then allow the measurement system to repeat the same routine on every part to achieve consistency across all parts produced. Also, mold builders can realize flexibility in part adaptation, consistent measurement *without* operator influence, greater speed, improved data management and tighter process control.

Inspection is integral to providing part verification against design specifications based on product functional requirements.

Smart Manufacturing Support

Smart manufacturing systems are gaining traction across all industries, but it takes the right technologies and equipment to accomplish. For example, flexible automated measurement that an operator can easily modify when responding to altered circumstances or conditions. Basically, the operator can let the machine make instant adjustments to production equipment, or he or she can perform the action. In either case, using smart technology means the process can be control-monitored to prevent an out-of-tolerance from occurring. This adjustment flexibility also eliminates the need to

Mold builders run the risk of lost productivity when measurements are inconsistent due to human error and result in elevated costs per part. Flexible measurement solutions for parts inspection can help avoid any monetary repercussions as a result of this risk.



3D modeling and CAD files with embedded tolerancing data helps eliminate operator error and provides real-time feedback for higher throughput without loss of product quality.

manually measure multiple dimensions or characteristics, which can take minutes, hours or days and lacks real-time feedback.

Also, even if a facility has embraced automated measurement, the use of only one measuring machine can still create backlogs if the ratio of operations to finished part is large enough. So, to truly support smart manufacturing throughout the manufacturing process, many shops are starting to use *multiple* automated measuring machines in one production room.

This move to multiple machines includes CAD that historically required the operator to select and input the points to measure, the order and the tolerances. However, most of today's CAD systems support PMI (Product Manufacturing Information) and include embedded tolerancing as an integral part of the CAD file, which the computer can read beyond producing just an image or picture.

Given that most CAD files have a graphical representation for printing purposes (which is not readable by external systems that generate programs for measuring equipment), a CAD file with PMI for the tolerancing contains the information in an embedded database that the external system can easily read to obtain dimensional characteristics (the design nominal, upper and lower specifications).

The data is embedded in the CAD file based on pre-established rules by size, customer, etc., so the operator can now program this CAD in conjunction with the automated measuring machine. This further supports smart manufacturing and reduces operator errors due to manual input.

Until recently, CAD files contained design specifications only as an image or picture, which could not be read as dimensional data with an external system. While visually readable to humans, it was not possible to transmit or interpret the image electronically. Flexible, automated measuring machines support data collection for machine tool feedback and automatically adjust the process to reduce scrap and rework, which allows mold builders and molders to achieve the highest throughput for quality production.

These benefits allow the user to send the specified measured dimensional result to machine-tool-capable machines that can make corrections to tooling. Also, integrated automated data collection means measuring machines can "talk" to all the production equipment on the shop floor, which not only benefits inspection and measurement but every operation that contributes to the creation of the final product. MMT

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David Miller, President, Dynamic Tool & Design

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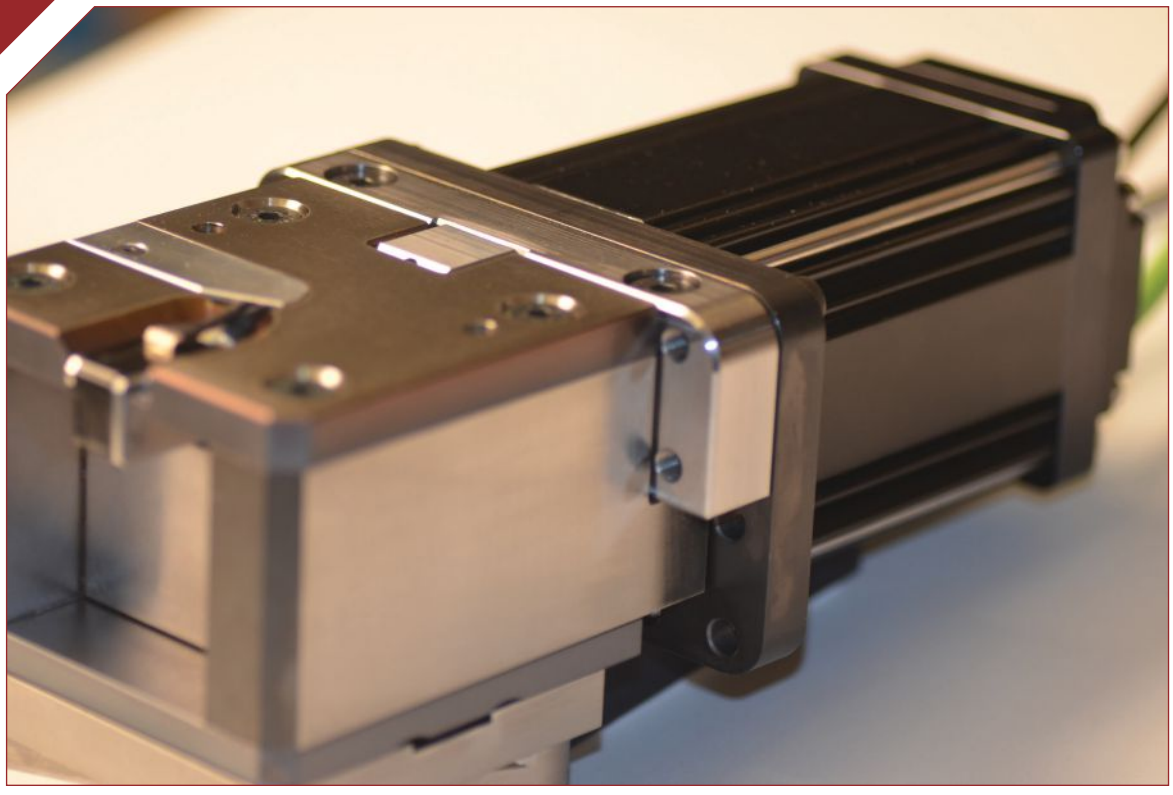
By Bill Rousseau

Looking at Electric Actuation

Hot runner valve gating has always offered pneumatic and hydraulic actuation, but today electric is an alternative to consider.



Images courtesy of Synventive.

Making an informed decision about adopting any new technology requires a solid understanding of the pros and cons, but when it comes to choosing the proper actuation method, the pros and cons get a bit more complicated as they vary across the supply chain—the mold builder, the molder and the end-user of the molded parts.

Molder Matters

Molders see many benefits with electrically-actuated hot runner systems, including the clean, quiet, energy-efficient electric actuators and the elimination of the risk of oil leaks due to the removal of hydraulic fluid from the process. Energy efficiency is another benefit. Hydraulic power requires large pumps with electric motors that continuously run, whereas electric actuators require only a small fraction of that power.

Electrically-actuated hot runner systems offer easy, precise control of valve pin positions, acceleration, velocity and stroke.

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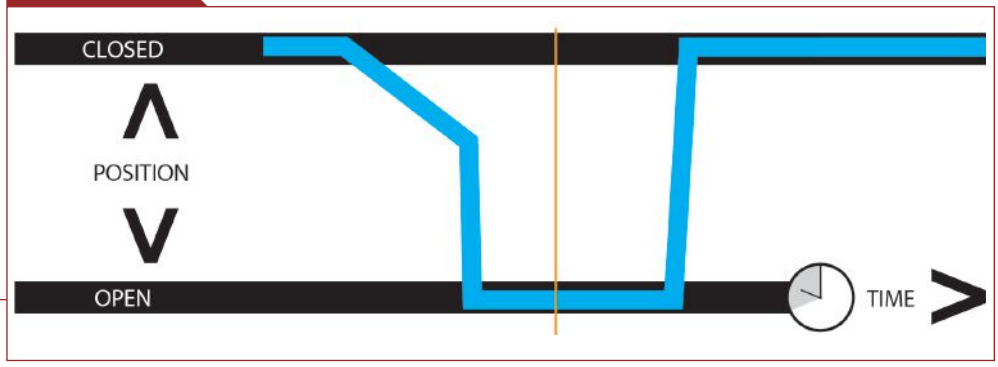
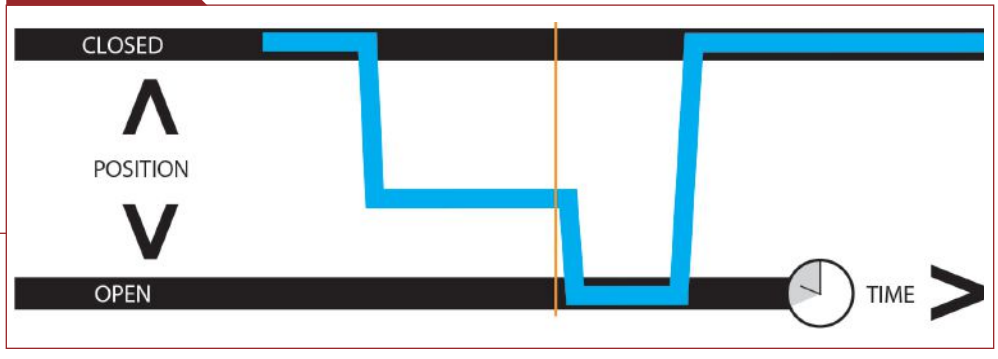
FIGURE 1



Pin opens at a reduced speed for the first few millimeters.

FIGURE 2



Pin opens quickly to an intermediate open position where it stops and stays until the screw reaches the switchover position.

Figures courtesy of Synventive Molding Solutions.

Electric Selection Criteria: 3 Questions to Ask

Asking questions up front is important when selecting the right electrically-actuated system.

1. How much steel must be removed from the back-plate to house motor assemblies? A common pitfall of some electric systems is the cut-out required to house the electric motors and the device that links the motors to the valve pins. Some electric systems require an excessive amount of steel removal, which not only adds machining costs but can weaken the mold. Also, in some cases motor assemblies mount to surfaces with critical tolerances. Machining to these tolerances adds more costs, and failure to hit these tolerances may cause premature wear and failures during production.
2. How complex is the mechanism that takes the movement from the electric motor and converts it to be able to move the pin? Simpler is better when it comes to these types of devices. Even if the electric motors are thermally isolated from the hot runner system, they generate their own heat when running and moving a load.
3. Does the system have a way to prevent the motor from overheating? Motors allowed to overheat can fail over time, requiring expensive repairs that may be required when production is critical.

Ask these questions to understand your investment and ensure you get the system that is right for your mold. Whether you are a mold builder, a molder or the end-user of the molded parts, electric actuation may be the answer.

A key benefit is the higher level of repeatability, both drop-to-drop and shot-to-shot. With hydraulic actuators and pneumatic actuators to an even higher degree, there is a significant lag time between when the signal is sent and when the pin starts to move. This lag time is an aggregate of many smaller delays, each with its own variability. Therefore, the overall lag will also have variability. Testing shows that the average lag time of a pneumatic actuator is about 0.350 seconds versus an electric actuator at about 0.002 seconds. The shorter lag time associated with electric actuators leaves little room for variability increasing repeatability. When the timing of the valve gates is critical, this improved repeatability can increase consistency with far less scrap.

Electric actuators are consistent and responsive from the very first shot, unlike hydraulic systems, which require time for the hydraulic fluid to reach a temperature equilibrium. Applications with critical pin timing may require adjustments to maintain part quality once the hydraulic fluid heats up and the valve pin speed changes. Electric systems do not require this adjustment as they perform the same from the first shot of the day to the last shot of the day.

The greatest benefit is complete pin control. With an electric actuator, movement is no longer restricted to a

simple open and close at full speed. Now the molder can control the speed, acceleration and stroke of the pins, and even program complex movements to manipulate the filling and packing of the mold.

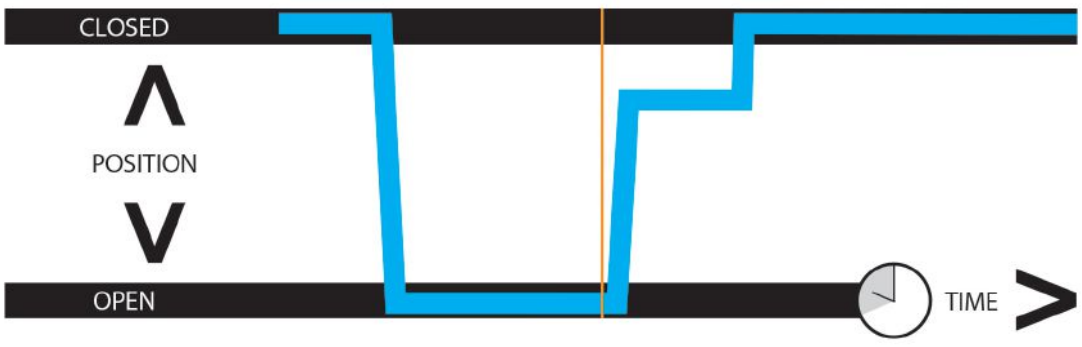
Although the number of pin movement variations is infinite, there are three common types used to manipulate melt filling and packing. **Figures 1**, **2** and **3** illustrate pin position versus time. The vertical orange line indicates the velocity/pressure switchover position.

Figure 1 shows the pin opening at a reduced speed for the first few millimeters. Once the pin reaches a specified distance, it continues opening at full speed and then closes at the end of the hold. This type of movement is commonly used on delayed pins during cascade molding because pressure builds up behind the delayed gates. If those delayed gates are opened at full speed, there is a sudden release of pressurized melt into the cavity, which causes an abrupt flow front acceleration, resulting in a line of differential gloss on the molded part. Controlling the opening speed of the pin, as shown in **Figure 1** will control the release of pressurized plastic, eliminating the sudden acceleration of the melt front and the cosmetic defect that it creates.

Figure 2 shows the pin opening quickly to an intermediate open position where it stops and stays until the screw reaches the switchover position, which reduces the amount

This controller for hot runners with electric actuation yields precision control of each pin to help improve part quality.

FIGURE 3



Pin opens quickly to full stroke as it would in a conventional process.

of material flowing out of this gate during the fill. At switchover, the pin opens fully to allow for unrestricted packing. It then closes at the end of the cycle. This type of profile balances family tools or reduces the amount of flow from specific nozzles when filling a complex geometry or moving a weld line.

Figure 3 shows the pin opening quickly to full stroke, as in a conventional process. At switchover, the pin closes part way and remains there until the end of hold and then closes fully. This type of profile can be used to restrict packing pressure to the area of the part near this gate. Family tools with different wall thicknesses or complex parts with areas that easily flash and other areas that need significant packing pressure can benefit from this type of profile.

The greatest benefit is complete pin control.

Multiple flow manipulation types can be programmed into a single pin move, which allows the shop to balance extreme family tools, fill complex geometries and reduce clamp force requirements.

Mold Builder Bias

Designing and building a mold with an electrically-actuated hot runner system can yield some significant cost savings, as gun-drilled hydraulic or pneumatic lines are no longer necessary. The slots required to run the wires from the edge of the mold to the motors are much smaller than traditional hoses, saving machining time. Mold assembly also takes less time because the electric motors plug into the junction box, eliminating any necessary plumbing to run air or hydraulics.

Electric systems can also save time during the initial mold sampling, which is often the mold builder's responsibility. A conventional system requires valve pin adjustments when the mold is out of the press if they are not set perfectly, which often demands an additional sampling to verify pins are properly set. On many electric systems, you can adjust the setting of the pins directly from the controller between shots, eliminating the need to pull the mold to make changes.

Lastly, electric motors are maintenance-free, unlike the seals of hydraulic or pneumatic pistons that operators must replace periodically.

End User Effects

The end-user of the molded parts also benefits from the use of an electrically-actuated hot runner system. For example, now that the molder can manipulate part filling and packing, part cosmetics are improved, dimensional tolerances are tightened and warpage is reduced.

Per-part cost savings can also be achieved with an electrically-actuated hot runner if a shop uses a family tool to produce parts, for example. Or, the scrap rate is reduced, which may not be possible with conventional valve gating. Some electric systems will also record the pin movements from every cycle. So, if a bad part reaches the end-user, historical data can help identify what went wrong and potentially quarantine other parts of concern.

Whether you are a moldmaker, a molder, or the end-user, electric actuation may be the answer you have been looking for. With so many benefits to offer there is little doubt that popularity of electric actuation will steadily grow. The question is will your company be leading the trend or following? MMT

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By Scott Paul

Exchange Rate Policy Impact on Manufacturing

An overvalued dollar can mean trouble for the goods-producing sector of the economy.

The value of the American dollar needs more attention. Sure, President Trump tweets about it (along with interest rates) from time to time, but what does that conversation mean to our manufacturing community?

It means plenty. If the dollar is overly strong—as it has been for most of the past 20 years—it can dampen U.S. exports and make imports cheaper in the American market. We've seen those trends reflected in the data; the U.S. share of global exports has dropped over the past two decades, and import penetration into American markets has increased. That means American manufacturers aren't selling as much as we should abroad and face more import competition than we should be here at home.

So we know there's a problem, but before we dive into how to fix it, let's talk about how we got there. For years, our economic policymakers in every administration, Democratic and Republican, have supported a "strong dollar" policy. There's a structural reason why that's the case: the U.S. dollar is essentially the world's reserve currency, and a strong dollar has powerful constituencies from Wall Street banks to big-box retailers that stock their shelves with imports.

A strong dollar sounds good. Who wants weakness, after all? However, a dollar that is overvalued can mean trouble for the goods-producing sector of our economy. There are a few issues at play here, and all affect exchange rates.

First, the policies our Treasury Department and Federal Reserve Board are setting on interest rates, borrowing and the money supply. Those are complex problems to manage, and one feature of our public system of finance is that it's designed to be separated a bit from pressure from Congress or the president.

The U.S. dollar is essentially the world's reserve currency, and a strong dollar has powerful constituencies from Wall Street banks to big-box retailers that stock their shelves with imports.

Second, the currency policies of foreign governments. This is a significant issue, too. There is no question that over time, countries such as Japan, South Korea, China and others have kept their currencies artificially low to gain an advantage in trade, resulting in export-led growth and massive trade surpluses. This is known as "currency manipulation," and it has harmful effects on American manufacturing and jobs.

And so the question becomes, what to *do* about this? It's been exceptionally difficult to hold these countries accountable, and some analysts even deny there's still a problem. Defenders of the status quo argue that countries like China are no longer manipulating their currencies to discount the price of their goods in the global market. And while it is true that China takes an occasional break from undervaluing its currency, manipulation has been its habit over the past two decades. Some economists have called it the world's most protectionist trade policy tool. Others say it's one of the biggest contributors to our trade deficit with China. Others still tie it to the loss of millions of American manufacturing jobs.

Some economists have called it the world's most protectionist trade policy tool. Others say it's one of the biggest contributors to our trade deficit with China. Others still tie it to the loss of millions of American manufacturing jobs.

It's for these reasons that Congress is roused every few years to consider a rule that would punish countries for artificially depressing their currencies. An anti-currency manipulation bill beat a Senate filibuster in 2011, and another passed the House of Representatives with more than 300 votes in 2010. None of those currency bills has ever made it to the president's desk because every time, the "we'll cause a trade war" notion comes up.

Yet every time, China has responded by letting its currency rise closer to its natural equilibrium. It would appear that threats of legislative or policy action work. In the 2016 campaign, candidate Trump took dead aim at China's perennial currency undervaluation. Trump vowed to designate Beijing as a currency manipulator early in his presidency. However, it took more than two years for President Trump to make good on his promise, and even then, there have been no direct consequences yet for Beijing.

Instead, what the president has done is impose tariffs on a massive amount of Chinese imports. It's a necessary step, given the egregious list of predatory practices—including hacking, espionage, and cyber theft—documented in a lengthy trade investigation of China's state-owned enterprises. Here's the problem, though: Since April 2018, Beijing has reduced the value of its currency by 10% against the dollar, and that has more than offset most of President Trump's tariffs. As a result, the U.S. trade deficit with China hasn't dropped significantly. Calling the Chinese government a currency manipulator is one thing. Making that label have consequences is another. MMT

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By Cynthia Kustush

STEM Camp Girls Get an Early Education About Moldmaking

Junior-high-school age girls get an overview on moldmaking from women and men who are in it.

Seeing and experiencing manufacturing firsthand is almost always the most effective first step in engaging young people in a discussion about rewarding careers in moldmaking. Janler Corp. (Chicago, Illinois) understands that very well and seized an opportunity to invite 12 girls, all middle school students, to tour its facility.

The girls were participating in the Camp GADgET (Girls Adventuring in Design, Engineering and Technology) summer program where, for two weeks, they get hands-on exposure to the world of engineering and manufacturing. Part of the program, which is put on by the Triton College Engineering Technology Program, includes visiting various manufacturing companies in the Chicago area, of which Janler was one.

Proving what a small world manufacturing can be, Chuck Klingler, vice president of sales at Janler, says the idea to do a tour with Camp GADgET stemmed from his sister, Janler President Carol Ebel's extensive involvement with the Technology and Manufacturing Association (TMA) in Schaumburg, Illinois, and his own active involvement with the American Mold Builders Association (AMBA) Chicago Chapter. "Triton was conducting a Camp GADgET program at Lake Park High School (Roselle, Illinois), and we have worked with Assistant Principal Ian Smith via TMA programs in the past. We met Antigone Sharris, who is Triton's Engineering Technology Program Coordinator, in the student pavilion at IMTS2016 where the Chicago AMBA was exhibiting. She created Camp GADgET," he says. Add to that the fact that the Chicago AMBA had awarded Triton's GADgET program with scholarship money to support its endeavors, and that Klingler was named the Society of Plastics Engineers (SPE) 2018 Mold Maker of the Year, which came with a $500 scholarship that he gifted to Lake Park High School's new Engineering and Precision Machining Technology class, and the world seems even smaller.

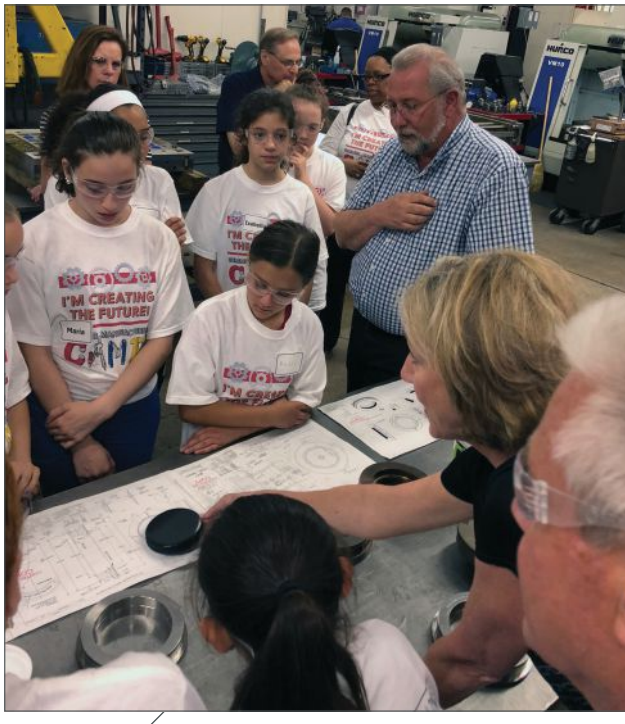
Janler President Carol Ebel and her brother Chuck Klingler, vice president of sales (both pictured here), hosted a comprehensive tour of Janler Corp., their family-owned mold manufacturing plant in Chicago, Illinois, to show middle school girls what moldmaking is and the many career options there are in the industry. The girls were participating in a program called Camp GADgET (Girls Adventuring in Design, Engineering and Technology) where, for two weeks, they get hands-on exposure to the world of engineering and manufacturing.

Getting GADgET Going

Sharris created Camp GADgET in 2011. "I did it because I saw very little traction with female engagement in tech programs and, since I saw way too many males in the tech programs in the high schools, I knew I had to do something to help change that," she says. To date, more than 200 young ladies have participated in the program,

and in the summer of 2019, GADgET had participation at Triton College, College of DuPage in Wheaton, Illinois, and at Richard J. Daley College in Chicago. Sharris limits the class size to about 16 girls so that each participant gets the best possible experience. She calls GADgET an unstructured structured learning environment because she begins the camp with a few structured activities for the girls to do, but then they are on their own to create their own maker projects, receiving guidance when needed.

"Academia is so heavily structured that the kids are not allowed to be creative because teachers aren't allowed to be creative," Sharris says. "Everything becomes cookie cutter turnkey and the kids don't really connect anything they have learned to the real world." She believes hands-on learning is the best way to teach and bring life to STEM-related (Science, Technology, Engineering and Manufacturing) curricula. In recent camp programs, participants performed hands-on activities like designing electronic devices, learning how to weld, building robotic arms and more. Janler Corp. is one of several companies that have opened their doors to the "campers," as Sharris calls them, to further expose them to a variety of manufacturing environments and career options.



During their tour of Janler Corp., the 12 young ladies of Camp GADgET learned all about moldmaking. Here, Carol Ebel and Janler team members explain what blueprints are and how they are used. Ebel offered up real-world examples of products, like the jar cap shown here, so that the girls could relate to products they use at home and see how the blueprint design helps with manufacturing the cap and other familiar items.

Girls on Tour

It was a warm, sunny summer day when Lake Park's Smith and Triton's Sharris arrived at Janler with their group of very curious young ladies. Joining them were Renee Nehls, a tooling engineer, former mold designer, and then Chair of the SPE Mold Technologies Division, and Dan Kuch, area account manager, Midwest, at Hasco America, to lend additional perspectives. "Hasco has been a partner and contributor to youth education and information about the plastic industry," Klingler says. "Dan offered to assist us and speak to these students, and we gladly accepted his participation. Renee is very actively involved with youth and is passionate about female participation in manufacturing. She speaks with authority and from the heart. You feel her intensity and you believe her message." *MoldMaking Technology* was also on hand to cover the event.

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Educating
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Reopening May 1st, 2020
Daily 10:00am - 5:00pm

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Both Ebel and Klingler greeted the girls outside the front entrance to the Janler plant, providing an overview of what they were about to experience. As expected, none of the girls knew what moldmaking was, but they were excited to see and learn about it. The GADgET Girls toured every department of Janler Corp., from the engineering department to EDM to CNC machining and production.

> It's important to understand the impact it can have, meeting someone like Carol, or myself, who has been in the trenches.

"Their eyes were wide open, and they had many good questions and comments that confirmed they were engaged," Klingler says, explaining how interested they were to see how molds are designed in 3D on a computer. When they saw blueprints and actual molds and could match the molded product to the prints and mold cores, they further understood how everything comes together. Sharris adds, "They became aware of how things are made. We don't have enough education on this front. They were not focused on moldmaking, but simply on *making*. There isn't enough *making* going on with our youth."

The Janler team made sure to provide examples of mold cavities and cores for products the girls recognized, like plastic containers and lids for candy, nuts and peanut butter-filled pretzels they buy at warehouse stores, and threaded caps for bottles—even tubes for lipsticks. The girls observed as plastic parts were molded, inspected and boxed, learning about that process from Alan Klingler, vice president. "We think it really starts in the molding and production of plastic parts. Everyone can see a component, and understand where and how it may be used, but then to see the moldmaking process that is needed to produce an injection mold so that component can be manufactured really opens their eyes.

"The size and speed of the molds and molding machines fascinated these young girls," Klingler adds. "I think they were also intrigued by the technology that is used in moldmaking, and by seeing several young people working in our shop as machinists and moldmakers."

Sharris says she knows the girls were impressed by what they saw at Janler, but she wants to see these experiences go deeper. "I think it is tough to show the mold industry to youth because it is all 'hidden' activity (inside the machine). I would like to see companies offer some hands-on time with a safe project that allows the youth to engage with the making process," she says.

Janler concluded its tour by gathering the young ladies in the company's conference room where they learned about mold components from Dan Kuch of Hasco America. Renee Nehls, a tooling engineer, former mold designer, and then Chair of the SPE Mold Technologies Division, also described her experience as a woman mold designer, telling them that working in moldmaking is a unique opportunity if they enjoy mechanical things and can visualize in 3D.

Girl to Girl

At the conclusion of the tour the girls were offered refreshments and bags with goodies to remember their experience. They gathered around a conference table where Hasco America's Kuch let them hold and pass around a variety of mold components and learn how they are used. Nehls described her experience as a woman mold designer. "I told them that working in moldmaking is a unique opportunity if you are able to visualize in 3D," she says. "If you enjoy the mechanical sides of things, where part A interacts with part B, which activates part C, and that is logical for you and you enjoy working on computers then this is a viable vocation. Running 3D software requires an understanding of the way software thinks if you are going to capitalize on its capabilities."

Nehls points out something that Carol Ebel said to the girls that she felt was very powerful. "She was talking about problem solving and that skill being a key attribute for moldmaking. She really hit on something very important when she said that," Nehls says, adding that it was such a benefit for the girls that they were able to see and interact with Ebel, a woman who has received several awards for her dedi-

cation to the industry and who has accomplished so much leading Janler Corp. "It's important to understand the impact it can have, meeting someone like Carol, or myself, who has been in the trenches."

Measuring the Impact

"Janler did a great job of relating to the students in an age appropriate way, too," Nehls says. "They didn't talk down to them and they didn't talk overly technically, which is so important because this was their first exposure to what a mold is and what it does." She says both Klingler and Ebel are clearly passionate about moldmaking and sharing their love of the industry with all students. "It was a very good tour and I would join them again if they asked me to."

As it happens, Janler continues to work with local schools and hosted a tour for Lake County College not long after this feature was written. Asked about the feedback Janler received from Lake Park High School and Camp GADgET, Klingler says he received a note from Ian Smith that said, "Thank you so much! The students were very amazed and appreciative of everything they saw. They continued to comment on it throughout the day Janler was mentioned, as well as the things they learned while there, over and over again. I think the impact on them was bigger than we know."

At the conclusion of each Camp GADgET experience, the young ladies are asked to create a PowerPoint presentation in which they present the product that they designed and created over the course of the two weeks. They share what inspired them to make the product, the design and prototype, materials used (including costs), equipment used and the product itself. On the final slide, they sum up their Camp GADgET experiences.

Nicole, a camper who has participated in the GADgET Girls program before, posted in her presentation that "going to Janler was fun. We got to see how molds are made and how you create an idea on the computer and then make it out of metal. They make plastic cup caps and watching them being made was cool."

A fellow camper, Emma, said the following in her presentation: "I have also seen how molds are created at Janler and how the people there are always working hard and coming up with new machines."

Sharris says, "Overall, most youths under age 18 are not even allowed in such a place, so simply seeing a production facility is a new thing for them. This was such an eye-opening experience to have the girls see the inside cavities they showed at the facility and show the products (the lipstick tubes were a standout). Janler gave the girls real examples that they can relate to, not widgets. This is important so the girls can relate what the facility makes to what they see at home."

In her thank you note to Janler, Sharris said, "Thank you for bringing in so many people to speak with them, for the hands-on explanations and demonstrations of the manufacturing process, and for all the goodies! I've visited many companies with student groups, but today's visit tops them all." MMT

FOR MORE INFORMATION

American Mold Builders Association / 317-436-3102
info@amba.org / amba.org
HASCO America, Inc. / 877-427-2662
bclark@hasco.com / hasco.com
Janler Corp. / 773-774-0166 / nospina@janler.com / janler.com
Society of Plastics Engineers, Inc. / 203-775-0471
seoderwald@4spe.org / 4spe.org

X-Cell Tool and Mold

MMT LEADTIME LEADER AWARD WINNER

Since *MMT's* feature on X-Cell appeared in the June issue, how has the company advanced its quality program?

Brian Dippel, operations manager: X-Cell has completed the internal audit and stage l of the AS9100D implementation process. Stage ll of the audit was completed in November and has enabled X-Cell to incorporate the AS9100D aerospace quality standard. With the actual certification on the horizon, X-Cell has already received P.O.'s from a new customer. We are working together to develop this new relationship, and the AS9100D efforts are supporting us through the process.

With the purchase of a second five-axis Yasda, combined with the requirements for the new standard, come tighter procedures for lot traceability, inspection documentation, documentation for material handling, material certifications, and required job training for individuals X-Cell will be in a strategic position to take on the stringent requirements of aerospace work.

International Traffic in Arms Regulations (ITAR) registration is in the future, and X-Cell is taking the necessary steps to ensure we are compliant with the regulation. We are still working with consultants to help guide our implementation efforts because with this standard comes great responsibility and great liability.

Image courtesy of X-Cell Tool and Mold.

Leadtime Leader shop X-Cell Tool and Mold recently purchased this new Zeiss Contura with a Vast XT probe system and Calypso software to be able to bring more 3D reverse engineering jobs in house and develop a useful, properly defined model from an existing piece of steel. X-Cell also hired CMM Expert John Zadorozny, pictured here, to manage all inspection processes.

Has X-Cell purchased any equipment that will support the new certifications and the overall goal of meeting customer requirements?

Dippel: We have added another coordinate measuring machine (CMM) to our quality lab in the form of a new Zeiss Contura with a Vast XT probe system and Calypso software for programming it. With the additional capabilities of this CMM, X-Cell will be able to bring more 3D reverse engineering jobs in house versus relying on an outside source to get it right. It is time consuming to have multiple phone calls, web meetings and re-scans to ensure the quality of reverse engineering supplied by an outside source. We can inspect and test the output results of the reverse engineering and focus on critical areas like shutoffs to ensure they are correct.

With the new CMM, the data collection is fully automated. Our next challenge is to create a translator, so to speak, that will be capable of taking the Zeiss output file and auto populate our own, conditionally formatted quality reports as well as our customer-supplied quality reports. This will all but eliminate the need to use a data entry clerk to prepare these types of reports before sharing with our customers.

Also, our new building addition is complete, and we have taken delivery of a new Wintec t-win 6500 (650-ton) servo hydraulic molding press with an iu 4800 injection unit for sampling our higher cavitation consumer product tools. The machine (Wintec is a subsidiary of Engel), is equipped with a five-axis NEXiA 800S robot from HYRobotics and is used for part removal to simulate the handling methods of our customers. We have already used this Wintec machine, robot and the Zeiss CMM to validate two higher cavitation consumer product tools.

What about personnel? Has X-Cell hired new employees to help manage these new capabilities?

Dippel: We hired John Zadorozny, a gentleman who is a 12-year veteran of running Zeiss CMM equipment. He will help us speed up the inspection process, automate it and make it more reliable in terms of accuracy and consistency. Additionally, with John running the Zeiss, reverse engineering is now completely managed in house, so those web meetings or phone calls are no more. Now it is a five-minute conversation with John at the CMM to review and plan the next steps needed to develop a useful, properly defined model from an existing piece of steel.

On the molding side, we recently hired another graduate from the Penn State Erie plastics program. He is now enrolled in the RJG Master Molder l & ll certification course and will begin training in December.

This further supports our efforts for a sound approach to developing centerline processes for molded parts to ensure accurate quality data and ultimately reduce rework or grooming timeframes. MMT

EDITOR'S NOTES

For more information on how to enter our Leadtime Leader Awards program, or if you have a question for any of the Leadtime Leaders, please email Christina Fuges at cfuges@gardnerweb.com, or visit short.moldmakingtechnology.com/leader

News and Reviews from **Industry Organizations**

American Mold Builders Association (AMBA)

Beginning February 2, AMBA will accept nominations for its prestigious industry awards: AMBA Mold Builder of the Year Award and AMBA Tooling Trailblazer of the Year Award. Visit the AMBA website to download and submit nomination forms. On February 7, the AMBA will host a State of the Industry webinar (free to AMBA members). AMBA Executive Director Troy Nix will break down the findings from the AMBA 2020 Business Forecast Report, the recent AMBA 2019/2020 Wage and Benefits Report and the 2020 MAPP State of the Plastics Industry Report. Register online at amba.org.

Save the date: The AMBA Conference 2020—Ready, Fire, TEAM!—will be held on April 29–May 1, in Indianapolis, Indiana. Attendees will be focused not just on building a team, but on how building the right team the right way can lead to consistent success. The conference will kick off with a pre-conference session exclusive to AMBA's Emerging Leaders that will focus on leadership development and roundtable discussion by functional area.

Since its last update, the Chicago Chapter of the AMBA held its Fifth Annual Supplier Night, which raised over $17,000 for its work in promoting mold manufacturing careers. In May, the chapter celebrated its second successful year awarding $15,000 in grant funding to area high schools to assist them in purchasing supplies and tools for manufacturing curricula related to moldmaking.

In addition, Chicago Chapter members continue to be very active visiting schools, participating in career fairs and hosting plant tours to promote mold manufacturing careers to students, parents, teachers and administrators.

Image courtesy of the American Mold Builders Association.

Beginning February 2, 2020, AMBA will accept nominations for its prestigious industry awards: AMBA Mold Builder of the Year Award and AMBA Tooling Trailblazer of the Year Award. Pictured here is Tim Myers of Century Die Company (center), which was awarded the AMBA Tooling Trailblazer of the Year Award for 2019, along with Don and Glenn Starkey of Progressive Components, award sponsor.

The Mold Technologies Division of the Society of Plastics Engineers (SPE)

In 2019, one of the primary focuses of the SPE Mold Technologies Division (MTD) was identifying and communicating workforce development best practices. They were fortunate to receive content from several outstanding companies that have made training, recognition and employee events part of their operations. Thank you to those who allowed MTD to share their strategies: Erler Industries, A1 Tool Corporation, Incoe Corp., Dynamic Tool Corp. and Hayes Performance Systems. The MTD also participated in two of the industry's more prominent educational events, Amerimold and the SPE Annual Technical Conference (ANTEC), using their booth to engage with existing and prospective SPE members. They also had the opportunity to speak with several students who were researching the industry. The MTD also sponsored a Tech Talk at Amerimold on misdiagnosed electrical issues in hot runner systems, collaborating with Alliance Specialties' hot runner division. They also presented at two of the ANTEC sessions and co-sponsored the In Mold Decorating Division's networking party.

FOR MORE INFORMATION

American Mold Builders Association / 317-436-3102 / amba.org
Canadian Association of Mold Makers / 800-567-2266 / camm.ca
Society of Plastics Engineers / 203-775-0471 / 4spe.org

Canadian Association of Mold Makers (CAMM)

CAMM co-presented the Fourth Annual Emerging Technologies in Automation Conference and Trade Show in September at Caesars Windsor. More than 350 delegates and exhibitors participated. During the event, Automate Canada, CAMM's newly formed association representing automation solutions in manufacturing, and Automation Alley, a Michigan-based non-profit association that brands itself as Michigan's Industry 4.0 knowledge center, announced that they have signed a memorandum of understanding, strategically partnering the organizations for mutually beneficial economic development initiatives, including the sharing of industry best practices and other relevant projects that help promote the industry. MMT

New Orders Offsets Supplier Deliveries

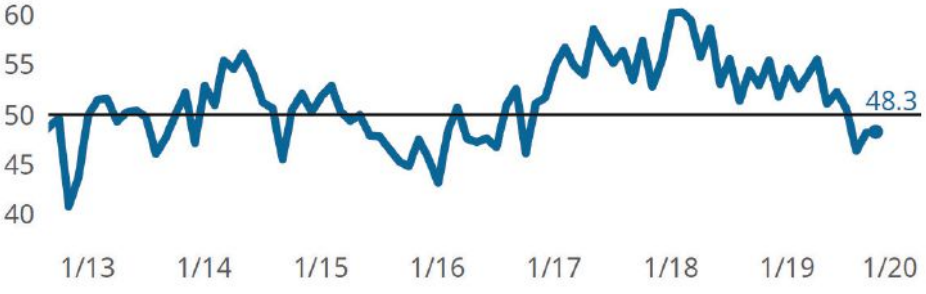
October 2019 – 48.3

The Gardner Business Index (GBI): Moldmaking reported another month of modest contraction, registering 48.3. Index readings above 50 indicate expanding activity while values below 50 indicate contracting activity. October's results were led by a strong expansionary reading in new orders followed by a modest expansion in production. For the first time since at least 2011, supplier deliveries were the worst performing Index component, falling over eight points in October, with exports, backlogs and employment also weighing in. October was notable for its strongly diverging readings of new orders and exports. An increase in total new orders coupled with a simultaneous contraction in export orders implies that domestic orders expanded greatly. October's strongly contractionary supplier delivery reading was not unexpected given that backlogs contracted during the last five months, total new orders have contracted in two of the last three months and production readings have averaged just slightly over 50 in the same period. Upstream suppliers may want to be particularly observant of downstream demand changes in the near-term. MMT

ABOUT THE AUTHOR

Michael Guckes is the chief economist for Gardner Intelligence, a division of Gardner Business Media (Cincinnati, Ohio, United States). He has performed economic analysis, modeling and forecasting work for nearly 20 years among a range of industries. He is available at mguckes@gardnerweb.com

Gardner Business Index (GBI): Moldmaking



The Moldmaking Index reported slowing contraction during October. Expanding new orders and production were offset by a downside surprise in supplier deliveries and on-going weakness in exports and backlogs.

Supplier Deliveries and New Orders (3-Month Moving Average)

Supplier deliveries registered its lowest reading since recordkeeping began in late 2011. During much of 2018 supplier deliveries raced to catch up with surging downstream demand. A sharp reversal in new orders during the second and third quarters of 2019 appears to have caused an abrupt reversal in upstream demand.

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EDM-Compatible Oil Captures Fine Graphite Particles

EDM Network and Chmer EDM offer an exclusive series of dust-free graphite mills to eliminate graphite dust while milling graphite electrodes. These mills are available with ball-screw drives and three-axis linear motor drives with precision glass scales for optimum precision and speeds. Fourth and fifth axes are available with Siemens 840D CNC controls and drives.

EDM-compatible oil in the oil shroud surrounds the 30,000-rpm spindle, capturing all of the fine graphite particles in the oil curtain. The particles are then filtered through two 30-micron filters before the system returns the particles to the oil reservoir to be reused. The use of the oil while high-speed milling also can prolong cutter life, reduce graphite chipping and improve electrode surface quality. The graphite electrode does not experience any detrimental effect after being soaked in the oil. Larger models can high speed mill hardened metals up to Rc63.

EDM Network Inc. / 888-289-3367 / edmnetwork.com

Pre-Hardened Steel Designed for Machinability

Hasco's plate program, especially in the P1 range, has now been supplemented by a pre-hardened steel, 1.2714HH. This pre-hardened EU tool steel is designed for dimensional stability and toughness. Hasco says that with a maximum hardness of 400 HB, it makes for optimum processing properties in machinability.

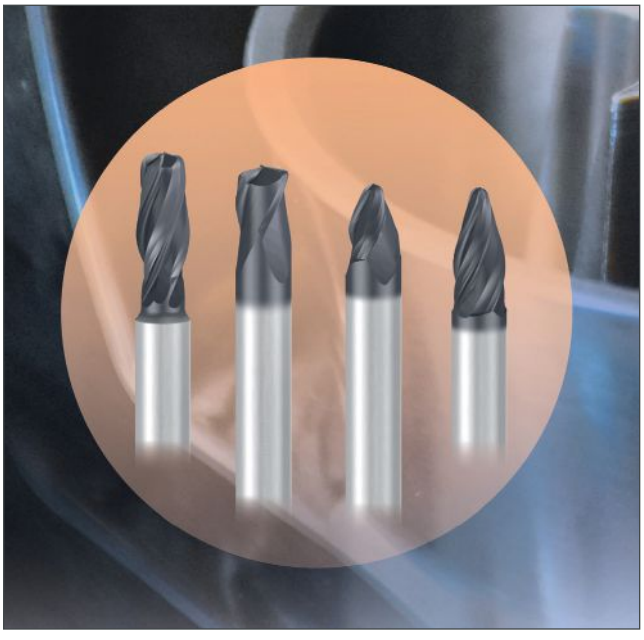
Benefits to users include excellent material properties for machining, welding, surface coating and use in injection molding tools, the company says. Other applications for the material include the efficient production of cavity inserts, cores and sliders. The steel is also designed for wear resistance and polishing and etching properties. It can be nitrided, coated at temperatures below 510°C and has good thermal conductivity. Performance is enhanced by the high-precision machining and surface quality as well as the plane-parallelism. The tolerances are geared to modern manufacturing techniques. Plates made from this steel are readily available from stock in the usual measurements. Special dimensions as well as P and K20 plates of 1.2714HH are available on request.

HASCO / 877-427-2662 / hasco.com

Angle Pin Inserts Reduce Setup Times

PCS Company launches angle pin inserts made from 420 SS and available in 30 sizes at 10-, 15-, and 20-degree angles. The pin inserts reduce setup time by allowing the moldmaker to machine while doing other flat work, require no secondary setups and prevent rotation with the keyed head.

PCS Company / 800-521-0546 / pcs-company.com



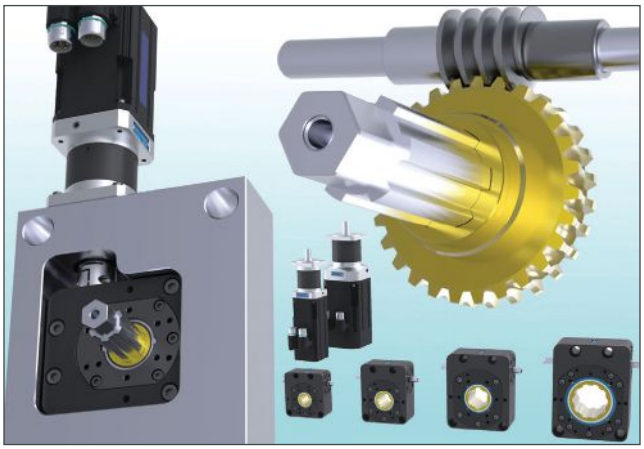
Circle-Segment End Mills Enable Faster Machining Cycles and Smoother Finishes

Emuge Corp.'s "circle-segment" cutters are a class of end mills designed to enable substantially more material removal with fewer passes in five-axis machining. The company says they also reduce cycle times by more than 80 percent and produce up to 50 percent smoother surface finishes.

Emuge says these cutters are ideal for mold making applications. They feature unique forms with large radii in the cutting area of the mills, allowing a larger axial depth of cut during pre-finishing and finishing operations.

Circle-segment solid-carbide end mills are offered standard in four geometries: barrel-shaped, oval form, taper form and lens shape. Oval and taper form mills are ideal for curved shapes such as straight-walled pockets, freely engaging more of the cutting edge. Barrel design mills provide highly effective flank milling to the sides of spiral grooves and similar applications, while lens shape mills excel in narrow channels or in lands on molds.

Emuge Corp. / 800-323-3013 / emuge.com



Integrated Indexing Plate Drive Achieves Short Cycle Times

i-mold adds to its Servomold solutions portfolio a line-up of servomotor-powered indexing plate drives that can be fully integrated into multi-component injection molds in a space saving arrangement. Available in four standard system sizes, the units are suitable for plate weights up to 250 kg. They are built to provide fast and precise rotary motions to achieve short cycle times and smooth production workflows.

The indexing plate drives provide unlimited rotary motion through 360 degrees and beyond, offering a time-saving advantage as it eliminates the need to return to a zero position before a new cycle starts. The system is based on all-rotational action, consisting of the servo motor unit (SAK type), an elastic servo coupling (SEK type), the indexing plate drive (SID type) and the splined output shaft to the indexing plate. The system is firmly attached to the injection molding machine clamping plate, permitting indexing plate molds of similar size to be operated with a uniform indexing plate unit, i.e., without requiring a separate rotary mechanism for every mold. SID indexing plate drives come in four frame sizes and with two SAK servomotor units delivering different outputs. Depending on the combination, the system can actuate indexing plates with a maximum weight between 10 kg and 250 kg. All systems are equipped with a safety brake to prevent mold damage in the case of a power failure. The output shaft is splined but can be individually adapted at the customer's request.

i-mold GmbH & Co. KG / 496062809330 / i-mold.de

Monitoring During Injection Molding Process

Meusburger offers sensors for cavity pressure measurement, which includes two types for direct and indirect measurement. Cavity pressure sensors make it possible to convert the pressure in the cavity to a measurable charge. The sensors are equipped with high-precision quartz crystals, which release a charge under the influence of pressure or force. This charge, amplified by a charge amplifier, provides precise information about the pressure applied to the sensor and makes it possible to monitor the exact cavity pressure in the injection molding process. The ideal installation position in the mold depends on the application. For example, for general monitoring and process optimization, the sensor is placed as close as possible to the sprue or on a thicker section of the molded part. Other typical applications are strength monitoring and monitoring or controlling viscosity, compression or shrinkage.

Depending on the application, there are two types of pressure sensors: direct and indirect sensors, which serve for direct or indirect pressure measurement. For direct measurement, the pressure sensor is inserted directly into the cavity so the pressure can be measured in the respective area. The indirect measurement is carried out via a force sensor located outside the cavity and is transmitted to the sensor as a force via an ejector pin.

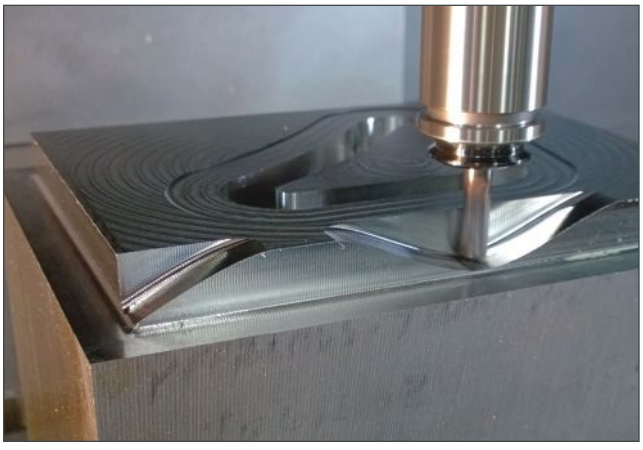
The sensors are available from stock with simple CAD data download from the company web shop and are compatible with all piezoelectric pressure sensors. The sensors are available with suitable mounting accessories and connection cables.

Meusburger US, Inc. / 704-526-0330 / meusburger.us

AM Powder Designed to Create Conformal Cooling Channels

Uddeholm announces the launch of Corrax additive manufacturing powder, a product designed for the additive manufacturing of tooling components. Uddeholm says that using Corrax additive manufacturing powder enables the creation of conformal cooling channels to reduce cycle times, among other possibilities. Uddeholm maintains that Corrax powder is excellent for additive manufacturing tooling applications because of high demand, short run series and the ever-increasing need for shorter lead times. Based in Hagfors, Sweden, Uddeholm has delivered high-alloyed steels since opening in 1668. Uddeholm provides tooling solutions through technical know-how, advice and support to customers from over 90 countries around the world. Uddeholm serves customers in a wide range of industries, providing local stocking and technical support for tool steels, mold materials and specialty alloys.

Uddeholm USA / 800-638-2520 / uddeholm.com/us



Solid Carbide End Mills Offer Four Cutting Actions in a Single Tool

Millstar says its new Quad Force Machining Tooling System provides maximum flexibility by way of its innovative hybrid geometry. The company says the line of solid carbide end mills is capable of four cutting actions in a single tool, making it a cost-efficient solution for diverse application challenges in mold and die making.

QFM's hybrid design combines high feed geometry, variable flute geometry, variable helix geometry and off set geometry. This unique combination allows users to seamlessly integrate multiple machining operations including high feed machining, trochoidal machining, side/slot milling and plunge milling.

Millstar's QFM end mills are said to offer superior metal removal rates in soft or hard tool/die steels, stainless steels and titanium. Their state-of-the-art geometry provides accuracy and repeatability while achieving greater depth of cut and preventing side vibrations. The durable QFM Tooling System also features a multi-layer hybrid nanocoating for excellent heat resistance and high hardness, which facilitates higher productivity and longer tool life.

Quad Force Machining end mills are made in the United States.

Millstar / 877-645-5782 / millstar.com

Cutting Sprue Bushing Removes Need for Secondary Operation

DMS adds Almo's cutting sprue bushing to its range of edge gate cutting components. The cutting sprue bushing enables feeding plastic components near the mold's center, virtually eliminating cold runners into a runnerless cold feed and trimming the gate as the mold opens, removing the need for secondary operation. It also provides a large edge gate area to reduce injection pressure and improve the packing and quality of the final plastic product.

DMS / 800-265-4885 / dmscomponents.com

Cavity Pressure Sensors Ideal for Grippers Designed for Efficient Task Automation

OnRobot offers its new Gecko Gripper and an update to its first edition RG2-FT intelligent gripper. The Gecko Gripper uses millions of micro-scaled fibrillar stalks that adhere to a surface using powerful van der Waals forces—the same way that geckos climb. The gripper enables robots to pick up flat, smooth objects and can affix to a wide range of surfaces, including fragile items. It also features the ability to operate in a vacuum, which enables it to pick up objects with holes. The Gecko Gripper interfaces with any robot while offering energy savings and a cost-efficient alternative to vacuum and electrostatic solutions.

The RG2-FT now features built-in force/torque sensing, supporting work in piece detection and centering. With built-in six-axis force/torque and proximity laser sensors at the fingertips, the RG2-FT can see and feel objects, ensuring faster deployment of collaborative applications and ultimately higher productivity. It also includes sensors with intelligent force feedback for adjusting applications for optimal design and positioning and can help in such tasks as assembly, insertion and quality inspection.

On Robot ApS / 455-353-5737 / onrobot.com

New End Mills Provide Cost-Effective High Performance on Tough Materials

Seco Tools' new Jabro-Solid2 JS 750 end mills are designed to provide longer tool life when machining tough materials. According to Seco, shops that struggle to maximize end-mill tool life when machining challenging materials can now achieve 25 percent to 40 percent longer life with this new family of end mills.

The JS754 and JS755 cutter geometries optimize conventional side milling, roughing and slotting, as well as advanced roughing and dynamic milling operations. Instead of struggling with chip formation, the smooth peripheral rake faces and strong radius design of these cutters evacuate chips efficiently while maintaining a true radius form. To avoid slow or unreliable cutting when interpolating or ramping for pocket machining, increased front back tapers enhance speed and reliability. The broad range of JS754 and JS755 variations and features ensure the highest cutting performance. Shops can match tool to application with various lengths, OD neck reduction sizes and corner radii, as well as chip splitters and through-coolant options.

Seco Tools, LLC / 800-832-8326 / secotools.com/us

New High-Speed Advanced Automatic Wire Feed System Improves Threading Capability

The new **Fanuc** Robocut C800*i*B-20 wire EDM from Methods Machine Tools offers new features for increased accuracy, efficiency and throughput. This EDM is available with a larger Z-axis configuration and can accommodate workpieces with a maximum size of 49.21" x 38.38" x 19.68" with a maximum weight of 6,613 pounds. The C800*i*B-20 wire EDM is ideal for a wide range of work, including large molds and stamping dies, and complex aerospace parts.

Fanuc's new high-speed advanced automatic wire feed AWF3 system helps to thread a wire within the machine's maximum 500-mm work thickness *submerged* with an automatic wire recovery to 150 mm work thickness *submerged* when cutting non-parallel plane workpieces.

Improved pitch error compensation over the entire cutting area, mapped by grid patterns to within +/-2 microns, increases accuracy. Factory tests show that a 0.0002-inch positioning accuracy and 0.0001-inch repeatability are fully ensured, even during long burns, according to the company.

A new *i*Pulse2 flexible pulse control improves straightness, corner accuracy, surface finish and cutting speeds by keeping the gap consistent according to discharge status and cutting shape.

Also, the innovative New FANUC core stitch slug retention feature prevents slugs from dropping, saving time and increasing efficiency. The core stitch function allows operators to set stitch points, which is ideal for long, unattended machining and multi-workpiece cutting.

FANUC America / 888-326-8287 / fanucamerica.co
Methods Machine Tools Inc. / 877-668-4262 / methodsmachine.com

Hoist Ring Prevents Damage and Increases Load Capacity

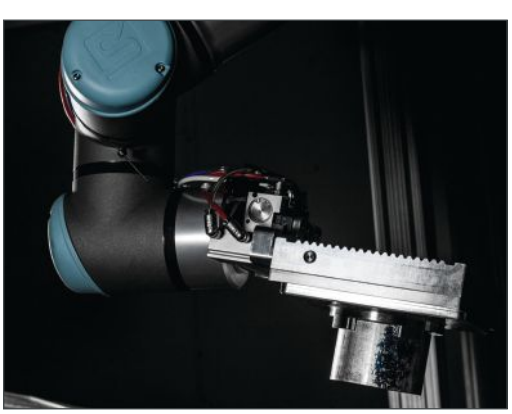
RUD Ketten, Rieger & Dietz GmbH u. Co. KG presents a hoist ring with a spring mechanism to ensure the anchor point turns in the load direction while raising, removing bracket damage from large shear forces and bending or breakage from sudden bracket turns. The spring also prevents a bracket 90-degree position and moves it in the direction of the optimal force transfer during lifting, avoiding a sudden dropping of the load.

In addition, the hoist ring's round bracket design achieves a secure and reliable sit for the hook, providing optimal force transfer and preventing component damage or tilting of the hook. It utilizes screw technology that combines maximum strength with high toughness to withstand high statically and dynamically bending loads. Additionally, the anchor point is reinforced at locations most exposed to loads, increasing load capacities as high as 30 percent compared to comparable sizes.

The hoist ring also offers abrasion lenses to determine whether the anchor point has reached discard criteria, as well as an undetachable but changeable combi-head screw for easy handling. It is available with screw diameters of ¾-inch, 5/8-inch, ¾-inch, 1-inch and 1¾-inch, and it will suit engineering, tool construction, the automotive and plastics industries and energy sector companies.

An RFID transponder is installed as standard to simplify operating equipment inspection, enabling the anchor point to be identified by a factory-set ID number transferable by laptop or mobile device to corresponding software tools. Users can manage test data and documents either in their own databases or through a cloud-based resource management tool. This reduces inspection costs and times and leads to more process reliability.

RUD Ketten, Rieger & Dietz GmbH u. Co. KG / 4973615041070 / rud.com



CNC Interface, Workholding System Integrate Automation

VersaBuilt, with **Universal Robots**, offers two products for collaborative robot and CNC integration: the CNC Communication URCap interface and MultiGrip workholding system. The CNC Communication URCap is an interface for machine tending applications, handling simpler integration and operation. It supports UR cobots executing any machining program stored on the CNC directly through the cobot's own teach pendant. Initially launching for Haas CNC machines, the interface maintains all Haas safety interlock features and works with Haas, VersaBuilt and other third-party automatic door openers.

The MultiGrip workholding system includes an automatic vise, machinable jaws and an end-of-arm tool for the UR robot. The system enables the robot and the CNC to share a set of MultiGrip machinable jaws for in feed, out feed and CNC machining, resulting in reduced engineering costs, easier robot programming, faster setup time and enhanced processing capabilities.

Universal Robots USA, Inc. / 631-610-9664 / universal-robots.com

Lifters Simplify Release of Small Undercuts in Molds

Cumsa USA offers new lifters from the Smart Worm family for the release of small undercuts. The company says that this new component is ideal for releasing small undercuts and that it comes in two versions. Cumsa offers the Smart Worm Pin (WP) or the simple version, which is capable of fitting small clips with short ejection strokes (ranging to 30 or 60 mm). Cumsa also offers the Smart Worm Lifter (WL), which is a long version to help simplify the release of small undercuts for large molds that require more ejection strokes (ranging to 125 mm). The WL is compatible with Cumsa DR lifters. Cumsa offers both Smart Worms in different sizes—the WP in Ø6 and Ø8 mm and the WL in Ø8 and Ø12 mm. Cumsa says that the advantage of the Smart Worms is that they do not need any mechanism in the ejector plates. Their bendable core (ranging to six degrees) makes it possible to release the undercuts simply by pushing up from the ejector plates.

CUMSA USA / 248-850-8385 / cumsa.com

Tool Mover Improves Safety with Secure Movement of Heavy Molds

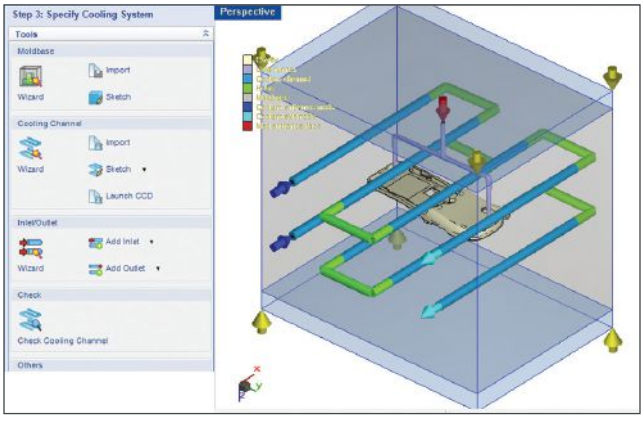
RUD Chain Inc. displays its Tool Mover. The handling and turning of heavy tools, dies and metal molding tools can be dangerous without the right equipment, causing risk to operators and damage to expensive tools if they are not turned effectively. RUD Chain Inc. says that its RUD Tool-Mover moves heavy and sensitive dies, molds and tools safely and securely and therefore limits costs that damaged tools incur and improves safety for the operator. The Tool Mover does not need to be bolted to the floor. It is available in a variety of models with load capacities of 10t, 16t, 32t and 64t, depending on the system. RUD Chain Inc. says that the mover is low-maintenance, low-noise and user-friendly.

RUD-Chain, Inc. / 800-553-7993 / rudchain.com

Software Package Offers Design Validation Behind the Desk

Moldex3D's eDesign solution package offers designers an easy-to-use package to validate designs behind the desk. The interactive interface, which facilitates the part and mold modeling and provides auto meshing technology, enables users to have efficient model preparation and to work in CAD environment with no need for advanced CAD knowledge. With the accurate 3D models, users can obtain product insights, visualize flow and thermal properties, and optimize processes before physical parts are built. The software helps companies to design products with quality, reduce development costs and shorten time to market. Other benefits includes modeling a part with complete runner and cooling systems within a few clicks, performing 3D numerical analyses with accuracy, and generating reports automatically and presenting results in multiple ways.

Moldex3D, EPS FloTek / 888-66533933 / epsflotek.com



Machining Center Combines 5 Axis Milling with Laser AM

Okuma America Corp.'s MU-8000V Laser EX multitasking machine combines 5 axis machining with a Trumpf laser, providing both additive and subtractive manufacturing capabilities. It enables complete part production on one machine.

The machine implements laser metal deposition (LMD) technology to provide users with the ability to cut parts of different sizes and shapes. LMD supplies powder from nozzles and performs laser melting and bonding to parent material. This enables the combination of various types of materials, as well as three-dimensional fabrication and cladding. Variable control of laser spot diameters (from 0.4 to 8.5 mm) increases efficiency and resolution, according to the company. This combination of features enables mid-process part inspection and material exchange, coolant use in the work envelope and greater process speed.

Okuma America Corporation / 704-588-7000 / okuma.com

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GLOBAL COMPETITION / BUSINESS MANAGEMENT

Five Ways to Ensure **Quality Offshore Tooling**

By Jim Sensenbrenner

When there are many miles between you and your mold builder, consider the following five approaches to ensure the mold is built on time, on budget and at the quality the project deserves.

- **Present clear mold expectations.** Provide thorough specifications as you'll be working with a translator who will need to relay the requirements to the tool-building team. Well-defined instructions will help them do their job accurately from day one. Any ambiguity will necessitate clarifying questions that can start eroding the timeline because of the need to go back and forth via email. With at least a 12 hour difference between the United States and China, that can amount to a lot of lost time over small details.
- **Have experienced mold engineers on your team.** The mold builder will provide the proposed tool design to the tool engineer for review, which is usually located in the U.S. If that person doesn't understand critical mold components, such as the overall mold flow, the proper amount of cooling and the gate location, the ramifications to the mold (or part) downstream can be substantial. A qualified engineer needs to be able to review the design, mark the problem areas and send the design back to China for a second pass to ensure the tool is robust. Included in this review should be a thorough audit of the proposed mold material.
- **Stay on top of timeline check-ins.** As key milestones arise, review the updates thoroughly and ask questions if something doesn't seem right. Working with a team abroad means you're relying on emails, software renderings and pictures for those checkpoints. For example, during a review of the completed mold, make sure you're getting images across a range of angles and lighting to ensure you can conduct an accurate assessment and provide specific, actionable feedback. Flagging miscues as you go makes it easier to fix them before the build gets too far along.
- **Prepare for first-run samples.** Be very clear as to what the expectation is for the first sample, including the number of required parts and the dimensional inspections for review. To help conduct a thorough analysis of the first run, ask for the moldmaker's record of the molding process and equipment. And, request a video that shows the parts ejecting from the mold and the total molding cycle. Without appropriate documentation, both written and visual, it can be easy to misrepresent cycle times or the quality of the parts.
- **Understand measurement methods for part qualification.** To ensure you understand how the moldmaker is conducting its measurements, ask to have their CMM measurement methods, including pictures of the part setup and the programs. These items will allow you to compare their methodology and confirm the parts are meeting standards. If the part is misaligned, measurement results are most likely incorrect, which will lead to incorrect decisions on mold adjustments.

Image courtesy of Evco Plastics.

Ensuring a robust mold build requires clear expectations and comprehensive reviews throughout the moldmaking process.

A well-made part starts with a well-made tool. For a myriad of reasons, shops are working with foreign makers. The best ways to help ensure a robust mold are to provide clear expectations and conduct comprehensive reviews throughout the moldmaking process. MMT

CONTRIBUTOR

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FOR MORE INFORMATION

Evco Plastics / 800-507-6000 / evcoplastics.com

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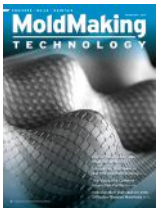

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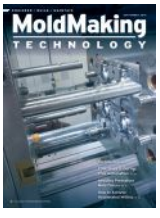

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