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MARCH 2019

Rethinking Injection Molds PG 14.

Power Up Your CAM to Streamline Your Process PG 20.

Determining Proper Vent Depth PG 26.

Multitasking Doubles Throughput and Cuts Costs PG 38.

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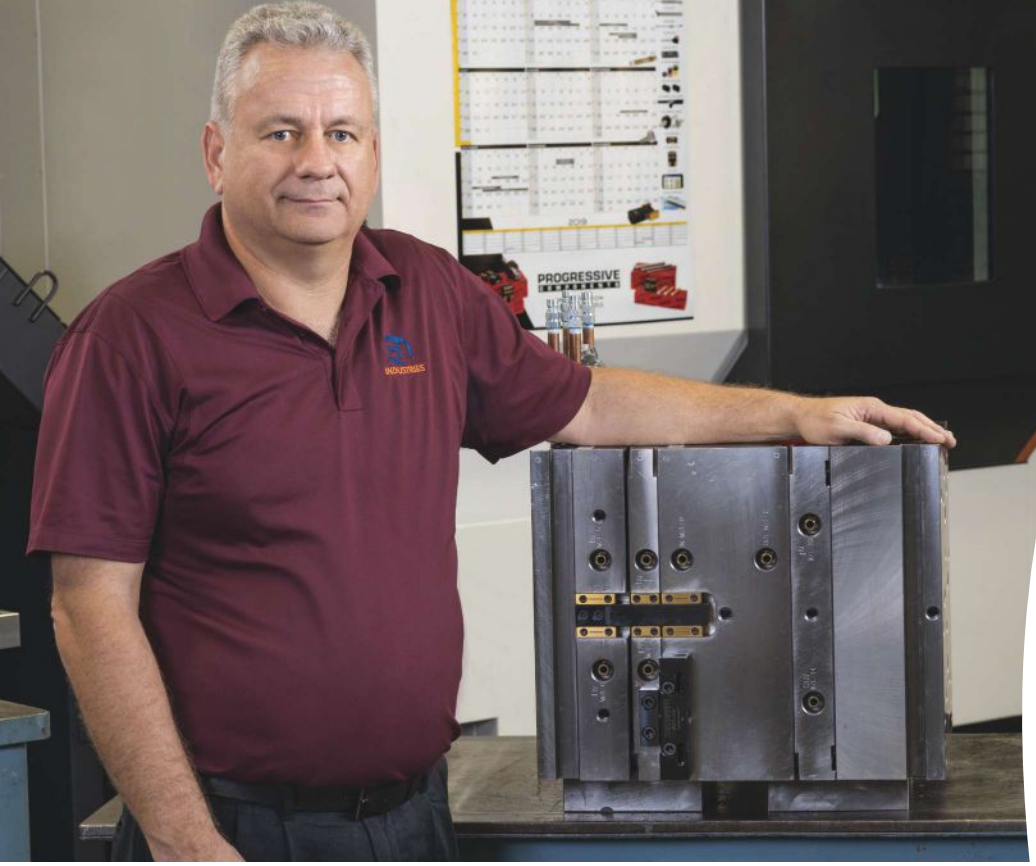

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MMT MoldMaking TECHNOLOGY®

Publisher
Ryan Delahanty . . . . . rdelahanty@gardnerweb.com

Editorial Director
Christina M. Fuges . . . . . cfuges@gardnerweb.com

Senior Editor
Cynthia Kustush . . . . . ckustush@gardnerweb.com

Assistant Editor
Heather Wintle . . . . . hwintle@gardnerweb.com

European Correspondent
Barbara Schulz . . . . . bschulz@gardnerweb.com

Art Director
Carla M. Turner . . . . . cturner@gardnerweb.com

Advertising Production Manager
Chris Larkins . . . . . clarkins@gardnerweb.com

GARDNER Business Media, Inc.

6915 Valley Avenue
Cincinnati OH 45244-3029
P 513-527-8800
Fax 513-527-8801
gardnerweb.com
moldmakingtechnology.com

Subscription Inquiries:
For questions or issues related to your subscription, please call 513-527-8800 or email subscribe@moldmakingtechnology.com

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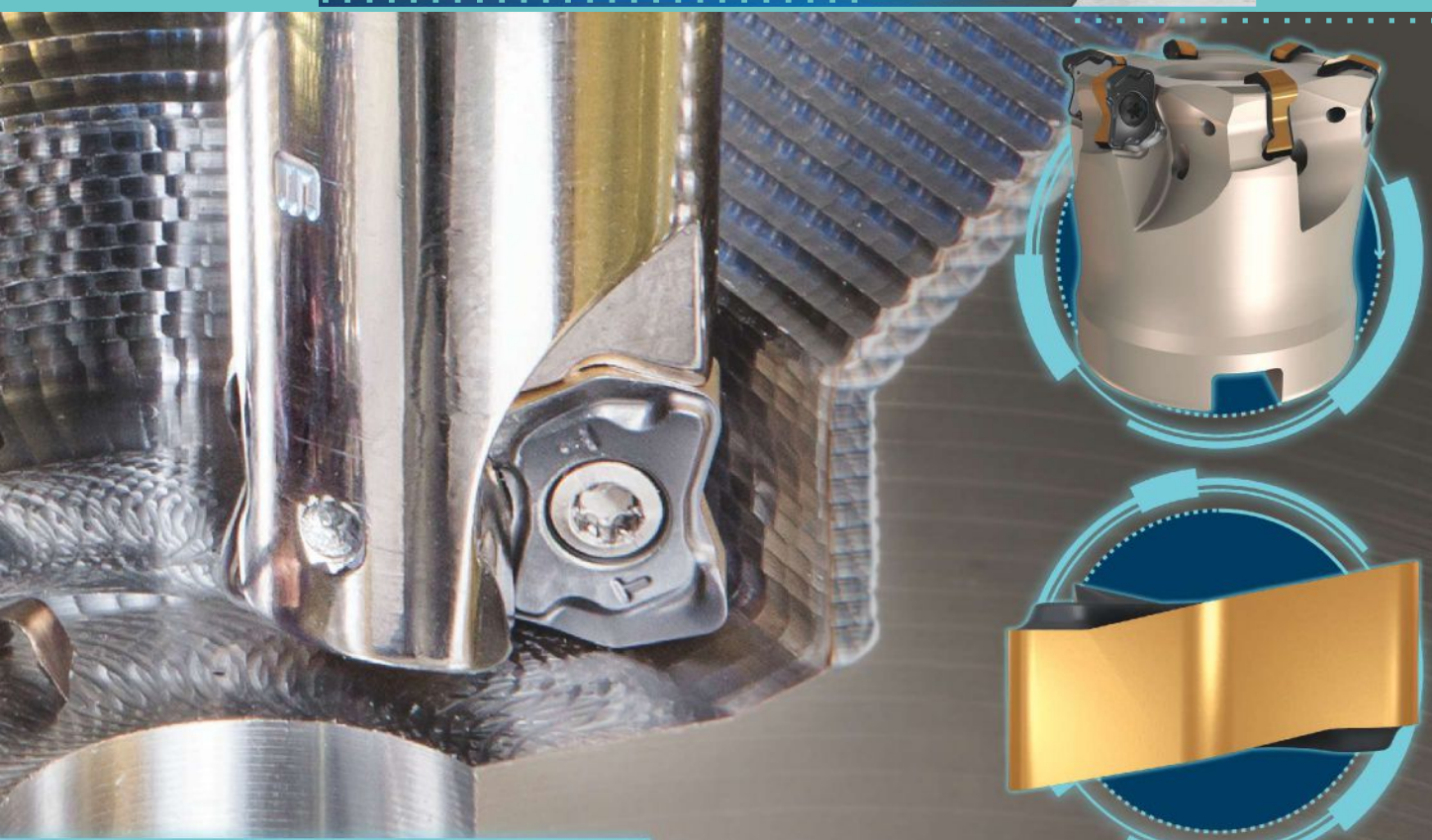
High Feed Milling
Twist Master



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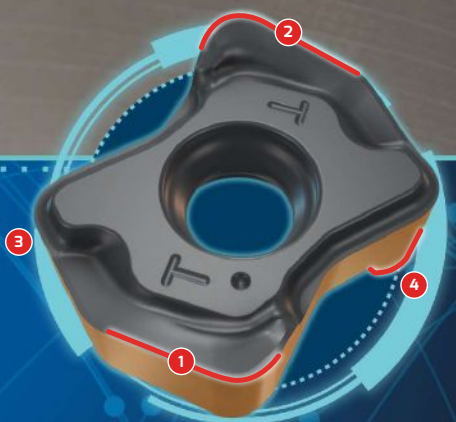

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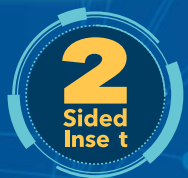

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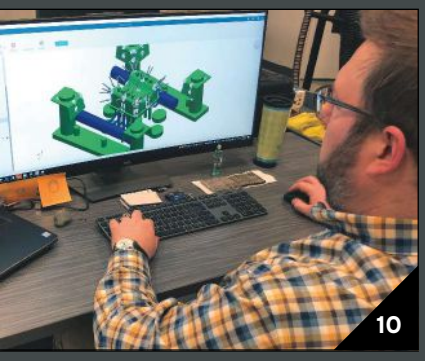

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ON THE COVER

Cover photo courtesy of Barbara Schulz. This month's cover shows a mold additively designed by Germany-based company Toolcraft using less material and standard parts and plates than conventional tools. According to Toolcraft, the mold is 50-percent lighter than their customer's original design, which means less energy consumption during the injection molding process and reduced cycle times. Plus, the mold was produced faster than using traditional manufacturing methods while keeping the costs at the same level. See related feature on **page 14**.

Images courtesy of (left to right) Next Chapter Manufacturing, The Estee Lauder Companies and Unisig.

VIDEO ACCESS

5 TRICKS OF THE TRADE
Great Tips from This Issue

1. Operator Not Needed
Workpiece probing within CAM software allows in-process control by using the probe to measure features, and then update the machining process and tool data in real time, based on the results.
PG. 20.

2. Sneaking Around
An effective strategy a mold technician can use to determine the correct vent depth is to sneak up on it by using a spare cavity and core stack and gradually increasing vent depth.
PG. 26.

3. Trade Tactics
As the U.S. and China continue to deal U.S. negotiators should address intellectual property protection, state-owned enterprises, absence of formal labor protection and nonexistent environmental regulations.
PG. 29.

4. Taking Stock
New tax rules require producers of inventory to capitalize raw materials, work-in-process (WIP), finished goods, associated labor, and other subordinate costs, known as overhead.
PG. 41.

5. True Value
High-value tools are the best fit for conformal cooling because when it comes to laser sintering the cost is high and the after-print surface finish still needs postprocessing.
PG. 48.

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Adding It All Up

Last year was a big year for *MMT*, with most of our attention focused on our 20th anniversary, NPE, Amerimold and IMTS. The growing interest, understanding and use of 3D printing and additive manufacturing technologies and processes within the mold manufacturing community was an area that stood out to me throughout all these events. It's exciting. So, I did an informal survey to get a better handle on how to cover this constantly-changing additive landscape. Here is a simplified look at what I discovered.

Most of you consider yourselves "somewhat" familiar with additive manufacturing/3D printing and can explain the difference between the two. Simply put, 3D printing is the process at the center of additive manufacturing (AM), but AM involves so much more. The most understood 3D printing processes are FDM, SLA, direct metal laser sintering (DMLS) and hybrid sintering/milling machines. The majority of respondents are not applying additive manufacturing/3D printing in-house due to budgetary constraints and undetermined ROI. Current AM applications include prototyping and conformal cooling. About half of respondents are contracting these services out to a facility specializing in AM/3D printing to print prototypes, steel cavities, aluminum inserts and conformal-cooled inserts. The processes respondents want to learn more about include: material jetting and hybrid DMLS. The moldmaking applications that respondents believe have the most potential are complex cooling in mold bases and small mold inserts that are difficult to machine, low- to mid-volume part production, reverse engineering of old components, replacement parts, repair, fixtures, end of arm tooling and mold components.

When it comes to aspects of AM/3D printing that people misunderstand, most respondents believe the biggest misconception is that it will completely *replace* how we manufacture. Other misconceptions include the over or underestimation of process speed, and part quality and cost; that it will work for every application; that a printed mold can produce any size part or complexity; and that if you can print something, it can be mass produced. To address these misconceptions, respondents are looking to technology and service suppliers to provide application analysis for cost-effectiveness versus possibilities; material and application limitations; better correlation between printed materials and engineering resins; the various outputs realized with each process; postprocessing requirements; safety concerns; training needs; designing for AM (DfAM) instruction; and, market trends and future expectations.

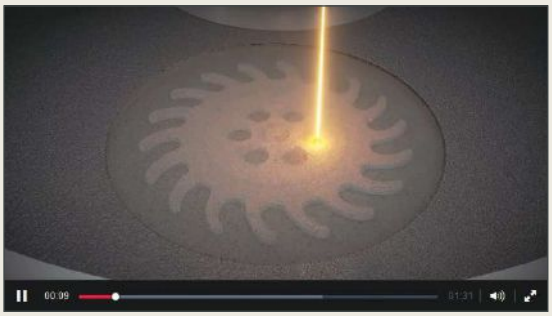
Overall, additive manufacturing/3D printing is another tool in your toolbox. So, use it. Where do you stand with additive and what is your plan to grow with this technology option? Hopefully, *MMT* can help get you there. For starters, take a look at some of the coverage this month in our EAB column, Profile, International Perspective feature, and Tip, which may be eye-opening for some of you. MMT

Christina Fuges

Christina M. Fuges
Editorial Director

Follow MMT on: Follow @MMT_ChristinaF

THIS MONTH ON moldmakingtechnology.com



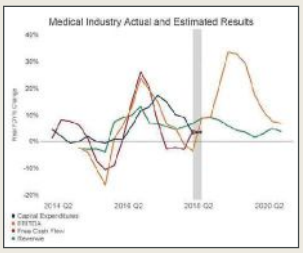
VIDEO: How Laser Cladding with Powder Technology Works

See how machines that can do semi-automated repair by laser cladding with powder can make repair more cost-effective versus replacement of a damaged component.
short.moldmakingtechnology.com/cladding

PODCAST: Interview with Wepco Plastics

This shop considers the whole employee when training, and today that includes financial management at home to being a smart consumer. We took our *MMT*/Manufacturing Alliance podcast to Connecticut to find out what else makes this shop tick.
short.moldmakingtechnology.com/wepco

BLOG: Regulatory and Market Changes Impact Moldmaking



Gardner Business Intelligence addresses market impacts from interest and concerns with the ongoing tariff changes and trade.
short.moldmaking technology.com/guckes

EVENTS: Amerimold 2019

This year's Amerimold Expo on June 12 and 13 in Rosemont, Illinois, will feature two new Molding and 3D Printing in Plastics Workshops in addition to its free show floor Tech Talk Program.
amerimoldexpo.com

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New Alliance Leads to Cutting-Edge Additive Capabilities

By Tim Krieger

Krieger Craftsmen recently added additive manufacturing (AM) as part of an in-house alliance to offer a full-service solution for customers. It all happened by chance, last year, because of a fortuitous reunion with Jason Murphy, whom I met more than 20 years ago through a friend and former co-worker and had not seen in 10 years. As far as I know, Jason has the only additive manufacturing machine in the U.S. that can print H13 and harden it.

Image courtesy of Krieger Craftsmen.

Krieger Craftsmen offers additive manufacturing of mold components, like this core printed in H13 that is split open to show its balanced internal cooling channels.

Jason has been on the forefront of AM for several years. He worked on AM while working abroad to bring tooling and molding solutions to customers. In addition to being a molder maker, he is also a master molder. Because he was looking to establish a business with this unique AM capability, and I was interested in bringing AM into Krieger, I added space between Krieger Craftsmen and J-Flex, our automotive lighting division, in Grand Rapids, Michigan, where Jason now operates the additive manufacturing operation called Next Chapter Manufacturing.

We began marketing to customers, introducing them to conformal cooling's benefits and showing how they can reduce cycle times by building conformal cooling channels that can reach into very tight areas like the tip of a lifter and into the nose of a slide detail, a feat rarely achieved by conventional drilling. Engineers I have spoken with see the potential, and we have had a lot of interest. Jason and I have implemented solutions for companies including a complete, conventional mold build and another mold built with conformal cooling for a company's study.

I believe AM will continue to grow and evolve as more people in our industry see the exponential return over time on their upfront investment in the technology. With the array of applications possible, including the ability to print H13, there is no question we need to be doing this. Krieger continues educating customers on the benefits of conformal cooling in H13 for molds running abrasive materials like glass-filled resins, and we strongly believe it will become more prevalent in mold building's future. MMT

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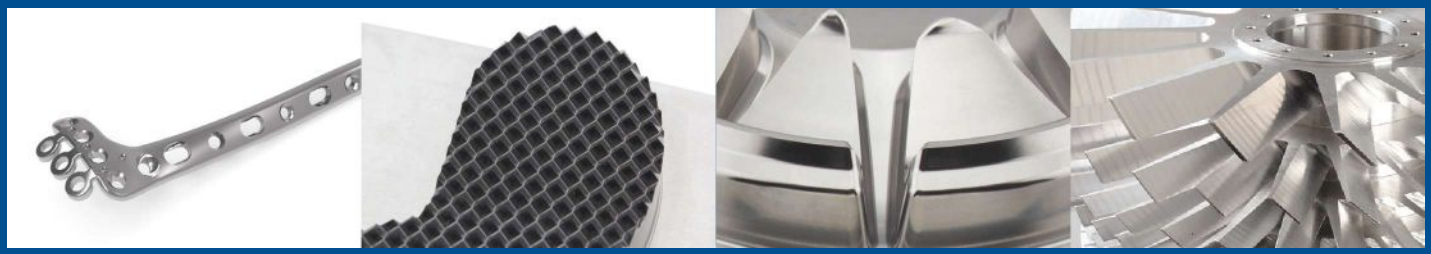

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Precision
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A Conversation with ...

Next Chapter Manufacturing

Images courtesy of Next Chapter Manufacturing.

Slides and lifters are the most difficult components to put cooling into. Next Chapter Manufacturing can contour cooling circuits in tight spaces with integrated baffling or bubblers without the risk of leaking in production.

Tell me a little bit about Next Chapter Manufacturing?

Jason Murphy, President, and CEO: The company's mission is to take a standard tried-and-true additive process, like direct metal laser sintering (DMLS), and use it innovatively to provide solutions to moldmakers and molders. When we launched the company, we used DMLS to retrofit and improve existing tooling. However, with my background in molding (certified Master Molder) and moldmaking, we have since expanded our focus to include the design side of tooling (molds, die-cast dies, end of arm tooling, fixtures and automation components) to improve speed, reduce cycle times and eliminate common molding defects (warp, burning, gas trap), primarily in the automotive and medical industries. Our specialty is high-volume, high-cavitation tooling or high-wear applications involving highly-engineered resins for which the industry is not 3D printing parts for to date. We build high-wear tools and offer a million shot guarantee. We accomplish this by partnering with mold shops to solve molders' production issues and maximize productivity (OEE, scrap, downtime). This year we are expanding our focus again to scale operations and move into the consumer, electronics and industrial markets for tooling and molding.

It seems to me that mold material plays a big role in how you've differentiated the company from the competition. Explain.

Murphy: To successfully work in mold manufacturing, you must speak the toolmaker's language. For example, H13 has been the standard for building robust molds, but that material did not exist within the additive material spectrum until recently. Standard offerings were not traditional grades of tool steel, which created additional barriers for moldmakers to adopt 3D-printed tooling into their moldmaking process. Previously, additive metals were held to one or two grades of steel for which additive machine builders developed machine parameters. As a tooling company and not a 3D-printing service provider, our focus is on providing the optimal tooling solution, which is dependent upon the right materials to produce tooling capable of high-volume and high-wear applications. Since tooling components is not the primary market machine builders tailor to, there has not been as much tool steel materials development compared to other markets, like aerospace.

The DMLS process has been around for decades and produces very complex geometries and cooling channels while building near finish stock conditions that need minimal machining

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- Founded in 2015 by Jason Murphy, President, and CEO.
- Specialty is eliminating cycle time and common molding defects by producing custom plastic forming inserts using additive manufacturing to eliminate the constraints of subtractive machining methods and open up tooling opportunities.
- Predominantly services the automotive and medical industries.
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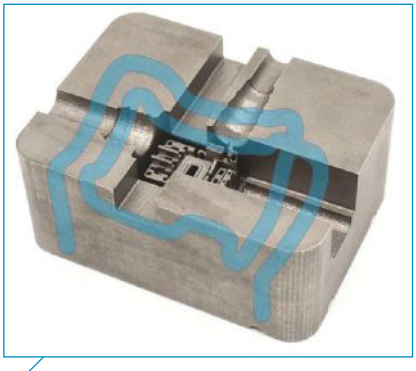
to achieve required tolerances and finishes. Our specialty is H13 in DMLS, where others use maraging steel. We believe this gives us a leg up because we've experienced H13 outperforming maraging steel by 20 to 25 percent, which aligns with the demand from moldmakers and molders to get the most out of their tooling investment.

We decided to partner with Farsoon Technologies because its system is open, which means we can develop specific processes that enable us to print H13 and other tool steels efficiently. This open parameter system also enables us to do test builds and refine our process to improve robustness and speed further. The technology of the Farsoon machine gives designers a significant amount of additional freedom to provide the most efficient designs for additive manufacturing, which other machines do not offer. However, we do remain technology agnostic, as we know the additive world is constantly evolving, delivering new, improved and different processes and materials. Our goal is to find the best technology on the market that suits the solutions we are looking to provide our customers and then integrate that technology into our workflow—from front end design and analytics to postprocessing.

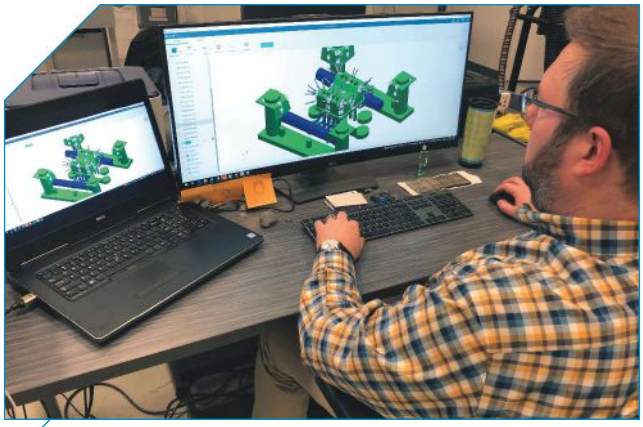
Speaking of materials, we are also emulating venting in the steel and using DMLS to make the part porous to allow venting. Venting is just as important as cooling, so being able to add vents where needed, not "where possible", is critical to providing the highest performance molds in the industry. This is a very new development that we are currently optimizing, so it is not yet commercially available.

You mention that your way of doing things is a "departure from traditional tools." Explain.

Murphy: Additive manufacturing (AM) allows us to think differently about what a mold needs to be. Molds don't need to look round and square or incorporate typical lifters, locks, pins, bushings, parting lines anymore. We don't need a mold to be a massive block



Complete tooling stacks complete with conformal cooling with all clearances and relief are incorporated to provide near net shape components. Post build, stress relief and heat treatment enable minimal machining (+/-.007" stock) to exact tolerances.



Generative design helps produce the most efficient tooling possible because it considers all of the dynamics and forces that the mold will experience during the process and then provides hundreds of solutions based on any number of parameters.

of steel. We just need it to support the load it can do under pressure. Here is where generative design comes into play, as it considers all of the dynamics and forces that the mold will experience during the process and then provides hundreds of solutions based on any number of parameters. All of this helps to yield the most efficient tooling possible.

For example, we apply shot tonnage and all the forces the slides and moving components experience, and then the generative design software goes to work and optimizes it for 3D printing. Basically, the mass of an A or A, B plate is somewhere around 50 percent of what it would be. So, although AM is a slow process, the generative design allows us to build the tool in half the time because we have half the mass. Incorporating generative design into the moldmaking workflow allows us to arrive at the solution quicker and optimizes the additive process to be competitive with current mold manufacturing methods.

You say that although the process used may not be all that innovative, it's more about how you use technology to bring customers innovative solutions. Give an example.

Murphy: We had a customer who was having trouble with mold cylinders, which nowadays are extruded aluminum, as they were running a high-temperature material in a high-temperature mold, which transfers heat into the cylinders, causing the switches to fail. Our solution was to create a cooling plate that flowed between all of the mounting holes that created a barrier between the cylinder and the mold. It had nothing to do with conformal cooling inside the mold or touching plastic, but it's a solution that eliminated their downtime. By considering the challenges molders and moldmakers face in production every day and removing the limits of design and manufacturing, we can quickly get to the right solutions to "never talk about this problem again."

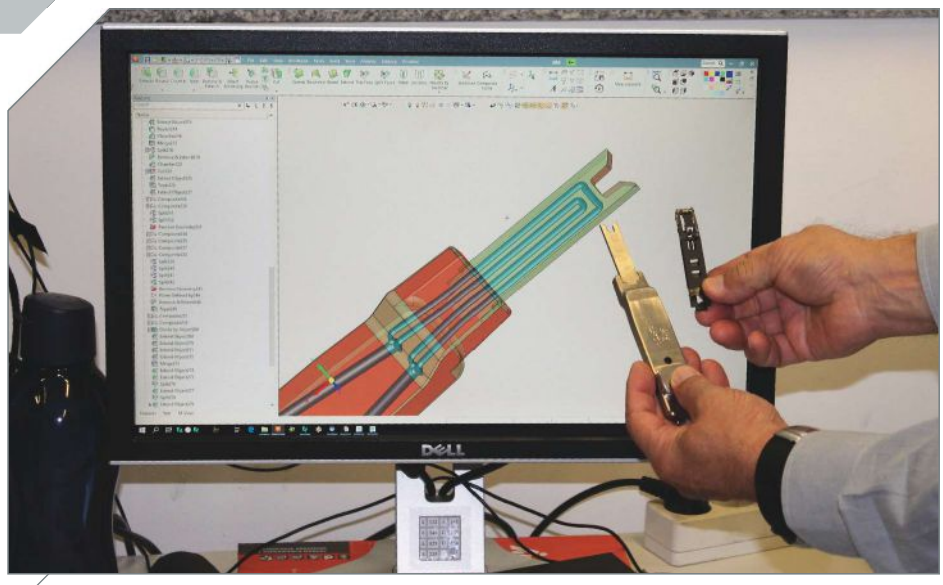
Where do you see growth within the company in the next five years?

Murphy: We see standardized customization. By that, I mean standardization of mold components. For example, our conformally-cooled sprue bushings offered through PCS Company that reduce design time. We also see a focus on rethinking the most mundane mold components and design them additively for a customer's specific application, which plays nicely into our customers' demands for insert consistency across their global supply chain. MMT

By Barbara Schulz

A European View on AM: Rethinking Injection Molds

Overseas business models and applications of metal additive manufacturing promise to improve or invent functionalities integrated into molds and tools.



Images courtesy of Barbara Schulz.

Conformal cooling is the number one application of additive manufacturing technology in the moldmaking sector. The flow path in the injection mold cavity can be better influenced, distortion minimized, and the cycle time is often optimized, sometimes decreased by as much as 40 percent.

The Mechanical Engineering Industry Association (VDMA) forecasted at its January press conference that the tool and moldmaking sector in Germany would have a very positive year. Average turnover increased by 8 percent in 2018 compared to the previous year. However, Marco Schülken, chairman of VDMA's toolmaking division, stated that he is worried about unfair business practices by some major customers in this sector that caused a "hemorrhage of German tool and moldmaking shops." This hemorrhage includes pre-financing of customer-specific projects, massive discounts on existing contracts to secure renewal contracts, and delays in mold approvals as a reason for working with tools that have not been paid for yet. Tool and mold exports, on the other hand, were very positive in 2018, Schülken says, with the U.S. remaining the biggest export destination, increasing by 20 percent last year. Due to the situation between the U.S. and Mexico, exports decreased by 15 percent at the same time.

These numbers illustrate that German technology and tools are still in high demand, but when it comes to innovations, trying new things and leaving the tried and tested path, German companies are lagging behind U.S. companies, says additive manufacturing (AM) expert Marc Dimter from Trumpf in Ditzingen. "Companies here enjoy new technology, including additive manufacturing," he says. "But the Americans are much more adventuresome in that respect. My colleague Christoph Dörr is looking into the U.S. die-casting market, as conformal cooling (which can be realized with AM) is much more common in that industry sector than here in Europe."

He also notes that customers in the U.S. demand conformal cooling, while German companies are buying these molds and dies from the U.S. because these shops have made a name for themselves when it comes to highly productive tools based on conformal cooling. However, there are interesting new developments and applications evolving here in Europe, too.

The Game Changer Is Conformal Cooling

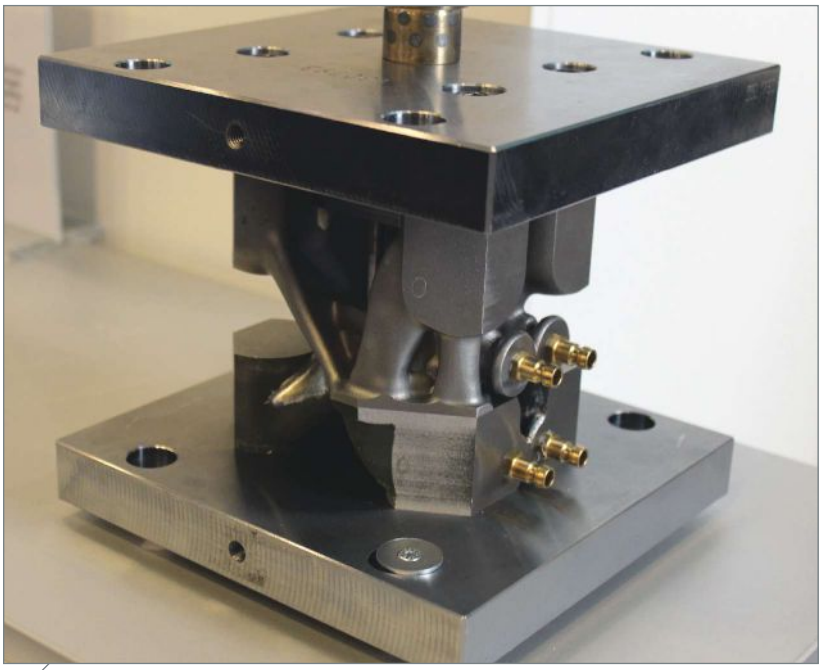
Conformal cooling is certainly the number one AM application in moldmaking, as it can improve the flow path, minimize distortion and reduce cycle time by as much as 40 percent.

Joao Frade, production manager at moldmaker Erofio in Portugal knows that. "The highest potential for improving part quality and speed lies with metal 3D-printed, conformally-cooled injection molds. In-mold part cooling is the most time-consuming part of the plastic injection molding process," he says. The company was the first in Portugal to run an M3 linear laser cusing machine from Concept Laser that offers customers the opportunity to integrate complex conformal cooling channels into their molds. "I believe in running machines with one laser as there is less heat and less warpage," Frade says. "It pays to design tools with conformal cooling, because customers and injection molders greatly benefit from this."

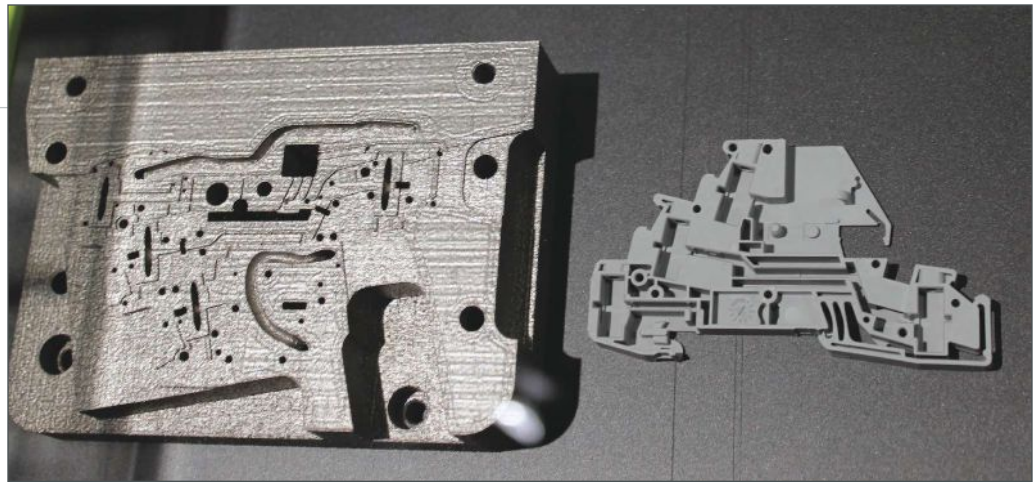
However, he adds, while conformal cooling solutions can significantly reduce the total cost of production by lowering mold cycle times, they also require sophisticated mold designs. "The purchase of a machine does not alone enable the production of useful inserts. First, you must have a skilled and experienced technologist or engineer on staff for the design and to run the metal printing process. This is not subtractive machining, and it requires a completely different skill set. Without that, the effort is doomed to be a disappointment at best," Frade says. "Moreover, you must remember that there are substantial upfront costs that can possibly justify the investment only if there is sufficient volume of parts or a high margin built into the finished product."

There Is More to AM Than Just a Machine

A gap exists in the market for specialist contract companies that supply moldmakers with AM parts because there is more to AM than just a 3D-printing machine. Shops need to ask about the requirements for ancillary equipment,



Instead of merely adding conformal cooling channels to mold inserts, this mold is additively designed by Germany-based company Toolcraft using less material and standard parts and plates as conventional tools. According to Toolcraft, the mold is 50 percent lighter than its customer's original design, which means less energy consumption during the injection molding process, a 30-percent reduction in cycle times and faster production compared with traditional manufacturing methods while keeping the costs at the same level.



This injection mold made out of tool steel was built by Phoenix Contact using Trumpf's LMF (Laser Metal Fusion) technology. Build time: 45 hours, number of layers: 740 à 50 m.

postprocessing, powder handling, metal part qualification and safety.

Protiq, an industrial 3D-printing service provider, has an answer to all these questions, and General Manager Ralf Gärtner sees great potential in providing this service to customers, including those in the moldmaking sector. "We still need to convince many companies to 'think additive' and apply additive technologies to produce conformal cooling channels, for example, which yield short cycle times and high-quality parts," he says. "However, many companies try to translate conventional technologies like milling, EDM and grinding into AM, which doesn't work. You need to think additive. You need to design parts with the possibilities AM technology offers in mind."

In contrast to conventional manufacturing, it is the design which defines the manufacturing process in AM. For example, weight-optimized molds that include internal structures and functions can be up to 75-percent lighter than conventional molds using standard plates, parts and machined inserts and cores.

"We can produce maximally optimized injection molds that are light, slim and are produced in a fraction of the time it used to take when making the tool by milling," explains Gärtner. He uses topology optimization and simulation to create the molds to make sure the conformal cooling channels are in the right spot and a minimum amount of material is used. "We saved around 25-percent of production time to make this mold, mainly because many functions are already integrated into the mold during the AM process, which do not have to be mounted and assembled after the machining process. With a cycle time of 3.2 seconds, this mold is one of the fastest we have ever built."

Establishing Close Partnerships

For Dimter, the idea of outsourcing AM and establishing a network among companies that excel in different aspects of technology is a viable option. However, he also sees an increasing demand for more and more automated processes and integrated process chains, which is increasingly shifting AM technology into the core business of tool and moldmakers.

Germany-based Toolcraft has achieved just that. The company is running Trumpf, EOS and Concept Laser machines (eight in total) and has realized a digital process chain that is consistent and traceable for all process steps. This is very important for the company that not only manufactures tools and molds, but also aerospace parts for which they are NADCAP-certified for non-destructive testing (NDT). "Introducing one software, Siemens NX, enabled us to get rid of isolated 3D-printers and four different software packages with numerous interfaces and formats," CEO Christoph

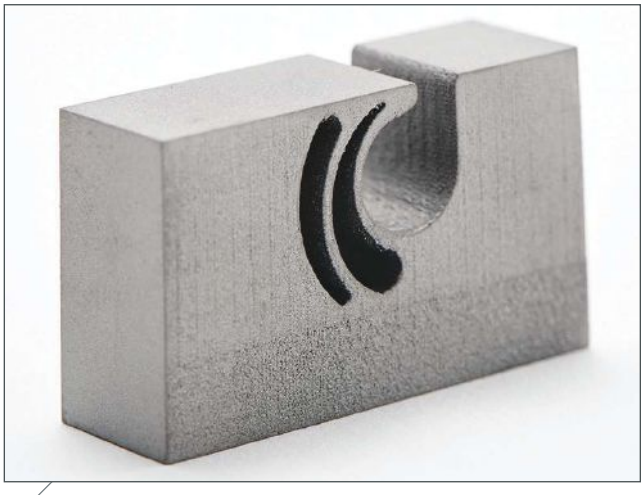


Photo courtesy of Hofmann.

Steel-on-steel seals are hard to implement especially for materials with a low viscosity such as polyurethane. Rubber seals, on the other hand, are highly prone to wear. 3D printing enables the construction of elastic functional elements directly in the split line.

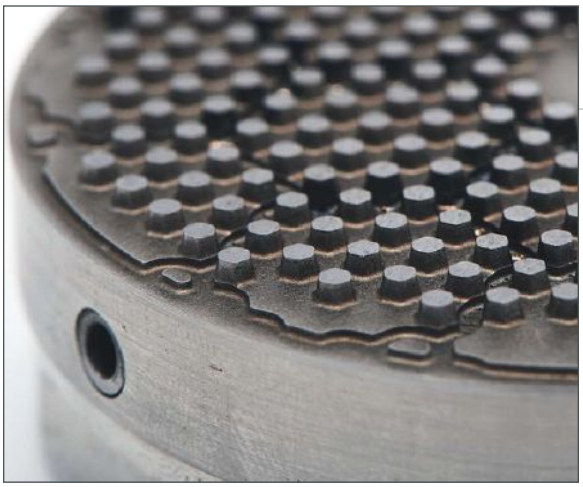


Photo courtesy of Hofmann.

Additively-made porous micro-structures in this pneumatic ejector enables the ejection of parts without mechanical components through flexible positioning of the ejector area in the mold. The use of microchannels, for example for ventilation or to hold films and depositors, is also possible.

Hauck says. "We work closely with our partners, including Siemens, which is paramount for our success."

"Using one software for design, topology optimization and FEM to verify the design has also helped to redesign a customer's mold tool," he explains. The mold design is similar to the one designed by Protiq described above, where the complete mold design is rethought. Instead of merely adding conformal cooling channels to mold inserts, this mold is additively designed using less material and standard parts and plates as conventional tools. According to Toolcraft, the mold is 50-percent lighter than its customer's original design, which means less energy consumption during the injection molding process, 30-percent reduction in cycle times and faster production while keeping the costs at the same level.

While bigger companies like Toolcraft or internal tool and moldmaking shops serving mainly their parent company might have a more flexible profit margin, additional costs are indeed a problem for the common small to medium moldmaker.

"Moldmakers are indeed excited about conformal cooling," Dimter says. "But very often it does not pay. On the contrary, the moldmaker must guarantee the number of shots; he carries the risk and he cannot benefit from the implementation of 3D technology. It's his customer, the injection molder, who benefits, but if the shop is dependent on a big OEM, he wonders who will pay him the overhead cost of a highly productive tool. So as a moldmaker, you must first convince the customer. In times of high price pressure and economic fears, the willingness to invest even more money in an optimized tool decreases. After all, the investment only pays off after several months of production."

Other Applications

Apart from creating intelligent conformal cooling channels, metal AM offers various possibilities to improve or invent new functionalities integrated into molds and tools. These can be of geometric nature (cavities and channels as well as cellular structures mainly used for cooling purposes), material-based (the possibility of using materials which cannot be processed or machined using conventional machining methods) and integrated functions (integration of sensors, actuators and electric functions), as well as mold repairs (replacement cores can be printed over night or within a few days).

Lichtenfeld-based tool and moldmaking company Hofmann (which is where

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the company Concept Laser was born), for instance, produces pneumatic injectors to eject parts without mechanical components through additively-produced porous micro structures and elastic split lines for steel-on-steel seals, which are hard to implement for materials with a low viscosity, such as polyurethane.

While the most common and suitable processes for mold shops and their specific needs and applications are powder-bed-based processes where the metal powder is either selectively sintered in layers by means of a laser beam (LBM) or locally melted by a moving electron beam (EBM), there are alternative processes available.

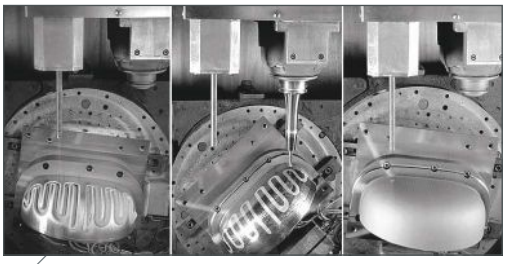

Photo courtesy of Hermle.

Hermle's Metal Powder Application process (MPA) is combined with five-axis machining in one machine. As opposed to many other additive technologies, MPA does not use any lasers. Instead, the metal powder is applied to the substrate via a carrier gas through a de Laval nozzle.

Hermle, for example, is offering the Metal Powder Application process (MPA), which is combined with five-axis machining in one machine. As opposed to many other additive technologies, MPA does not use any lasers. Instead, the metal powder is applied to the substrate via a carrier gas through a de Laval nozzle. Layering happens simply through plastic deformation in the particles' impact. In this process, neither the powder particles nor the substrate are molten. According to Hermle, this results in a comparably low tension of the structure and nearly non-warping components.

Tool and moldmaking for plastic injection molding is a field of application where MPA can fully display its strengths, the company says. Here, cycle times can be drastically reduced through skilled use of conformal cooling ducts, Hermle says. Moreover, in the hot-working steels often used for mold components, the material is 100 percent impermeable after a heat treatment, and the function surface of the injection mold can even be polished to high-gloss (according to ISO 4287, roughness depth measured Rz = 0.1 microns, average roughness value Ra = 0.005 microns).

With this, the implementation of AM becomes possible even with the highest demands on surface finish, Hermle says. Specific applications can be found, for example, in the production of reflectors and cover elements of headlights for cars, where surface faults cannot be tolerated because of the formation of scattered light. MMT

CONTRIBUTOR

Barbara Schulz is Gardner Business Media's European correspondent. She can be reached at bschulz@gardnerweb.com.

FOR MORE INFORMATION

Erofio / erofio.pt
Hermle Machine Co. / hermlemachine.com/en/home_en
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By Jesse Trinque

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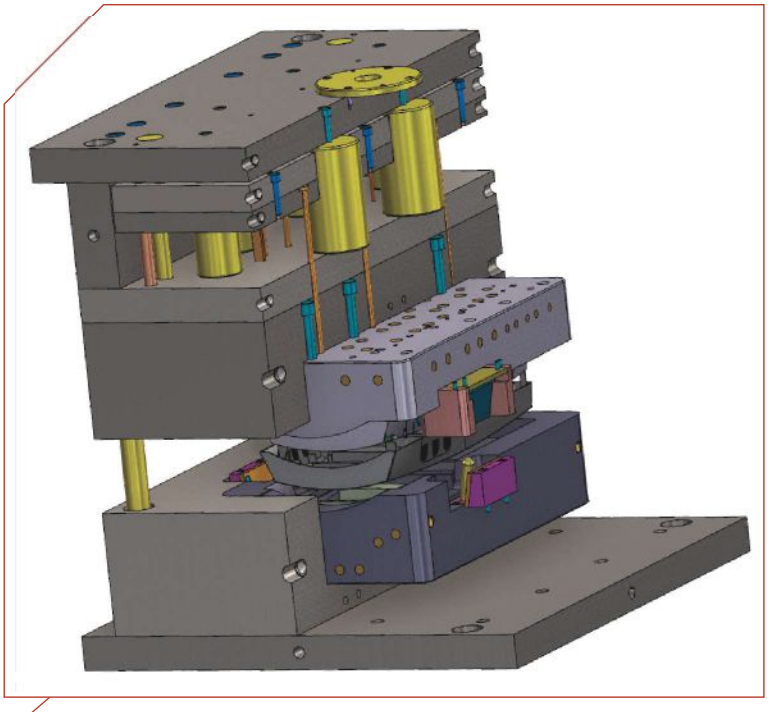
Power Up Your CAM to Streamline Your Process

Advanced CAD/CAM improves performance of cutting tool designs, probing, process simulation and verification and data gathering and monitoring.

The necessity for productivity reigns throughout manufacturing, and that certainly includes moldmaking. Recent CAD/CAM software advancements can help achieve significant improvements throughout the shop and moldmaking process from quoting, programming and roughing operations through to finishing, deburring and shop connectivity.

New tools in CAD/CAM packages are geared toward CAD solid model preparation and are designed to make the file cleaner, smaller (data size) and easier to work with. In toolpath creation, dynamic roughing tool paths continue to become smarter, and now even finishing operations are enjoying a boost with new algorithms. Also, certain CAM packages offer highly focused moldmaking tools for electrode creation, core/cavity model separation and parting line creation.

Important aspects of all this software advancement for mold shops include gaining the necessary CAM power to take advantage of the latest in cutting tool designs, probing, process simulation and verification, and data gathering and monitoring.



Images courtesy of Mastercam/CNC Software Inc.

A moldmaker using quick visual sectioning can see inside complex assemblies, like the one shown here, to confirm he gets exactly what he wants.

CAD for CAM

The first step to streamlining the moldmaking process is *model preparation*. It begins with the CAD solid model file. Most CNC tool paths are generated by directly editing the solid model versus sketching or wireframe-based modeling. It's vitally important for the CNC machine programmer to work with a model in its cleanest form. This will create the most optimal and efficient toolpath strategies to cut the mold cores, cavities and various inserted components.

When a designer or operator inputs or views a CAD model file in the CAM system, they may see defects, especially if the file was transferred from person to person and CAD system to CAD system, which is common practice. New utilities in the CAM program can query the solid model, discover defects, and even fix the model, such as filling in gaps and deleting unnecessary data remnants.

The next step is *model editing*, and there is new software functionality for viewing, reducing and simplifying the solid model for the programming task at hand. Take, for example, a mold with a large drafted face that also has small detail features. When programming the roughing strategies, the programmer only needs to consider the large face because the small details will be machined later in the process. New CAM

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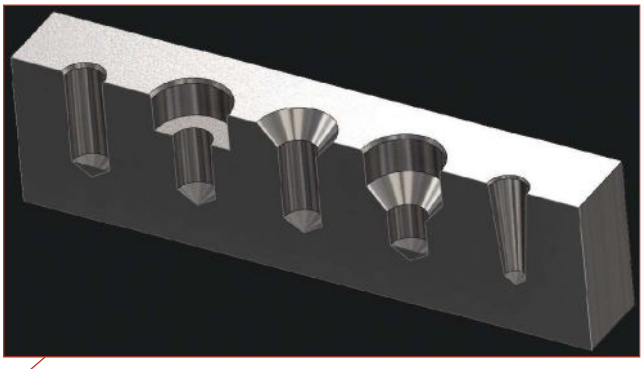
tools allow the programmer to delete those smaller, more complex features on the model and focus on cutting the larger drafted faces, which simplifies the programming and reduces the required time it takes to complete this task.

When it comes to the design side of CNC programming, *hole making*—almost every mold has holes, ports and threads—has experienced several advancements, including smart consolidation of hole making functionality. For example, certain CAD/CAM packages combine the operations that each hole requires, such as center drilling, drilling, reaming and tapping.

The emphasis now is more on the feature, the hole as a systematic process, and what needs to be done from start to finish, rather than selecting and programming each operation in the program. One such new feature allows the solid creation of four or five conventional solid model operations in one dialogue. Previously, a counterbored hole with a small counter sink on top would require the use of several independent features in the software. While that is still a valid approach, it can now be done in one selection via one associative solid feature. That associativity has the added benefit of being capable of modification later in the process. For example, making the counter sink a couple of millimeters larger. The programmer can quickly and easily click on that hole system as a feature and change it without having to remodel the entire feature.

Additionally, a software advance beneficial to many moldmakers is *editing surfaces*. A programmer can simply click on any surface and add, remove or modify the U and V lines of that surface definition. A simple click-and-drag can completely change how that surface looks or is defined. This can be used by an advanced programmer to modify tool path behavior.

For example, the programmer can build a custom bulge in the surface to smoothly transition the tool over a fixture bolt. Or, perhaps hand polishing is required for a certain critical area and the programmer needs to leave a bit more stock on that feature to accommodate the handwork or machined blends. Changing that surface in the model is now much easier than old methods to accomplish a similar or better result.

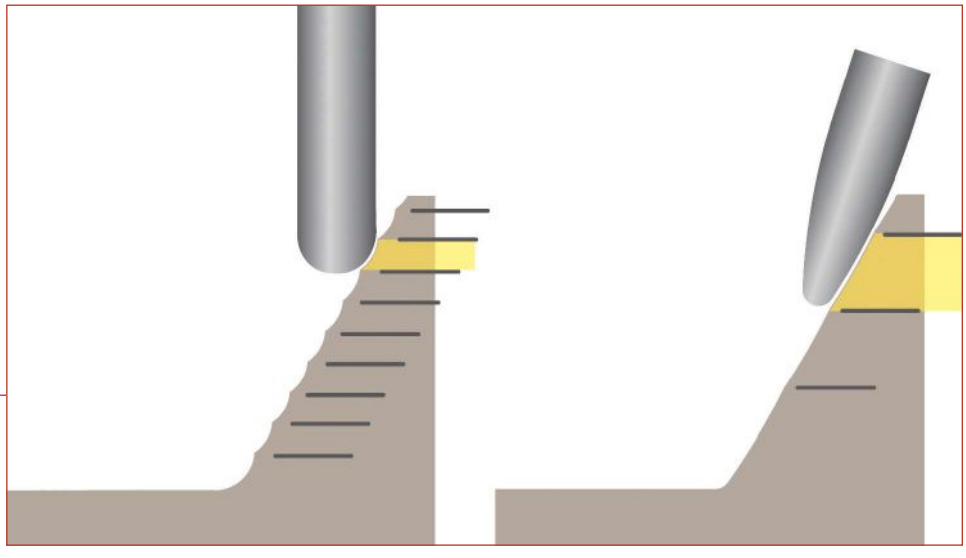


Typical molds include many holes of different types, as shown here. Smart solid hole programming can make this process much faster.

Another advancement allows a programmer to see the solid model in a *cross-sectional view*, which is helpful not only at the toolpath creation stage but also when quoting a job. The estimator can readily access all the features that might otherwise be hidden, helping to understand the scope of the part, such as which machine will cut the part, required cutting tools needed, and process requirements.

Tool Paths

Once the model is in good shape, it's time for the programmer to create the CNC tool paths to machine the mold. Newer, dynamic tool paths allow a moldmaker to remove a lot of material as quickly as possible. At their essence, these tool paths constantly change the amount of engagement of the tool in the cut to ensure it is continually removing material, using the optimal chip load for the cutting condition. This can significantly reduce the time it takes to complete near-net mold roughing.



Shaped tools like the ones shown here combined with precision multi-axis programming deliver much better finishes and cut times than traditional ball end mills.

Dynamic motion machining is a significant timesaver for shops that want to rough molds as quickly as possible.

Some CAM packages today include accelerated finishing tool paths developed in conjunction with the most advanced cutting tool manufacturers. These toolpath strategies are aimed at the new oval, barrel, taper and lens-shaped forms. When programmed correctly, these cutters can allow a small diameter tool to have a large effective cutting radius at the contact point, reducing cycle time and improving surface finish.

Cutting tool manufacturers continue to develop new profiles, so it's important that CAD/CAM software advances accommodate futuristic combinations of these current profiles and whatever new cutting tools the future holds. For example, new deburr tool paths that can reduce this secondary operation and allow mold builders to run lights out, increasing quality and throughput while reducing handwork and improving the company's profitability.

Verification

A vital step once the program is created is program verification. The step involves simulating the process and the actual machine tool's motion in a visual way before making the first cut. Simulation color codes the part, machine, stock and fixture so that, at a glance, the programmer and machinist can

CAM's accelerated finishing function provides faster machining and better surface finish on select mold surfaces by taking advantage of today's emerging shaped tools.

Mold builders should ensure that their CAD/CAM system offers verification functionality to avoid crashes and the expense of scrapped parts.

easily see all important details of the metal removal process, even the brand name of the machine tool on the sliding door. Mold builders should ensure that their CAD/CAM system offers this functionality to avoid crashes and the expense of scrapped parts.

Workpiece probing within the CAM software is another development that allows for complete control of the machine's work and tool probe within the CAM programming and simulation environment. This is a necessity for lights out manufacturing because it promotes in-process control by using the probe to measure features and then update the machining process and tool data in real time, based on the results. This feature gives the machine the capability to make programmed decisions about the quality of the part without an operator.

Connectivity

Many mold shops today are at least observing, if not embracing, the emerging shift in manufacturing toward the Industry 4.0 concept of digital connectivity, data gathering and monitoring. The shop's CAD/CAM program is essentially a platform for the shop to accomplish a variety of tasks, whether it's metrology, robotics or digital tool management. So, it's important for mold builders to work with CAD/CAM providers that have partnerships with machine tool builders, cutting tool developers, metrology instrument companies and other software utilities in the industry. These partnerships help to ensure that all the pieces of the moldmaking process connect, which is the intention of Industry 4.0.

Primary trends in CAD/CAM software have remained fairly consistent and focused on the moldmaker's primary need for productivity in recent years. This productivity extends through the entire process and shop, which drives CAD/CAM advancements that yield workpieces faster on the machine and faster off the machine with the highest quality. MMT

CONTRIBUTOR

Jesse Trinque is an applications engineer for CNC Software Inc.

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By Steven D. Shannon

Determining the Proper Vent Depth

Vent depth is critical to optimizing mold performance, so here is one approach to finding that elusive right number.

Venting is one of the most important aspects a mold technician can get right when tweaking a new plastic injection mold for production. When vents are not designed and executed properly, problems can occur.

For example, a build-up of nonaqueous volatiles (NAVs) that can etch (burn) mold cores and cause parts to stick. NAVs are gases that come from the fillers and additives present in the many resins molders use today. On top of parts sticking, a mold technician cannot simply clean off this etching. He must use diamond polishing, which causes unscheduled mold stops and increases startup scrap rates, which in turn add costs in time, money and labor.

One solution for eliminating this situation is to increase the number of vents and determine the proper vent depth. It sounds simple, but there are many components to proper venting, such as vent location, vent width, number of vents, land width of the primary and secondary vents, and primary vent depth.

For this article, we'll focus on vent depth, as it has no set number. Vent depth is typically a range that is provided by the resin material supplier. Herein lies the confusion.

Images courtesy of The Estee Lauder Companies, New York.

The trickiest aspect of optimal venting is getting the depth right. This cavity for a cap has eight primary vents around its perimeter, measuring about 0.0005-inch-deep x 0.200-inch-wide, that feed into secondary vents. The recessed secondary vent around the diameter of the cavity measures about 0.030-inch-deep with four secondary exhaust ports at the same depth that carry air or gas out to the atmosphere, allowing the plastic material to fill completely and at optimum speed.

Figuring it Out

My early years as a moldmaker in a captive shop for the cosmetics industry taught me a lot about venting.

For example, primary vents are connected to the cavity or core. It is these vents that have the most critical depth requirements. Secondary vents are deeper (by 0.025 inch to 0.030 inch) and are connected to the primary vent and then exit to the atmosphere. Land widths refer to the thickness of the primary vents (distance between the cavity wall and the secondary vent, generally 0.060 inch to 0.080 inch).

I also assisted process techs with sampling and debugging molds, and learned to adjust gate sizes, cooling lines, runners, flash issues, preloads, shutoffs and vent depths, as required.

Today many of the molders I work with contract their mold builds to an independent moldmaker, but they still must accept responsibility for making the final vent adjustments. However, not all molders know or believe they need to adjust venting areas in the mold. Instead they believe that if the cavities are filling, and they do not see burn marks, the venting is correct. Wrong. Never assume that the venting is correct or that the vents are deep enough just because gases are exiting the mold.

I have seen molds where primary vents were installed but no secondary vents, so although the molds appeared to be filling efficiently at first, the absence of secondary vents did not allow the gas to escape the mold. Mistakes like this can cause inadequate filling, which leads to dimensional variation in the part, holes, voids, short shots and other defects like flash, because the pressure builds up enough to actually separate the mold halves just enough for the material to leak out.

Fitting the vents to the proper depth will not only help the mold fill faster, it will help avoid compressing the gases, which creates more heat. Proper depth will also help the mold cool faster, reduce cycle times, and yield better part-to-part consistency and Cpks (process capability indexes).

The Moldmaker's Role in Venting

Many times, an independent moldmaker builds a mold based on the type of resin being used, so shrink rates, heat expansion and vent depth are taken into consideration. For instance, if a moldmaker builds a mold that will be running polypropylene, the material supplier will spec a vent depth range (for example, 0.0005 inch to 0.002 inch) based on material type and potential processing temperature, mold temperature, vent location from the gate, injection pressure, mold complexity, wall thickness, clamp tonnage and cooling lines. All of these factors mean that no two mold scenarios are alike, which is why material suppliers spec a range.

Once the correct vent depth is established, it is imperative that all vent depths, land widths and secondaries are identical from cavity to cavity because deviations in vents can cause an uneven fill, which impacts part-to-part consistency. This cavity for a cap shows a proper gate and runner with a primary ring vent around the whole diameter of the cavity. A recessed secondary vent with four exhaust vents allow gases to escape into the atmosphere.

As a result, the moldmaker does not know exactly how the molder or OEM is going to process the mold, which means he or she cannot predict the proper vent depth within the range provided. Installing vents with depths on the high side of the range is risky because it could produce a mold that flashes and requires repair. To avoid this scenario, the moldmaker usually sets the vent depths to the lowest number in the range, enabling the molder or OEM to produce a part and then proceed to do the final tweaking of vent depths themselves based on their process parameters.

Sneaky Solution

An effective strategy a mold technician in a molding facility can use to determine the correct vent depth is to sneak up on it. By that I mean, use a spare cavity and core stack and gradually increase the depth of the vents by about 0.0002 inch to 0.0003 inch, cycling the mold after each increase and noting the appearance of the parts at the vent locations. As vents deepen, a whisker-like flash will appear, indicating the need to back off by 0.0002 inch, and revealing the correct depth. Other indicators include burn marks that go away and a slightly improved appearance.

However, it is important to first establish the mold processing window along with clamp tonnage, water temperature, preloads, cooling time, ejection and overall cycle time, as these parameters impact vent performance.

The full benefits of this exercise will only be evident after the technician determines the correct depth and adjusts all of the mold cavities accordingly. It is also crucial that all vent depths, land widths and secondaries are identical from cavity to cavity because deviations in vents can cause an uneven fill, which impacts part-to-part consistency. Once the technician adjusts the vent depth to the proper number, he may find he can then slightly adjust the process parameters, which enhance the mold's ability to fill the cavities quicker, reduce cycle time and improve part quality and dimensional tolerances. This may seem tedious, but it will pay off in the end.

The next step is documenting the proper vent depth, so that when the mold comes in for preventive maintenance, the technician can more easily check vent depths and compare them to the baseline that was established.

Another important maintenance issue to be aware of is that constantly cycling a mold can cause venting areas to coin into the opposing side of the mold. Coining occurs when an unsupported area (in this case, the vent channel) is subjected to pressure (clamp tonnage) heavy enough to cause embossing where one side is depressed and the other raised. A mold technician should check both sides of the vent location to ensure the vent is not being pinched off due to coining and that it is at the correct depth.

Molders and OEMs should never assume that venting is at the optimal setting when a mold arrives in their facility. Instead, *they* should determine the proper vent depth because only they know the exact processing parameters they will use. By adopting a process that adjusts the vents to the proper depth at the beginning of mold startup, molders and OEMs will have a better-running mold with good part-to-part consistency, lower cycle times and fewer headaches down the road. MMT

CONTRIBUTOR

Steven D. Shannon is director of global supplier technical excellence and R&D fellow for The Estee Lauder Companies, New York.

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By Scott Paul

The Impact of International Trade Policy on Mold Manufacturing

The first step to impacting policy decisions is staying current with issues such as the U.S.-Mexico-Canada Agreement and U.S./China negotiations.

International trade policy impacts every mold builder, and policy shifts matter even more. Each decision potentially makes it easier or more difficult for a mold builder to export or to push back against unfair trade practices originating overseas. After a year of laying out a comprehensive, and very controversial, trade agenda, the Trump administration began to implement dramatic shifts in 2018. Our nation has plenty of policy irons in the fire, including unilateral tariffs on steel and aluminum imports, a new NAFTA and face-to-face negotiations with Beijing.

Here's a quick rundown of some of the decisions that the government will need to make, along with some of the issues it needs to address this year.

Completing the U.S.-Mexico-Canada Agreement

The U.S., Mexico and Canada signed the NAFTA update, called USMCA, but the deal now faces scrutiny from the U.S. Congress to determine if they will approve it or not. Although the President spent the first half of his term governing as a deep-red conservative, his negotiators, led by U.S. Trade Representative Robert Lighthizer, fashioned this deal with the prospect of a divided Congress in mind. As a result, some of its more notable updates could help gain bipartisan support.

The USMCA includes an increase in the percentage of North American content an automobile must contain to qualify for duty-free status. This item is an improvement that will keep more automotive parts manufacturing in the trade zone. The deal also stipulates that 30 percent of cars must be made by workers who earn at least $16 an hour. That is a rule that will mean more automotive manufacturing in the U.S. and will simultaneously encourage the low-wage Mexican automotive industry to improve the pay of its manufacturing workforce.

Another rule prohibits the USMCA signatories from signing a bilateral trade deal with any non-market economies, which leads to the next outstanding issue in American trade politics: U.S./China negotiations.

U.S./China Negotiations

The purpose of the aforementioned USMCA rule is to secure America's economic backyard while the U.S. tries to reshape an increasingly lopsided trading relationship with the world's second-largest individual economy. China's economic growth can be described in exponential numbers, and explicitly so since 2000 when Washington granted the nation permanent normalized trade relations and assisted the nation joining the World Trade Organization.

The liberalization that China promised in return for this fiscal bonanza didn't materialize, and a decline in American manufacturing employment correlates to the increasing Chinese trade deficit since that year. According to a recent report from the

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Economic Policy Institute, that deficit can be linked to 2.5 million lost manufacturing jobs from 2001 to 2017, which is simply a jaw-dropping figure. And in the plastics and rubber products industry alone, the deficit eliminated more than 78,000 jobs.

A combination of lax American trade enforcement and bald-faced Chinese mercantilism increased the U.S. deficit and caused major job loss. This outcome has made the significant tariffs the Trump administration erected very appropriate, although some exemptions, such as those granted to injection mold imports, were wisely applied.

As Washington and Beijing continue to deal, here are a few fundamental issues that U.S. negotiators should insist their counterparts in China address:

- Dismal intellectual property protection for foreign firms and a habit of currency manipulation, which subsidizes the country's export industries and levies a tax on competitive imports;
- State-owned enterprises, some of which are actively seeking footholds in the American marketplace, particularly in railcar and bus manufacturing;
- The complete absence of formal labor protections for its massive workforce; and,
- Nonexistent environmental regulations.

Another ongoing trade deal is one with the European Union, the now post-Brexit U.K. Still another is with Japan, as Tokyo's economic growth model is export-based with a very lucrative automotive market that is notoriously closed, while Japanese automakers are fully integrated into the American marketplace. That market will take significant muscle to pry it open.

It will be an interesting year for our unsubtle President as he wrestles with the newly divided Congress, even more so now than when his party ran both chambers. The brisk pace at which he's forcing a reckoning on trade policy may make for some interesting headlines in 2019.

Not only will it be important for moldmakers to stay ahead of them, but it's also incumbent on shops to make their voices heard in these policy debates. Insert your priorities into the discussion by inviting your members of Congress or staff to visit your shops, so they can learn more about your value to the community and how policy decisions impact you. MMT

CONTRIBUTOR
Scott N. Paul is president of the Alliance for American Manufacturing

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Alliance for American Manufacturing
202-695-8112
spaul@aamfg.org
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SECO

By Cynthia Kustush

This article is part of a series of roundtable discussions with industry suppliers addressing recent trends in moldmaking, the challenges moldmakers are experiencing and the latest solutions that are or will be available to resolve them.

Workforce Development With A Twist

Two moldmaking companies and the owner of a machine tool distributorship blaze their own trails to recruit, train and inspire young people for careers in manufacturing.

MoldMaking Technology continues its coverage on a variety of workforce development programs in North America. In this installment, a Canadian shop and a U.S. shop share their unique approaches to building a skilled workforce.

An Architect's Approach to Workforce Development

Unique Tool and Gauge (Windsor, Ontario, Canada) is fully dedicated to workforce development and has been for many years. Seven years ago, the company hired Chad Thomas as its human resources manager, and Thomas has since stepped up Unique's game when it comes to recruitment and training.

Unique Tool and Gauge was founded in 1982 to build molds for the automotive industry. The company specializes in manufacturing very large, high-volume production injection molds in both tool steels and hybrid aluminum materials, the latter of which the company says it helped pioneer in the automotive sector. With 85 employees work-

Image courtesy of Unique Tool and Gauge.

Chad Thomas (second from right) manages human resources at Unique Tool and Gauge in Windsor, Ontario, Canada. He is the architect of Unique's rather unique training program which condenses a traditional three-year training curriculum into one year led by a dedicated, full-time master moldmaker. Pictured with Thomas are, from left, Aston, Reed and Lucas, each of whom very recently graduated from Unique's program.

ing within a 60,000-square-foot facility, moldmakers make up 50 percent of Unique's current workforce, and the company is growing.

"The recession in 2009 saw many moldmakers leave to work in the oil industry in Alberta, never to return. It was becoming harder and harder to recruit young people into moldmaking, and we got tired of the usual 'poaching,' then training the recruit only to see them leave," Thomas says. "The stereotypes about manufacturing jobs still exist, but the government is trying to emphasize career opportunities in manufacturing, and it is getting better." As a result, he became the architect of a new, comprehensive, in-house workforce development program that, timing-wise, works in step with the Greater Essex County District School Board's Ontario Youth Apprentice Program (OYAP). OYAP is a school-to-work program that provides eleventh- and twelfth-grade students with a pathway to learn about and work in apprenticeship occupations, like moldmaking and more than 150 other skilled trades. Unique's program also includes a partnership with the Dual Credit Program offered at St. Clair College for students in its General Machinist program.

Another key move Thomas made was to hire a full-time trainer to lead the new program. "Having a full-time trainer is key. It differentiates Unique's program from every other training program. We no longer rely on lead employees who are limited on time to teach because of regular work," he says, adding that "no other company has taken more OYAP students on board than we have." Over the last ten years, Unique has trained more than 71 apprentices at its facility. The average age of employees at Unique is between 36 and 40 years old.

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Immersion Training

While Thomas continues to represent Unique by giving presentations about careers in moldmaking at local high schools and colleges to generate possible candidates (the program is open to anyone who would like to apply), most apprentices are recruited by Unique in the eleventh grade, through OYAP's one-year paid co-op placement program.

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Taking Manufacturing's Message Mainstream

Terry Iverson's family has been in manufacturing for 93 years, so it stands to reason that he is proud of his heritage and passionate about manufacturing. He works in manufacturing himself as president and CEO at Iverson & Company, which specializes in selling and repairing used Hardinge machine tools nationally and represents new machine tool lines in the Midwestern states. The company was founded by his grandfather, Edward Iverson, in 1931. "I was taught at a very young age to appreciate all the mentoring role models I had, whether they were family members, friends, teachers or coaches," he says. "Because of that, I've been compelled my entire adult life to help young people in the same way."

Rallying Industry Support

Iverson says that when he retired from coaching his kids' travel soccer teams about 10 years ago, he decided it would not be the end of his mentoring mission, and he turned his attention to more actively mentoring the young people within the manufacturing industry. "In 2010, I started my 501C3 CHAMPION Now! initiative," he says. "At the time, I was serving on the CTE Education Foundation in Washington D.C., an organization whose mission it is to bring educators and industry together to create equal opportunity in education by bringing programs in STEM and CTE (career and technical education) to all students. I was really struggling with how to make a difference, and while I was on a flight, I was literally jotting ideas on a napkin and came up with 'champion,' which is the acronym for what CHAMPION Now! is based on." Change How American Manufacturing's Perceived in Our Nation. Iverson says the organization exists "to change the image of manufacturing from the unrealistic, stereotypical 'dark and dirty' industry to one that is filled with extremely high technology, advanced innovations, and exhilarating and good paying careers available for the next generation."

Reaching Beyond Manufacturing's Walls

In addition to serving on the CTE Education Foundation, Iverson has championed the value of U.S. manufacturing, serving as an advocate in many more mainstream arenas, including the following:

Iverson was nominated by John Stilp, vice president of Milwaukee Area Technical College, to serve on the National Visiting Committee of Florida Technical Education (FLATE). He served for eight years and pushed to the National Science Foundation for FLATE to be a national model for the entire country. "FLATE had a huge influence on the state of Florida in both curriculum (Engineering Technology degree) and outreach (involvement in Mfg Day events around the state)," Iverson says. "They also managed HI-TEC, an annual, national conference on advanced technological education, where I was a presenter and served on panels in Washington D.C., Chicago and other annual meetings."

Locally, Iverson was also actively involved on the Schaumburg, Illinois-based Technology and Manufacturing Association's (TMA) Education Foundation board for three years. "Here I was able to help formulate many facets of the local education landscape. This included working on fundraising events, voting on grants and other associated functions for the Foundation. Further, he volunteered on boards of Chicago area high schools and technical colleges. "I was involved with the development of the Harper Promise Scholarship Criteria at Harper College and developed a promotional poster for high school students in STEM and Project Lead the Way programs at Palatine High School."

During much of his community service, Iverson self-published a book. He says it is his family, colleagues and others that influenced him deeply throughout his life and inspired him to take the manufacturing message mainstream by writing *Finding America's Greatest Champion: Building Prosperity Through Manufacturing, Mentoring and the Awesome Responsibility of Parenting*. Visit moldmakingtechnology.com to learn more about Iverson's book.

Iverson continues working to build awareness about the importance of maintaining a strong manufacturing industry. His foremost goal is to get his message to the industry and go more mainstream. "That's where we hope to achieve significant traction and, ultimately, where perceptions will be changed," he says.

Terry Iverson (center) meets with Illinois Congressman Brad Schneider (left) and Rick Schwind of Continental Tool & Manufacturing in 2013. Schneider invited Iverson to give a testimony to the Small Business Committee of the House of Representatives, stressing the difficulties faced by small businesses looking for qualified talent in manufacturing.

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"During the interview process, I am looking for many types of qualities, like their initial greeting, their clothing selection for an interview, what questions they ask, how mature they are and what they know about us as a company," Thomas says. He also learns what mechanical knowledge a candidate has and whether they liked taking things apart and reassembling them when they were growing up. "I like to ask them what they think an employer would expect of a new employee because that helps us set expectations for them." After being interviewed, seven or eight students are chosen among many applicants who have taken shop classes to learn some basic skills. Trainees are hired to work at Unique for a year, like being on sabbatical from school. The program begins the first week of February each year.

Unique's training program is highly structured and condenses the typical three-year apprentice training down to one year. This is possible because Unique has a master moldmaker, Bob Clifford, whose only job is to train recruits in all areas of moldmaking. Thomas says Clifford was an instructor in the past and joined the team at Unique almost four years ago. "With Bob leading them, the students are immersed in all areas of moldmaking. While I developed the training program, Bob's fingerprint is definitely on it. He has to execute and own the program, and his experience as a trainer ensures its success."

The first three months of training is dedicated to learning all the foundational elements to moldmaking, like shop safety and machining fundamentals including drilling holes, chamfering, and so on (on manual and machine-directed equipment), how to use calipers and other measurement devices, moldmaking terminology and so on. Thomas meets weekly with Clifford and daily with the apprentices to track progress throughout the year.

"The current group of trainees is exceptional, though there really have not been any that have disappointed in the past," Clifford says. "But these are smart kids, and they are going to see laser welding and waterjets; they are going to see handwork (though we have gone from having 15 handmen down to two because the machines are cutting closer). Who better to adapt to new technologies than these young kids?" Clifford says he enjoys working with young people because they have more fun. He also likes to challenge them by giving them individual projects that make them use their heads before hands to figure out the best approach for

completing them. "I had one guy who was a troublemaker—like a bull in a china shop," Clifford relates. "I told him that I was going to prove that he's the number one trainee, and I gave him a work order for a repair job on a big chair mold. These molds come in so dirty and filthy that they used to put beeswax on them to release the plastic that's caked on. I told him, if he's got a problem, he should come to me and say, 'here's how I would do it, what do you think?' We would talk back and forth like that until one day, he came to me and said, 'what if we do it this way?' He had seen what others were doing and came up with a better way, and it changed the way we did things."

After the initial three months, the apprentices go on an eight-month rotation that includes about 15 percent design and engineering training, 25 percent CNC machining instruction, 20 percent EDM training and 40 percent moldmaking instruction, Thomas says. "Throughout the year, these high-school kids are full-time employees making CAD $30,000 before taxes and gaining skills and potential for a career in moldmaking."

Students who successfully complete the year at Unique return to school to complete required high school courses before graduating with offers to join the team at Unique Tool and Gauge. "Of the apprentices that we bring in each February, we keep roughly 40 percent," Thomas says. His goal is to recruit enough young people that Unique can fill all required positions for two shifts. "We are hoping to bring as many as three groups of trainees through our program in the next two years, with a new group starting in November. That way, in two to three years or so, the company will reach the level of productive, full-time employees that we need. After that, we hope to eventually become a resource for other Canadian shops once we are fully staffed."

Driving Workforce Development Through Real-World Product Development

At PM Mold Co. (Schaumburg, Illinois), apprenticeship kicks off with the driving core of any moldmaking project: product design and development. According to Tom White, vice president of operations and business development, it all began as the company began preparing to exhibit at the National Plastics Exposition (NPE) in 2012. "We were discussing giveaways and decided to focus on an item that showcased our two-shot capabilities and included our logo," he says. "Everybody loves a golf game, so we decided to make a two-shot golf tee. You don't see many like that on the market."

White says that the mold for the tee was built by their apprentices at the time and designed by the company's

Images courtesy of PM Mold Co., Inc.

This golf tee began as a trade show giveaway idea but soon developed into part of PM Mold Co.'s apprentice training program. Apprentices assisted with product development, engineering, moldmaking and even marketing, which helped broaden their understanding about their chosen careers in the industry. Inset: The resulting range of golf tees, packaged and sold in retail sporting goods stores all over the United States.

young engineers. "During the design phase I told them to go out and look at golf tees currently on the market and if they see anything that interests them, even if it's a gimmicky item, to buy it (they were reimbursed) and we will use it to help spark some creativity for what we are trying to do," he says. The apprentices examined the products they found and listed the features and functions they liked and disliked. White then asked them to brainstorm how they could incorporate the benefits of the other products into the new golf tee, while eliminating any of the negatives to develop a better golf tee. "We are providing a springboard to innovation.

> We were kind of our own customer, and we worked through all aspects of our company to do for ourselves what we do for others.

"The first tee we made was red, white and blue. We put them in a fish bowl in our booth and gave them away. Then a gentleman who worked at a major golf component supplier stopped by our booth and asked about the tee," White says. "He liked the bigger head and said it was the first time he'd seen a tee like that, and he explained how there is a scientific setup with having this bigger head that reduces side spin on the ball."

PM Mold's team, including the apprentices, began working with the gentleman to further develop the size of the tee and the eighty dimples in its cradle that prop up the ball and reduce friction yet put just the right amount of pressure to reduce top spin. "The project made up about five to ten percent of the apprentices' training, depending on where we were with the project," White says. "It was definitely a hands-on learning experience, as they were involved with part design concepts, prototype tool design and build, as well as the package design. Actually, the packaging design concepts came from our engineering intern."

After testing prototypes on the golf supplier's hitting machine and learning it outperformed the average tee on the market, the team finalized design changes and patented it. "We were able to put a lot of employees on the patent, and we had some fun working on it, so that's really rewarding," White says. The U.S.-made tee, called TeeTech, is approved for use by the United States Golf Association for professional golf.

"This kind of represents what PM Mold does. We have resources to help our customers with design. We have resources to design a tool, build a tool, run parts and take it all the way to assembly and packaging. We were kind of our own customer, and we worked through all aspects of our company to do for ourselves what we do for others," White says. "When new apprentices come on board, they attend classes and work, like a traditional, paid apprentice program, but in addition to that, we will have a new project for them and ask them, 'What could we do to improve this product?' just as we did with the golf tee project. Generally, when we bring people in that way, we can keep them interested. Part of that is on us because we must keep that interest level going and keep challenging them. But part of it is on them to keep asking questions and keep pointing to where they need to go as part of the PM Mold team, and we can guide them."

PM Mold currently has four apprentices, and White says the company is always on the lookout for more. MMT

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

Multitasking Machining Centers Bring the Future Home to Canadian Moldmaker

Images courtesy of Concours Mold Inc.

Concours Mold Inc. has realized several significant benefits since purchasing three Unisig USC-M Series multitasking machining centers for its Lakeshore, Ontario, Canada moldmaking facility. The multitasking Unisigs have enabled Concours to eliminate three boring mills and two gundrills, and, as shown here with the Unisig M38, complex milling operations can be performed as well. Overall, Concours reports that it has reduced setups times by 50 percent.

By Cynthia Kustush

Concours Mold Inc. (Lakeshore, Ontario, Canada) makes it a priority to keep its machinery and equipment up to date to ensure competitiveness. From its enterprise resource planning (ERP) system and advanced scheduling system, to its radio frequency identification (RFID) tool management system, to rigorous quality-check procedures, not to mention five-axis machining centers, the company does whatever it can to continually improve its processes. In fact, the company recently invested millions of dollars in new equipment, but one machine, the Unisig USC-M, has so improved Concours' machining processes that, according to Ed Ergun, corporate sales manager, it has been a game changer.

Concours specializes in building small to very large injection, compression and hydroforming molds as a primarily Tier-One supplier to the automotive industry and has additional locations in Cullman, Alabama, and Puebla, Mexico. All locations run 24⁄7. Molds built for interior automotive parts produce instrument panels, door assemblies, A, B, C and D pillars⁄assemblies and much more, while molds for exterior parts produce such items as fascias, grilles, spoilers and rockers. The balance of the company's business encompasses building molds for heavy-truck parts and consumer products.

Still, it is the automotive OEMs that dominate Concours' customer list and, as anyone who has experience serving the automotive industry knows, high quality is expected, and mold deliveries are tight. "As our company announcement said when we launched our third Unisig USC-M in February 2018, the USC-M series brings unmatched capabilities in a single, game-changing machine," Ergun says. "This is our tomorrow."

CONCOURS MOLD INC.

PROBLEM: The efficiencies in standard machining processes at Canada facility due to multiple setups required on each of two machines (boring mills and gundrills) necessitated more outsourcing of work to keep up with deliveries.

SOLUTION: Addition of a Unisig USC-M50 and two Unisig USC-M38 multitasking machining centers.

RESULTS: Significant reduction in setups, virtually eliminating downtime between setups. Faster machining, better accuracy and fewer mistakes reduced lead times, allowed first-time quality and enabled more time to handle more work coming through the machines.

It's About Throughput Gained

Boring Mill. Gundrill. Before purchasing its third Unisig in February 2018, Concours utilized these machines every day, repeatedly. "Anything that came into our facility basically hit these machines at one time or another," Ergun says. He adds that each machine needed to be reserved in the schedule to complete that portion of the build, to keep blocks and components moving. If any issues arose that prevented movement of the workpiece, then the scheduling would be off, and machining delayed till the next available slot opened. It was a constant struggle to update and revise the schedule to remain current.

"Now, instead of reserving a boring mill for three days, and then the gundrill another three days, we can take care of all the boring and high-speed gundrilling on the Unisig," Ergun says. "The USC-M Series machine is very much a multitasker and has reduced our lead times by roughly 30 percent."

It's About Reducing Costs

Concours regards the time spent setting up jobs as throw-away

costs. "There are so many setups involved on just a boring mill alone, it adds up to costs that we have to absorb, plus a crane and any employees required to work on it," Ergun says. For example, he says to set up a block in the boring mill would take half an hour to an hour, depending on the setup, to bore/drill five holes, then lay it down and set it up to complete another series of holes and so on.

"Now we have the five-axis positioning capability of the Unisigs and FCS clamping systems along with automatic pallet changers on each machine, which is a 100 percent time-saver when it comes to switching a tool from one setup to the next," Ergun says. Concours now sets up one pallet while the other is being worked on. When setups are required on the original block, the pallets are shuttled so machining can begin on the other job while the first block is being set up. "Because of these new improvements, the Unisigs stay in production mode with minimal downtime. I can honestly say that our setup time has decreased by more than 50 percent."

Ergun says that as Concours purchased its first, second and eventually its third Unisig USC-M Series multitasking machining center, the company was able to eliminate other machinery and significantly reduce outsourcing work. "When we bought the first Unisig USC-M50, we were able to eliminate two boring mills right off the bat," he says. The USC-M50 features a 120-position toolchanger. In addition, it has a 25-ton capacity table for work pieces as large as 3,000 mm, 50 mm diameter capacity for both BTA drilling and gun drilling up to a depth of 1,830 mm, and dedicated 5,000 rpm, 24/30 kW drilling spindle power.

Then Concours purchased the first Unisig USC-M38, featuring a rated gundrill diameter of 50 mm and a BTA drilling diameter of 38 mm. With dedicated drilling spindle power of 4,500 rpm, 22 kW, drilling depth capability is 1,500 mm. The M38 also has a 120-position toolchanger and a 15-ton table-weight capacity. "That eliminated our need for another boring mill and one of the two gundrills we had, but we were still outsourcing a large amount of work plus using our remaining gundrill," Ergun says. Since purchasing a third Unisig, another M38, Concours has eliminated its gundrills, and outsourcing has become an "only as-necessary" option that is rarely used. "It's about the throughput that we have gained by having these machines," he says.

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It's About Quality Control

Ergun explains that Concours outsourced work due, in part, to tight timelines from customers and being limited by how much work could get through the older machines with their limited capabilities. "We also feel at risk when outsourcing because of supplier limitations with regard to quality and their capabilities," he says. "We spend much of our own resources managing vendors to ensure we get the quality we need in the timeframe required. Keeping jobs in house is definitely the best option to get the quality we need, complete the work on time and keep costs down.

"Our Unisigs are extremely fast, accurate and have made it possible to keep previously outsourced work in-house," Ergun says. "Since launching the second M38 last February, we have reduced outsourcing costs by 20-30 percent."

He adds that the speed and accuracy of the Unisigs, as well as fewer required setups, has reduced the risk of mis-

This Unisig USC-M50 was the first of three multitasking Unisigs purchased by Concours Mold to help speed deep-hole drilling and reduce setups. Little did they know it would be a game-changer for the machining processes used. The M50 features a 25-ton capacity table for workpieces as large as 3,000mm. The employee at left helps illustrate the size of the machining center and yet Concours says its footprint is smaller than the machines it replaced.

takes inhouse, too. Concours opted to equip its Unisigs with Renishaw RMP600 wireless probes for on-machine inspection to verify work, further reducing instances of rework due to error. "The old technology was sometimes unpredictable, and surprises would come up. For example, if we drilled a water line 40 inches deep and expected it to hit an existing water line but it didn't because the drill wandered, we went into rework mode," he says. "Where did the drill wander and how much did it wander and so on? We must gather the facts and get that information to the engineering department to fix this issue and then back on the machine for added drilling to make the circuit work." Ergun admits that would be the best-case scenario. "If our drill hit another line, or worse, came too close to the cavity face, we could be forced into a full replacement of the block, which could cost us about $80,000-$100,000 plus the cost of all the work that was completed that now we have to scrap. Every time you move the tool from one setup to the next, you risk accuracy, bottom line.

"With the old technology, we used to accept large tolerances and could do nothing about it. Now we work within fractions of those tolerances and will accept nothing less," he continues. "The ability to catch any potential issues on the machines enables us to deliver first-time quality in our molds. Nothing helps our business more than that."

Ergun points out one more thing. "Yes, we're paying a lot of money for this new technology, but the accuracy and throughput will pay for that additional cost with every job we do moving forward." MMT

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Tax Reform Impact on Inventory Deductions

By Michael J. Devereux II, CPA, CMP, Timothy O'Neill, CPS, Joel Hundelt, CPA

The changes made to Internal Revenue Code (IRC) 471 Rules for Inventory of the Tax Cuts and Jobs Act ("Act") present some tax-savings opportunities for "small" mold shops. The rules define small businesses as those with less than $25-million of average gross receipts for a trailing three-year period. The shops that have not been in business for three years must use the average gross receipts of the years in operation.

The first step to evaluating the inventory treatment change is understanding how the shop treated inventory before the Act. An asset is a "resource owned by a company which has future economic value that can be measured and expressed as dollars." Inventory is the most crucial asset regarding operations. IRC 471 and a basic accounting principle known as the "matching" principle require producers of inventory to capitalize raw materials, work-in-process (WIP), finished goods, associated labor and other subordinate costs, known as overhead. The reason shops must capitalize inventory, labor and overhead costs is to "match" the expense(s) of producing (or acquiring) the inventory with the revenue received from selling the inventory. This concept was true for both financial and tax accounting with potential minor adjustments in the tax realm.

Small mold shops must immediately expense raw materials after purchase including de minimis inventory purchases and non-incidental materials and supplies.

On August 3, 2018, the Internal Revenue Service (IRS) issued guidance to provide small businesses procedural guidance on accounting methods affected by the Act. This guidance also provides "automatic consent" if a shop changes its accounting method. By making the change automatic, mold shops will not be required to request permission from the IRS or pay a fee to change their method.

One of these provisions permitted small businesses to avoid the application of IRC 471, as described above. Rather than capitalizing inventory costs when purchased and produced, small businesses are permitted to treat inventory as *non-incidental material and supplies* under the treasury regulations. These regulations clarify that non-incidental materials and supplies are deductible at the time a shop "uses or consumes" them, rather than at the time a shop purchases, transfers or sells them to the next user of the sales cycle. Also, mold shops may elect a "de minimis" safe harbor exemption for raw materials, which mirrors the de minimis safe harbor election government introduced with the tangible property regulations.

Impact on Small Mold Shops

Small mold shops must immediately expense raw materials after purchase, which are subject to limitations and an immediate write-off for currently capitalized WIP and finished goods inventory. Here is a two-step process for mold shops to follow:

1. De Minimis Inventory Purchases

Treasury regulations permit **all** mold shops to immediately expense the cost of property used in a trade or business, if the cost of the property does not exceed $2,500 *per item*. If the shop has an "applicable financial statement" (AFS), that limitation is $5,000 per item. The most common applicable financial statements for small businesses are financial statements audited by an independent CPA firm used for credit purposes, shareholder reporting or other substantial non-tax purposes.

Manufacturers that meet the definition of a small business are now eligible to immediately expense, via an annual election, raw material purchases under $2,500 per item, per invoice. There is a small caveat, however, in that the de minimis election binds both financial and tax reporting, meaning that if a mold shop capitalizes the qualifying de minimis inventory for financial purposes, the shop is required to capitalize the inventory for tax purposes as well.

Small businesses may not elect to immediately expense inventory because many shops have covenants tied to long-term financing that an inventory reduction can negatively affect. Also, excess losses from these changes may not be deductible by an individual taxpayer. Instead, a shop must assess each on a case-by-case basis.

2. Non-incidental Materials and Supplies

Shops can now deduct non-incidental materials and supplies when a shop uses or consumes the materials. This change leads

to the elimination of WIP and finished goods inventory for tax purposes. Unlike the de minimis rule in step one, the tax treatment of non-incidental materials and supplies does not have to follow the financial accounting treatment, which requires a book-tax adjustment on the shop's annual tax return.

Next, a shop must consider WIP and finished goods that were still in inventory on December 31 of the prior year and current year WIP and finished goods stemming from the manufacturing of raw materials that could not be expensed under the de minimis rule. A shop must identify to which year the inventory is attributed, ensuring correct tax adjustments. Also, if a shop elects to treat certain inventory costs as non-incidental materials and supplies, direct labor and overhead costs associated with the production of the inventory will be fully deductible as incurred.

Making the Changes

The shop can write off raw materials under its respective de minimis safe harbor election when preparing its tax return. However, the change must be reflected on the financial statements. Shops must report the 471 inventory change on Federal Form 3115: Application for Change in Accounting Method under the automatic method change procedures. The shop must identify which WIP and finished goods were present as of January 1 of the prior tax year and report the amount, known as a 481(a) adjustment, as an additional expense item in Cost of Goods Sold.

Once this method change is elected, a shop must record the cumulative increase or decrease in the amount of WIP and finished goods between two tax years as a book-tax adjustment on its tax return.

This inventory adjustment has slipped through the proverbial crack due to a majority of the coverage of the Act revolving around individual income tax changes, the 20-percent flow-through deduction, and the 100-percent accelerated bonus depreciation deduction. For small shops, this seemingly untouched change could result in large tax savings. MMT

CONTRIBUTOR

Michael J. Devereux II, CPA, CMP, is a partner and director of manufacturing, distribution and plastics industry services, Joel Hundelt, CPA, is a senior tax manager and Timothy O'Neill, CPS, is a tax supervisor at Mueller Prost.

FOR MORE INFORMATION

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Index Reports Expansionary Start

January 2019 – 54.6

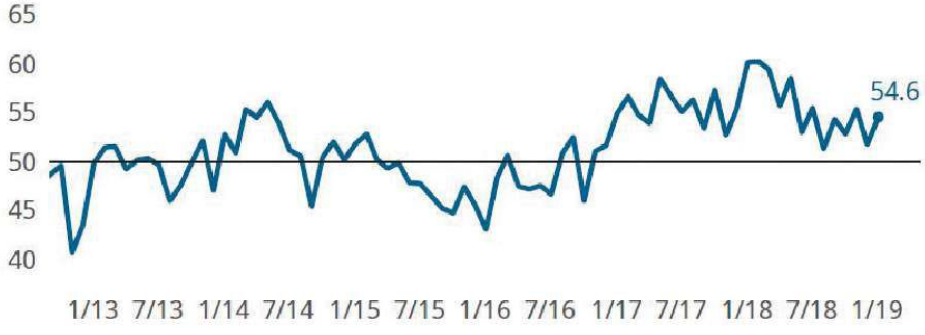
The Gardner Business Index (GBI): Moldmaking moved to 54.6 due to accelerating growth trends in both production and new orders. Compared to January 2018, the index has fallen 9.8 percent; however, data from January and February of 2018 represent both the peak growth rate of the current economic cycle and all-time high readings for the Moldmaking Index. January's reading was within 1-point compared to the average expansionary reading since 2017. Gardner Intelligence's review of the month's underlying data reveals that production, new orders and supplier deliveries lifted the index higher. In contrast, employment, exports and backlogs pulled the Index lower. Excluding backlogs, all components reported an expansionary start to the new year.

Rebounding strength in new orders during 2018's fourth quarter and the first month of 2019 after a brief slowdown in the third quarter will likely bolster readings for production, supplier deliveries and backlogs. Employment and export expectations are more tenuous as they will be subjected to unique factors, including an exceptionally strong job market resulting in many unfilled manufacturing positions and the success of future trade negotiations respectively. 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



Data from the mold industry indicated strong expansion in new orders, supplier deliveries and production. These are generally representative of a healthy domestic market. The slowing picture presented by Gardner's export data may improve after current tariffs are renegotiated.

New Orders and Exports (3-Month Moving Average)

New orders and production expansion continued to rebound at the start of 2019 after experiencing slower growth in the third quarter of 2018. New orders are considered a leading indicator of several other components constituting the Index.

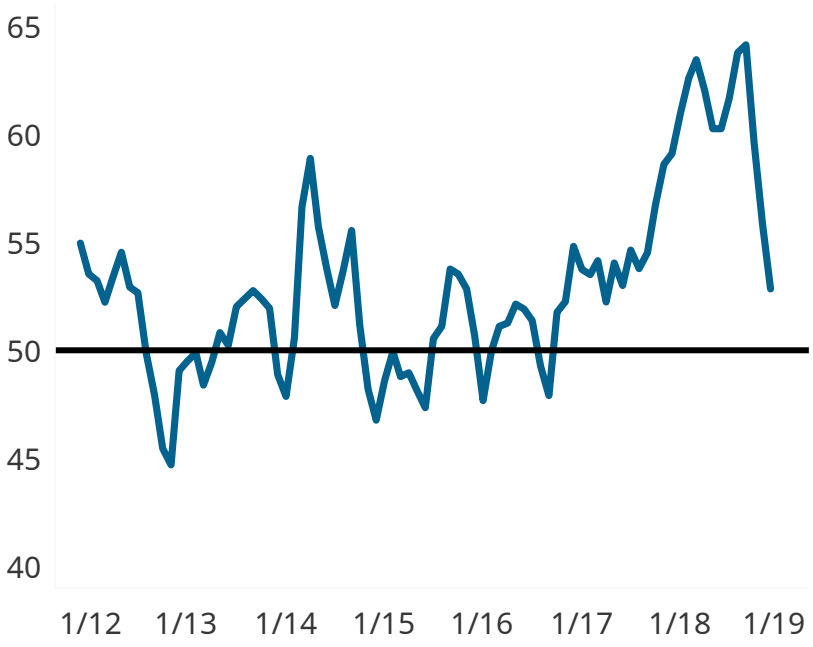
Expectations for Electronics Defy Headlines

The electronics industry expects to follow in-line with the U.S.'s economy growth in 2019, though firms with greater exposure to China may have to be more cautious.

The electronics industry entered 2019 overshadowed by concerns of shrinking demand for electronics goods in China, joined with tepid demand in the U.S. This was capped by Apple's January 2nd announcement of weaker-than-expected fourth-quarter 2018 sales of its core electronics products. Such headwinds at the start of the year combined with an extended U.S. government shutdown and prolonged tariff negotiations with China have generated concern among many businesses. These events have complicated matters for those looking for insights into what 2019 may hold and how to respond in the face of potentially greater near-term volatility. These early announcements sent the Dow Jones Industrial Index into a frenzy during which it fell more than 10 percent in the course of just a few weeks in December. This was in part because Apple's shares constitute a nearly 5-percent stake in the Dow Jones Industrial Index and more than a 10-percent stake in the Nasdaq 100, according to Factset.

Examining the electronics industry—less Apple's share—illustrates an industry that is expected to see inflation-adjusted revenue growth of 3.5 percent in 2019, combined with even stronger earnings growth. This is based on the actual and forecasted financial results of nearly 60 electronics industry firms generating $658 billion in revenues in the 12-month period ending with the third quarter of 2018. Including Apple's third quarter 2018 projections pushes the industry's overall revenue higher to 8.5-percent by year-end 2019. From a domestic perspective, the sector seems expected to follow in-line with the overall economy's growth; however, firms with greater exposure to China may have to be more cautious during the year.

Gardner Business Index: ELECTRONICS
(3-MONTH MOVING AVERAGE)



Gardner's proprietary data from U.S. manufacturers serving the electronics industry largely mirrors Wall Street's tepid 2019 outlook. The latest Gardner employment readings are above long-run averages which suggests that firms are still optimistic about making investments in people and thus are optimistic in the longer-run. Simultaneously, expansion in production, new orders, backlogs and supplier deliveries at year-end 2018 were flat to slightly growing after a 2-year period in which many of these measures set record highs. Despite a toughening trade environment in 2018, Gardner's export data did not contract during the second-half of 2018, although the data indicated generally slowing export growth through December.

Lastly, Gardner's data indicated that smaller firms under-20 people experienced disproportionally more challenging economic conditions during the fourth quarter of 2018 than their larger peers with more than 100 employees. This reinforces the common understanding that smaller firms often have fewer options when maneuvering through more challenging business conditions and are thus more sensitive to economic change. MMT

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FOR MORE INFORMATION:
Michael Guckes, Chief Economist, Gardner Intelligence
mguckes@gardnerweb.com / gardnerintelligence.com

AUTOMATION

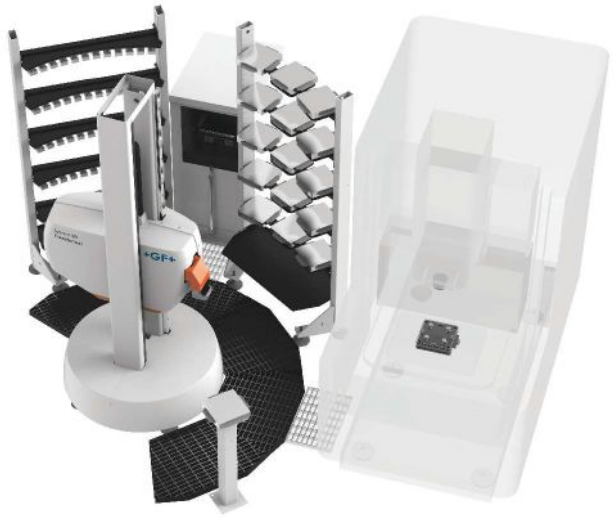
Modular Automation System Integrates with Wide Variety of Technologies

GF Machining Solutions announces the System 3R Transformer, a modular automation system designed to integrate with a wide variety of existing tooling systems.

With this system, manufacturers can begin by automating a single machine and then expand to include as many as 12 machines within the cell. A Transformer cell accommodates a wide range of machining technologies and enables components from different manufacturers to be included within the same cell. End users can then create an automation cell where each individual component decision is optimized, as opposed to having choice constrained by compatibility.

For maximum flexibility, the system offers additional in-process accessories that can be integrated into a cell, including multiple loading stations that can be used without stopping production, a draining station for emptying workpiece cavities after machining processes, a washing machine to clean workpieces, and a coordinate measuring machine (CMM) for presetting and/or part inspection.

The System 3R Transformer provides cell management software whereby all production data is entered in a structured manner or imported through a data exchange interface for major enterprise resource planning (ERP) systems. The



software then controls every aspect of the cell, from automatically loading jobs to machines to recording and monitoring cycle times for each job. The core of the system is an efficient database that uses chip identification of the pallets to ensure that correct data is used for every part in the cell.

GF Machining Solutions / 847-913-5300 / gfms.com/us

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 teach pendant. 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 UR robots. The system enables robot and 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

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

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TIP

ADDITIVE MANUFACTURING

3D Printing Considerations

Photo courtesy of 3DEO.

Parts smaller than a golf ball are typically more cost-effective to 3D print than larger ones, but size is just one consideration. These sample parts were made using a proprietary Intelligent Layering technology.

By Christina M. Fuges

Digging into metal additive manufacturing (AM) quickly reveals how expensive it can be, as some parts produced using incumbent technologies, such as laser sintering and binder jetting, can cost thousands of dollars. If there's one lesson Matt Sand, President of 3DEO, a Los Angeles, California-based metal AM parts supplier, has learned over the last few years, it's that cost is everything when it comes to serial production.

"If you are not cost competitive, you're not at the table," Sand says. So, to get the *total* cost structure down, 3DEO developed an end-to-end manufacturing process around Intelligent Layering, a very low-cost metal additive manufacturing technology the company's founders invented. Based on binder jetting technology, Intelligent Layering uses a proprietary spray system to bind the entire layer, and then uses a CNC end mill to cut the perimeter of the part and any internal features.

Although 3DEO's Intelligent Layering process offers a new take on additive, the company's differentiator is that "we are not trying to sell machines, we're only selling parts," Sand says. The competition for its additive process is not metal 3D printing; it's traditional manufacturing. 3DEO is competing against CNC machining and metal injection molding and is already cost competitive with both of these technologies when it comes to small and complex metal parts, according to Sand.

There are three key factors he considers in determining whether it will be cost-effective to 3D print a given part:

1. Part Size

Is it bigger/smaller than a golf ball? One thing Sand has learned over the last few years is that as part size increases, the cost increases on an exponential curve.

Smaller (golf ball-sized) parts manufactured traditionally are price competitive. However, as the part size starts to reach softball size and greater, the cost skyrockets. It's not uncommon in laser sintering for very large parts to cost $20,000 or more.

2. Assembly

Is the cost of assembly less than the cost of printing a consolidated part? Sand believes there is often a disconnect from reality when it comes to parts consolidation. "For example, a customer wants a five-piece automotive assembly printed as one piece. What they typically overlook is that the cost of the individual components and assembly is still very low," he says. "The total cost of the metal 3D-printed part needs to be less than the total cost of the assembly. Given consolidated assemblies are large, it's usually much more expensive to print versus assemble."

3. Complexity

Does the part have complex features like conformal cooling, and is it likely to require substantial postprocessing? Conformal cooling is a hot trend in additive manufacturing, but 3DEO tries to be realistic with interested customers. The reality is that high-value tools are the best fit, because when it comes to laser sintering (the most common method used to make conformal cooling channels) the cost is high and the after-print surface finish still needs postprocessing.

3DEO's strategy is not to provide the near-net shape component, but instead, provide the block with the channels already created. They focus on where CNC adds value and where 3D printing adds value. 3DEO believes that if you're going to have to finish that block anyway, then there's no point in trying to achieve extremely tight tooling tolerances.

"For example," Sand says, "if the part needs to be a hemisphere, we'll print the block with the internal channels, so the customer can have the conformal cooling, and ship the block to the customer in an unfinished state because they have to machine it anyway. This then brings the cost of the tool from thousands of dollars down to hundreds. If you don't have to achieve extremely tight tolerances, it's a lot less expensive. These tooling inserts can be very low cost from creating internal channels, but still allow the customer to reap the benefit of 3D printing." MMT

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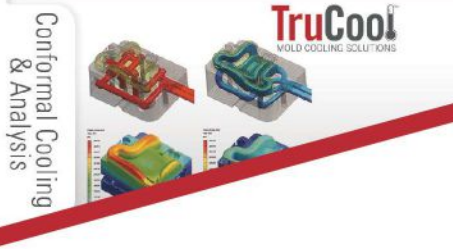

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