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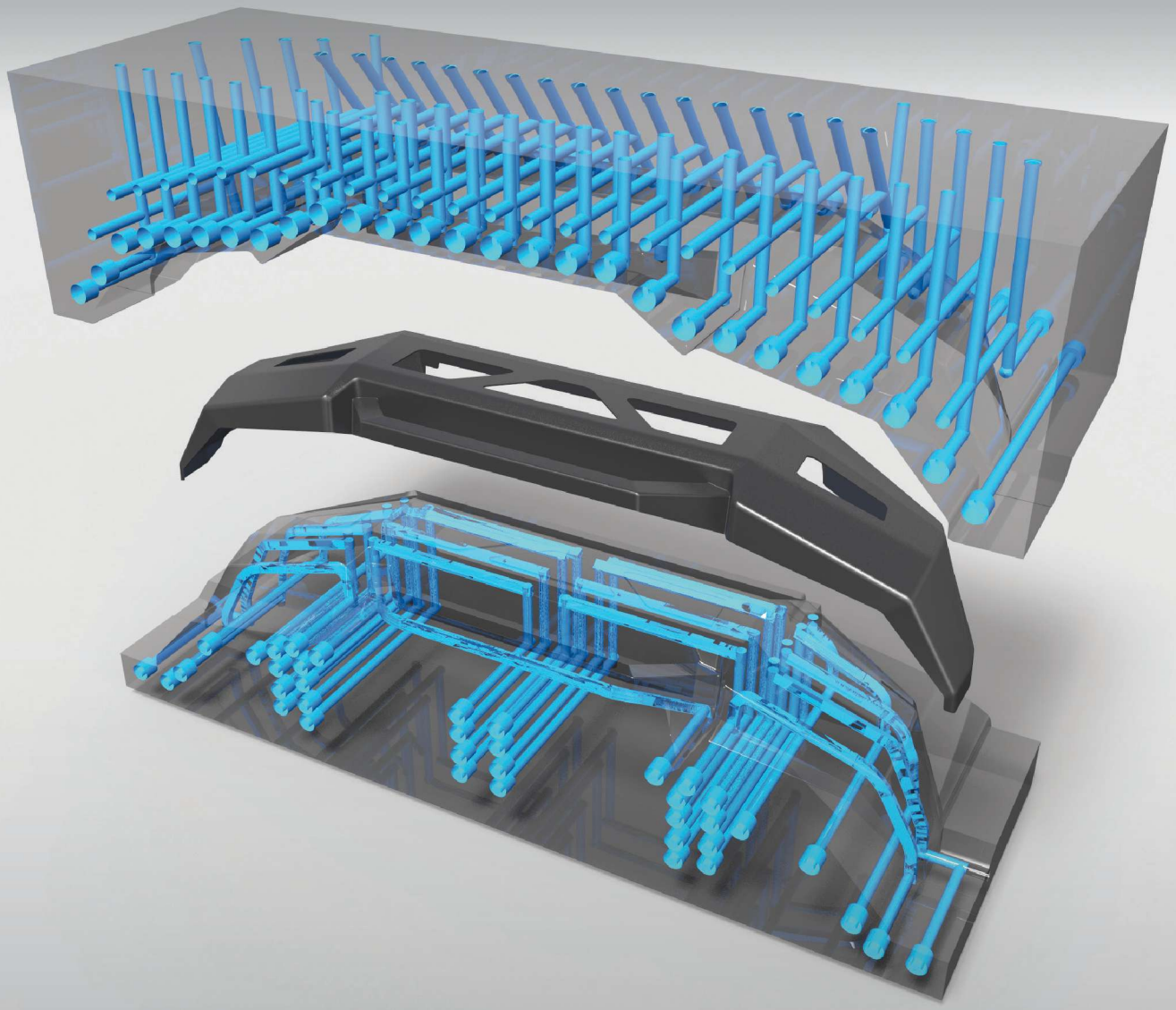

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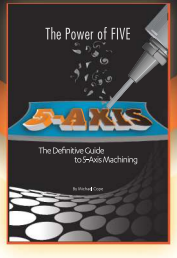

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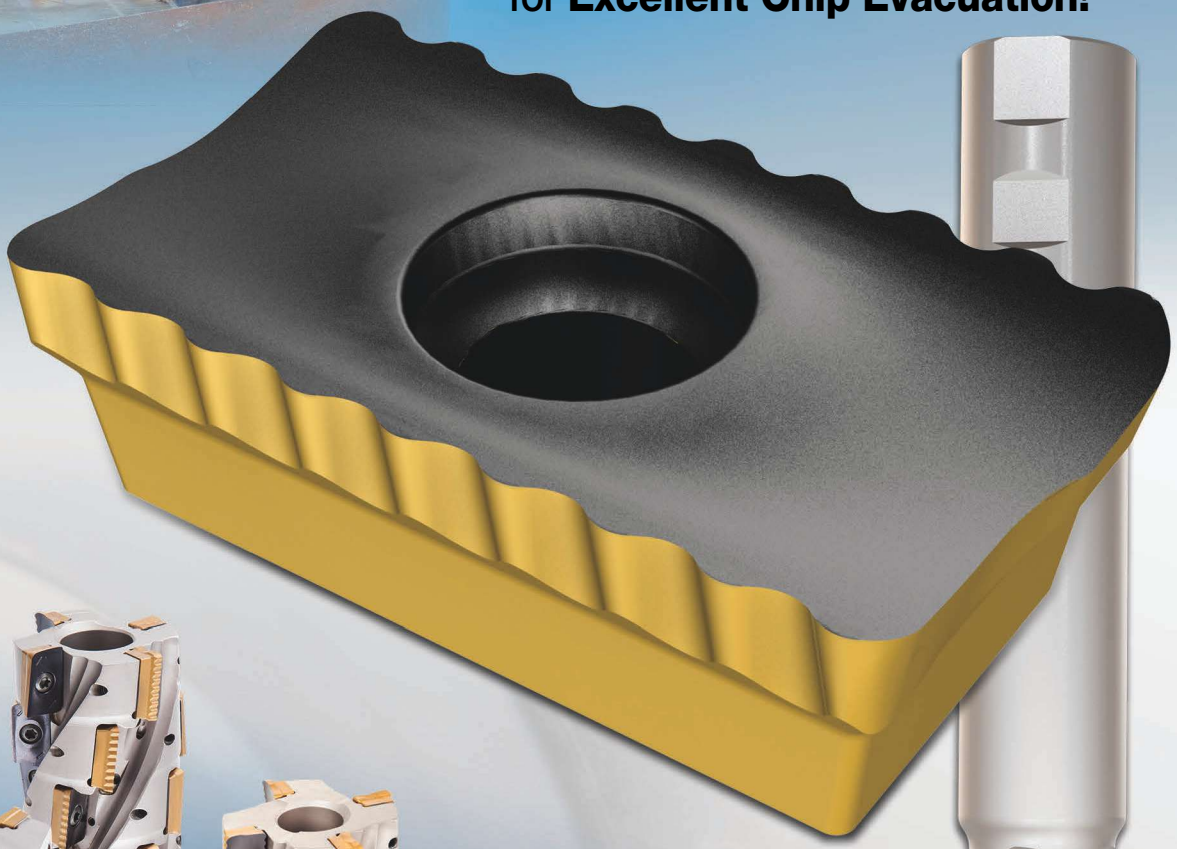

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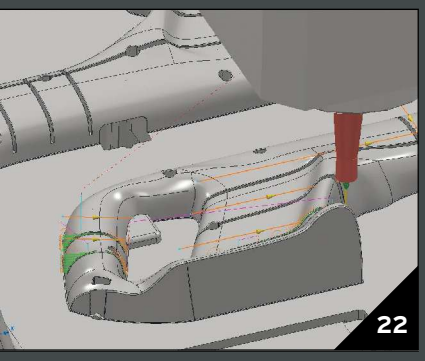

Features

Departments

ON THE COVER

Image courtesy of Conformal Cooling Solutions. This month's cover is a rendering of the coolant-hole layout for the conformal-cooled core of a bumper mold. A conventionally cooled core required more than 100 holes and baffles, while a conformal-cooled core only required 38 in and out water lines and no baffles. Cooling channels follow the surface contour of the core face, allowing maximum coverage to evenly and quickly cool the molded part. The amount of available area in the conformal-cooled core would give designers the flexibility to add lifters and slides. See the related story on page 18.

Images courtesy of (left to right) Autodesk Inc., Accurapuls Canada Inc. and Model Die and Mold Inc.

VIDEO ACCESS

5 TRICKS OF THE TRADE
Great Tips from This Issue

1. Leading the Way
Leading indicators of plastic part production and consumption are home building and family formation. Both result in significant direct, indirect or direct and indirect consumer consumption of plastics across end markets.
PG. 14.

2. Lay It Down
The most efficient way to deposit any alloy is in the flat position, so that gravity is not a factor. The conformal cooling channel is perpendicular to the floor. This ensures that the bead sequence is consistent within the channel.
PG. 18.

3. Hammer Time
The machine-hammer peening process flattens cutter cusp peaks into valleys, maintaining dimensional uniformity. Hand stoning and polishing, by constrast, changes geometric and dimensional accuracies.
PG. 28.

4. Selling Season
Buy/sell agreements serve multiple purposes in one document. They identify the person or the people who can buy interest in the company, and they indicate how to determine the transfer price of the ownership interest.
PG. 40.

5. Match Game
Each machine requires a different adapter, and that can even be true of different models of the same machine, so be sure to provide the machine tool's OEM with the machine model and software version.
PG. 48.

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2018: A Big Year

Happy New Year! Gardner Intelligence reports growth opportunities for mold builders this year and beyond and even notes specific future spending plans on technology (see the related article on page 14). This positive projection in growth and spending is coincidentally timed with what I call the **trifecta of trade shows: NPE, Amerimold and IMTS**.

These upcoming events will help make 2018 a big year for moldmaking, in terms of big opportunities to learn and grow. With NPE taking over Orlando in May, Amerimold moving into Detroit in June and IMTS occupying Chicago in September, both the metalworking and plastics side of mold building will have the spotlight. What a perfect and powerful opportunity to research equipment and processes and to learn about new business prospects. And, *MMT* will be right there with you and for you, as we cover each event in print, online and live.

On top of this (and of special, personal importance to me), ***MMT* will celebrate its 20th anniversary!** It was exciting when we launched the magazine 20 years ago, and it is still an exciting time for the industry. We are honored to celebrate this milestone with you, and we look forward to many more years.

CELEBRATING 20 YEARS 1998-2018

I recall sitting at a table with founder Joe Prischak and then partner Gary Orfe back in 1997, planning out the mission and focus of a magazine dedicated to the unique challenges and complexities of mold manufacturing. This industry, which is utterly dependent on accurate, repeatable and efficient technologies throughout the design and build stages, was so worthy of a publication of its own. So, after much research, the premier issue hit the streets in April 1998. In this year's April issue, we are excited to revisit the people, companies and topics that filled the pages of *MMT*'s first six issues. However, you do not have to wait until April to see anniversary coverage. Beginning this month, take note of our 20th anniversary emblem throughout the issue, which identifies original *MMT* supporters.

Last, but certainly not least, 2018 marks the **15th anniversary of our annual Leadtime Leader Awards**, which continue to grow in industry importance and prominence. Our running list of winning shops demonstrates the value of the honor to businesses and their employees. During Amerimold this year, we will feature a panel of past winners who will share their best practices for continually raising the bar in mold manufacturing. Mark your calendars for June 13–14 today!

We hope you will join us in celebrating the good news and our milestones not only by continuing to read *MMT* and by attending Amerimold, but also by sharing your ideas and feedback throughout this special year. Feel free to drop me an email at cfuges@gardnerweb.com, or call 513-338-2187. MMT

Christina Fuges

Christina M. Fuges
Editorial Director

Follow MMT on: Follow @MMT_ChristinaF

THIS MONTH ON moldmakingtechnology.com

VIDEO: The Meaning of the Gardner Business Index

With the Gardner Business Index, Gardner Intelligence makes understanding trends in manufacturing as easy as possible.
short.moldmakingtechnology.com/gbimmt

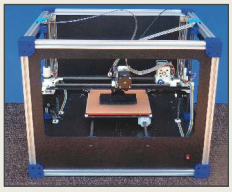
BLOG: Take a Look Inside Deep Hole Drilling

Take a look at deep hole drilling with *MMT*'s Christina Fuges, as she reports on a UNISIG event that showcased its USC-M five-axis, deep hole drilling and milling machine.
short.moldmakingtechnology.com/deepdrill

SLIDESHOW: Four European Countries in Three Days

MMT's European Correspondent Barbara Schulz joined The German Association of Tool and Mold Makers (VDWF) and 40 moldmakers on a three-day trip to visit original equipment manufacturers and innovative mold shops in Germany, Austria and Switzerland.
short.moldmakingtechnology.com/tourthree

ADDITIVE MANUFACTURING: Democratizing 3D Printing of Injection Molds



MMT's Christina Fuges writes about the ways in which full-service design and mold delivery, moldmaking materials, and a low-cost, high-precision printer minimize the technical risk of 3D-printed mold tryout.
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Collaborative Training

Kylee Carbone
Director of Human Development & Marketing
Westminster Tool
Plainfield, Connecticut

Kylee Carbone, EAB member and Westminster Tool's director of human development and marketing, shares key aspects of building a successful workforce development program. Kylee has been very involved with building the company's internal skills training program, Westminster Academy.

Based on my experience, I can honestly say that implementing a workforce development program is a large, multi-faceted undertaking. I believe that collaborating with other members of the community provides a multitude of resources that makes tackling such a big project more feasible. The resources that we have gained from collaboration has allowed us to advance Westminster Academy further than we could have done as an individual organization. We have formed relationships with the local school systems, neighboring manufacturers and our local government to create an environment that supports manufacturing workforce development in Eastern Connecticut.

The collaborative efforts of the Eastern Advanced Manufacturing Alliance (EAMA) have provided this phenomenal environment for workforce development. Often, people are intrigued when they learn that EAMA is comprised of over 60 diverse manufacturers. Each of the organizations does something vastly different from what the others do, but how the organizations go about it is not. They all need qualified people who are hard workers and who have a baseline of entry-level, manufacturing-specific skills.

Members of EAMA came together to create the Advanced Manufacturing Certificate Program at Quinebaug Valley Community College (QVCC). The program, which was developed based on our EAMA members' needs, provides comprehensive training that allows someone without any manufacturing experience to begin a career at a company like Westminster Tool. Westminster Academy is then able to focus its efforts on the more complex skills that would not to be taught on the outside: the processes, methodologies and thought processes that are unique to Westminster Tool.

Perhaps what has been most valuable to me is meeting the people who are having such a positive effect on workforce development. Colleen Lugauskas, principal of Moosup Elementary School, is one of those individuals. Colleen had a dream of establishing a makerspace program at Moosup. Her program will provide a pipeline of students who are passionate about working with their hands into QVCC's Advanced Manufacturing Certificate program. Progressive thinkers like Colleen are shaping the future of workforce development. Collaboration will not only help to implement, grow or improve workforce development initiatives, it will inevitably provide the opportunity to improve and grow all other areas of a business. MMT

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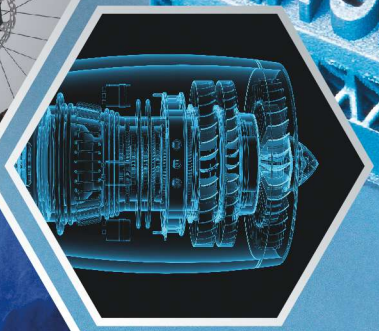

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A Conversation with ...

Maximum Mold

Image courtesy of Maximum Mold.

The purchase of Mach Mold equipped Maximum with gun drills, boring mills, large horizontal machining centers, five plastic molding machines and laser welders.

You do not often hear about a mold builder your size acquiring another shop. How did you know it was time to make this move?

Dave LaGrow, Owner: When the acquisition of Michigan Mold presented itself in October 2015, I just knew it was time to grow. The success of that acquisition gave me the confidence that I needed to grow further after a few customers requested that we invest in larger equipment to handle larger molds. It was then that I developed a business plan to construct a new building and begin adding bigger equipment. However, when the Mach Mold opportunity surfaced, it was a perfect fit with our business plan because the purchase included an equipped building, an established customer base and a quality workforce. So, we chose to buy Mach Mold instead of constructing a new building.

We are a smaller mold builder and about one-third the size of Mach Mold, so the acquisition was the sensible next step toward real growth. This move allowed us to capture a lot of the job-shop work that was available in the area and put us in the market of building head tooling for plastic injection and blow molding machines. The purchase increased our press size, EDM and larger boring mills to enable greater capabilities and capacity at our tooling shops.

What factors did you consider prior to purchasing Mach Mold?

LaGrow: Our four main considerations were the customer base, facility, employees and equipment that Maximum Mold did not possess on its own. Here is a simple rundown of those factors:

- *Diverse customer base.* We had two customers specifically request an investment in larger equipment and others who were interested but did not ask. Mach Mold was already building large tools, and its customers were quite different

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from Maximum Mold's, giving us a wider base of customers who are interested in the capabilities of all three companies: Maximum Mold, MAX2 and MAX3.

- *Newer building.* Since the recession, industrial buildings have not been valued the same as they were 10–15 years ago. Mach Mold's building was turnkey with a very professional appearance. The option of constructing a new building would have been significantly costlier than purchasing Mach Mold's building.
- *Employees.* Mach Mold has 40 trained employees, with many of them having 20–30 years with the company. I even worked at Mach Mold prior to starting at Maximum Mold, and many of the same people whom I respect still work there. This greatly influenced my decision to purchase the company. Let's face it, the only way you earn profit in a tool shop is to have hardworking, smart, dedicated people designing and building the tools.
- *Equipment.* The purchase of Mach Mold diversified our capabilities as well as theirs. Mach Mold did not have access to wire EDM, five-axis high-speed machinery, and coordinate-measuring-machine and laser-scanning technologies for inspection and reverse engineering. Maximum Mold did not have access to gun drills, boring mills, large horizontal machining centers, five plastic molding machines for mold sampling and small production runs, and laser welding for mold and die repair and engineering changes. MAX2 has larger-capacity lathes and mills with fourth-axis rotary tables for milling round components and ID/OD grinding.

What is the meaning behind the Maximum name, which continues with Max2 and now Max3?

LaGrow: In 1996, my wife Cindy chose the name Maximum Mold because we were committed to doing what had to be done to grow the company. We believe our current and potential customers prefer to see the people with which they do business investing and growing. It sends the message that the company is doing something right and delivers a comfort level to customers. By changing Michigan Mold to MAX2 in 2015 and now Mach Mold to MAX3, we are continuing to build and promote the Maximum Mold brand to build more trust with our customers.

What is the business strategy behind your current three companies?

LaGrow: Through effective management, teamwork and continual technology investment, we are building three state-of-the-art mold and die manufacturing companies that are all connected by a common goal: to prove our current capacity to customers, so we can win larger packages and push as much work as we can through the three companies. It does not matter where the sale occurs, or which company does the work. The key is building more sales, delivering successful jobs and earning profit.

Effective management involves consistent focus and clarity through communication and employee recognition for a job well-done. Teamwork is promoted with meetings that bring every facet of the facility together, from engineering and design to machining, to vet projects from kick-off to debriefing meetings at job completion. We also continually invest in technology to ensure the most efficient programs.

Do you have any advice for other mold builders considering this acquisition growth strategy?

LaGrow: Get advice from your accountant on payback time. Do not go solely with your gut. A long slow down can hurt a shop if it has too much debt, and everyone knows how fast the economy can change because of events that are out of our control, like new interest rates or federal tax regulations about which we are not well versed, for example. So, we have our banker and accountant sit on our vetting team to help plan any expansion. Their respective expertise helps them view a project through a different lens and see things we might not see.

What technologies do you have your eyes on?

LaGrow: Our investment plans include new five-axis machining technology, EDM technology, and toolholding and fixturing systems to improve setup efficiency. More specifically, we are planning to purchase a five-axis bridge machine. We already have an 800-millimeter five-axis machine, but the larger five-axis will enable us to eliminate EDM and reduce lead times. After much research, we are considering machine tools from FPT North America, Parpas and Makino. We are also looking closely at the OPS-Ingersoll Gantry Eagle 1200 sinker EDM machine, which we've heard can drastically reduce electrode wear and reduce burn times by up to 50 percent, especially in graphite.

Lastly, in the past we discussed your visit to China for what you called a "reverse trade show strategy." Can you explain what that means and share the outcome or impact of that strategy?

LaGrow: The reverse trade show was our strategy for breaking into the international moldmaking marketplace for building and selling tools outside of the United States. Basically, after learning about the large die casting and plastic injection molding market in China and its rising tool prices, we decided to promote Maximum Mold at a die casting show in Shanghai in July 2016. We have not won a job yet, but we have quoted work to companies in China and have established a solid network of suppliers and vendors internationally. Two challenges to exporting to China are customs and maintaining local tool-shop support. MMT

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By Michael Guckes

2018: Long-Term Opportunities Abound

Positive data helps mold builders prepare for upcoming industry changes and growth opportunities.

Manufacturing everywhere is undergoing considerable change. This change can represent a threat to what has worked in the past, or it can represent an opportunity to grow in new markets and for companies to try different things. Gardner Intelligence recognizes the challenges that industry, regulatory and technological change can bring to any shop. The purpose of this 2018 outlook is not only to share the trends that Gardner Intelligence's data reveals, but to build awareness of these trends as well, so mold builders can better prepare for future opportunities and grow their businesses.

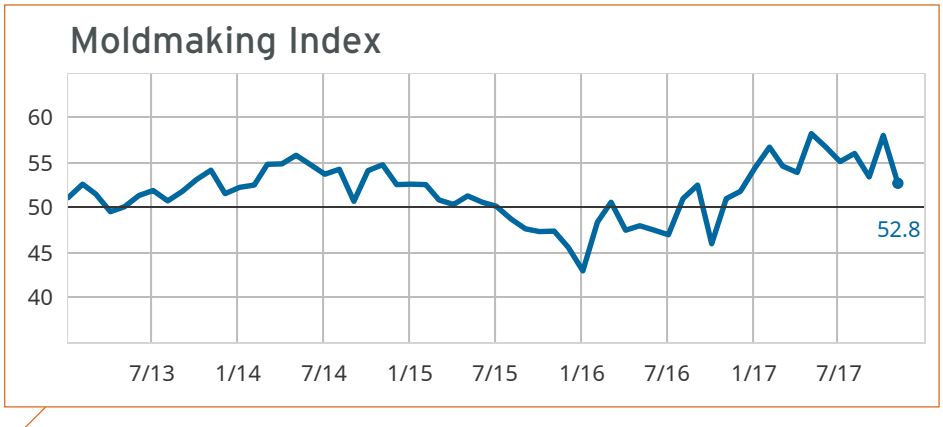
Moldmaking Growth Trends

The GBI: Moldmaking Index results between January and October of 2017 broke records with an average index reading of 55.8. By comparison, the last time the index experienced a comparable period of prolonged expansion was in 2014, when the average index reading from January to October was a respectable 53.8.

When interpreting Gardner Intelligence data, a reading of 50.0 means that no change in the industry has occurred. All index readings above 50 represent growth. The greater the number is above 50, the faster the speed at which the industry is expanding. Readings below 50 work in a similar manner but represent industry contraction. The index is calculated by six underlying business conditions: backlog, employment, exports, new orders, production and supplier deliveries. The total index is the average of the movement of these six drivers. During a typical month, all six drivers may be expanding, but those expanding below the average of the six are considered to "pull the index down."

The two most significant drivers of the Moldmaking Index in 2017 have been the production and new orders components, both of which had multi-year high growth values in 2017 that easily surpassed high records from the past. The readings for new orders in 2017 have been especially strong, which likely explains the growth in backlog and exports figures in 2017. At the end of October, backlog readings reached their 10th consecutive month of expansion. This far surpasses the most recent record for consecutive months of backlog growth, which lasted for three months.

Growth in new orders, which Gardner Intelligence uses as a proxy for demand, has greatly improved in 2017. Data on prices in 2017 indicates that this increased demand for molds is resulting in improved pricing for mold builders. Readings of prices received began improving (or having



Data from the Moldmaking Index indicates that the industry has grown at a faster rate during the first 10 months of 2017 than during any other consecutive 10-month period in at least the last five years. The primary drivers behind this growth are increases in new orders and production.

index scores above 50) in the third quarter of 2016 and have steadily improved through to the present. The full history of data suggests that the industry can expect further expansion in the industry well into the future when the Moldmaking Index registers strong backlogs and strong pricing power.

Spending Trends

Metalworking Capital Equipment Investment Plans

Each year Gardner Intelligence sends a Capital Spending Survey to metalworking shops asking about their intended spending on equipment for the coming year. If the responses from mold builders who completed the metalworking survey were extended to represent the overall industry, then the top-five projected equipment-based purchases in 2018 would be:

1. Vertical machining centers (< 20 inches Y).
2. Horizontal machining centers (< 400 millimeters).
3. CAD/CAM software.
4. Vertical machining centers (> 20 inches Y).
5. Vision systems.

To clarify, a projection is different from a forecast. Projections are forward-looking statements that are based on the results of a single survey. Forecasts are the predictions of future results, and they are based on a wider variety of data and statistical techniques.

Spending on equipment types other than those in the top five are projected to be greater than in 2017. For example, spending on mold flow analysis software is expected to be strong, as the number of mold builders indicating an intention to purchase this software is more than three times greater than the number of mold builders who indicated the same intention in 2017. Data also shows that mold builders have significantly more interest in purchasing ram-type, horizontal lathe, wire-type and automatic coordinate measuring machine equipment.

Plastics Processing Capital Equipment Investment Plans

Gardner Intelligence also conducts a capital spending survey for the plastics processing industry. The results of the 2017 survey, which asked for projected spending in 2018, indicate that next year should be an exceptionally strong year with total growth of 20 percent. Within this, primary processing and auxiliary equipment spending for injection molding, blow molding and thermoforming should increase by approximately 25 percent and 15 percent, respectively. From the 347 responses received, Gardner projects 2018 new spending of $4.5 billion.

According to the survey results, the top five equipment-type purchases by dollar amount in 2018 will be:

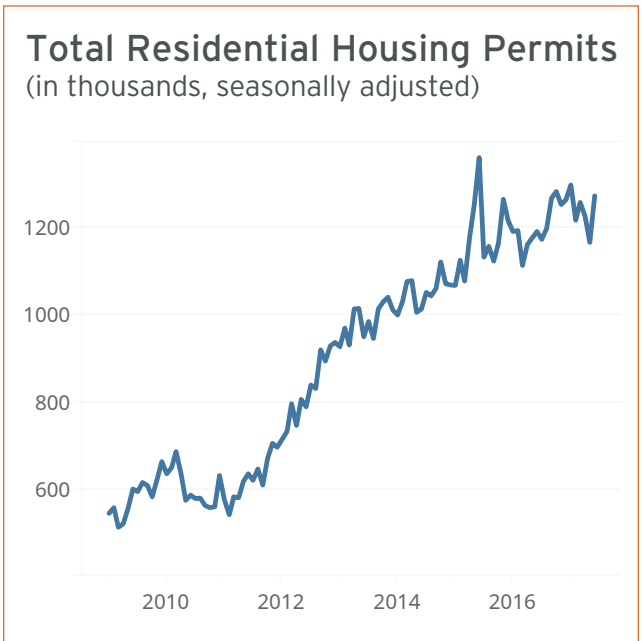
1. Hot runner molds.
2. Injection molding machines (horizontal/electric).
3. Blow molding machines.
4. Cold runner molds.
5. Robots.

The survey results indicate a significant difference in consumption of new equipment by plant size. The results suggest that firms with between 20 and 49 employees are expanding their spending the most. The results also suggest the spending by firms with fewer than 20 employees is expected to contract by 26 percent. While spending projections between the two groups is directionally different in 2018, the combined spending of both categories at $1.9 billion is expected to be divided approximately equally. For comparison sake, large plants of more than 250 employees are expected to increase their spending by 32 percent, which would generate a smaller total of $1.3 billion in 2018.

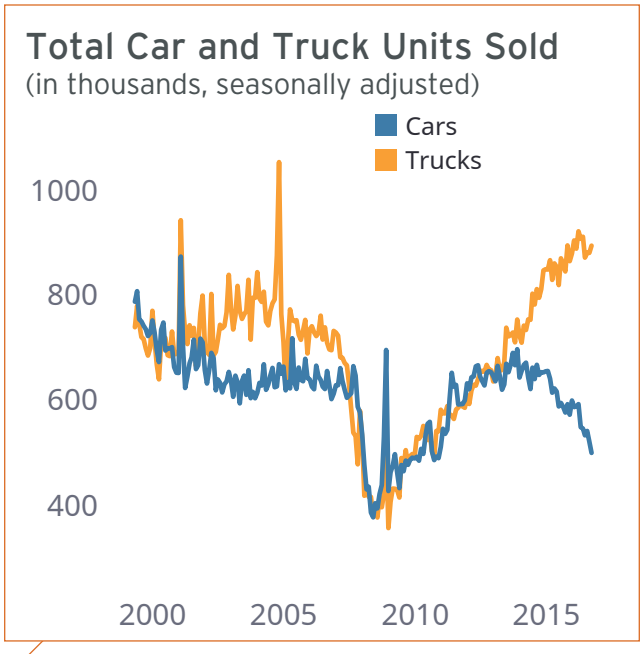
Examining only the primary processing equipment data from the survey, consumption in 2018 is projected to be very strong. Among major machine types, spending in both blow molding and thermoforming is projected to contract by more than 30 percent. Projected consumption of cold runner and hot runner molds in 2018 is expected to grow significantly, with hot runner mold consumption more than doubling from last year's projected level. Furthermore, processing equipment data suggests that spending on injection molding machines is projected to increase by 15 percent. However, when including all injection molding components, Gardner Intelligence projects a 32-percent increase in 2018 over 2017.

Leading Growth Indicators

An overarching, leading indicator of plastic part production and consumption is the housing market, specifically figures in



Strong growth in housing permits broadly encourages plastics consumption. As more millennials form families and enter the housing market, this will create broad-based demand for plastic products.



Car sales deteriorated in 2015 and 2016 but were more than offset by growth in the light-truck category. 2017 could be the first year in which sales in light trucks are unable to offset the decline in cars.

home building and family formation. Both result in significant direct, indirect or direct and indirect consumer consumption of plastics across all end markets in the form of products and the packaging of those products.

Authorized housing permits of both homes started and not started showed strong growth through the third quarter of 2017. The latest permit authorization data, when compared to new household formations and historical permits data, suggests that permit volumes could quite easily increase without the concern of a correction from an oversupply of housing. In fact, recent data suggests that there is a lack of single-family housing, which partly explains the strong appreciation of housing prices in recent years.

Millennial-driven, future household formations will continue to grow well into the 2020s. Millennials were born between 1980 and 2000. Home purchasing data informs us that the average millennial is getting married at approximately 30 years of age and purchases a house between 33 and 34 years of age, according to Zillow. The weighted average birth year of a millennial is 1998, which suggests a fair amount about where the housing market is likely to go in coming years. Specifically, if consumption by age remains relatively constant, the demand that is based on new household formation between now and the early 2030s should propel plastic product consumption well into the next decade at least. Also, homeownership rates among millennials fell between 2006 and 2015 before turning upward in mid-2016. As millennials make up for lost time from the impact of the Great Recession and from paying off debt from student loans, it is possible that there will be an above-normal growth in new household formations and thus in the demand for homes.

Automotive Trends

Speaking of long-term trends, there are significant factors that will impact vehicle demand. Examples include powertrain development, body material and autonomous vehicles. During the last two years, U.S. automotive sales have grown as the growth in light truck sales has more than offset the simultaneous decline in car sales. Through the first three quarters of 2017, car sales continued to decline, while sales growth in light trucks was largely flat and thus unable to offset a decline in total vehicle sales. In brief, there are several headwinds in the industry. Assuming that all or most of these will be short-term concerns, Gardner Intelligence's long-term outlook for the industry is positive.

The short-term headwinds include a slowing of financing, a lengthening of loan terms and an inability from original equipment manufacturers (OEMs) to sustain the exceptional growth of finance incentives on new vehicle sales. Lending and loan data suggests that banks may have over-lent in recent years, as delinquency rates on auto loans have been trending higher since 2014. The auto-loan delinquency rate is currently at 3.92 percent, which is well above its 20-year average. However, the persistence of low unemployment into the future should help to mitigate delinquencies on auto loans.

> Mold builders can look forward to opportunities in 2018 and 2019, as OEMs strategically invest in equipment and technologies over the next few years to position themselves for a very different automotive industry.

It is important to note that these headwinds in the industry do not represent the entire automotive industry story. In fact, mold builders can look forward to opportunities in 2018 and 2019, as OEMs strategically invest in equipment and technologies over the next few years to position themselves for a very different automotive industry. According to the U.S. Vehicle Forecast by LMC Automotive, OEMs are expected to create more new models in 2018 and 2019 than in recent years. Outside of normal competitive pressures to produce attractive new models, regulatory pressures to meet aggressive miles-per-gallon goals will force manufacturers to create new models with more efficient drivetrains. Additionally, those regulatory pressures may force manufacturers to create models that are significantly lighter, or to create models with more efficient drivetrains

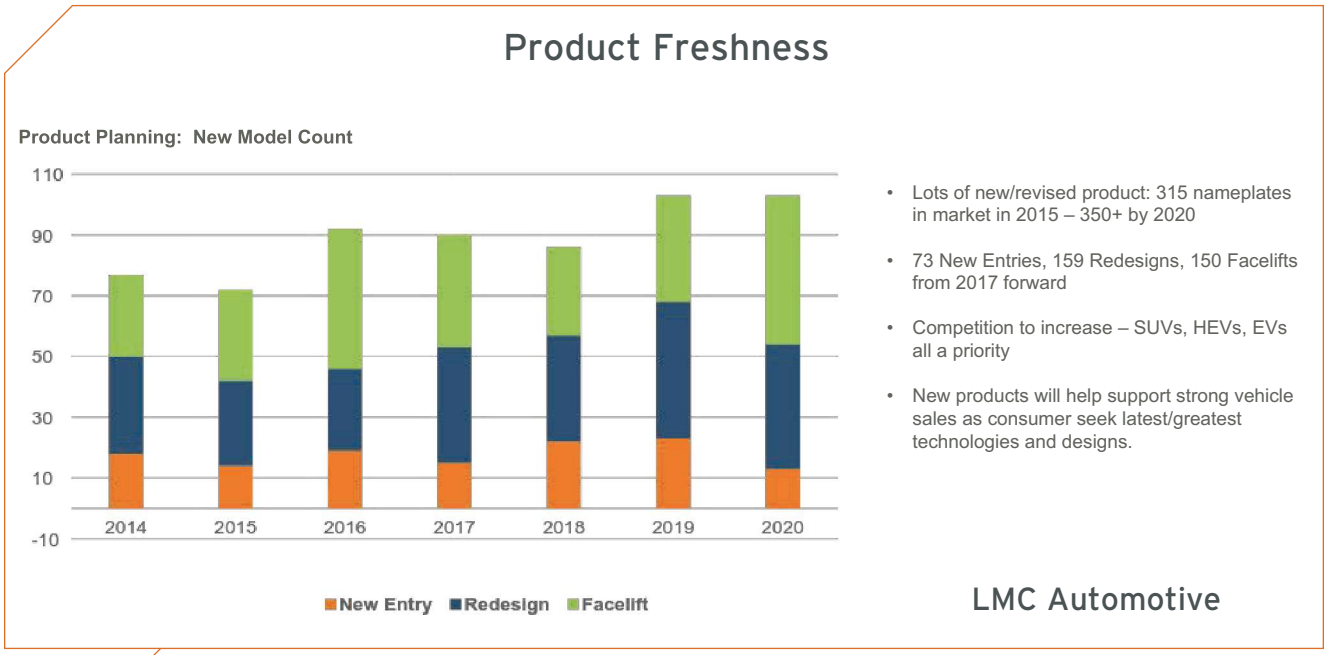


Image courtesy of LMC Automotive.

Several industry pressures are provoking original equipment manufacturers to bring new vehicles to market over the next few years. The increase in new models and redesigns will benefit the metalworking and plastics industries.

and to create lighter models. This will drive the use of different building materials and thus also new tooling.

Medical Trends

Another market that consumer spending impacts is medical. U.S. industrial production of medical equipment and supplies in the year-long period ending in October 2017 had fallen nearly 7 percent. Looking at the last decade of U.S. data, indexed production of equipment and supplies was relatively stable between the end of the Great Recession and 2015. Production began to diminish as early as the beginning of the second quarter of 2016. By the third quarter of 2017, production had fallen to 92.4, putting the index at its lowest level in more than a decade. While production has been contracting, pricing continues to increase with a third quarter index reading of 117.7, representing yet another all-time high.

Demographic data for the United States suggests that the demand for additional equipment will naturally move with the aging of the baby-boomer population.

Although medical production data is disappointing, demographic data for the United States suggests that the demand for additional equipment will naturally move with the aging of the baby-boomer population and the increased aging of the population born after the boomers. According to the U.S. Census Bureau, "By 2030, more than 20 percent of U.S. residents are projected to be aged 65 and over, compared with 13 percent in 2010."

What This All Means

Several of the major plastics processing drivers that Gardner Intelligence tracks indicate that the moldmaking industry can expect additional growth in both the short and the long term. New environmental standards and technological advancements in the automotive industry will look to plastics processors for solutions. Demographic trends suggest that the United States will see many years of strong new household formation ahead of it and a need for additional housing, goods and associated purchases. Lastly, other demographic trends suggest that the total number of citizens in their senior years will only increase the need for additional medical goods. Gardner Intelligence survey projections and the Moldmaking Index data both agree with the macroeconomic data that the industry can expect gains in 2018. MMT

CONTRIBUTOR

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By Christina Fuges

3D Robotic Deposition Advances Conformal Cooling

A new conformal cooling technique has emerged, rooted in a multilayer robotic deposition technology that is capable of manufacturing near-net shape objects.

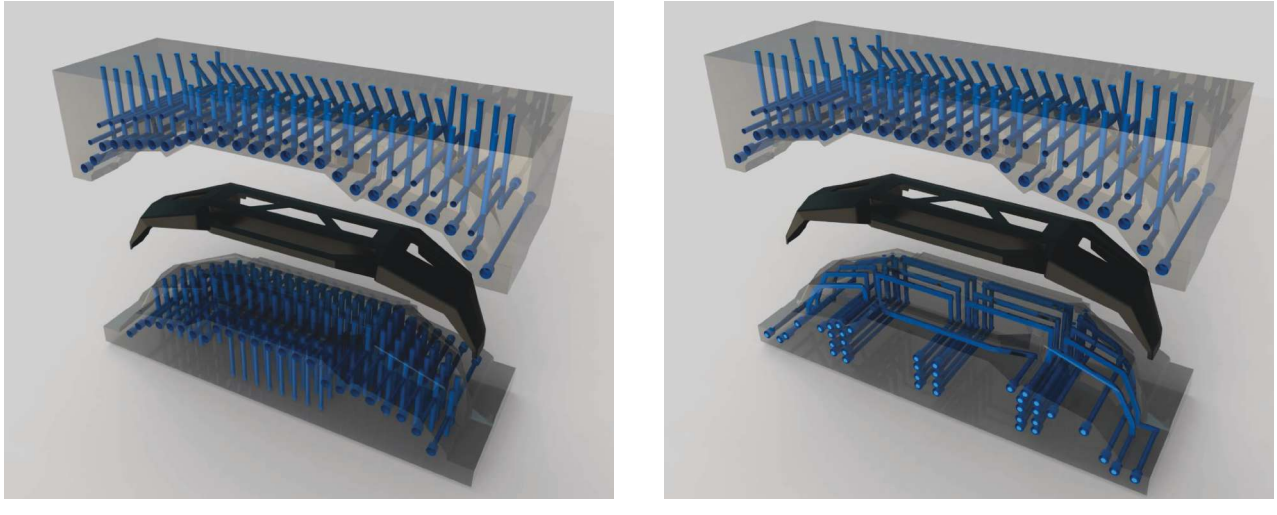
Injection molds for automotive fascia bumpers, wheel liners and instrument panels have multiple sweeping contours. During the manufacturing of a mold, the cooling design will significantly determine the cycle time. A newly patented conformal cooling technique has been developed that can greatly reduce cycle time by improving the cooling process while enhancing part quality, decreasing electricity and labor usage, and adhering to health and safety practices. The process uses a multilayer robotic deposition additive manufacturing technology.

Six years of collaboration among welders; mechanical, electrical and software engineers; and graduate students from the University of Waterloo, along with private and government-granted funding, enabled the development of an additive metals technology to create an accurate 3D object on an existing 3D contour surface. This research ultimately led to an advanced method for achieving conformal-cooled molds. Here, we'll examine the evolution of this technology by reviewing control and consistency benefits.

Technology Evolution

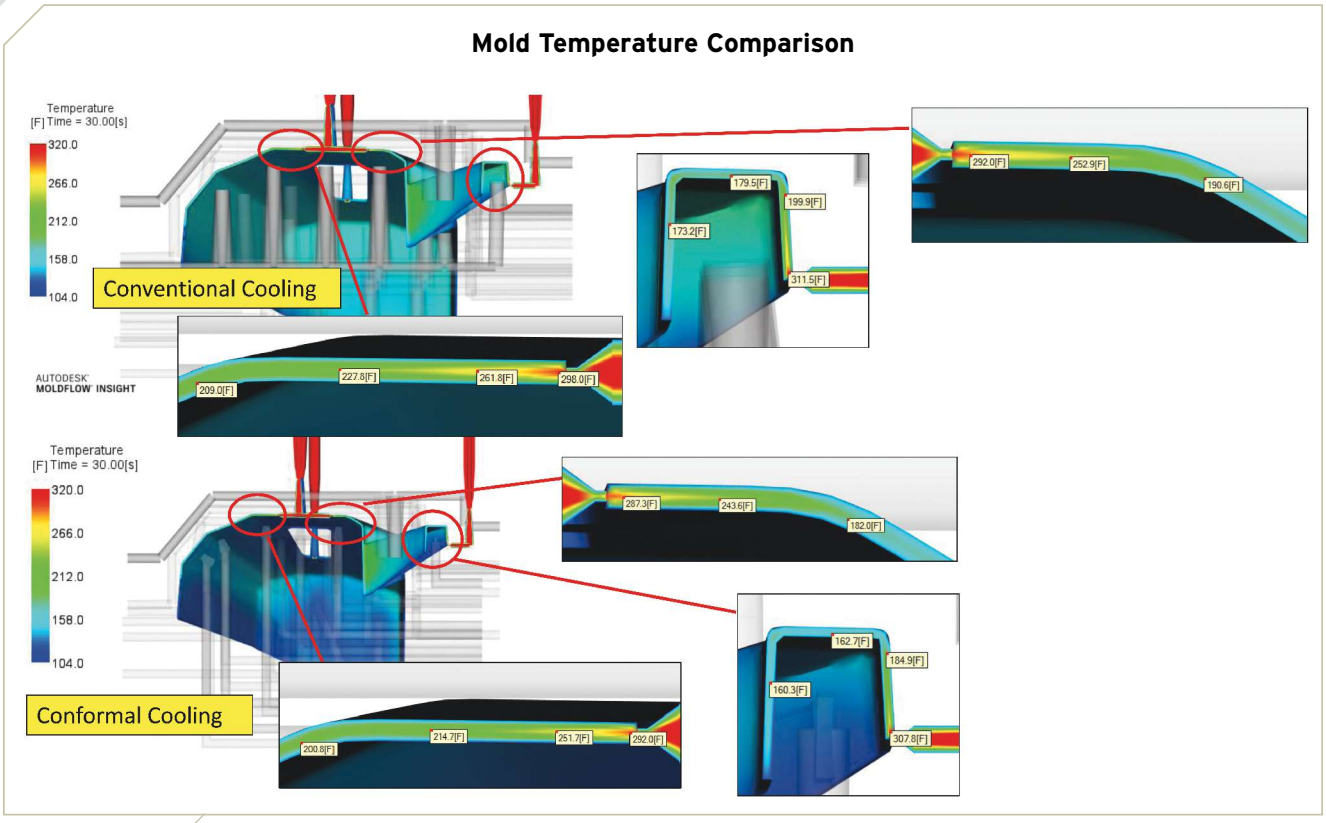
Manual TIG welding has its shortcomings, according to Pat Zaffino, managing director for Conformal Cooling

Conventional Cooling and Conformal Cooling Comparison



Images courtesy of Productive Design Services.

These renderings illustrate coolant hole layout for a conventionally cooled core and cavity for a bumper mold (left) and a conventionally cooled cavity and a conformal-cooled core of a bumper mold. The conventionally cooled core required more than 100 holes and baffles while the conformal-cooled core required only 38 in and out water lines and no baffles. Cooling channels follow the surface contour of the core face allowing maximum coverage to evenly and quickly cool the molded part. Note that the amount of available area in the conformal-cooled core would give designers the flexibility to add lifters and slides.



The results of a temperature analysis of a conventionally cooled and conformal-cooled bumper mold show the part temperatures through the thickness after the 30-second cycle time. Note that the average temperature delta is 19°F to 23°F between both cooling methods. This allows part ejection at lower cycle times without affecting part quality. Note the temperature difference at the nozzle outlet, which is typically the last area to cool.

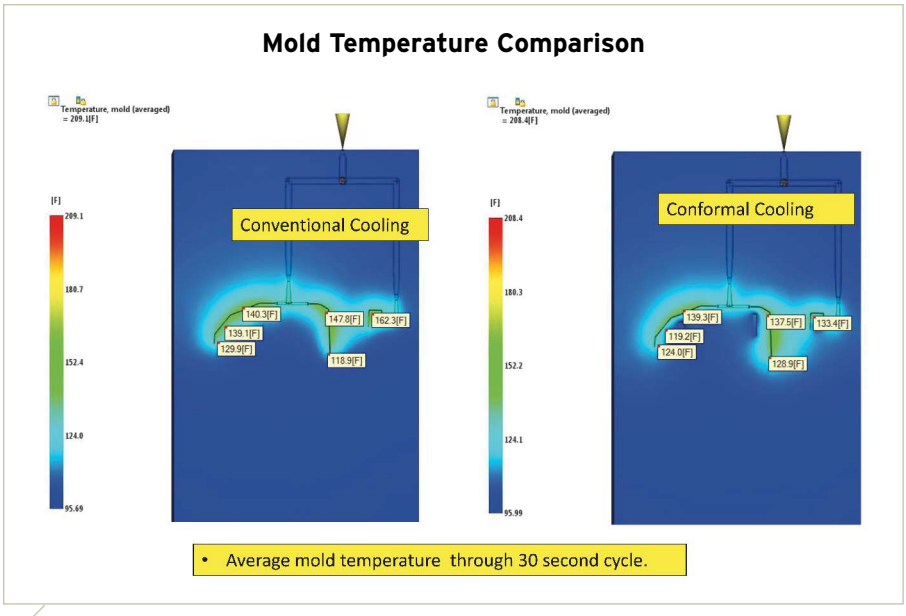
Solutions. For example, it is prone to weld imperfections on the mold surface, such as pin holes, porosity, surface cracks and weld hard lines. The tungsten electrode used may be contaminated several times per hour, which affects weld quality and increases costs. It is also very difficult to create 3D objects manually with this process. Typically, skilled welders can only deposit 0.75 pounds of weld per hour, cannot create two identical weld beads (inherent variation occurs) and are exposed to extreme temperatures (450°F to 750°F) when welding on large molds, which poses safety and comfort issues.

> This patented process was tested and proven in a mold that has produced more than 20,000 fascia bumpers.

Zaffino was especially concerned about the safety issues of the manual TIG welding process. “Sure, there are welding blankets that cover the mold; however, no matter how you try to keep the welder cool, that heat dissipates up. It becomes a real health and ergonomic hazard.” This inspired him to create a process that would make welding safer and more comfortable for his employees. The resulting 3D robotic deposition system takes the welder away from the very hot mold and eliminates a very difficult manual welding process.

For this system, the team developed a process that reads CAD files to locate the required surfaces and the 3D volumes to be added to a mold, then determines the required deposition paths and arc parameters, which is forwarded to the robotic cell. In the robotic cell, the operator locates the pickup points on the mold (tooling ball). Then the robotic software interpolates the paths to create layers of tool steel beads on a 3D-contoured mold surface, controlling factors such as end-of-arm deposition angle, wire feed and temperatures.

It does this exactly as a welder would, while knowing where the robot is in relationship to the mold surface. Basically, the team developed code functions similar to a CNC machine, except to add material instead of to remove it. The deposition process is performed in layers. For example, where multiple objects are being created, the deposit of tool steel materials



Results show the mold surface temperature after a 30-second cycle time. Note the average temperature delta between the conventional and conformal methods is 9.3°F, allowing more even heat distribution and faster part cooling.

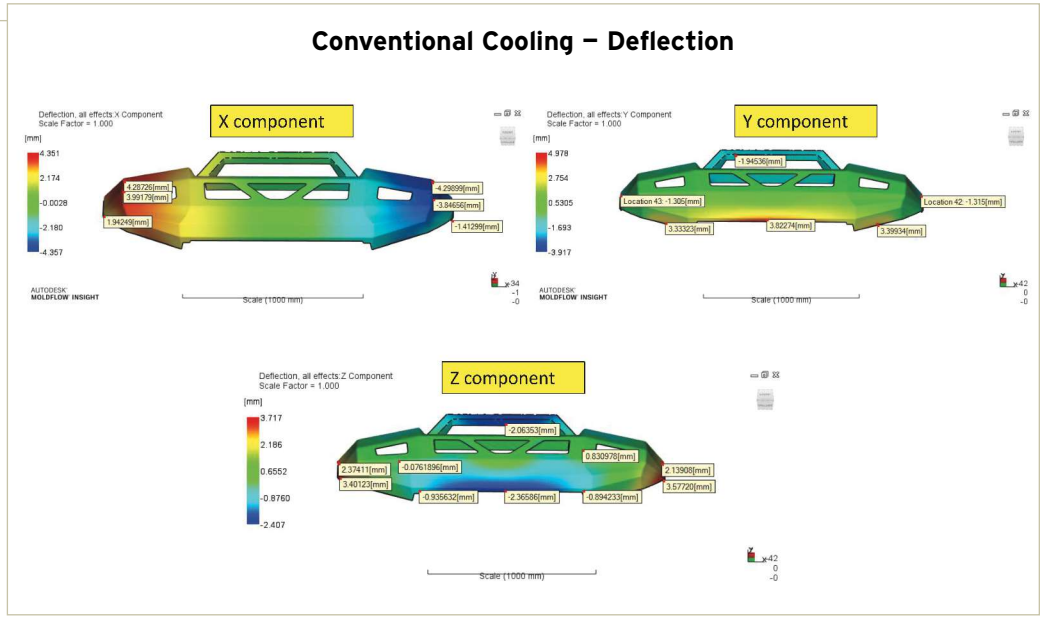
Using this robotic multilayer deposition system for conformal cooling can eliminate the majority of the baffles or bubbler systems, which in turn, reduces gun drilling and tapping by 75 percent.

can also be completed on each object one at a time. This helps to minimize distortion and residual stress of the object and the mold.

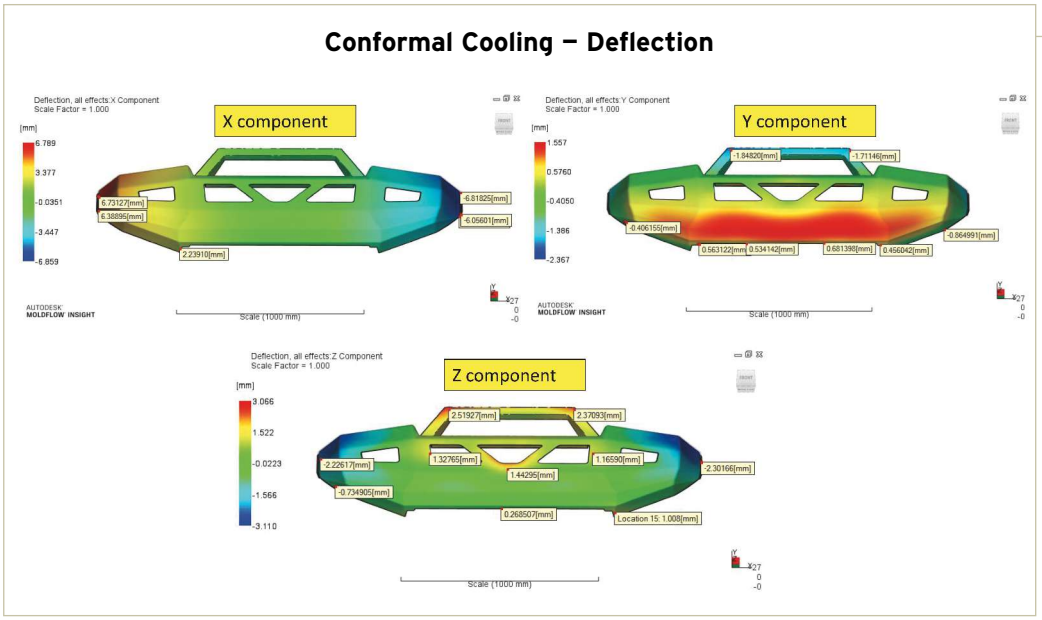
These features and functions enable the multilayer robotic deposition system to deposit up to 2.5 pounds of tool steel alloy per hour, creating consistent and reproducible beads, while eliminating defects and reducing issues related to extreme temperatures. Through his past experience, Zaffino claims that in manual TIG welding, the welder tends to contaminate the tungsten as many as six times per hour by touching the steel, which affects quality and cost. With the robotic deposition system, a single sharpening of the tungsten electrode has been able to endure up to 8 hours of depositing tool steel alloys.

Application Evolution

"Once we were able to create near-net-shaped objects on an existing 3D surface, we started to develop the technology further to produce conformal cooling water circuits using the same 3D format," Zaffino says. Current mold cooling technology for a bumper mold



This part-deflection study of the conventionally cooled bumper mold shows the deflection of the molded part in the various planes. The X plane shows more uneven shrinkage at the ends of the part, which are typically difficult to cool. Note the uneven shrinkage across the part face, which could show as a wave pattern in the finished part. The Y plane shows the part deflecting along the bottom edge, causing the part to frown. The Z plane shows the ends being pushed inward in the midsection and outward at the ends. This condition will make installation more difficult during assembly.



This part-deflection study of the conformal-cooled bumper mold shows the deflection of the molded part in the various planes. The X plane shows more even shrinkage across the part, minimizing warpage (including the ends of the part). The Y plane has the part being more evenly cooled in the midsection and across the face. It also shows the part being pulled toward the cavity due to the effective cooling of the core, which assists with demolding. The Z plane shows the part maintaining an even deflection with minimal warpage. Note that the ends are deflecting inward, which eases installation during assembly.

could require 50 to 100 baffler/bubbler holes, which are drilled from the bottom of the mold up toward the molding surface where coolant passes through the baffle system. The drilling is time-consuming and uses an enormous amount of space in the mold, which limits a designer's ability to place other mechanisms, such as lifters and ejector pins into the mold.

Using this robotic multilayer deposition system for conformal cooling can eliminate the majority of the baffles or bubbler systems, which in turn reduces gun drilling and tapping by 75 percent, according to Zaffino. This increases design flexibility for other mold mechanisms and permits cooling channels in the core half of a mold. Cooling channels can also be placed in the lifters and slides and can closely follow the surface contours for maximum cooling effectiveness.

A channel is machined in the core molding surface and the multilayer deposition system closes this channel to create a closed chamber for water flow. The channels are now a consistent distance from the molding surface, which provides predictable cooling of the mold surface and reduces cycle time.

The most efficient way to deposit any alloy, Zaffino says, is in the flat position, so that gravity is not a factor. The conformal cooling channel is orientated by the system, so it is perpendicular to the floor. This ensures that the bead sequence is consistent within the channel. There are set standard operating procedures within the system. For example, if the channel receives 24 beads for a 0.750-inch channel, there will be 100 percent consistency for all similar channels of the same dimension. The only variation would be the length of the channel. For this process, 0.500- and 0.625-inch channels have been implemented.

A simulation study was conducted using Autodesk MoldFlow Insight to determine the impact of conformal cooling channels produced via the multilayer robotic deposition system. The findings report that conformal cooling created a more even temperature across the molding surfaces, reducing cycle time and improving part quality; circuit pressure with conformal cooling reduced pressure by a factor of 20 times throughout the circuit; and, the mold interface temperature with conformal cooling resulted in a 25.5°F-temperature reduction, better dimensional stability, the elimination of hot spots, quicker production startup and less material waste.

In addition, a part deflection study indicated more even linear shrinkage across the length of the part, and more even cooling across the center portion of the part that featured the largest surface area. Finally, the study found more even distortion in the Z plane and minimized warpage.

This patented process was tested and proven in a mold that has produced more than 20,000 fascia bumpers. The cycle time was reduced by 25 percent compared to the conventionally-cooled mold. "We are encouraged by these results and believe that it could greatly benefit molders through improved cycle times, provide better part quality, increased press utilization rates and decreased energy use," Zaffino says. MMT

FOR MORE INFORMATION

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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.

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

Software Technology Is More Versatile, Efficient and Simplified

Software suppliers are working diligently to provide moldmakers with relevant but easy-to-use solutions that speed processes and lower costs.

It is almost impossible to keep pace with technological advancements today, especially where software is concerned. So, *MoldMaking Technology* reached out to representatives of several software providers that serve the industry to offer a glimpse of the current trends and new developments in CAD/CAM, simulation and job-tracking software.

Making CAD/CAM More Versatile and Efficient

Recent trends in machining and automation have spurred advancements in CAD/CAM software capabilities that are helping moldmakers remain competitive in the global marketplace. *MoldMaking Technology* asked a few CAD/CAM experts to share their perspectives.

"The biggest trend I have seen is the move to five-axis machining," Ryan Weekes, North American sales manager for CGS North America (Ontario, Canada), says. "CAM software companies now work closely with machine tool and cutting-tool companies to develop easier ways to control the tilt direction of five-axis toolpaths. As creating these toolpaths becomes easier, programmers are less resistant to doing simultaneous five-axis toolpaths."

Alan Levine, managing director of Open Mind Technologies USA (Needham, Massachusetts), says, "Additionally, machine controls, such as those from Heidenhain, FANUC and Siemens, have new capabilities and improved performance. Importantly, CAM software strategies enable the use of shorter cutters, which improve feed rates and produce better surface finishes."

Casey Goodman, marketing and inside sales manager for Tebis America (Troy, Michigan), says that mold designs are becoming more complex, and the use of multi-axis, simultaneous milling machines is more commonplace, particularly in the automotive industry, which puts more emphasis on the ability of the person using the software. "Automating processes in mold manufacturing is becoming more crucial and necessary for companies to stay competitive. It is also one way to overcome the skills gap," he says. "Automation is achieved by setting standards and establishing machining templates, then measuring those standards and adjusting them as needed. The benefit is that less experienced employees do not have to learn complete software programs, but can grow into them while still meeting management's expectations."

Manufacturers are now looking at ways in which they can work smarter and not harder, according to Clinton Perry, product marketing manager at Autodesk Inc. (San Rafael, California). "In tooling, two trends deal with automation and interoperability," he says. "Using automation, mold and die manufacturers can convert their best CNC machining practices into a suite of intelligent macros and templates that can be automatically applied to families of parts. Automation enables the creation of high quality, predictable CNC machining code with minimal human input and risk of human error."

Regarding interoperability between software, Perry, who is based in Birmingham, U.K., says that traditionally, design and manufacturing software were only designated to one or two steps in the entire part-design process. As a result, workers were making any needed changes manually during the other steps, ultimately introducing the potential for error. "Now, we are seeing the ability to make a change in one area, and then that change is triggering a dynamic update across the entire workflow," he says.

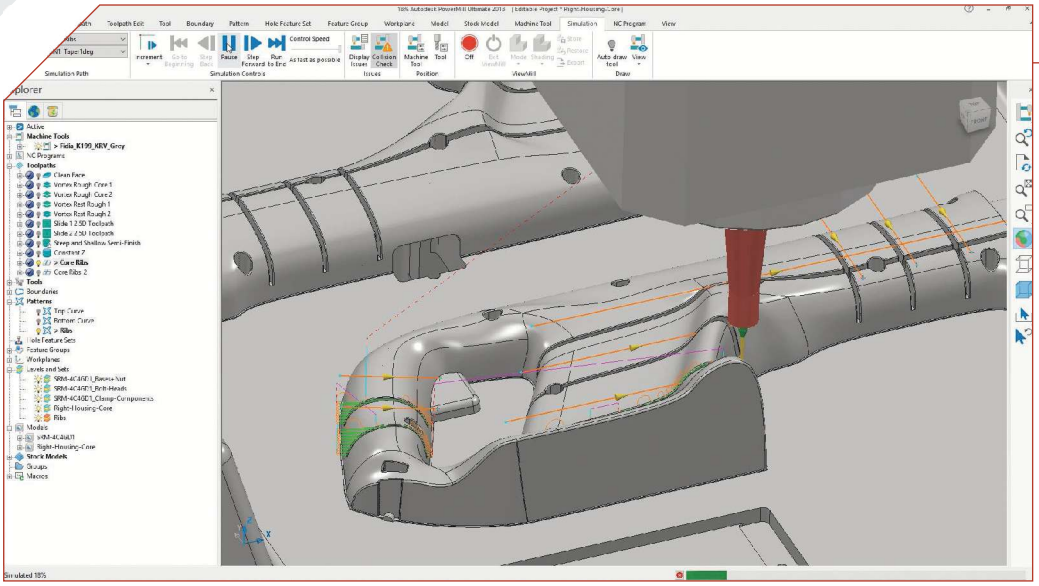

Image courtesy of Autodesk Inc.

As mold designs become more complex, software must be easier to use and offer a wider range of applications, including the ability to automate processes by creating high quality, predictable CNC machining code with minimal human input and risk of human error. Here, software performs collision checks on NC code.

Perry adds that, increasingly, manufacturers are using the cloud to improve levels of collaboration within their organizations. The ability to share interactive, 3D representations of designs and manufacturing processes enables these teams to interact with key stakeholders (including the end customers).

Shawn Schwartz, sales and services director-Americas for WorkNC by Vero Software (Southfield, Michigan), agrees that automation is a key trend in moldmaking. "Programmers are utilizing software to make those toolpaths that do not have to be manually edited or tweaked. Machinists are using workholding and fixturing tools to reduce setup times and make the transitions between machines easier, and they are using palletization so that pickup and repositioning is eliminated," he says.

> [Moldmakers] have used their current software for so long that they are unwilling to change systems, even though they understand that it would significantly increase productivity once they have made the switch.

As for advancements, Alan Levine of Open Mind Technologies USA says that CAM software provides a platform for change and that suppliers continually provide updates, including the latest capabilities in graphics, toolpaths, probing and simulation. "In the toolpath area, for example, the application of conical barrel cutters to planar, ruled and shaped surfaces provides huge benefits for reducing cycle times by as much as 90 percent or more and enhancing cutter life. This offers advanced blending techniques to help meet critical mold-surface finish requirements while avoiding undercuts or cusps at the blending of different cut regions," he says. Ryan Weekes of CGS North America also calls out CAM companies' adaptation of circle-segmented tools or barrel cutters, which are specifically designed for five-axis machining. "These tools have a large radius on a small tool, the purpose of which is to enable much larger step-downs to produce a smaller cusp while not driving up the cost of the tool with a large amount of carbide," he says. "In the right application, these tools will increase efficiency and surface finish. For moldmakers to use these tools effectively, the CAM software must drive the toolpath in a very specific motion to utilize the largest part of the radius." Vero Software's Shawn Schwartz says that WorkNC recently introduced a new version of a planar roughing tool and improved it to require fewer cutters so that finishing times are much faster. "It also is able to do that in the Z-level finishing, which is critical for mold and die," he says.

Clinton Perry of Autodesk Inc. says that using new technologies like machine learning to review an application and match it against the right manufacturing process, and combining it with cloud computing for on-demand computer hardware, enables moldmakers to quickly evaluate all possible design and manufacturing options. As a result, the moldmaker not only makes a part, but engineers the right part in the shortest amount of time while using the proper material and the processes that the application requires.

Making Simulation Software More Adaptable

Though simulation software has been around since the late 1970s, its breadth of use in moldmaking continues to grow as new mold building technologies take hold within the

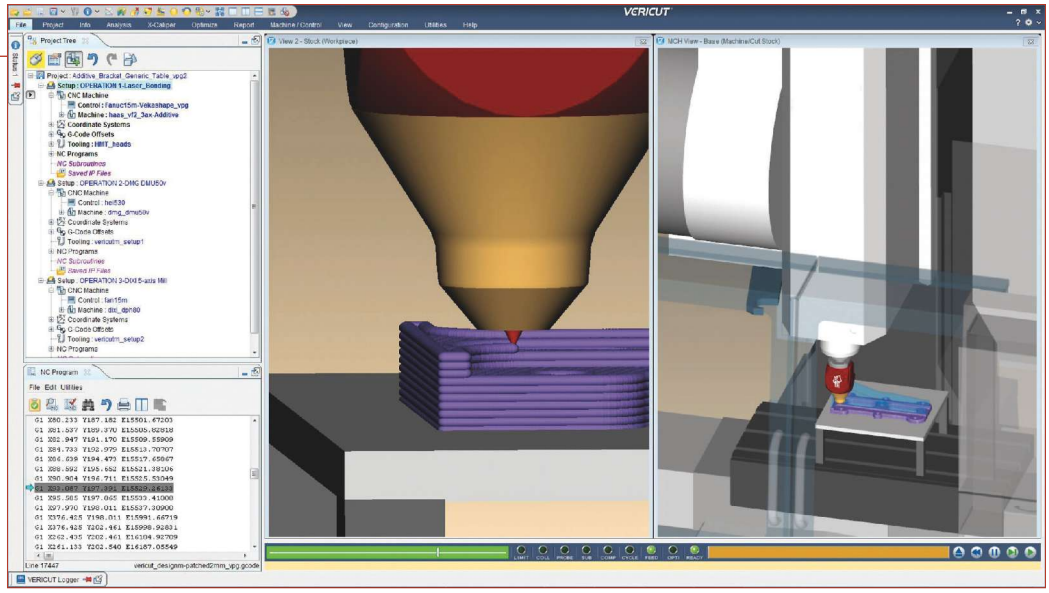

Image courtesy of CGTech.

A new trend that is emerging in simulation software is the ability to simulate any manufacturing process (additive, milling, turning, welding and so on) in the order used to fabricate a part. This image shows a simulation of laser-directed energy deposition (DED) used in a multi-operation manufacturing process.

industry. Simulation experts say that simulation software is becoming easier to use and more diverse in its application to meet the increasingly diverse needs of moldmakers.

Gene Granata, Vericut product manager at CGTech (Irvine, California), says that a continuing trend is to educate and energize the moldmaking industry about the prospects of using additive manufacturing (AM) to manufacture better molds and to achieve faster times to market. "As more mold companies move to adopt AM, simulation software is offering more variations of additive motion paths and is attempting to predict heat distortion and material deformation that could pose problems during the build process," he says. "These advancements are driven by the need to build additive parts that not only have sound functional design, but also have sound structural integrity."

Simulation software is already available to optimize machining based on optimal chip loads, cutting forces and so on. But, what about additive?

Granata says that additive building and programming software is becoming more robust. With that, a new trend is emerging for simulation software developers for subtractive and additive processes—software is making it possible to simulate any manufacturing process (additive, milling, turning, welding and so on) in the order used to fabricate the part. This more "global" view of verification can expose potential "surprises" between operations and ensures that the final part (after moldmakers perform all operations and processes) is correct and is made as efficiently as possible. "The need for more comprehensive simulation stems from the fact that many additive processes still require post-process machining to achieve desired tolerances and surface finishes on at least some mold features," he says.

Another trend is the emergence of more varieties of hybrid machine tools (machines that can add and subtract material). Hybrid machines can be a mixed blessing, Granata says. While they are certainly more capable than their non-hybrid counterparts, they also have many more functions and NC codes that moldmakers must properly manage. Hybrid machines require different NC programming techniques than those with which most NC programmers have familiarity, and they come with new safety hazards such as dangerous, high-powered laser equipment and potentially caustic powdered metals. "Simulation software makes it possible to test various manufacturing methods and determine which will produce the best part while maximizing use of the available CNC equipment," he says. In order to do the best job, users will want to choose simulation software that is driven by the same NC code that will drive the machine, thereby ensuring the highest level of verification possible. "We believe the next logical advancement AM adopters will need is the ability to optimize the additive and hybrid processes," Granata says. "Simulation software is already available to optimize machining based on optimal chip loads, cutting forces and so on. But, what about additive? Moldmakers who are using AM will want to know that they are applying material as quickly and efficiently as possible and within the limits that their additive material and CNC

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More simplified machine and tooling-focused job-tracking software is trending in the market, making it much easier for mold shops to adopt them and use them effectively. Here, a screenshot of machine monitoring and job tracking software shows how user-friendly and easy it can be to access real-time or historical data reports that are customized for moldmaking.

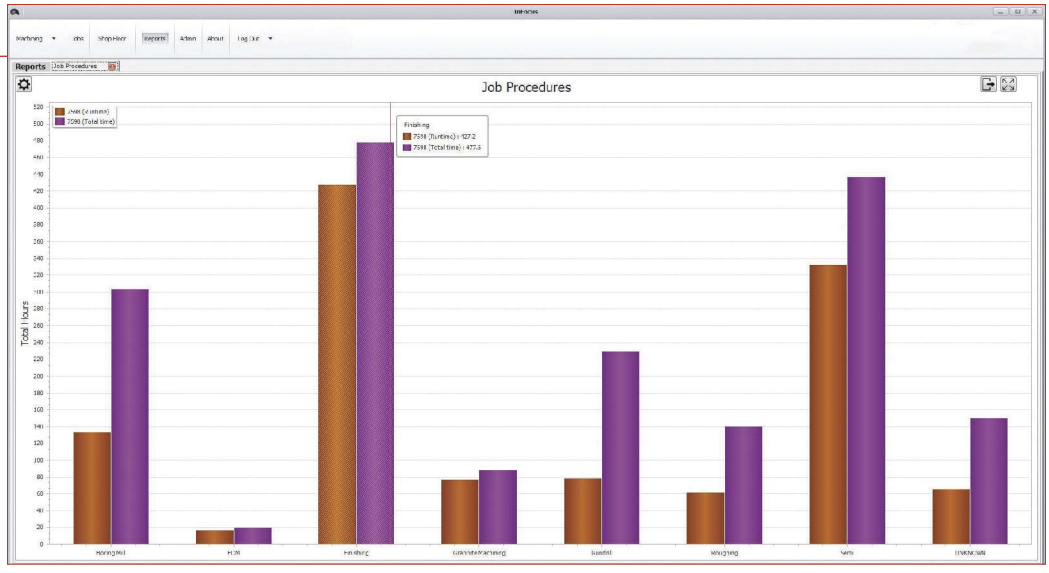

Image courtesy of R.E.R. Software Inc.

equipment impose. These are perfect tasks for the simulation software of our additive future!"

Tim Lankisch, director of engineering at CAE Services (Batavia, Illinois), says that developing tools that make products like Moldflow simulation software easier to use enables engineers to test more of their ideas and solutions. Parts manufacturers and moldmakers are continually driven to reduce dimensional tolerances and improve strength characteristics or reduce part weight at the same time. "Those factors typically result in the potential for more part warpage, making the use of simulation critical to predict and correct the dimensional issues that can arise for those challenging parts," he says. Because of this, the development of simulation software has emphasized improving the quality and ease-of-use of 3D meshing. Additionally, software development has focused on creating and improving tools to help modify geometry to test both design modification solutions and windage solutions to warpage problems. "Partnering with companies that use world-class simulation to identify and solve molding problems is an important part of mitigating that challenge up-front," he says. CAE offers simulation services for shops, sometimes basing an employee at a customer's facility to work. "Simulation software vendors will continue to address the speed, accuracy and user-friendliness of their products based on direct user feedback and correlation studies."

Making Job Tracking More Actionable

In the realm of job-tracking software, the trends and challenges for moldmakers are the same as they are for other types of software. Moldmakers are trying to do more with less. They need accessible data that is easy to use, and they

want software that will help them cut costs and lead times. "Whether you use terms like cloud computing, Internet of Things (IoT) or Industry 4.0, these trendy buzzwords have one common theme, which is giving users instant access to rich and actionable information," Sean Brolley, business development manager at Toolstats (Ferndale, Michigan), says. He adds that sensors and live monitoring capabilities are becoming more popular in production facilities, but if companies do not have an efficient way to store and share that information with the suppliers and stakeholders that need it, the information becomes less powerful. That is where the right software platform can make a difference.

Roger Bassous, president of newly-established R.E.R. Software Inc. (Rochester, Michigan), says that companies are increasingly more interested in tracking their jobs, using an enterprise resource planning (ERP) system to better understand their job costs and gain more control over current jobs. "ERP systems are designed to facilitate a lot of the overhead that big enterprise companies face," he says. "They tend to be extremely expensive, both initially and over the long-term, and data is typically collected manually." He adds that ERP systems are not quite designed for a specific industry and always require detailed industry software development to integrate with each implemented location. Nevertheless, Bassous agrees that there is a need for job-tracking software in moldmaking because using measurable data to understand past work makes it easier to more accurately quote and plan future jobs.

Both Brolley and Bassous note that the biggest challenge for mold shops that want to adopt or should adopt a job-tracking software system is making the leap to implementation of the new technology. The answer is simplicity. Both Brolley and Bassous agree that if the software is too complicated and is not built to suit the people using it, then no one will use it. "Cloud-based solutions are becoming much easier to use and even easier to implement," Brolley says. "Software products these days no longer require downloading or complicated installation because they are hosted off-site, which makes the maintenance process much easier for IT departments. If new versions of the software or enhanced features need to be released, it can happen almost seamlessly without disrupting workflows."

Bassous also says, "Automation is a critical component. Much of the newer technology of both machinery and software provides for automatic data retrieval. The easier it is for humans to interface with a technology, the easier it will be to adopt job-tracking software." MMT

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By Thomas Pickhardt and Brian Guild

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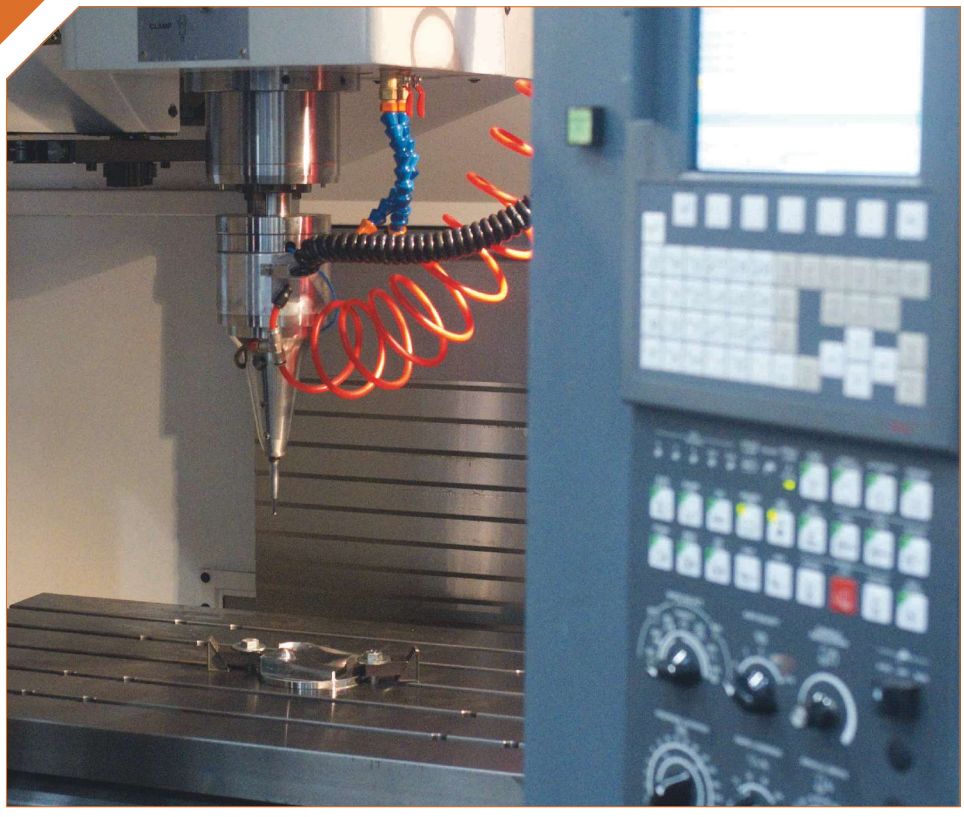
Machine-Hammer Peening Automates Mold Polishing

A polishing automation solution eliminates hand work, accelerates milling operations and controls surface geometries.



Images courtesy of Accurapuls Canada Inc.

High-quality, smooth surfaces are essential in mold manufacturing. Customers insist on it, but the processes for achieving these surfaces are costly and difficult. Polishing is one such finishing process that requires abrasive rubbing or a chemical action to produce a smooth, shiny surface and to diffuse reflections. The challenge for moldmakers is the labor-intensive nature of these operations that are completely dependent on the personal skill and expertise of an experienced mold polisher. The bottom line is that polishing requires a lot of time and skill, is prone to costly errors and delays and causes frustration.

Polishing Basics

An unpolished, milled surface that is magnified 1,000 times has the appearance of miniature peaks and valleys. To reduce this roughness, a polisher rubs the surface using coarse grit, then progresses to finer grit and eventually buffs with compound pastes. Repeated abrasive rubbing over the surface literally "wears" the peaks down until they are flat or shallow hills, and the surface becomes smooth. A polisher uses hand stones, emery cloth and honing compounds to achieve the required grade of smoothness.

However, since the polisher physically removes the material in this process, the polisher often compromises the dimensional outcomes and surface geometries, rendering them "unknown" and impossible to repeat. Control over the finished product is lost. Surface inspection becomes a subjective opinion and can lead to customer disputes or dissatisfaction. What is more, overworking the surface can lead to defects, such as orange peel, scratching and pitting. Polishers must take great care to avoid these flaws.

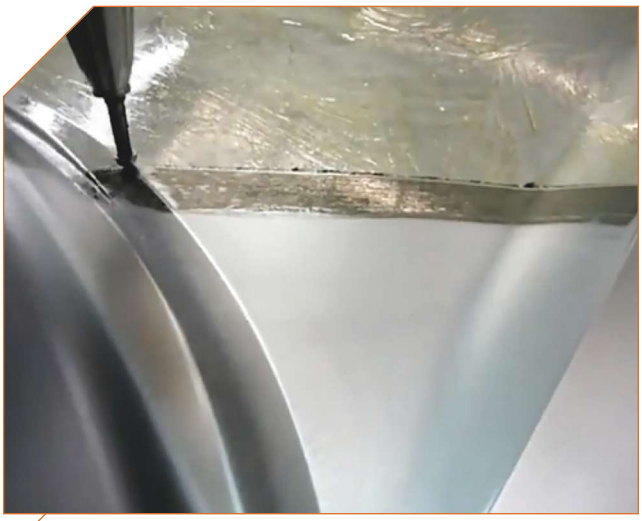
Many mold manufacturers today address these risks by finish-milling the surfaces as smoothly as possible to minimize

System components for machine-hammer peening include the peening hammer and striker, spindle adapter, flex cable, air hose, computer, CAM software, control console, handheld pulse generator, machine tool and workpiece.

or eliminate hand polishing. Cusp height, or the distance from the top of the microscopic "hill" to the bottom of the "valley," is a measure of the milled surface roughness and is recorded in micromillimeters or microinches. A general rule is that the closer the milled pitch distance is from sidestep to sidestep, the lower the cusp height will be. Ball nose endmills with larger diameters also reduce cusp height at the same pitch since cutters with larger radii produce wider tool paths.

In theory, this method makes sense. However, in practice, it is a costly exercise because these cutting operations require a lot of machining time and use accurate, rigid, expensive machine tools with high spindle speeds, feeds and processing capacity. These cutting operations also require expensive consumable cutting tools that actually "cut" the steel as opposed to simply sliding, scraping or dragging them over the surface. Also, the use of improper cutters can cause surface defects. Simply put, cutting alone can never achieve perfect smoothness. So, despite the best final milling practices, polishing remains a necessary finishing process for achieving customer-required surface qualities.

Nevertheless, moldmakers today can choose a different polishing strategy. Automated technology that is capable of enhanced surface quality can replace manual polishing. This mechanized system also facilitates faster milling operations, which reduces costs and accelerates job completion.



Machine-hammer peening is applied through the operation of a controllable electro-magnetic hammer head imparting rapid reciprocal motion of a striker ball against a workpiece surface. This image demonstrates the before and after of a mold surface being peened.

Automated Polishing

Peening is the process of working a metal's surface to improve its material properties, using mechanical means, such as hammering, blasting with shots (shot peening) or blasting of light beams (laser peening).

Peening itself is not a new treatment, as Ancient Egyptians practiced it to improve the strength and durability of their chest armor and spear tips. They understood that a cold-working process produced better results than heat treating their metals. Today, this process uses automation to hammer and control each point of impact. An electronically-controlled hammer head produces machine-hammer peening, and a CNC machine or a robot controls the head positioning, executing CAM software that is programmed specifically for peening applications.

A separate moveable console unit on rollers contains a computer and a 110-volt power supply that converts DC for the hammer head. Electromagnets in the conical-shaped head create a powerful Lorentz force (or the force exerted on a charged particle moving with velocity through an electric

and magnetic field), which causes the striker tool to reciprocate rapidly when placed against the workpiece surface. This produces the hammering action.

The metal strikers have spherical tips and range in size from 1–25 millimeters in diameter. These interchangeable strikers are the actual tools that hammer on the surface. Both the impact force and the hit rate (or the frequency) are variable, generating up to 180 kilograms of force per strike and 500 hits per second. A flanged adapter fastens the head to the CNC machine, and that is where the head's position is manipulated by programmed axis movements against the workpiece surface. The CNC machine controls the feed direction of the head on the surface. The direction is usually perpendicular to the previously milled toolpath.

> An electronically-controlled hammer head produces machine-hammer peening, and a CNC machine or a robot controls the head positioning, executing CAM software that is programmed specifically for peening applications.

This peening process creates smoothness on the surface by flattening the material peaks into valleys. The material flow that radiates beneath the surface achieves a perfectly smooth outer surface that is uniformly polished, avoiding any need for hand finishing. Technically speaking, peening can reduce the cusp height as much as 0.075 micrometer. That is, 0.000075 millimeter or 0.000003 inch, which is equivalent to anything that can be produced by hand. At the same time, this process enhances the surface by mechanically increasing the hardness and imparting residual compressive stress into the outer layer, which produces a more durable surface that is less prone to fatigue, wear or micro-cracking.

Additionally, since the hammer produces considerable strike force, the final milling pitch and the corresponding cusp height before peening could be much coarser than if hand polishing were to follow. Typically, finishing pitch distance can be doubled or tripled, reducing finish milling time by 50-60 percent.

Machine-Hammer Peening Benefits

For most jobs, an automated polishing solution is ideal. Moldmakers save a great deal of time and money, they rely

less on experienced hand polishers, and they eliminate the risks from overworking surfaces. Justifying its use on larger surfaces, such as door panels and dashboards, is easy, but even fine details and radii are effectively polished using the smallest 1-millimeter diameter striker. Occasionally, certain spaces like deep ribs or similar features on grill molds, for example, may restrict striker access because they are difficult to reach. Those areas may still require hand work. However, even in those cases, combining the automated system with hand polishing will save time.

Automated hammer peening offers process control, decreased processing time, and reduced or eliminated manual polishing and overwork defects. These benefits are possible because the surface geometries are maintained with proprietary CAM software that controls the CNC machine for peening operations on 3D geometries, ensuring predictable and repeatable results. Code is generated from parasolid files for the workpiece. The software recognizes special features, such as sharp corners and pin holes, keeping them safe from damage. Impact force and frequency parameters are also regulated during set up. The entire peening process is automated, design data is preserved, and finished results meet simulation predictions every time.

A single workpiece setup for milling and peening can save substantial processing time. Moldmakers can complete finish-milling operations 50 percent faster when peening follows, and they can substantially reduce or eliminate manual polishing. For example, a hardened P20 or H13 steel mold that is finish-milled using a 6-millimeter ball mill at a feed rate of 6 meters per minute with a 0.1-millimeter pitch distance and then peened for polishing using a 6-millimeter striker at a feed rate of 6 meters per minute and the same 0.1-millimeter pitch distance will produce a perfectly smooth, finished surface. The combined time and cost savings could be up to 100 hours or more of man- or machine-based labor, depending on the job. MMT

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By Barbara Schulz

Small but Smart

Germany's Toolmaker of the Year 2017 does things small but in a smart way when it comes to the design and manufacturing of multi-component molds, in-mold-labeling and tools with integrated assembly functions.

Images courtesy of W. Fassnacht Werkzeug- und Formenbau.

W. Fassnacht Werkzeug- und Formenbau has continuously invested in automation, including a five-axis machining center, CNC measuring machine, two EDM machines and a handling system.

For more than 25 years, W. Fassnacht Werkzeug- und Formenbau has been providing high-quality molds to a diverse range of industries. Recently, the Swabian company was named Germany's Toolmaker of the Year 2017 because it believes in doing things in a small but smart way.

The company has sustained healthy growth since its inception in 1990. A continuously growing customer base left company founder Wolfgang Fassnacht and his team of 20 workers at a crossroads about eight years ago: Should they grow the company, or keep it a medium-sized family business? "When I asked my team if they wanted to remain a small-but-smart mold shop or grow into a big business with up to 300 employees, everyone agreed to continue doing things in a small way," Fassnacht says.

Today, the branding "made by Fassnacht" is synonymous with high-quality molds and attracts international customers from the automotive, medical, packaging, electronics and white goods industries. "I never wanted to create a niche for my company. I always thought that it is too risky in times of economic crises, as we saw in 2009," Fassnacht says. "Today, there is no industry that we are not servicing."

But like most mold shops these days, Fassnacht faces fierce competition abroad, especially from Asia, he says. So, the company constantly reinvents itself to remain globally competitive. Among Fassnacht's measures to ensure a solid, future-oriented business is his aforementioned decision to keep the company small and healthy. The company also has heavily invested in automation systems and in a laser cusing machine to additively manufacture mold inserts. He also makes a priority of trusting his employees.

Focus on Core Competencies

These are the reasons why Fassnacht won the "Toolmaker of the Year" award in November 2017. The Fraunhofer Institute for Production Technology and the WZL tooling laboratory at RWTH Aachen University, Germany, organize the competition. The award's jury also praised the shop's decision to outsource less demanding work and its choice to concentrate on its core competencies—the design and manufacturing of multi-component molds, in-mold-labeling and tools with integrated assembly functions.

"We don't sell machine hours, we sell design and manufacturing know-how and keep our core capabilities like five-axis

machining, electrode milling, EDM and design in-house," Fassnacht says. "Things like plates, rails and other standard parts we buy from other suppliers, which helps our small team to concentrate on the essential tasks."

For the same reason, Fassnacht has continuously invested in automation. The factory's centerpiece is a five-axis Röders machining center that mills electrodes and other mold components, a CNC measuring machine and two EDM machines from German company Zimmer + Kreim, which has supplied Fassnacht's handling system as well.

The linear automation system is called Chameleon. It features magazines on a length of 7.5 meters, offering space for 600 electrodes and 21 workpiece pallets. The Chameleon handling robot moves through the flexible manufacturing system on an expandable rail system and can handle pallets from 500 by 500 millimeters and 400 by 600 millimeters.

"We first thought we'd be less flexible with this automation solution, but we soon realized that it pays off to invest in automation and batch-size-one production, even for a small company like ours" Fassnacht says. "Some of our molds require up to 400 different electrodes, which are hard to handle without automation. Moreover, we used to waste a lot of time when we had to interrupt an EDM process for urgent design changes. New setups and machine changeovers caused machine downtime and extra work for the operators. Today, we stop the EDM process, and the handling system temporarily stores the workpiece until the machine is ready to finish the machining process."

Increase in Productivity

The automated production cell also contributed to an increase in productivity, even though Fassnacht never deviated from his decision to keep his company at a size of 20 employees. He says, "One reason for our increased efficiency is higher throughput. The other is improved quality and higher machining speeds thanks to the new EDM machines, which are about five times faster than our old ones. Spotting times have been reduced, which has a huge impact on our labor costs and our ability to deliver molds to our customers more quickly." Ten years ago, Fassnacht produced 30–40 molds per year. Now, depending on complexity, the mold shop annually makes as many as 80 injection molds that weigh as much as 5 tons.

While Fassnacht admits that his company has grown from a craftsman's workshop to a modern mold shop that is inspired by industrial manufacturing principles, it is the people who make the difference. "We need automation to remain competitive, but the key to success is what happens before and after a flexible manufacturing system. The most important factor is the mold design and whether time and money are lost for rework and post-processing. What set us apart are our smart mold solutions and the people behind them."

Investment in Additive Technology

Part of Fassnacht's smart mold solutions are additively-manufactured mold inserts with conformal cooling. "Molds should earn money in the injection molding process in terms of cost per part, especially when we are talking about large volumes," Fassnacht says. "Our conformal cooling solutions add value for the injection molder. Very often, however, our customer is not the end-user, but a contractor with a fixed budget. In those cases, it takes some effort and cycle time calculations to convince them to invest in an additively-made insert. Other customers demand designs with conformal cooling channels. Historically, these molds reach achievable and realistic reductions in cycle time in series production of up to 40 percent."

Fassnacht came across the selective laser melting technology as early as 1995. When Concept Laser exhibited its first M3 linear machine as the world's first industrial 3D metal printing system at Euromold in Frankfurt in 2001, Fassnacht decided to use this technology to create inserts with conformal cooling and hybrid parts, where the complex geometries of the mold insert are "fused" onto a conventionally machined base. When more and more customers started to realize the potential of metal additive manufacturing, conformal cooling and the resulting cycle time reductions, Fassnacht decided to take the technology in-house. He invested in a laser cusing machine from Concept Laser in 2008.

"Meanwhile, we have found ways to manufacture many additively-generated inserts more cheaply than conventionally-machined ones," Fassnacht says. "Since we cannot use the machine to its full capacity, we also do contract work for other companies, including local mold shops." According to Fassnacht, competition comes from Asia, not from the mold shop around the corner. He enjoys talking to other shop owners to exchange information and share ideas and news on the latest developments. He says, "Competitions like the one in Aachen bring tool and moldmakers together. This is how I learned about metal additive manufacturing and became one of the first moldmakers to bring such a machine in-house. We all need to cooperate, not compete." MMT

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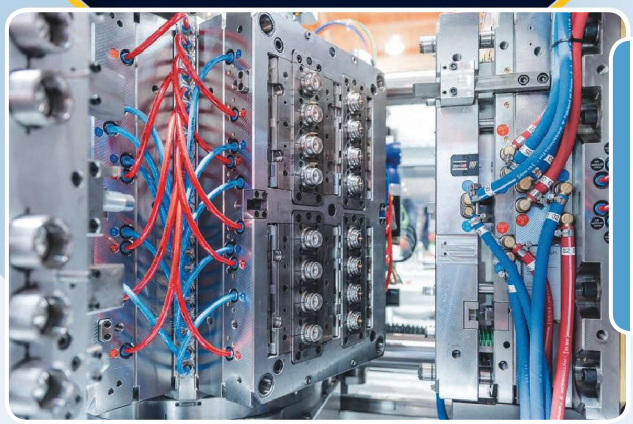

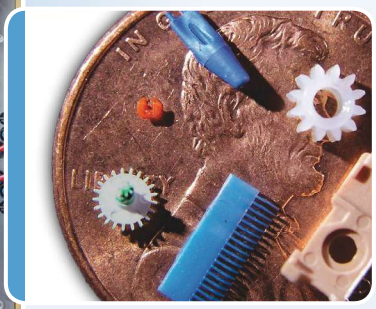

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Molding 2018

CNC Gives Moldmaker More Capacity, Greater Reach for Large, Contoured Molds

Images courtesy of Model Die and Mold Inc.

Model Die and Mold Inc. needed a CNC machine that could handle finish-machining of very large, contoured molds with deep, constricted areas like the one shown here. The Parpas Diamond Linear 30 gantry-style, five-axis machining center provided those capabilities and more, including faster cycle times and a significant reduction in EDM and other secondary steps like polishing.

By Cynthia Kustush

When building molds ranging in size from 150–5,000 tons, it is important to have CNC equipment that provides both the capacity and the capabilities to achieve accurate, efficient machining on a wide variety of jobs. It also helps to be able to confidently run jobs unattended and reduce, if not eliminate, the need for secondary processes. Model Die and Mold Inc. has 67 employees and builds molds fitting that size range for customers who are original equipment manufacturers primarily in the automotive, heavy truck, luxury vehicles and public transportation industries. Monica Neibarger, project manager, says that the Wyoming, Michigan-based company manufactures between 150–300 molds a year, depending on size. For a while, size was a challenging factor.

"We were experiencing bottlenecks in our CNC finishing department, particularly with very large molds that had deep, contoured cavities. We had to outsource that work, causing a loss in profits," she says. In addition, Model Die had to turn new work away because of insufficient CNC capacity and required delivery times.

MODEL DIE AND MOLD INC.

PROBLEM: Recurring bottlenecks in CNC finishing made it necessary to outsource work, which reduced profitability. Additionally, the group needed a larger footprint to accommodate very large workpieces.

SOLUTION: Parpas Diamond Linear 30 gantry-style, five-axis machining center.

RESULTS: Increased speed and capacity. The machine provided the ability to finish-machine in tight areas, significantly reducing most secondary operations like EDM.

To remedy the situation, the company began looking for a machine with a larger work envelope and, more importantly, the ability to cut deep, contoured cavities. Model Die already had two Parpas Diamond machining centers from Parpas America Corp. in Bloomfield Hills, Michigan. One is an Active Five five-axis gantry high-speed CNC mill, and the other is a Diamond Linear featuring an overhead gantry and five-axis head. Each has XYZ travels of 87 inches by 59 inches by 39 inches, and Neibarger says that they have been top performers in terms of speed (20,000 rpm), surface finish, five-axis precision and automatic tool changing capability (84-position and 40-position, respectively). "Investing in a new, larger Parpas Diamond 30 Linear machining center made sense, given the excellent performance of the machines we had," she says, adding that the five-axis, gantry-style Diamond 30 provided the same benefits and more.

Increased Capacity Wins Work

Turning away work because of inadequate CNC capacity was frustrating for Model Die. Despite having another CNC Bridge Mill, which features a 44-inch Z travel, its table size maxed out at 72 inches by 136 inches. While the

table size was generous, it was not enough to handle the very large and complex molds that Model Die was asked to quote.

"The Parpas 30 has a Z travel of 47.25 inches and a table size of 118 inches by 102 inches," Neibarger says. "The other CNC mill serves us well, but having that extra few inches on the Z travel can make a difference in whether we are able to set up and machine a large, detailed workpiece." For example, she says the company recently used the Diamond 30 to machine what she believes is its largest mold-half to date, measuring 85 inches by 110 inches by 27 inches thick. Thomas Hagey, operations manager and sales professional at Parpas America, explains that the Diamond 30's ability to machine large molds with very deep cavities can be attributed to its orthogonally-designed Model TOE-29 head. "The head's A-axis indexes every 0.001º, and both the A and C axes can be used as machining axes," he says. "Additionally, the TOE-29 has been designed to drastically reduce the length of tools when machining in deep cavities. In other words, the end of the TOE-29's head has been designed with a longer snout compared to the same feature from many other manufacturers, thereby allowing for the use of much shorter tools."

> We basically doubled our capacity for tools that are 24 inches and thicker with a lot of contouring.

"Getting this machine enabled us to land new business that we would not have had otherwise because of the timing the customers needed it in, and our lack of capacity to take such large molds," Monica Neibarger says. "We basically doubled our capacity for tools that are 24 inches and thicker with a lot of contouring, and we have greatly reduced the need to outsource work to other shops."

Greater Reach, Stability Reduces EDM

Neibarger says that Model Die customers have been approaching them with an abundance of deep, contoured cavity work that required a lot of engraving along those contours. For this type of work, it was challenging to find an EDM machine large enough to allow use of the special setups required for reaching the deep areas of the cavities. For example, after machining, tight areas (and especially angled surfaces) would be left steel-safe, and then the company would have to build special beams from which the electrodes

This image shows how the Parpas Diamond 30 features a generous table size for machining very large cavities and cores. With its orthogonally designed Model TOE-29 head that features a longer snout, it can reach into difficult-to-machine areas using shorter cutting tools. For Model Die and Mold, these capabilities have been a game changer by helping win new work and enabling more work done in-house.

could hang while they burned engravings and other details onto the workpieces. The process was very time-intensive and expensive. "Our EDM tanks are large enough, but it requires special, multiple setups to get into those tight areas," she says. It gave the company one more reason to invest in the Diamond 30. "It has a linear drive for better stability, so we have no trouble meeting customers' specified tolerances," she says. "The workpiece is stationary on the platen, and the cutting tool hangs down from the gantry so that it can move in X, Y and Z directions. The small, five-axis machining head rotates and tilts to get into corners and other tight spaces that otherwise would require EDM work."

Hagey says that the X, Y, and Z axes are all run on linear guide-ways using linear motors. "These motors offer notable acceleration, reliability and consistency while machining. The A and C axes utilize direct torque-driven motors for increased machining power and accuracy," he says. "These axes, including the X, Y, Z, A and C, are all measured using Heidenhain optical scales, making it possible to achieve a resolution of 0.001 millimeters (X, Y, Z) and 0.001° (A, C), respectively." The Diamond 30 also features a third guiderail, which, together with Parpas's patented Thermostatic System, improves the stability of the machine's ram, especially when it is fully extended. He adds that because the TOE-29 head makes it possible to use shorter tools, additional advantages come into play. Advantages include less vibration between the tool and the milling piece, better machined surface quality, higher machining feed rates and reduced wear overall on the tools that are used.

Neibarger attests to those benefits. She says, "Now we are able to machine all required details onto the workpieces using the Diamond 30, with almost no EDM required. We added Delcam's FeatureCAM software, which gives us the ability to loop programs together and not worry about a collision, particularly when we run lights out." She says that the company's goal is to be able to accomplish CNC finish machining on the mold's B side, and reduced polishing on the A side using lights out operation and reduced EDM. "With our larger molds, there might be 1,900 hours of machining required and only 16 weeks or fewer to build a job, so we have to be able to run 24/7 confidently. We still do some outsourcing, but not nearly as much," she says.

Neibarger shared a recent project that illustrates several of the advantages that the Parpas Diamond 30 brings to Model Die's operations. "We recently built two large, deep tools that were mirror images. The cavity size was 30 inches deep by 52 inches by 80 inches. We machined everything on the Diamond 30," she says. "Five years ago, we built two nearly identical molds with the same cavity size on equipment that was more than 10 years old." When Model Die compared the actual production data between the two projects, they discovered that:

- CNC machine hours decreased by five percent because of the Parpas's ability to reach and machine ribs and tighter areas with its smaller head and shorter tools.
- EDM hours decreased by 70 percent.
- Lights-out CNC machine hours increased by 10 percent, largely because the Diamond 30 has an automatic tool changer, which spared someone from having to stop in to change out tools.
- Polishing decreased by 27 percent.
- The Diamond 30 achieves a finer finish.

"Our overall mold-building time has been reduced by two weeks because of the Diamond 30," she says. "It's really been a game changer." MMT

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Updating **Buy/Sell Agreements**

By Tiffany L. Kuntemeier, CPA, CSEP &
Michael J. Devereux II, CPA, CMP

As owners contemplate exiting their businesses, they need to look at their specific circumstances and understand that there is no standard exit-platform that fits every business. Owners need to consider their plans for the company, the direction that the industry is headed and consider unpredictable events. As these facts change with time, the operating agreements must adopt the changes as well. Having the right documentation in place ensures that a company has a strategic start to a succession plan.

The first step is to review the current operating agreement to make sure it outlines a buy/sell agreement. Business owners young and old should consider how to exit the company (voluntarily or involuntarily). In addition to retirement, these agreements should protect every owner from the potential death, divorce or incapacity of the other owners.

Consider that two best friends start a mold shop. They put in their sweat-equity and now the company is making nice profits. The ownership agreement states that each friend owns 50 percent of the company. Then an unforeseen event occurs leaving one business partner incapacitated. According to his estate plan, all of his assets turn over to his life estate, in which his wife is the trustee and management decision maker. In the blink of an eye, one of the 50-percent owners is now his wife, who has no previous experience in tooling or operations management. She may not have interest in being an owner, but unfortunately her spouse did not have adequate life insurance. Now she is looking to the company to be able to sustain her family's lifestyle. Suddenly, legal is taking up most of the company resources, which could continue for a few years because the agreement did not include what to do next. If the operating agreement of a company does not have a buy/sell agreement in place, this path is a real possibility. Implementing or updating a buy/sell agreement through a company's operating agreement is one of the most important pieces of a succession plan.

Buy/sell agreements serve multiple purposes in one document, including identifying the person or people who can buy interest in the company, how to determine the transfer price of the ownership interest, how to structure the terms for the buyout and tax implications of the chosen structure. Here are some objectives to consider when creating or updating a buy/sell agreement.

Protecting remaining owners from being in business with an unqualified person. Once a specified incident occurs, other owners are typically given certain rights on purchasing the new owner's interest. These rights help keep the departing owner's spouse, children or appointed person of an estate from taking over the ownership. Often, decedents may take over a majority interest, so outlining who can buy the interest enables the remaining owners to determine the company's best future ownership structure.

Making sure the purchase price criteria are outlined. A methodology for owners to determine the purchase price of a departing owner is something the owners should outline in the operating agreement. This governs the steps for determining the value. Formulas can facilitate obtaining fair value appraisals and can facilitate taking specific discounts and multiples into account, based on the industry. Some may be based on historical financial results, while others on the fair market value. It is good practice for the owners to review the formula every few years.

Ensuring that the purchase agreement is not going to strap the company or other owners for cash, while still providing for the financial needs of the departing owners or their heirs. A lump-sum buyout is not always feasible, so consideration of the buyout structure must be given to both the buyer and the seller. This prevents the company from sacrificing the cash that it needs to sustain operations. If the departing owner leaves behind a family that needs support, the terms should afford the heirs the means necessary to maintain their standard of living. Payouts over a term of years is typical, but each agreement should consider company cash flows for payments, and perhaps reserve the rights to skip principal payments during low cash-flow periods.

Reviewing the tax implications of the company structure along with the business structure. When it comes to buying and selling assets and investments, there is always the underlying question of what the "net tax" will be for the cash received. Owners must consider the company structure and the payout terms. For example, if the company is a C-corporation and converts to an S-corporation, the company might still be subject to corporate tax implications. Also, depending on the structure of the buy/sell agreement, the IRS might view it as a taxable redemption, which results in taxable dividends. It might also be considered a stock sell, triggering gains in the company and then again on the stock held. Reviewing the possible implications to both parties and any modifications is vital.

Taking the right steps before the need for an exit plan arises will significantly improve the process, lessening the emotional aspect of what an owner must pay or what an owner will receive. It also will help owners avoid lawsuits, so business operations can continue without concern for any resulting financial impact. MMT

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Tiffany L. Kuntemeier is a certified specialist in estate planning and a senior manager with Mueller Prost. Michael Devereux is a partner and the director of manufacturing, distribution and plastics industry services at Mueller Prost.

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Mold Material Matters

MoldMaking Technology's Leadtime Leader Award celebrates its 15th anniversary in 2018, so the magazine is asking past winners to share their perspective on a variety of industry issues, challenges and solutions. This month the magazine is examining mold material selection and innovation.

Understanding that mold material selection is application specific, what do you consider the most essential criteria?

Rich Martin, business development manager, JMMS: The most essential is strength (or durability), based on warranty (or shot life) and customer specifications.
Mike Zacharias, president, Extreme: When it comes to mold life, I consider machinability the lowest priority, which probably sounds odd from someone who builds molds. I look at thermal properties, durability and corrosion resistance first.
Ryan Katen, general manager, Micro Mold Co.: Strength would be the most important in regard to wear resistance and longevity.
Ed Ergun, corporate sales manager, Concours Mold Inc.: The most essential is thermal conductivity, as we use different material when we find areas that are hard to cool.
Toby Bral, sales manager, MSI Mold Builders: With strength as a given because the material must fit the application and annual volumes, machinability is the most important factor for most of the molds we build.

What is the most important innovation in steels and alloys for moldmaking?

Martin: Advances in machine tools and cutter technologies for all mold materials are key innovations, as proficiency in machining and EDM processes across all tool steels is essential for every moldmaker.
Zacharias: I believe that the development of additive materials and performance alloys have been the biggest developments. The old standbys have been "tweaked" occasionally, but not much has occurred in the way of a significant development.
Katen: Improved properties through powder metallurgy technology is an important innovation.
Ergun: Steel manufacturers have done an excellent job of creating a library of steels for every application, which has enabled us always to find a way to make our molds work.
Bral: Steel and aluminum grades that do not require stress relief have been the most important innovations. We make very large molds with blocks that require the removal of a lot of material, and we rarely stress-relieve the blocks. This helps us remain competitive from a lead-time perspective.

Do you use copper mold alloys? Why or why not?

Martin: Yes, we use them for thermal conductivity. JMMS has been doing hybrid tooling for more than 15 years.
Zacharias: Yes, we use them frequently and always for cycle-time benefit.
Katen: We use them infrequently, and only in selected applications for improved thermal conductivity.
Ergun: We do use copper for certain applications, but the applications are minimal for moldmaking.
Bral: We use copper mold alloys regularly when a customer agrees upfront, as they are considerably more expensive than other materials. They are very good at getting the heat out of an area and still stand up to more shots than aluminum. For the types of molds that we build, we restrict the use of copper mold alloys to areas of concern. We do not use copper mold alloys for very large areas or entire cavity or core halves, which is very cost prohibitive.

Many engineered materials manufacturers are looking to develop mold materials based on the needs and wants that customers voice, so what would you like to see in a new mold material?

Martin: The silver bullet could be durability of H13 tool steel with the thermal conductivity of Moldmax.
Zacharias: Performance alloys (high thermal conductivity) with the strength and durability of steel and that are more easily machined like steel would be the next frontier in mold material development.
Katen: I would like to see improved hard-milling capabilities with tool steels in the 58–62 Rockwell hardness range.
Ergun: We love the benefits of one material but often cannot live with the negatives. For example, if we get thermal, we lose strength. If we get strength, we lose flexibility. If it is flexible, we lose surface finish, etc. So, a one-stop-shop mold material for all applications that machines at speed and is durable, thermal and cost-effective would be ideal.
Bral: If you ask our customers, they would want something as strong as steel, as thermally conductive as aluminum but far less expensive than a copper alloy. That is probably not a reasonable expectation, so the decision will still come down to what meets the needs of the mold. Given materials that meet the performance requirement, we would want it to be very machinable, dimensionally stable and reasonably priced. MMT

Visit the Leadtime Leader Zone for information on past winners:
short.moldmakingtechnology.com/leader

Structured, In-House Training **Fosters Future Leaders**

By Cynthia Kustush

R&D/Leverage in Lee's Summit, Missouri, has successfully trained eight apprentices since starting its formal, four-year program in 2011 and has seven active apprentices today. The company specializes in all aspects of moldmaking. The group focuses on injection stretch blow molds (ISBM), injection blow molds (IBM) and injection molds for customers in the home and personal care, food and beverage and healthcare and medical industries. It has 252 employees working within seven buildings that offer 260,000 square feet of manufacturing floor space spread out over its 12-acre campus.

Chris Lavery, vice president of manufacturing, says R&D/Leverage seeks apprentice candidates who possess specific qualities. "Since we already know the candidates have no experience, we look for other qualities during the interview process. We look for a positive attitude, good character traits, hobbies such as wood working or auto mechanics, references from any training programs, teachers, neighbors, coaches and R&D employees etc. and a good score on a mechanical aptitude test. We know that if a candidate presents well with these qualifications, we can teach him or her the skills and knowledge he or she will need to be successful," Lavery says.

> We set expectations, tell them to do their best and that we're here to support them. They are taking the first step of a tremendous journey that will give them a rewarding career and enable them to support a family, which is very important.

The machinist apprenticeship program at R&D, which Lavery oversees with the assistance of shop foreman Jim Martin, team leaders and senior-level machinist mentors, is a structured, four-year (or 8,320-hour) training program that covers all aspects of the machinist trade. The company designed the training program around the moldmaking and tool making trades to support the company and the industry, he says. On-the-job training at R&D requires one machinist apprentice to work with one senior-level machinist while on the shop floor to ensure that the apprentice completes the work safely and as required. Additionally, the program requires each apprentice to purchase and maintain the basic set of tools, including calipers, micrometers, a calculator, Allen wrenches in English and metric sizes, depth micrometers and a six-inch scale.

Image courtesy of R&D/Leverage.

At R&D/Leverage, senior-level machinist mentors like Lonnie Wise (right) provide structured skills training on the shop floor. They also teach the right set of work ethics that will help apprentices succeed in the moldmaking industry. Wise also imparts critical "tribal knowledge" that fosters a deeper understanding of the processes and machinery used in moldmaking. Here, first-year apprentice Isaac Denney, 19, shows examples of lessons learned, long-hand, in his notebook, which he always has with him.

To ensure that apprentices become well-versed in the theory and practice of skilled machining, the R&D/Leverage apprenticeship program schedule requires approximately six months training in each of the following areas: CNC mills, CNC lathe, wire EDM, hard milling, ID/OD grinding and hard turning. During each of these steps apprentices learn about safety, preventive maintenance, inspection techniques, set-up and operation of the various machines. Apprentices then spend 12 months learning skills directly applied to moldmaking. They spend about three months

on each relevant area including engine lathe, manual milling, surface grinding and bench work. Mentors like Lonnie Wise, who is a senior toolmaker, work closely with apprentices through these steps. "With the apprentices, it's very important to set expectations. You don't know what kind of home life they have had or who has been mentoring them or whether anyone has even talked to them about the keys to success," Wise says. "We set expectations, tell them to do their best and that we're here to support them. They are taking the first step of a tremendous journey that will give them a rewarding career and enable them to support a family, which is very important." Lavery also says that there are no shortcuts for trainees where Wise is concerned. "He's not just training them on how to set up and run a Bridgeport or a surface grinder, or how to do the math long-hand, though he will sit them down with a piece of paper and teach them old-school ways. He's also teaching them important work ethics, which we've missed a lot of with this next generation—and that's a fact. When he tells you to be here at 7 a.m., you better be here at 7 a.m. If he wants you to stay late to finish a job, you will do it."

Apprentices also spend time in the company's stretch-blow lab, where they learn about tool setup and installation, molding machine operation, PET materials and processing, bottle inspection techniques and more. The program keeps detailed records of every element that apprentices learn,

With the apprentices, it's very important to set expectations.

and the program evaluates apprentices in 90-day intervals to determine if they are ready to advance to the next training segment. Upon completion, apprentices receive an R&D Certificate of Completion for the machinist apprenticeship program.

The company is active in many programs and organizations like the National Tooling and Machining Association (NTMA). Lavery says, "We are a member of the NTMA, and we use all their training programs to help structure our internal programs as well as for recruiting interns and full-time employees." Other organizations with which R&D participates include the American Mold Builders Association (AMBA), Kansas City Manufacturing Network (KCMN), Metropolitan Community College of Greater Kansas City (MCCKC), Kansas City Kansas Community College (KCKCC), local high school robotics programs, college programs like the Missouri Innovation Campus and the company's grassroots efforts with Support Plastics USA. "We participate in local job fairs as well as offer campus tours to high schools and colleges. I only see this getting better with time," Lavery says. "As more attention to the skills gap grows through social media, supporting organizations and in continual articles in publications like *MoldMaking Technology*, the word is getting out about how great this trade can be for a career path." MMT

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Index Shows Continued Growth in 2017

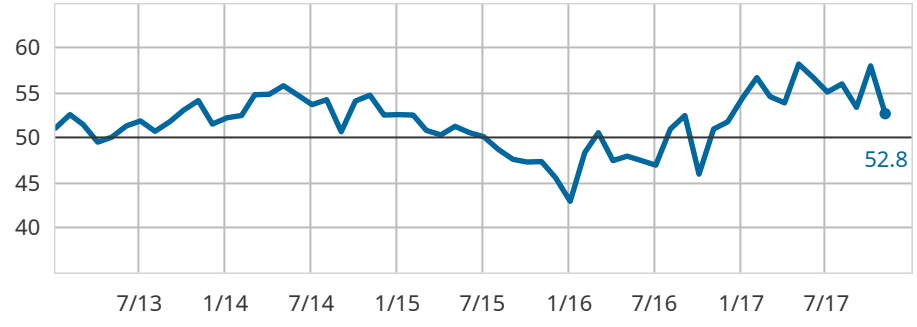
Employment and Production Lift Index, at 52.8 for November

Registering 52.8 for November, the Gardner Business Index (GBI): Moldmaking expanded at its slowest pace of any month in 2017. In spite of this, the 2017 year-to-date average for the Moldmaking Index of 55.5 suggests that 2017 is on pace to be one of the fastest growing calendar years since the inception of the Moldmaking Index. For the sake of reference, 2014 was an excellent year, and it experienced an average reading of 53.9. For the year-to-date period, the Moldmaking Index has increased by 1.7 percent. Gardner Intelligence's review of the underlying data for the month indicates that employment, production and supplier deliveries lifted the Moldmaking Index higher while new orders, backlog and exports pulled the Moldmaking Index lower. The employment reading was the only component to increase during November. For the month, backlog contracted for the first time this year, and exports contracted at its fastest pace in the calendar year. Measuring only custom processors, the Moldmaking Index also fell in November. Examining custom processors only, the Moldmaking Index is up 7.0 percent in the year-to-date period, bolstered by supplier deliveries and held back by backlog and exports. MMT

ABOUT THE AUTHOR

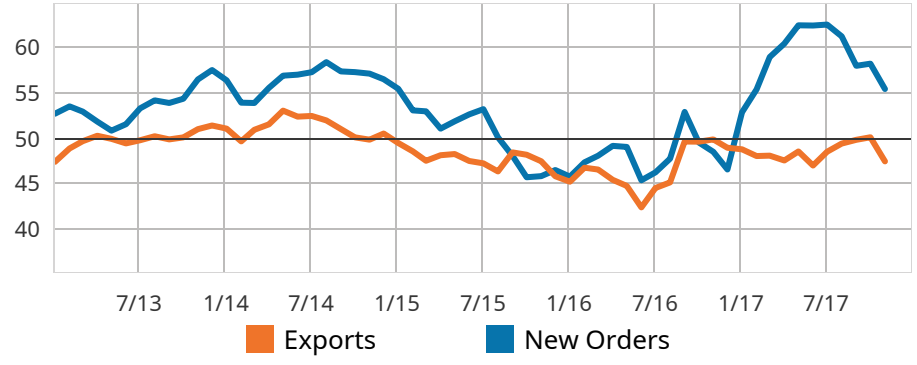
Michael Guckes is the chief economist for Gardner Intelligence, a division of Gardner Business Media (Cincinnati, Ohio, United States). He has performed economic analysis, modeling and forecasting work for nearly 20 years among a range of industries. He is available at mguckes@gardnerweb.com.

Moldmaking Index



November saw the slowest growth of the Moldmaking Index of any month in the calendar year. Still, the year-to-date period shows that the Moldmaking Index has an average reading of 55.5, which puts it on-track to have its best year since the Moldmaking Index began.

New Orders and Exports (3-Month Moving Averages)



November's export reading indicated significant contraction in November. Volatile exports readings the third and fourth quarters of the year have seen exports swing between mild expansion and moderate contraction. November's contraction in exports, in part, may have slowed the growth in overall new orders.

By Michael Guckes

AUTOMOTIVE

Gardner Intelligence diligently works to provide *MoldMaking Technology*'s readers with information that connects economic data to the current and expected business conditions of its readers. To accomplish this goal, Gardner Intelligence collects both economic and equities data from Wall Street firms. By monitoring and reporting data from both domains, Gardner Intelligence creates a more comprehensive view of what is and what will happen in the specific manufacturing spaces covered by Gardner Business Media.

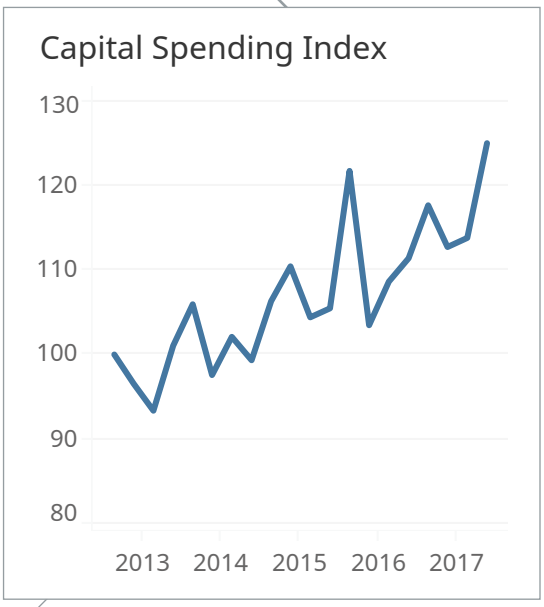
In recent months, we have called attention to declining car and flattening truck sales, among other high-level metrics. Yet, this broad-brush picture misses critical dynamics of the industry, such as how the introduction and mass-placement of new technologies and new drivetrains are creating significant demand for equipment in the automotive industry.

For this reason, Gardner Intelligence recently examined the financial statements of 14 major automotive original equipment manufacturers (OEMs) to discern possible industry trends in capital expenditures, new property plant and equipment and working capital. Gardner Intelligence selected these 14 OEMs because of the richness of the quarterly data they provided during these years in their Security and Exchange filings and then indexed this data to build a representative model of the industry.

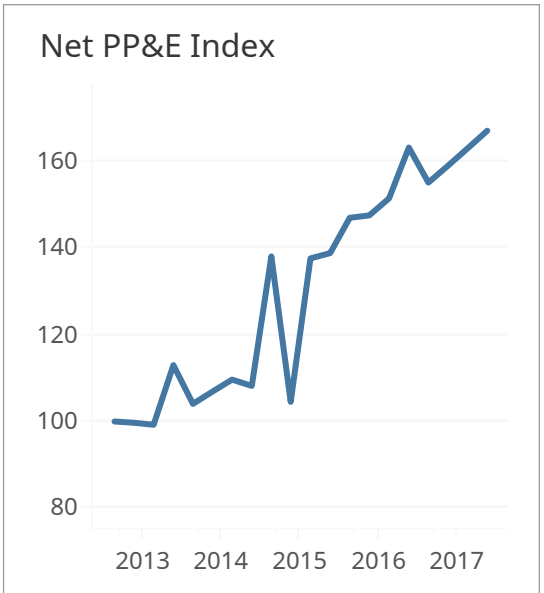
Gardner Intelligence found that between the fourth quarter of 2012 and the third quarter of 2017, Capital Expenditure grew at a nominal annualized rate of 4.7 percent. Unadjusted for inflation, the industry—as represented by our data—is spending 25 percent more on capital expenses than it did at the end of 2012. Additionally, Net Property Plant and Equipment data (Net PP&E) has grown even faster during this time with annualized growth of 17 percent. Net Property Plant and Equipment data includes a broader range of purchases including equipment and the depreciation of old equipment. The result is that Net Property Plant and Equipment today is nearly 70 percent higher than it was in 2012.

Working capital between 2012 and 2015 was relatively stable. In 2016, it fell by over 20 percent from its level at the end of 2012. At present, the 14 firms for which Gardner Intelligence has data are holding 73 percent of the working capital that they had at the end of 2012. Although working capital has diminished during these years, we see that major OEMs are spending more on R&D as a percentage of revenue than they did in the past. According to YCharts, for example, Honda and Daimler spent over 5 percent and 3.7 of their revenues, respectively, on R&D in the third quarter of 2017. This is significantly more than two years ago, when Honda spent 4.25 percent, and Daimler spent 3.25 percent of revenue on R&D in the third quarter of 2015.

While increasing sales in recent years has certainly bolstered some of these figures, it is important to realize that the new technologies coming to market in the next few years will require investments that will create sustained demand and industry growth for advanced automation, machinery, tooling, composites and plastics. All OEMs understand that the significant changes that their industries are facing and will continue to undergo in the next few years will result in significant purchases of more technically capable and complex equipment. MMT



Capital spending has increased 4.7 percent since the end of 2012.



Net PP&E is nearly 70 percent higher today than it was in 2012.

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EDM

Machine Control Simplifies Production on EDM

The new M800 EDM control is now included in **Mitsubishi Electric Automation** wire EDM machines to increase productivity and help keep track of production jobs. The M800 series control uses rotational and tilting functionality, while providing job monitoring and important information in a single view. The 19-inch touchscreen enables the user to swipe, pinch and tap to view, which the company says makes the interface easier to interact with over previous models.

Additionally, the M800 control enables the user to analyze machine profitability and see reserves to optimize processes and boost efficiency. Diagrams are available to depict operating costs and output, and a touch retrieves all operating material statuses and maintenance cycles. Currently, the MV1200-S, MV1200-R, MV2400-S and MV2400-R Advance wire EDM machines feature the M800 control. **MC Machinery Systems, Inc.**, a Mitsubishi subsidiary, is working on incorporating this technology in its laser machines as well.

MC Machinery Systems Inc. / 630-616-5920 / mcmachinery.com
Mitsubishi Electric Automation / 847-478-2500 / us.mitsubishielectric.com/fa/en

EDM Machine Has High-Column Design for Work on Large Molds

Sodick, Inc. has unveiled a new high-column model wire EDM machine, the VL600QH. The VL600QH is Sodick's latest addition to their VL range of versatile wire EDM machines. With a 500-mm Z-axis stroke, the new high-column model is designed to accommodate a wider variety of large workpieces. The unit is therefore suitable for large molds and for automotive and aerospace applications. Like other models in the VL series, the VL600QH offers an improvement to the Sodick SuperJet Automatic Wire Threader (AWT) "Pop-Up" search function. The upgraded AWT is suitable for unattended machining and improves the success of multi-hole threading and the threading of curved surfaces. The VL600QH also offers three-pass fine finish technology that has improved since the variation available on VZ series machines.

Sodick Inc. / 847-310-9000 / sodick.com

EDM Unit Has Power Optimizer to Reduce Machining Time

Makino introduces a new EDM machine in its Edge-Series, the Edge2, to the U.S. manufacturing market. The machine was built for general precision machining applications. It provides accurate and reliable performance for standard die and mold components or contract manufacturing with a space-saving design.

The Edge2 is configured with a variety of productive, adaptive EDM technologies to efficiently handle many tasks while reducing machining time. SuperSpark4 dynamically optimizes the power discharge levels and jump cycles to reduce machining time up to 50 percent. Intelligent Expert System (IES) has advanced adaptive power to automatically stabilize EDM processes and enhance accuracy. MGH6 Control features a 15-inch touch-screen control system and simplified programming using the Makino Program Generator (MPG) function.

The Edge-Series sinker EDM machines feature an integral rise-and-fall work tank designed with unobstructed access to the work zone for setups, which Makino says greatly improves visibility to monitor the machining processes. The machine includes an eight-station automatic tool-changer (ATC) to extend unattended operation, and fully supported robotic automation for greater unattended operations. The machines are equipped with critical safety features, such as flame sensor and fire extinguisher systems, that are integrated and monitored by the machine control.

Makino / 248-232-6200 / makino.com

Compact EDM Has Varied Features for Accuracy and Ease of Use

GF Machining Solutions's new compact Form E 350 machine is a suitable die sinking EDM solution for small shops. The Form E 350 has sturdy C-axis construction, a cross table and a cast-iron frame for stability and force reduction, which helps maintain a precise spark gap between the part and the electrode. GF Machining Solutions says that regardless of part weight or dielectric volume, the machine delivers consistent accuracy. Integrated glass scales preserve long-term repeatability and eliminate the need for recalibration. The Form E 350 also eliminates errors from backlash and wear.

The machine features a programmable dielectric management system with a 270-liter capacity integrated inside the machine cabinet. This system fills and empties the work tank without human intervention to keep the machine in production. The Form E 350 also comes with the Intelligent Speed Power Generator (ISPG) to provide quality surface finishes and precision applications in any conductive material. The generator improves machining speeds by 40 percent and reduces corner wear by 50 percent.

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

ADVERTISERS' INDEX

MACHINING

Intelligent Monitoring with **MTConnect**

Image courtesy of Mazak.

MTConnect enables today's manufacturers to collect data from digitally connected manufacturing equipment for process optimization.

By Neil Desrosiers

In the past, responding to alerts, watching dashboards and manually analyzing data sets were the standard way to monitor machines in the manufacturing industry. But today's hyper-dynamic, highly distributed application environments have become too complicated to keep pace with the increasing amounts of vital data. The sheer volume of information is simply more than shops can manage using traditional tools. Manufacturers who want to stay competitive need not only to embrace digital connectivity, but also the Industrial Internet of Things (IIoT) to truly understand their data and use it effectively.

A standard digital connectivity platform that some of the world's leading manufacturers use is MTConnect, which enables users to collect data in structured XML rather than in proprietary formats to open up a world of new industry applications. Analysis that used to take experts hours or days to harvest can now be realized in seconds. While MTConnect can significantly help boost manufacturing efficiency and productivity, issues can arise (as is the case with any computer-based system). Fortunately, these issues are generally easy to recognize and resolve.

Here are seven of the most common issues with implementing the MTConnect standard:

1. Mismatch between the adapter and the machine. Each machine requires a specific adapter. Even different models of the same machine require specific adapters that may be different from one another, so be sure to provide the machine tool's original equipment manufacturer with your machine model and software version when acquiring an adapter to ensure you receive the correct one.

2. A missing agent. If a machine does not have an agent, a manufacturer will need to run a PC-to-host stand-alone agent on the network to communicate with the control via a transmission control protocol (TCP).

3. Wrong error log setting. When installing MTConnect agent or adapter software, it is important to set the error-logging level in the configuration file to "information only" or "fatal" rather than "debug." The debug setting is used to test the agent and adapter and continually provides comprehensive operating information during installation.

4. Firewall interference. The firewall feature of Windows may disrupt communication between the machine and software. Manufacturers can resolve this issue by configuring specific firewall exceptions for the 7878 and 5000 ports used in MTConnect.

5. Duplicate port configuration. By default, MTConnect software communicates with the agent through Port 5000. However, when multiple stand-alone agents are located on a server, every agent has to be configured with a unique port number so that the software will correctly gather data from each agent and machine.

6. Inconsistent file names. The names of device files must match those in the configuration file.

7. Incorrect adapter IP addresses. Incorrect or out-of-order numbers in the IP address that a manufacturer's application uses to communicate with the adapter will produce errors. If the address is correct but is for the wrong adapter, machine data will be transmitted for a machine, but not for the one that the manufacturer intended. MMT

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Regardless of your molding application, Mold-Masters engineers a range of hot runner solutions focused on solving industry challenges that are proven to deliver precision, control, reliability and results. See how the Master-Series hot runner can solve your next molding challenge.

Collaborate with us on your next system.

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