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Nylon 66 Conundrum

Suppliers, Processors Weigh Options in the Face of Tight Supply

14 Report from Fakuma 2018 Show

22 Automation Made Simple at This Automotive Molder

38 How Two Medical Molders Moved to Industry 4.0

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CONTENTS

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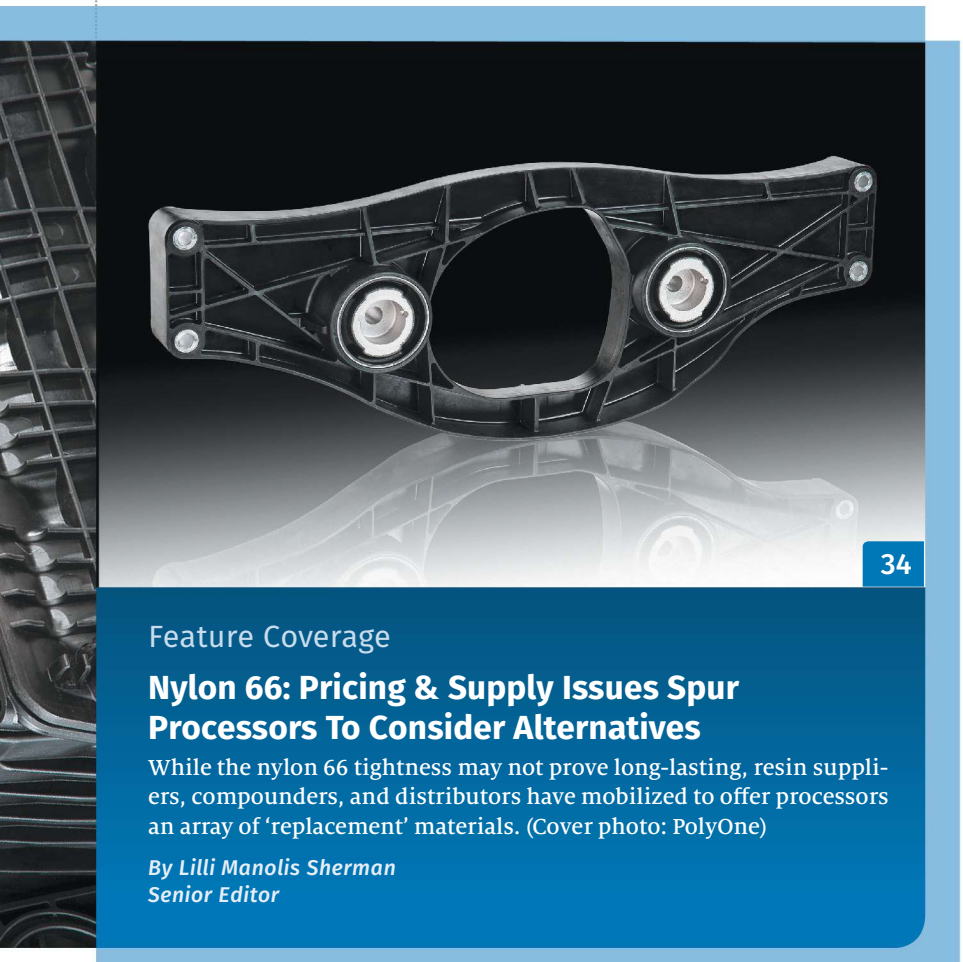

34

Feature Coverage

Nylon 66: Pricing & Supply Issues Spur Processors To Consider Alternatives

While the nylon 66 tightness may not prove long-lasting, resin suppliers, compounders, and distributors have mobilized to offer processors an array of 'replacement' materials. (Cover photo: PolyOne)

By Lilli Manolis Sherman
Senior Editor

On-Site 38

Digital Manufacturing: Two Medical Molders Embrace Industry 4.0

'Digitalization' and 'connectivity' are loaded terms—shorthand for a whole new way of doing business. It can't be accomplished in one go. But two Midwest molders in the sensitive medical field are already feeling the benefits of their initial steps in that direction.

By Matthew H. Naitove
Executive Editor

6 FROM THE EDITOR

8 STARTING UP

CLOSE-UP ON TECHNOLOGY

14 Fakuma
18 Extrusion
22 Robots

KNOW HOW

26 Materials
28 Injection Molding
30 Extrusion
32 Tooling

KEEPING UP WITH TECHNOLOGY

43 Extrusion
44 Injection Molding
44 Blow Molding
45 Process Cooling
45 Additives
45 Materials
46 Compounding

YOUR BUSINESS

47 Resin-Pricing Analysis
49 Gardner Business Index: Plastics Processing
50 Market Watch
51 Marketplace
56 Processor's Edge

There's more on the web at *PTonline.com*

Ube Opens Facility Expansion (and Sake Barrels)

Plastics Technology was on hand in late October in Ann Arbor, Mich., when injection molding machine manufacturer Ube Machinery Inc. officially opened the new fourth bay of its factory. The expansion will allow it to double capacity for machine assembly and rebuilds. To mark the occasion, Ube invited local dignitaries to participate in a traditional Kagami Biraki ceremony, replete with mallets and sake barrels. Kampai!
youtu.be/uihhxg3OTLU

BLOG Early Scoops from Fakuma

Plastics Technology Executive Editor Matt Naitove posted two early reports on the Fakuma plastics fair (Friedrichshafen, Germany; Oct. 16-20). Trexel highlighted a non-destructive method to test the internal structure of molded parts, while Milacron showed the first integration of the iMFLUX low-pressure molding technology into its machine controller. (For more news from Fakuma see Naitove's report on p. 14.)
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SLIDESHOW Speaker Highlights from Extrusion 2018

Plastics Technology's annual Extrusion conference organized its largest and most successful edition to date in Cleveland in September. Nearly 600 participants chose from more than 70 presentations to deepen their extrusion expertise. This slideshow features some speaker highlights from the two-and-a-half-day event. Shown here is *Plastics Technology* Editorial Director Jim Callari, who is the event's technical program chairman.
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PUBLISHER	Ryan Delahanty *rdelahanty@ptonline.com*
ASSOCIATE PUBLISHER EDITORIAL DIRECTOR	Jim Callari *jcallari@ptonline.com*
EXECUTIVE EDITOR	Matthew Naitove *mnaitove@ptonline.com*
SENIOR EDITORS	Lilli Manolis Sherman *lsherman@ptonline.com*
	Tony Deligio *tdeligio@ptonline.com*
	Heather Caliendo *hcaliendo@ptonline.com*
ADVERTISING SALES	Lou Guarracino *loug@ptonline.com*
	Jackie Dalzell *jdalzell@ptonline.com*
	Dale Jackman *djackman@gardnerweb.com*
	Michael Schwartz *mschwartz@gardnerweb.com*
ART DIRECTOR	Sheri Kuchta Briggs *sbriggs@gardnerweb.com*
MARKETING MANAGER	Chris Saulnier *csaulnier@gardnerweb.com*
AD PRODUCTION MANAGER	Becky Taggert *btaggert@gardnerweb.com*

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

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HEADQUARTERS	*NEW YORK OFFICES*
6915 Valley Avenue	1441 Broadway, Room 3037
Cincinnati OH 45244-3029	New York, NY 10018
Phone 513-527-8800	Phone 646-827-4848
Fax 513-527-8801	Fax 513-527-8801
gardnerweb.com	*ptonline.com*

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New Study Refutes Negative Environmental Impact of Plastics Packaging

Packaging has been the favorite whipping boy of environmentalists. But a new report shows that replacing plastic with other materials would have widespread adverse environmental effects.

Jim Callari
Editorial Director

Packaging has been targeted more than any other segment of the plastics industry. Not surprisingly, since it's omnipresent. I've been around long enough to remember where it all started: in the late 1980s with the hamburger clamshell (which ironically, to my recollection, was replaced by an extrusion-coated wrap). Since then, environmentalists have set their sights on foamed PS, bags, PET bottles (the latest claim is that bits of PET from bottles are getting into the food supply) and lately, straws.

With that in mind, processors and their brand owners might want to check a new study released last month by the Plastics Division of the American Chemistry Council (ACC). Prepared by Franklin Associates and titled *Life Cycle Impacts of Plastic Packaging Compared to Substitutes in the United States and Canada: Theoretical Substitution Analysis*, the 172-pg study concluded that replacing plastic with alternative materials in packaging applications would cause increases in energy use, water consumption and solid waste, as well as increase greenhouse gas emissions (GHG), acidification, eutrophication and ozone depletion. The report focused on six packaging categories: caps and closures, beverage containers, stretch and shrink film, carrier bags, other rigid packaging, and other flexible packaging

> ***"The findings challenge common misperceptions around plastics and underscore that plastic is a versatile, efficient material that is helping to solve some of our greatest environmental challenges."***

"This report builds upon established data on the energy and GHG benefits of plastics, compared to alternatives," said Steve Russell, vice president of plastics for ACC. "It expands our understanding of critical environmental benefits beyond energy and highlights key environmental indicators like water use and waste generation."

The study expands upon a 2014 report that used life-cycle assessment methodology to assess the energy consumption and GHG emissions potential of the same six categories of plastic packaging produced and sold in the U.S. and Canada relative to alternative packaging.

Looking at the U.S. data alone, when compared with alternatives, production, use and disposal of plastic packaging across the six areas studied saves per year:

- Enough energy to fuel 18 million passenger vehicles;
- Enough water to fill 461,000 Olympic swimming pools;
- Waste equivalent to the weight of 290,000 Boeing 747s;
- The acidification potential of 292,000 railcars of coal.

"The findings challenge common misperceptions around plastics and underscore that plastic is a versatile, efficient material that is helping to solve some of our greatest environmental challenges. However, we can't realize its full benefits if we don't work toward better end-of-life solutions," said Russell. ACC and North American resin producers established a goal that 100% of plastic packaging will be reused, recycled or recovered by 2040. Meeting this goal and eliminating plastic waste in our ocean will further improve the environmental performance of plastic packaging. "We all want a world without plastic pollution, but we wouldn't want a world without plastic."

Call me naïve, but I think the problem most environmental groups have with plastics is emotional. It's based on fear, and the perception that "Well, if it's chemicals, it's got to be bad." One way to combat fear is with facts. If you serve the packaging market, you might want to download the study and take a look. Try this short URL: ***short.ptonline.com/ACC***

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Hahn Group Acquires Cobot Technology of Rethink Robotics

Hahn Group, a German-based collection of robotics and automation companies, has added collaborative robots ("cobots") to its stable. In October, Hahn purchased all patents and trademarks of Rethink Robotics of Cambridge, Mass., along with its Intera 5 software platform for robot programming. Rethink was a pioneer in the cobot field with its Baxter and Sawyer models (Sawyer is pictured here). But Rethink shut down on Oct. 3, owing to financial difficulties. Hahn already owned a stake in Rethink and had been selling its cobots in Germany. Newly organized Hahn Plastics Automation also includes Waldorf Technik and GeKu of Germany, as well as Wemo of Sweden. Currently based in Hebron, Ky., the U.S. branch of the robotics division plans a move to New England (see September NPE report on robots for more details).

Ube Doubles Assembly & Rebuild Capacity

On Oct. 25, Ube Machinery Inc. celebrated the opening of a fourth bay at its Ann Arbor, Mich. facility. Ube said the added space and capabilities will allow it to double the annual capacity for assembling mid-to-large size injection machines, including two-platen servohydraulic, servohydraulic toggle, and all-electric models.

In 2017, Ube merged with the injection molding machine division of Mitsubishi Heavy Industries (MHI) and created a new combined business: U-MHI Platech Co., Ltd. (U-MHIPT). Ichiro Motoki, president of Ube's U.S. machinery business, noted that the first product line borne out of collaboration between Ube and U-MHIPT has launched in Japan and will soon be coming to the U.S. The MEIII plus series of all-electric machines ranges in clamp force from 720 to 950 tons, utilizing U-MHIPT's machine base integrated with Ube's press technology.

Barnes Group Acquires Robotics Firm

Private-equity firm Barnes Group Inc., Bristol, Conn., which already has a substantial plastics portfolio, has made its first acquisition in the field of robotics and automation. Barnes recently purchased Gimatic S.r.l. of Italy, which develops robotic grippers, sensors and other automation components. "This acquisition will provide us a gateway into the industrial automation market—a highly attractive market that is well aligned with our strategic growth plans," says Patrick Dempsey, president and CEO of Barnes Group.

Barnes's Molding Solutions portfolio already includes hot-runner, moldmaking, sensors and controls suppliers: Foboha, Gammaflux, Männer, Priamus, Synventive and Thermoplay.

Road Trip: Bulk-Handling Systems on Wheels

Meet TED. Short for Traveling Equipment Display, it's a mobile display that Coperion and Coperion K-Tron launched in October to bring the latest solutions for feeding, pneumatic conveying, complete systems, components and extruders right to the your doorstep anywhere in the U.S. It's free and offers

processors hands-on learning demonstrations as well as direct contact with a factory representative to answer questions and discuss specific applications. TED is also equipped with several video screens for viewing all the latest information Coperion has to offer.

Nordson Building New Hub for Flat Die Business

Nordson Corp. broke ground in November for a new world headquarters for its EDI extrusion and Premier fluid-coating product lines. The 145,000 ft² facility (with ample room for expansion) will be located near three existing Nordson sites in Chippewa Falls, Wis., including the current EDI headquarters and extrusion die manufacturing facility; a plant for Premier dies and all aftermarket service; and a technology center for R&D and lab trials. Relocation of these operations to the new facility will begin next summer and be completed by late 2020.

"The new global hub for our EDI brands will redefine the way that dies are built," says John J. Keane, executive v.p. of Nordson's Polymer Processing Systems business. "Advanced manufacturing equipment will streamline workflow and produce dies with tighter tolerances. A complete reconfiguration of our operation will integrate people and resources previously deployed in separate locations, generating collaboration and synergy that will improve the customer experience and reduce lead times."

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New Twist on 3D Blow Molding

3D suction blow molding is known for its ability to mold automotive and appliance ducting in complex shapes with minimal trim scrap. As shown here, sports equipment is another opportunity for this technology. This paddle-ball racket was molded of a mix of nylon 66 and 6 with 18% glass. The parison for the hollow handle is wrapped in a complete 360° turn. The machine used was an ASPI model from S.T. Blow Moulding in Italy, such as was exhibited at NPE2018 in Orlando (see April NPE preview).

Athena Automation Is Now Niigon

Injection machine builder Athena Automation Ltd. in Vaughan, Ont., has changed its name to Niigon Machines Ltd. "This allows us to emphasize our business objective of becoming a global leader in customized injection molding machines," says Robert Schad, chairman and founder. "Niigon is an Ojibwa word that means 'for the future.'" Niigon builds hybrid two-platen presses from 150 to 550 metric tons.

KraussMaffei Rolls Out 'Digital Service Solutions'

At the Fakuma 2018 show in Germany in October, KraussMaffei announced that two products from the company's new Digital Service Solutions business unit are now ready for general rollout. Both were first implemented for Netstal machines and now will be offered for all products of the KraussMaffei Group.

One is the e-Service platform, making service available anytime, anywhere. Features include access to machine-specific documents and a 3D spare-parts finder with order functions. It was presented in prototype at K 2016 and has been field tested since. Some 200 machines are connected at present. Access to the main features is free.

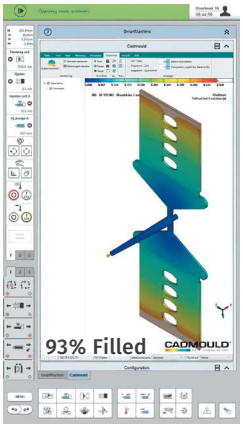
Second is the AnalytiX cloud-based production-monitoring app for recording, storing and analyzing up to 500 signals from an injection machine at a resolution of 5 millisec. These can be standard machine signals or special signals such as mold cavity pressure. A simplified dashboard (pictured) provides key performance indicators of stability and productivity for all machines at a glance. Data is available anytime, anywhere on mobile devices. KM calls this "having an injection molding machine in your pocket."

Molding Simulation Added to Injection Machine Controls

Two injection machine suppliers at October's Fakuma 2018 show in Germany showed off a new approach to making machines "smarter" at assisting in setting up the process for a new job.

Both Arburg and Wittmann Battenfeld have introduced elements of filling simulation to their newest machine controls. This involves giving the machine information about the part geometry, which it has never had before. Both firms are using Cadmould simulation software from Simcon in Germany.

Still at the prototype stage, Arburg showed integrated filling simulation in its new Gestica controller. This option is planned for introduction next year. Meanwhile, Wittmann Battenfeld has integrated filling simulation (pictured here) into its B8 machine control. It provides the setup technician with information on the filling pattern, filling pressure, location of weld lines, and potential short shots (as shown here). Right now, this feature only shows the simulated effects of machine settings; the next step will be to reduce trial and error by deriving optimized machine settings from the simulation results.

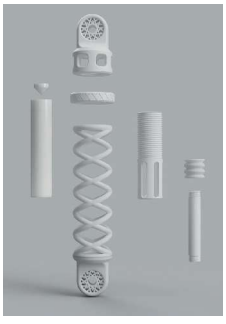


Unique 3D-Printed Shock Absorber

A complex 3D-printed demonstrator for a shock absorber was showcased at the recent Fakuma 2018 show in Germany by Covestro.

According to the company, this part marks another milestone in the move from 3D printing of individual prototypes to the integration of practical functionality and mass production. This shock absorber is unique in that the individual parts were produced from three different materials and with the aid of three different additive manufacturing processes:

The outer spring of the 40 x 7 cm (15.7 x 2.8 in.) part is made of powdered TPU using selective laser sintering (SLS). Because the adjusting screw inside the shock absorber has to be very strong and hard, it is made of filaments of Covestro's PC material, using the fused filament fabrication (FFF/FDM) process. The air chamber in the interior is created from a liquid PUR resin via the digital light processing (DLP) method. The individual components are subsequently assembled.



According to Covestro, "This complex structure would not have been possible with conventional production processes. Another new development is the combination of different materials with various tailor-made properties. This has enabled us to significantly expand the possibilities of additive production."

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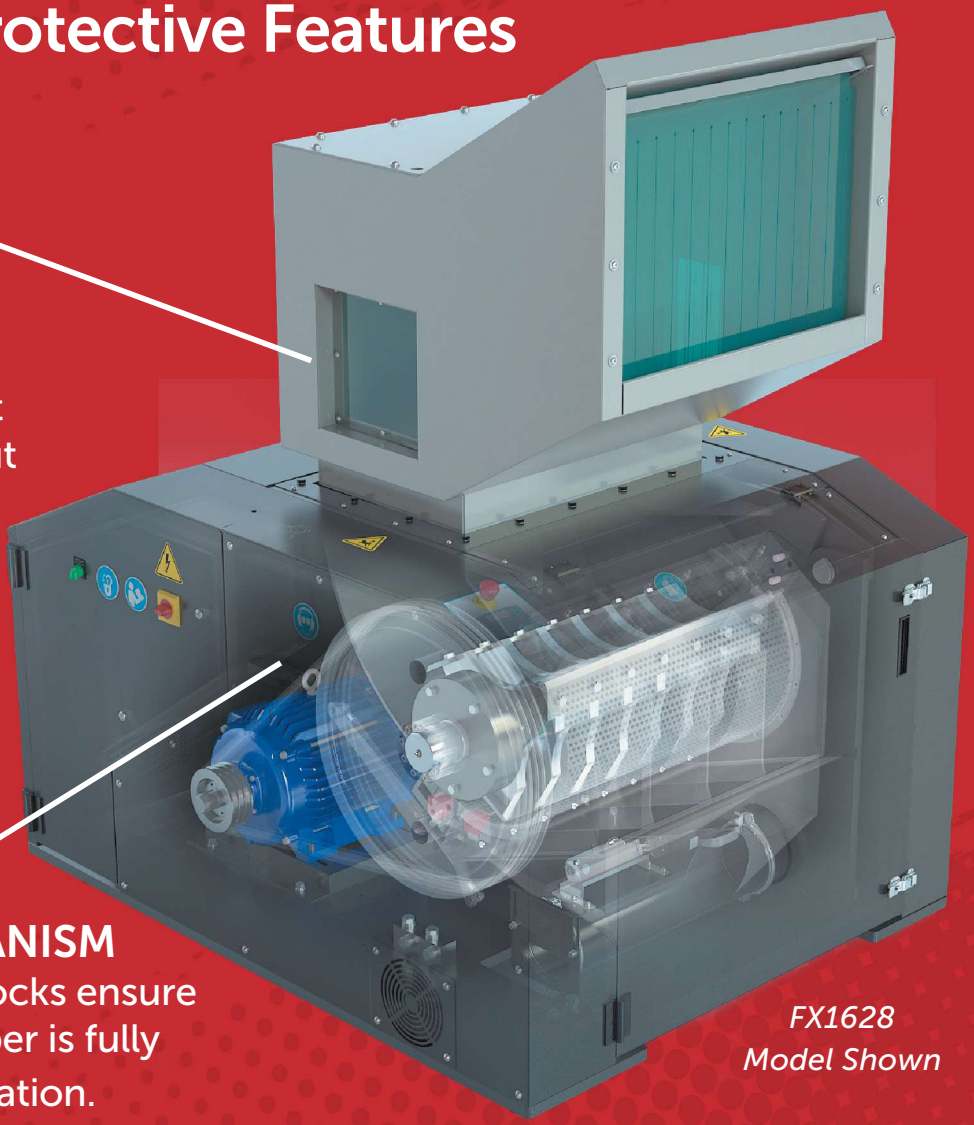

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Closed-Loop Bottle Control Saves Truckloads of PET for Blow Molder

For Mexican beverage producer GEPP, automatic control of the stretch-blow molding machine based on in-line bottle wall-thickness measurement has saved literally tons of PET resin every day. Line 1 at GEPP's Hermosillo plant has trimmed the weight of its 2L low-carbonation PET bottle from 52 to 46 g. Given operating speeds of 24,000 bottles/hr, the 6-g (11.5%) reduction is saving the company approximately 7 tons of resin in each 48-hr production run. This impressive saving has been accomplished despite challenging environmental conditions at the plant, where temperature swings by 40° F or more throughout the day. As noted by Jesús López, GEPP corporate technical manager, "You don't want to put the same amount of heat on a 90° preform as a 70° preform."

Successful lightweighting demands strict adherence to the material-distribution recipe for the bottle. That is a lot harder to do when working with less material, says López. GEPP's success is attributed to the Process Pilot system from Agr International.

Located in the blow molder takeout area, the Pilot's sensors measure the thickness of each bottle at 12.5-mm intervals along the sidewall. Agr's control algorithms instantaneously analyze the measurements and compare them with the recipe. If necessary, the Pilot adjusts the appropriate machine function—for example, tweaking the preblow setting or lamp temperature.

In addition to savings from lower material consumption, the Agr system has enabled GEPP, the exclusive bottler of PepsiCo beverages in Mexico, to speed changeovers among six different bottles blown on Line 1 in sizes from 600 ml to 3L. It used to take an average of 1.5 hr to replace the molds on the 16-station blow molder and then another 30 min for process verification and quality checks. Now, with Process Pilot, the machine produces good bottles on startup, with no need for sampling and tweaking, making each changeover 25% faster and saving 6000 bottles of startup scrap. Likewise, when jams occur, "Pilot brings the process back to baseline two to three times faster," López says. What's more, improved bottle consistency with Process Pilot produces fewer disruptions in downstream labeling, capping and shrink-wrapping.

López hopes to install Process Pilot on Hermosillo's second blowing line and to establish the plant as the model and training site for all GEPP's 25 PET bottle operations.

Larger Freeformer from Arburg Can Print Three Materials

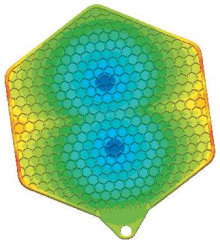
Last month, Arburg introduced a larger model of its 3D printer, the Freeformer 300-3X. It has a part-carrier surface area of 300 cm², almost 50% larger than on the model 200-3X. It can build 50% wider parts measuring up to 234 × 134 × 200 mm. "3X" stands for three moving axes (x, y, z) of the part carrier. Like the previous models, this Freeformer uses standard molding or extrusion pellets as raw materials. What's new is the ability to build parts from three components, such as a hard-soft combination plus a support structure. Also new is a two-part build-chamber door, which enables the feed hoppers to be refilled while the printer is operating by opening only the top half of the door.

Software upgrades over the past year include a more user-friendly operator interface, updated slicing software, "smart" automatic generation of supports adapted to the individual part, pressure regulation to improve adhesion of the first layer to the base plate, and new or revised material profiles.

Autonomous Optimization Proves Its Worth in LSR Molding

A tricky LSR injection molding demonstration at the Fakuma 2018 show in Germany in October was made possible by a new type of simulation technology that automatically performs multiple iterations to home in on a desired outcome. Introduced at the previous year's Fakuma by Sigma Enginering, Sigmasoft Autonomous Optimization is similar to an automated design of experiments (DOE), except that it seeks an optimized result based on the programmer's instructions (see June feature for details).

At Fakuma 2018, Momentive Performance Materials operated a molding cell producing an LSR pot holder with a challenging honeycomb design. Its largest dimension is 210 mm and overall thickness varies from about 3 to 7.5 mm. But the honeycomb walls are only 1 mm thick, and the 83-g shot has a max. flow length of 135 mm from two gates. According to Momentive, this project would have been "very difficult to realize without simulation." This type of product had never been injection molded before—only compression molded. "We didn't know what exact injection pressure or clamp force would be required," says Momentive's Oliver Franssen, senior global marketing leader for transportation. It was essential to determine in the shortest possible time whether the part could be molded on a machine small enough to fit in the company's booth. "Also, we wanted to avoid two costly mistakes—air entrapment and excessive temperature difference across the cavity."



Sigma ran a total of 60 different simulations, involving three different filling times and 20 different gate positions, over about two days using Sigmasoft Autonomous Optimization. The software evaluated all the results to identify the best solution. The software determined optimal placement of two gates and, in a second optimization, the position, length, and temperature of electric heaters in the mold. The result was a 55-sec cycle time with no flash, no short shot or air entrapment, and reduction of temperature differences in the cavity from 40° C initially to no more than 10°.

Based on the results of the virtual analysis, the mold was built by Emde MouldTec in Germany. The extremely compact tool needed no cold-runner block for sprueless molding; instead, Emde's cold-runner head was attached directly to the 90-ton SmartPower injection machine from Wittmann Battenfeld.

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Headlines from Fakuma 2018

Integrating a special low-pressure process into machine controls; novel shop-floor quality-inspection technology; MES systems from machine and controls vendors; and sophisticated in-mold decorating.

By Matthew H. Naitove
Executive Editor

With 1933 exhibitors from 40 countries, the Fakuma 2018 show in Friedrichshafen, Germany, attracted 47,650 visitors over five days in October. Fakuma was loaded with news—much more than one article can present; so the following is a brief selection of some major introductions and themes at the show. (See also Fakuma news announcements in Starting Up and Keeping Up sections this month and in our August through November issues.)

MILACRON INTEGRATES IMFLUX PROCESS

As previously reported in an October Starting Up, Milacron announced—and demonstrated live—a first-of-its-kind collaboration with iMFLUX, the new subsidiary of Procter & Gamble that developed a novel injection molding concept based on low and highly consistent injection pressure. Through this agreement, Milacron will integrate iMFLUX's proprietary process-control software into its injection machines with a native user interface and screens on its Mosaic controller. Milacron will be the first machine builder to offer such integration, which eliminates the need for a separate iMFLUX control screen.

Ethan Stiefel, iMFLUX plastics processing engineer, demonstrating the iMFLUX low-pressure process integrated with Milacron's Mosaic press controller.

iMFLUX uses low but highly consistent pressure, allowing velocity to vary with the geometry of the part, to achieve up to 50% faster cycles with reduced part weight, lower stress, less warpage, and fewer sinks, as explained in a March '18 feature article. Outfitting a machine for iMFLUX typically requires a nozzle adapter with a pressure sensor, a CPU in the control cabinet to send signals to the machine controller, and special control software. Company sources say the process has been tested on machines from 20 to 5500 tons and on molds with up to 196 cavities. Although iMFLUX offers relatively little speed advantage in very fast-cycle molding, it reportedly still offers quality benefits through improved balancing of high-cavitation molds. For that reason, the company is exploring cap and closure applications. iMFLUX has also done some experiments with the process in co-injection and gas-assist molding.

At Fakuma, iMFLUX showed a new enhancement in the form of automatic viscosity-adjustment software. It recognizes a change in melt viscosity and adjusts filling to maintain consistent low pressure. At the show, this capability was demonstrated by switching on the fly from molding a 20 MFI PP to 8 MI PE and vice versa. In real life, iMFLUX sees this capability as assisting in the use of scrap or recycled materials, whose viscosity can be variable, especially when the proportion of reused materials may vary. (See October blog for more details.)

RAPID INSPECTION OF PARTS' INTERNAL FEATURES

A new noncontact, nondestructive, and nonhazardous technique can perform dimensional QC and look inside plastic parts for voids, foreign bodies, foam structure, glass content and glass orientation in as little as 30 sec. New TrexelVision system offers a way to perform immediate shop-floor inspection and QC without sending parts to the lab. It allows you to "see the invisible" inside solid or foamed parts either in-line or off-line.

TrexelVision is the result of an exclusive distribution agreement that allows Trexel, the source of MuCell microcellular molding technology, to offer the STRIPP Control IM technology for injection molded parts from TeraTonics of France. STRIPP stands for Single Shot Terahertz Sensing for Rapid Industrial Product & Process Control. It employs terahertz (THz) spectroscopy, a method involving ultra-short pulses (measured in picoseconds, or 0.001 nanosecond) of electromagnetic radiation in the submillimeter wavelength range—in between microwaves and infrared light. TrexelVision integrates a broadband source and detection system ►

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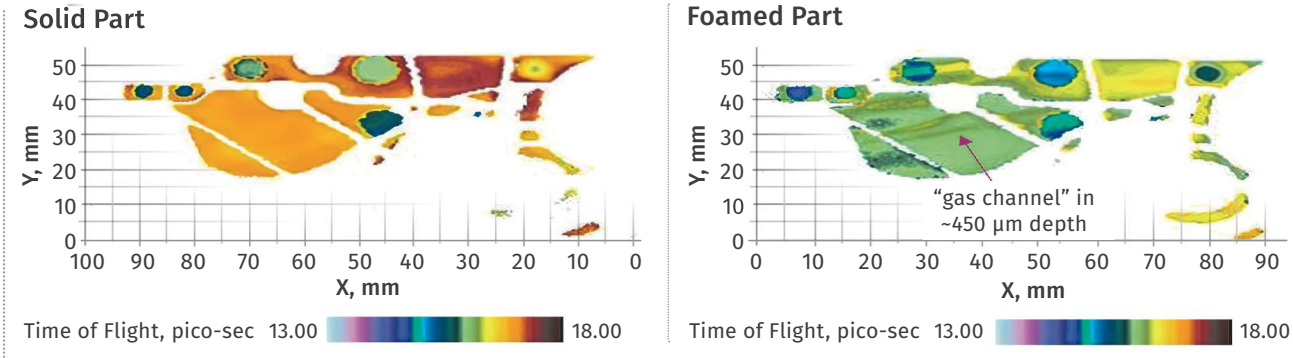


Trexel's new TrexelVision terahertz spectroscopy system allows quick, nondestructive, noncontact, nonhazardous QC inspection of internal features of foamed or solid parts.

for the 0.1 to 1 THz spectral range, as well as an industrial control and data-acquisition unit with proprietary software for scan motion and data processing. It allows for robotic scanning of 3D objects based on their CAD files—beside an injection press, for instance.

STRIPP has been used to measure the thickness of multilayer coatings, to inspect composites, and to measure glue layers in assemblies of composite parts. For injection molding, it can perform wall-thickness measurements to ±3 microns. In foamed parts it can measure thickness of the solid skin vs. the foamed core. It can also determine the density and uniformity of the foam cell structure; find voids or bubbles in solid parts; reveal foreign-body inclusions, internal weld lines, or the quantity and orientation of fiber reinforcements; and even show the boundaries between materials in multi-component parts. Another capability is to "slice" the part into virtual layers, revealing internal structure at different depths, as in medical tomography (CT) scans. (See October blog for more details.)

In addition, Trexel rolled out a new system that allows molders to operate multiple presses running the same parts with MuCell foaming off a single gas booster unit. This cost-saving approach involves a new satellite dosing unit that can be fed by Trexel's T-Series or new P-Series boosters (the latter for fast-cycle packaging), as well as its B-Series for blow molding, or a non-Trexel pressure source. Also new from Trexel are T-Series central gas boosters based on T300 and T400 compressors to feed satellite units.

MORE SOURCES OF MES SOFTWARE

Major injection machine suppliers have indicated that MES (manufacturing execution systems) are essential components of their Industry 4.0 strategies. Several of these OEMs offer their own MES products, have purchased MES software vendors, or formed alliances with such vendors.

Among the latest developments, Wittmann Battenfeld has purchased a stake in Italian software firm ICE-flex and is now offering a version of that company's TEMI modular MES package. Called TEMI+, this version is tailored to work with Wittmann 4.0 production cells and provides special functionality made possible by Wittmann 4.0 router technology. In particular, TEMI+ connects automatically with Wittmann Battenfeld presses and Wittmann auxiliaries—whether or not those auxiliaries are connected directly with the injection machine. Any alterations in the composition of the production cell—such as connecting different auxiliaries when changing jobs—is recognized, saved and displayed automatically by TEMI+. This capability is said to be unique to TEMI+, as is the ability to display on a computer or mobile device a dashboard of Key Performance Indicators (KPIs) of all connected equipment in the cell. This dashboard offers OEE for the machine and entire cell.

Engel showed automated changeover of mold inserts (front row on fixture) and robot EOAT (back row) in production of a two-piece caliper. In about 1 min, the robot changed EOAT from part handling to mold-insert handling (and vice versa), and then changed mold inserts to produce two different parts in alternating batches. The robot also placed matching pairs of parts into an assembly device and laser-marking fixture. (For more details, see October Keeping Up.)

Wittmann Battenfeld says TEMI+ offers a simple approach to entry-level MES data collection. Modules include ERP connection, production planning, "alarm messenger" specifying time and cause of stoppages, QMS module that records process data and stores quality-inspection instructions, and a production monitor that displays all machines' status at a glance.

Wittmann Battenfeld USA anticipates that it may be three to six months before TEMI+ is launched in this hemisphere.

Meanwhile, Engel's wholly owned MES provider, Austrian-based TIG, will open next month a U.S. subsidiary in York, Pa., home to

Kurz Duo SI IMD reel-to-reel system feeds two independent single-image foils through a two-cavity mold using servo drives, optical sensors and registration marks on the foils for precise positioning.

Engel's North American headquarters. TIG also announced several modifications to its product line. One is a new "rental" or subscription model for its authentig standard MES package. Another is a new entry-level package, called TIG 2go, also on a subscription basis. It requires installation of a data-acquisition box on each machine—or one device can collect data from up to 20 machines—to send data to the cloud. Users have access to an online dashboard showing machine operating status in one or multiple plants, as well as OEE performance data, SPC figures, and historical data for up to six months.

At the other end of the scale, "TIG big data" is an open system for connecting all machine and plant sensors, ERP, MES, and other business software platforms, along with custom analytics. High-volume data storage can be local on company servers or in the cloud.

As a sign of spreading interest in MES, Kistler Group, the Swiss-based maker of sensors, monitors, and controls for injection molding, has taken a further step into Industry 4.0 solutions with the acquisition of IOS GmbH in Aachen, Germany, which develops modular MES software.

Kistler's MES offers automatic data acquisition from injection machines via the machine controls or, for older machines, via a web-connected mini-PLC installed on the machine. Kistler offers a full system as well as an "MES Light" version designed as an entry-level product that allows users to get started quickly with minimal setup. At present, this option includes two pre-configured modules for data acquisition:

- **Machine data**—cycle times, machine status, good/bad parts production quantities.
- **Operation data**—transfer of production orders directly from an ERP system, starting and stopping of jobs, recording reject reasons, and calculating OEE (overall equipment efficiency).

Kistler also offers a full-blown MES system with the foregoing two modules plus modules for batch traceability, maintenance management, production planning, and workstation-based staff-time logging.

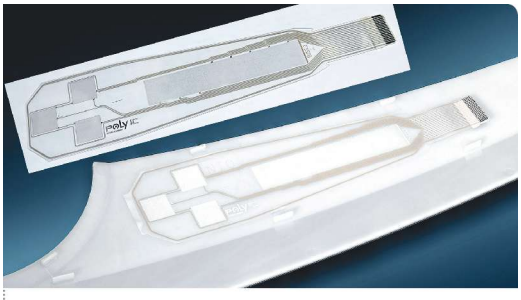
IMD ON A ROLL

While in-mold labeling (IML) for packaging has become ubiquitous at major trade shows, Fakuma this year was notable for high visibility of the related technology of in-mold decorating (IMD), aimed largely at automotive, appliances, and consumer electronics. As distinguished from IML, IMD for durable goods frequently involves roll-to-roll feeding of decorative and functional surfacing materials for back molding; paint films on a carrier film, which are deposited via back molding; or functional electronics (e.g., touch sensors) that can be applied in the mold like IML or bonded to the part after molding via vertical or roll-on hot-stamping.

Kurz's new Varioform IMD foils and topcoats are said to be the first to accommodate complex 3D shapes.

At Fakuma, three injection machine suppliers demonstrated varieties of IMD, all in cooperation with Leonhard Kurz (parent of Kurz Transfer Products in the U.S.). Engel, for example, showed off a roll-to-roll system for vacuum forming, back-injecting, and punching out diverse surface structures within the mold. This demo showed off Kurz's new single-step "IMD Varioform" foils and topcoats that accommodate complex 3D shapes—something not available previously, according to Kurz. Possibilities include metalized (brushed or chrome) surfaces; wood, marble, or carbon-fiber look; single-image designs; partial and full-surface backlit designs; and tactile qualities from smooth surfaces to distinctive structures or soft-touch effects.

As reported in September Starting Up, KraussMaffei operated a cell demonstrating Kurz's patented dual-IMD technology that indexes two independent heat-transfer foils through a two-cavity mold with the aid of servo motors and optical sensors to detect registration marks on the foil. This reportedly allows, for the first time, deposition of two single-image designs with precise positioning. At Fakuma, dual IMD was supplemented by IML in the same cycle to produce an automotive HMI display with integrated electronics, black decorative frame, and scratch-proof coating (UV cured outside the mold).



Kurz Functional Foil Bonding (FFB) uses its PolyTC sensors, with electrical circuits printed on a PET carrier and connected to an integral plug. These are applied after molding the part, using vertical or roll-on hot stamping. The flexible sensors conform to curved surfaces.

And Sumitomo (SHI) Demag demonstrated two decorating steps in production of an automotive door sill with day/night design and touch-activated backlighting. Kurz day/night IMD decoration was applied; then, in a post-molding operation at Kurz's own booth, the same parts were hot-stamped with transparent touch sensors having silver-based circuitry printed on a PET carrier. Kurz calls this Functional Foil Bonding (FFB). Its elastic PolyTC sensors can be integrated into fashionably curved components. PT

Worldwide Switch to New Gauging System Pays Off for Haartz

Leading supplier of sheet and roll stock for automotive applications reevaluated its thickness-measurement technology in 2012, and now has 15 scanners in place worldwide from one supplier.

By Jim Callari
Editorial Director

Family owned and in business more than 100 years, Haartz Corp., Acton, Mass., is the world's leading supplier of automotive topping fabrics and a leading producer of soft-trim car interior materials. Roll and sheet goods made by Haartz can be found in almost every automotive brand worldwide, especially in convertible tops.

In Acton, surface effects such as simulated leather are embossed into extruded PVC, TPO or other compounds to create formable and hand-wrap materials. These materials are used in door panels, seats, console lids, instrument panels, and more for automakers from Nissan to BMW. Some lines are set up to extrude material onto a thin layer of foam, giving the trim more cushion. Haartz also extrudes plastic between two layers of fabric.

In 2012, an effort to streamline production focused on the company's web gauging and control systems. "Back then, our web scanners were made by two well-known manufacturers," recalls John Gilbert, senior process engineer in Acton. "Our people wanted to find the best scanner brand for us as we began planning the upgrade of our extrusion lamination lines."

> ***"Lots of companies sell scanners that could probably meet our needs. The real difference for us was the technical aptitude and service attitude of Mahlo's people."***

Haartz (*haartz.com*) typically runs at thicknesses ranging from 0.5 to 1.3 mm. Strict control of the extrusion process is critical to meeting Tier 1 supplier specs as well as IATF16949 Automotive Quality standards. Going outside standard deviation limits risks failing spec and wasting material. So, by employing just one brand of gauging system across the board, Haartz could enable all line operators to gain a better knowledge of the system selected and produce more consistent and efficient products.

After conducting a worldwide search of web-gauging and control systems in 2012, sheet processor Haartz selected Mahlo, and now has 15 scanners running worldwide. Pictured are John Gilbert, Haartz's senior process engineer (right) and Eric Reber, Mahlo's North American sales manager.

"Because we run the lines on a 24/5 or 24/6 basis, our operators need to move from line to line so vacations, sick days, and shift changes can be well covered," Gilbert said. "It was crucial to select a system they all could easily adapt to and that could fulfill all our requirements as we pushed our capability."

KICKING ALL THE TIRES

The company wanted the best system for its future. "We talked with every major manufacturer out there," Gilbert explains. "Our search included a parade of presentations and proposals, plus dozens of site visits over many months and several states."

What they learned surprised everyone on the selection team. One brand not only fit all their needs, but Haartz found ►

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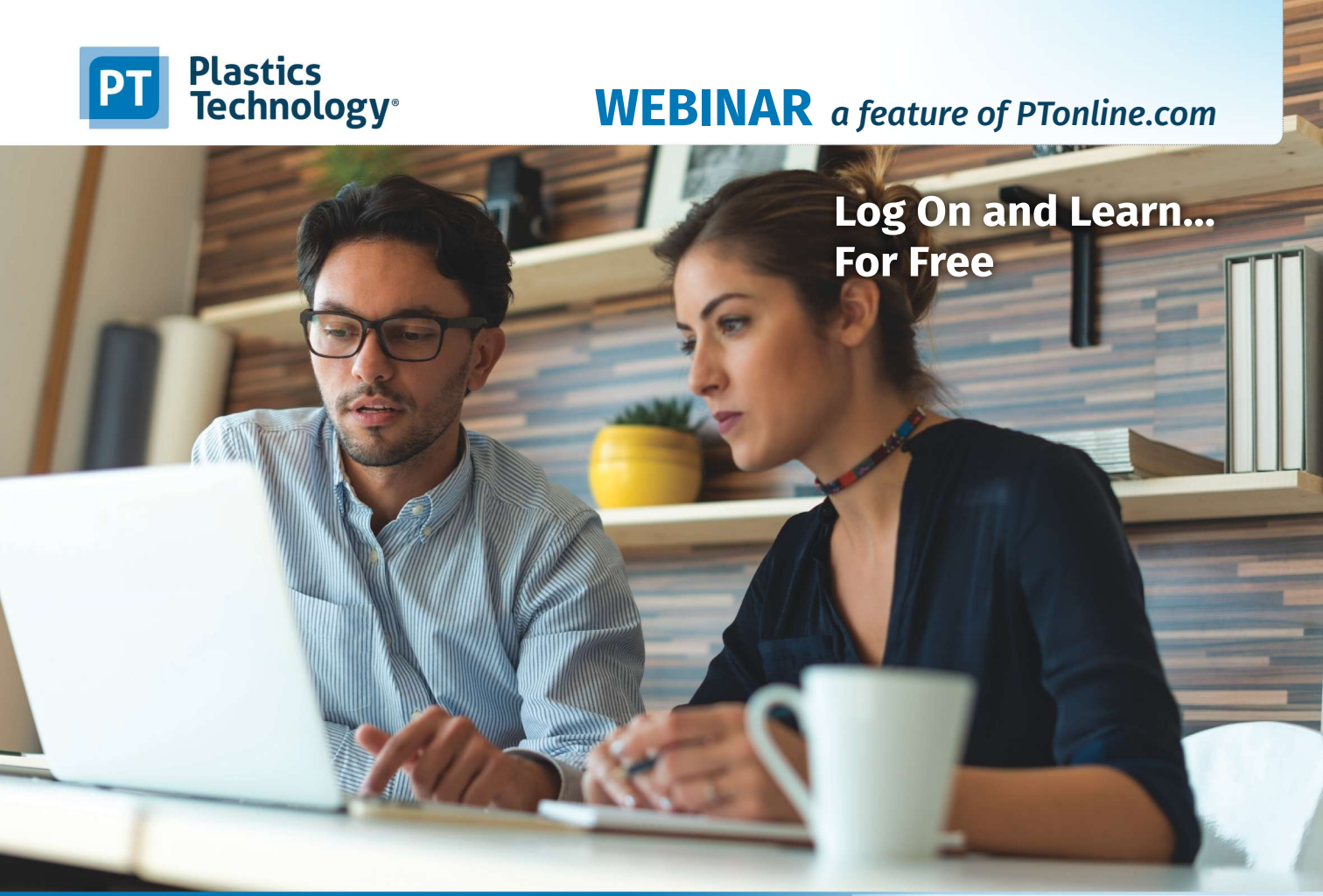

Tuesday, December 11th

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How to Develop and Control Plasma Treatment Processes for Polymers

Plasma treatment has been utilized for decades for engineering the surfaces of polymeric materials for adhesion. Recent development of atmospheric pressure treatment systems has made continuous processes practical for many manufactured products, including cast, molded, extruded, and thermoformed parts. Medical device, electronics, automotive, aerospace, and consumer products industries have been rapidly adopting these processes. This webinar discusses the basic principles of plasma treatment of polymers and outlines well-defined methodologies for developing, evaluating, and controlling these processes.

PRIMARY TOPICS:

- Basic understanding of parameters that affect plasma treatment of polymers
- Knowledge of the effects of plasma treatment on polymer surface
- Basic skills in developing and evaluating plasma treatment processes
- Tools for controlling plasma treatment processes, in the lab and manufacturing

PRESENTERS

BTG LABS

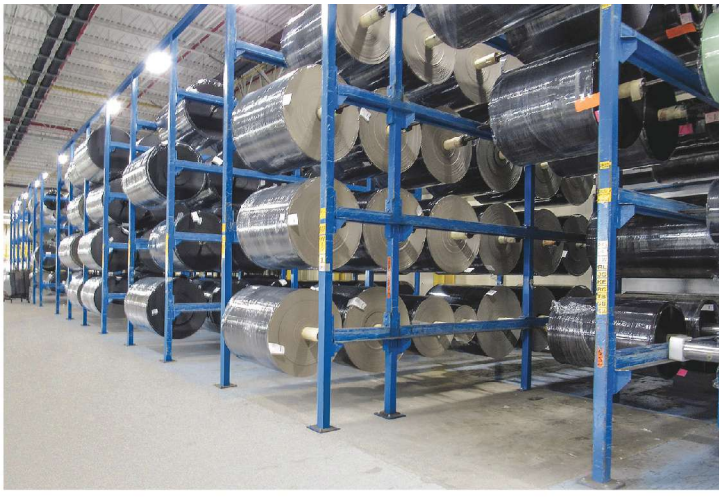
Dr. Giles Dillingham
CEO/Chief Scientist

Dr. Giles Dillingham has worked in the areas of surfaces, interfaces, and adhesive bonding for 30 years. He earned a Ph.D. in Materials Science from the University of Cincinnati, then worked at Dow Chemical developing surface treatments for aerospace applications. Returning to Cincinnati he worked on plasma processing of materials and adhesive bonding of advanced composites while incorporating and growing BTG Labs since 2001.

Khoren Sahagian
Chief Process Engineer/Applications Manager, Plasmatreat USA

Khoren Sahagian is Chief Process Engineer and Applications Manager to Plasmatreat USA. His expertise in surface manufacturing technologies includes process development, surface chemistry and characterization for high performance material systems and bonding in the medical device, automotive, electronics, and aerospace markets.

Haartz installed in first Mahlo system in 2013, and says it was able to easily integrate the new technology into its other lines worldwide.



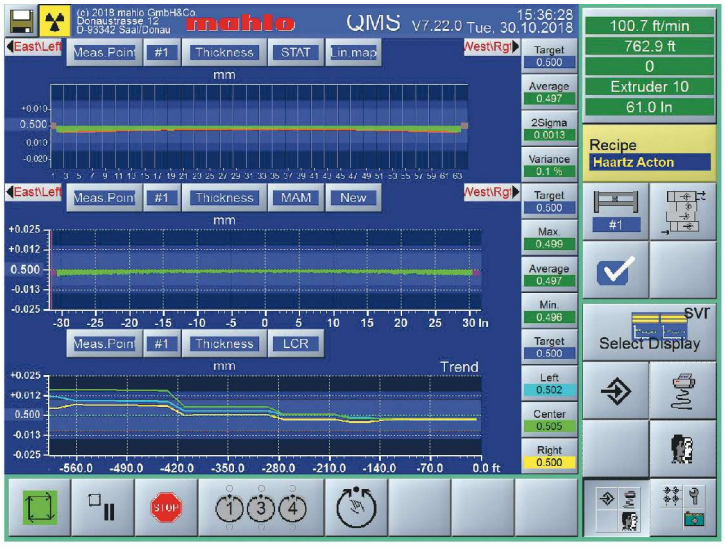
Haartz extrudes PVC, TPO and other materials into rollstock that is used in a variety of automotive applications, convertible tops in particular.

the differences between a system provided by Mahlo America, Spartanburg, S.C. (***mahloamerica.com***) and those from all other vendors were "stunning." The team's first impression was that the machine "is built like a tank." As a bonus, most Mahlo parts are easily sourced from aftermarket suppliers--even motors and circuit boards. "With our legacy scanners we were compelled to sign service contracts," Gilbert admits. "After X number of years, the manufacturers stop supporting them. We were expected to buy new."

Gilbert adds, "Mahlo said they still support scanners 25 and 30 years old. That moved them to our short list." Still, changing control systems is a challenge. Change can cause people to fear making mistakes, losing control. "Once operators learn a system they don't want to give it up," Gilbert said. What's more, Haartz has high standards to maintain. With operations in the U.S., Mexico, Germany, India, China and Japan, changes at the headquarters plant can have a global impact.

Two things about Mahlo America gave the Haartz decision makers the encouragement they needed. "Although the system had all the bells and whistles a process engineer craves, the Windows Embedded-based interface is very intuitive," Gilbert notes. "It's so simple, our production crews took over after just 10 or 15 minutes of training. "Second, and probably most important, every person we met and spoke with at Mahlo knew their system thoroughly. And they totally understood our processes and challenges."

Haartz installed its first Mahlo scanner in 2013 to test its performance in measuring total weight on a line producing material for nose and tire covers. As product requirements and challenges mounted, Haartz was easily able to assimilate Mahlo scanners into its other lines, measuring total weight, then film weight and laser thickness on the substrate, followed by full Auto Profile Control (APC) of the film weight. "The Mahlo APC gets up to production speed fast. Less material is wasted, and uptime maximized," Gilbert noted. "Our crews and engineers were all in favor of the change."



Haartz says the Mahlo systems are loaded with bells and whistles, with an operator interface that is very simple and intuitive.

By the end of 2018. Haartz will have 15 Mahlo scanners online worldwide. "Lots of companies sell scanners that could probably meet our needs," Gilbert states. "The real difference for us was the technical aptitude and service attitude of Mahlo's people. Any time an issue comes up, Mahlo's staff makes getting us back online their first priority."

"Only twice since our first Haartz installation have we had to make an on-site service call," notes Eric Reber, North American sales manager at Mahlo

America Inc. "We have received the occasional call along the way, but these issues were addressed quickly through our TeamViewer service."

The TeamViewer program is a secure remote-access service licensed with every Mahlo system sold. With it, users can give technicians temporary access to the control interface online in real time. This allows a technician to diagnose the system quickly and remotely. "TeamViewer can also be used to provide remote training for operators or engineers. Mahlo Telephone Support and TeamViewer service is included at no charge, around the clock, for the life of our system," Reber notes.

Another feature on every Mahlo Auto Profile System is the die-bolt heater-failure alert. Haartz discovered that some of their legacy systems had quite a few dead die bolts and their graphs were giving them excessively averaged readings. "Mahlo systems graph in high resolution like a real-world sheet and give us an alert for any die bolt that's not responding," says Gilbert. "We've been able to reduce our scan-to-scan standard deviation to about 0.5% from greater than 2% previously. Also, seeing both the new scan and composite average on a single profile graph is a great feature."

"We've been able to reduce our scan-to-scan standard deviation to about 0.5% from greater than 2% previously. Also, seeing both the new scan and composite average on a single profile graph is a great feature."

In addition to limiting waste in its manufacturing processes, Haartz strives to be "locally green" with its neighbors, communities and customers as one way to cut its carbon footprint. Haartz sources raw materials locally when possible, recycles TPO and PVC, and encourages carpooling. Continuous education and training, workplace safety, on-site fitness facilities and community-outreach programs are credited with keeping the average employee retention high.

"Maybe it's a thing about family-operated companies, but we really like Mahlo's simple, 'Old World' business approach." Gilbert concluded, "Mahlo doesn't make machines in order to sell proprietary parts and service contracts. They engineer scanner systems that help support and strengthen our brand. That makes for a lasting business relationship." PT

QUESTIONS ABOUT SHEET EXTRUSION?

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Simplicity Conquers Complexity in Automotive Molding Cells

Six-axis robots are often recommended for complex automation cells, but here's an example of how cost-effective, three-axis linear robots can be up to the task.

By Matthew H. Naitove
Executive Editor

Two identical, highly compact vertical injection molding cells are among the most recent additions to the KHG Plastics GmbH plant in Velberg, Germany. The new cells, which together can produce some 40,000 overmolded electrical contacts per week for automotive lighting systems, combine a sequence of metal fabrication, overmolding, testing and packaging into fully automated production. And, they do so with elegance and simplicity.

Originally, the company considered moving parts through these diverse functions with the help of two six-axis robots, a human operator, and additional automation. But a much simpler proposal, evolved by robot maker Sepro and kiki Ingenieurgesellschaft mbH, a local systems integrator, convinced KHG Plastics that the cells would be more compact and productive using three linear, three-axis robots, all integrated through a single control system. This solution offers a tip to other molders on how unconventional approaches can lead to success.

AUTOMATING MULTIPLE FUNCTIONS

After winning the chance to produce a new overmolded metal contact for an automaker's vehicle lighting systems, KHG got to work designing the production system for this part. The company sought a fully automated process that would integrate a variety of production equipment:

- A metal-punching and bending machine to receive metal blanks and produce left- and right-oriented metal contacts;
- A vertical injection molding machine to receive and overmold the metal stampings;
- A test station to short-circuit test the overmolded contacts;
- A packaging station where "good" right-hand and left-hand parts are transferred to stackable trays that can be moved to further automation in-house or palletized and shipped to the customer.

The only human involvement in each cell's operations is removal of full parts trays about every 6 hr.

Since the application involved moving parts through a series of pre-and post-mold operations, the company considered an initial proposal that envisioned the use of two six-axis robots, which would offer 360° of operational reach along with the ability to handle even the most complex part manipulations. This approach suggested that one large, centrally located, six-axis robot could do the bulk of the work, handling parts from the stamping machine through overmolding to the testing apparatus. From there, a smaller six-axis robot would remove the parts and load them into trays, which would proceed to an automatic tray-stacker and onto carts for removal.

Two identical molding cells each include three Sepro linear robots operating together with Arburg vertical injection molding machines.

QUESTIONS ABOUT ROBOTS?

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Though the logic of the proposal was clear, company officials had questions and sought input from other trusted business partners. Based on past experience, they asked Sepro if the largest six-axis robot could be replaced by a linear robot.

After considering the company's requirements and comparing alternatives, Marius Svagnea, area sales manager for Sepro, replied, "Yes." His analysis found that a Sepro linear robot—a three-axis model S5-35—could replace the large six-axis robot at the center of the cell, reducing footprint requirements and allowing easier access for mold changes, maintenance and service to the bending, molding and testing equipment in the cell.

Each robot has its own control, but the largest robot's "master" control coordinates all robot operations and cell safety.

As discussions proceeded, Svagnea proposed using a second linear robot—a smaller Success 7—to handle tested parts instead of the smaller six-axis robot. Finally, a Success 11 was added to flexibly automate tray handling. Because the linear robots could be positioned above the molding machines, they would simplify machinery placement, reduce floorspace requirements, and improve access. Reach would be no problem, since their horizontal beams could be of any length required.

KHG was impressed by the logic: "We saw that a six-axis robot would have taken too much space and had too limited a reach, said CEO Lutz Karrenberg. "The Sepro/Kiki solution combined several standard robots in a very small space. This was the main reason behind our decision."

Karrenberg added, "We did not necessarily at first think of a solution with a tray cart that would include loading via a third robot system. This idea came completely from Sepro, who had already implemented ►

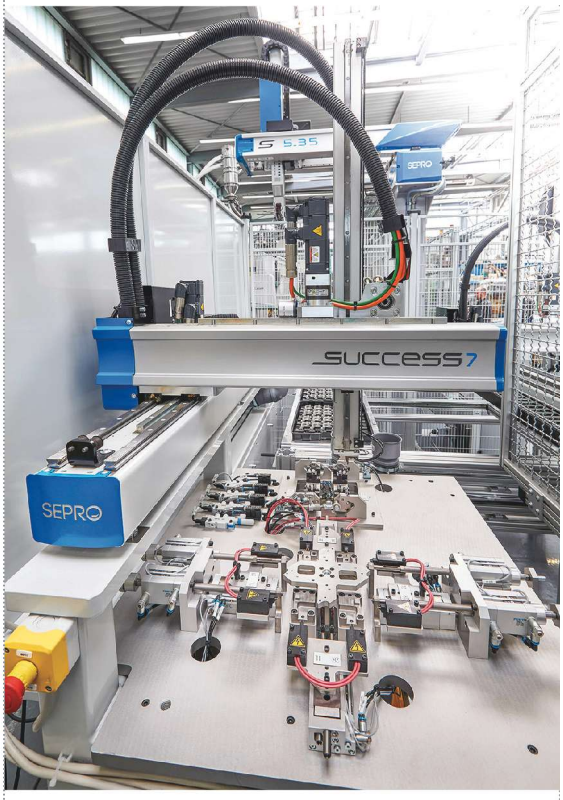
The largest of the three robots in the system, the Sepro S5-35 performs the main automation functions—including insert placement, part removal, part positioning for electrical testing, and good/bad part sorting—before handing components off to the other two robots.

something of a similar nature. This solution not only saved us a lot of space, but also optimized our workflow and brought a high flexibility to the system for future production tasks."

CELLS IN OPERATION

Each robot has its own Sepro Visual control, and each is individually programmed to perform its own functions within the cell. However, the Visual 3 control on the first and largest robot, the Sepro S5-35, also functions as the "master" robot control, coordinating cell safety and robot operations.

The large Sepro S5-35 robot has a horizontal stroke of 4000 mm. In the KHG cells, this robot begins the production process, picking up four stamped and bent metal contacts (two right-hand and two left) from the shuttle table of the punching and bending unit. The robot then moves to the vertical injection molding machine. After removing four overmolded contacts from the previous cycle, it places each of the four metal contacts into the lower half of the mold that rests on the open turntable of the machine. The robot's end-of-arm tooling holds these contacts just long enough to lock them securely into position before the mold rotates into the machine for overmolding. Meanwhile, the same robot places the four finished parts onto a test station, where they are checked using a 500V short-circuit test. Then, the S5-35 "master" robot picks up the tested parts again, moving acceptable parts to a transfer station and removing failed parts from the process.



A Sepro Success 7 picks finished components from a transfer fixture and places them in trays for left- and right-hand parts.

Next the Sepro Success 7 takes tested parts from the transfer station, identifies them as left-hand or right-hand parts, and places them into the appropriate part tray. This robot has a horizontal stroke of 1500 mm.

Finally, the Success 11 robot takes over. It is responsible for moving filled trays of left- and right-hand parts to unloading stations, where it stacks full part trays onto movable carts. Then it retrieves another part tray (left or right, depending on the full tray it dropped off) from stations that contain empty trays, and places it into position on the sliding table for filling.

The only human involvement in the cell's operations is removal of full parts trays—approximately every 6 hr.

SIMPLIFYING MULTI-MACHINE INTEGRATION

Ordinarily, integrating and controlling the operation of three robots and diverse pieces of equipment for metalworking, injection molding, electrical testing, and tray loading/stacking would require a separate PLC and extensive custom programming. However, cell designers were able to coordinate and integrate the all the key equipment in the cell by

The Sepro Success 11 positions empty trays for filling by the Success 7. It also removes filled left- and right-hand trays and positions them for removal by an operator.

The Visual 3, the most advanced in Sepro's family of controls developed especially for injection molding, controls all robots and peripheral equipment, synchronizing with the molding machines.

leveraging the capabilities of Sepro's Visual 3 control.

Sepro's latest improvement in integration, a feature set called Easy Package, encompasses not only the injection press/robot interoperability functions in Euromap 67, but adds a range of additional synchronization, control, monitoring, and data-exchange capabilities. By dramatically augmenting the functionality of E67 and evolving Euromap protocols (E79, E81), Sepro's Easy Package not only enables and simplifies the integration and control of injection machines and robots, but also of complete production systems—like KHG's twin production cells.

"In our opinion, the ease of integration is the big advantage of Sepro's portfolio," said KHG's Karrenberg. By leveraging Sepro's integration capailities through trusted vendors, KHG obtained two production cells that deliver more elegant, powerful, and cost-efficient results, with less programming and integration effort, than the more sophisticated systems that they first considered. Because both Sepro robots and the Visual control are designed around the needs of injection molders, initial programming, operation, and integration of multiple elements is said to be far easier, as is asset redeployment when future needs demand production changes. PT

Sophisticated robot controls eliminated the need for a separate PLC to integrate an entire molding cell.

MATERIALS

PART 11

A Processor's Most Important Job

It's the processor's job to ensure molded parts contain enough stabilizer to perform to the expectations of the end use.

By Mike Sepe

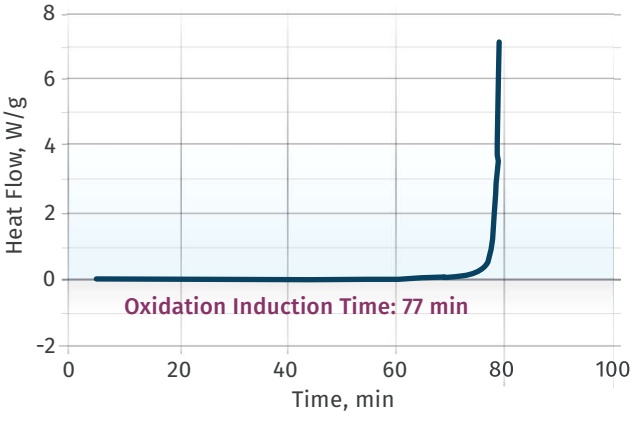
The final aspect of processing that is designed to ensure good retention of mechanical properties involves taking good care of the additive package. All commercial polymers contain an additive package, a combination of compounds designed to provide the stability needed to allow melt processing to occur without degrading the polymer. Resins may also contain additives provided to enhance end-use performance. The constituents in the additive package can vary from compound to compound, and may include UV stabilizers, nucleating agents, antistatic agents, antimicrobials, colorants and flame retardants. But at minimum they are likely to include some level of lubrication and some degree of stabilization against thermal and oxidative degradation. It is this stabilizer package that we are most interested in for purposes of this discussion.

Antioxidants, as these compounds are generally referred to, are incorporated in a material for two purposes: to allow the material to survive the high temperatures and shear stresses of the molding process; and to provide stability that may be needed so that the part can fulfill its application requirements. Often, these functions are delegated to two different sets of chemicals, classified as primary and secondary antioxidants. The chemistry of these materials is fascinating and complex. But when all is said and done, the purpose of these substances is to protect the polymer from degradation that can occur during processing and in use.

The molding process will always consume some amount of the antioxidant in the raw material.

The exact amounts of these additives will depend upon the polymer being stabilized and the applications that the material is intended for. Polypropylene and polyethylene are good examples of materials that require protection from oxidation. Generally, PE is more resistant to oxidation than PP and therefore requires lower loadings of the additives. But all commercial PE and PP materials require some minimum level just to get through melt processing. If after the part is molded it is expected to withstand elevated temperatures while in application, a higher level of stabilization will be needed to ensure that the product does not fail. For PP, these types of high-temperature applications can be anything from coffee-maker components to tanks for holding automobile engine coolant.

Oxidation Induction for a Typical PP



Using DSC, a sample of material can be exposed to a constant elevated temperature in the presence of oxygen to determine the time it takes for the material to undergo oxidation. The accompanying graph shows a result from such a test. The sudden change in the slope of the plot is associated with the onset of oxidation. This material can withstand 77 min of exposure to these conditions before the antioxidant package is consumed and the material rapidly fails.

The material supplier will incorporate a certain amount of the stabilization package in the material, making this the starting point for that material. It is now the processor's job to handle the material during processing so that the molded part contains enough stabilizer to perform to the expectations of the end user. The molding process will always consume some amount of the antioxidant in the material. This is expected. But the amount of stabilizer that is consumed will depend upon the process conditions, most notably the melt temperature and the time the material spends in the molten state. Lower melt temperatures and shorter residence times will produce parts that retain a higher level of stabilization, and these parts will be more capable of handling the application environment. If melt temperatures

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become elevated or residence times become extended, the molded part will be less capable of managing the application demands.

In the lab we can measure the stability of a material against oxidation. Using an analytical technique known as differential scanning calorimetry (DSC), we can expose a sample of material to a constant elevated temperature in the presence of oxygen and determine the time it takes for the material to undergo oxidation. The measurement is known as the oxidation induction time (OIT) and the technique was first used to help polymer scientists understand the premature failure of wire insulation in the 1960s. The accompanying graph shows a result from this test. The sudden change in the slope of the plot is associated with the onset of oxidation. This raw material can withstand 77 min of exposure at these conditions before the antioxidant package is consumed and the material rapidly fails.

Regrind can be expected to exhibit some level of depletion in the antioxidant package.

If this test is run on parts molded from this material, the result can be used to determine how the process influenced the long-term stability of the material. In practice, we have observed molded parts that retain as much as 75% of the OIT of the raw material. and we have seen parts that preserve as little as 10% of this baseline value. The difference between these two outcomes is related to the thermal history of the process. And the lifetime of the part in the field will be governed to a significant extent by the level of oxidative stability that the part has when it goes into use.

This has implications for the use of regrind. Regrind can be expected to exhibit some level of depletion in the antioxidant package. The degree to which this occurs will depend upon the process conditions. Often, I am asked how much regrind should be used or how many times a material can undergo melt processing. The answer is always that it depends upon the thermal stresses the material was exposed to when it passed through the molding process previously. This depletion can also occur while the part is in use.

Recently, I reviewed an analysis of a material that had an OIT of 140 min in pellet form. The as-molded parts retained an OIT of 100 min, and parts that had been exposed to a prolonged elevated temperature routine were at 60-70 min. As we move in the direction of using more post-consumer recycled material, it will become increasingly important that we consider the life cycle of the initial product as well as the types of products that we plan to make from the recycled material. It may be necessary to reconstitute the stabilizers when producing the regenerated raw material.

It has taken us some time to review all the aspects of processing that relate to maintaining the integrity of the polymer. All of these are factors that are not part of most quality plans associated with molding parts. Processors are typically focused on making parts to print at a cycle time that allows them to make a profit. The molecular weight, polymer structure, level of internal stress, and integrity of the reinforcements and additives are seldom considered to be part of the job.

Many processors may not even be aware of their role in achieving optimal results in these areas. There are some interesting common strategies in doing so. For example, molecular weight and additive retention are both optimized by running materials at the lower end of the melt-temperature range. Maximizing crystallinity and minimizing molded-in stress are both achieved by running higher mold temperatures. Once processors become aware of their role in these matters, they can use this understanding to inform their process-development strategies. The world of plastic products will be a better place for having gone through the learning process. PT

ABOUT THE AUTHOR Mike Sepe is an independent, global materials and processing consultant whose company, Michael P. Sepe, LLC, is based in Sedona, Ariz. He has more than 40 years of experience in the plastics industry and assists clients with material selection, designing for manufacturability, process optimization, troubleshooting, and failure analysis. Contact: *(928) 203-0408 • mike@thematerialanalyst.com*.

INJECTION MOLDING

PART 1

The Importance of Consistent Fill Time

To make identical parts, you need to keep fill time constant. Here's why.

Want to make consistent parts run to run, summer to winter, machine to machine? Keep fill time consistent.

By John Bozzelli

Molding is a complex process. If there are any doubts, consider the number of settings on injection molding machines, the complexity of the various controllers, the number of variables in the process, and the significant fact that identical settings do not produce identical results. So, where you start?

Pick the variables you want to control and prioritize them. I wish there were a consensus as to which ones to watch, but I have yet to see it. One strategy is to track as many as possible, but few can interpret that much data. I follow Dr. Deming's strategy: Fewer is better. First on my list to produce consistent functional parts is fill time. Fill time is defined as the time from the start of injection to when the screw reaches the transfer position, filling 90–99.9% of the part by volume. It is a "result," not a setpoint.

Why is controlling fill time important? Basically, it is because the viscosity of plastics changes during production. To make identical parts, ideally you want the plastic to flow or fill the part or parts identically. If you have viscosity changes, the flow pattern and balance to fill your parts will change. Parts will not be identical. Keeping fill the same attenuates viscosity changes. So, controlling fill time is critical. Before we go into the how to control fill time, let's review the causes of viscosity change, some of which you can control and others you cannot:

1. **Fill time.** This is the main point of the viscosity curve: Plastics change viscosity if you change fill time. Plastics are shear-sensitive; that is, resins change viscosity dramatically with changes in injection speed. To make identical parts, you need to keep fill time constant. Believe it or not, shear has a larger impact on resin viscosity than temperature.
2. **Resin temperature.** Any variation in melt temperature due to barrel heaters or hot runners changes melt viscosity
3. **Moisture content.** Certain hygroscopic resins, like PC, nylon and PET, will suffer chain degradation due to hydrolysis if not dried properly. It's not just splay you need to worry about. Infinitesimal amounts of residual water will greatly influence the viscosity of these materials. This amount of water is so small that you will not see splay in the part or foam at the nozzle, but it will react with the polymer and break the polymer chains. This reaction actually consumes water, reduces the viscosity and produces good-looking parts that will fail in end-use.
4. **Lot-to-lot changes.** Though certified to be within the specifications, resin lots can and do differ in viscosity.
5. **Screw-rotate time.** Since most of the energy to melt the plastic comes from the mechanics of the screw geometry and rpm, changes in screw-rotate time—a result, not a setpoint—cause viscosity variations.
6. **Additive type and quantity.** Usage of colors, fillers, mold releases, flow aids, antistats, antioxidants, regrind, etc. has an impact on viscosity. The quantity, type, size, how well mixed, etc. all add to the complexity of melt viscosity.
7. **Mold temperature.** The melt behaves as if the viscosity changed if you have a hotter or cooler mold.

With all these variables in viscosity, keeping fill time constant minimizes their influence and provides a more stable process and therefore consistent parts. Even though the resin can start out at a different viscosity, if driven to the same shear rate, viscosity variations are minimized, which provides a more consistent process.

Once you find a fill time that makes good parts, it is the fill time for the life of the mold. So how do you maintain that fill time? There are differences of opinion in the industry. In Part 2 I will cover how to keep fill time constant, along with procedures to check out your machines.

Bottom line: Run to run, shot to shot, summer to winter, and machine to machine, keep fill time the same and your process will be more consistent. PT

ABOUT THE AUTHOR: John Bozzelli is the founder of Injection Molding Solutions (Scientific Molding) in Midland, Mich., a provider of training and consulting services to injection molders, including LIMS, and other specialties. Contact *john@scientificmolding.com*; *scientificmolding.com*.

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EXTRUSION

Telltale Signs of Screw Wear

Determining the cause of wear is the first step in eliminating it.

Screw and barrel wear can be one of the most expensive operating costs in an extrusion process. But it can be reduced or even eliminated if you understand the cause. Wear of this type is caused by several things. Assuming the screw and barrel materials are compatible—there are many fully developed and tested materials available—let's focus on other possible causes of screw wear, and then talk about how you can distinguish one type from the other.

By Jim Frankland

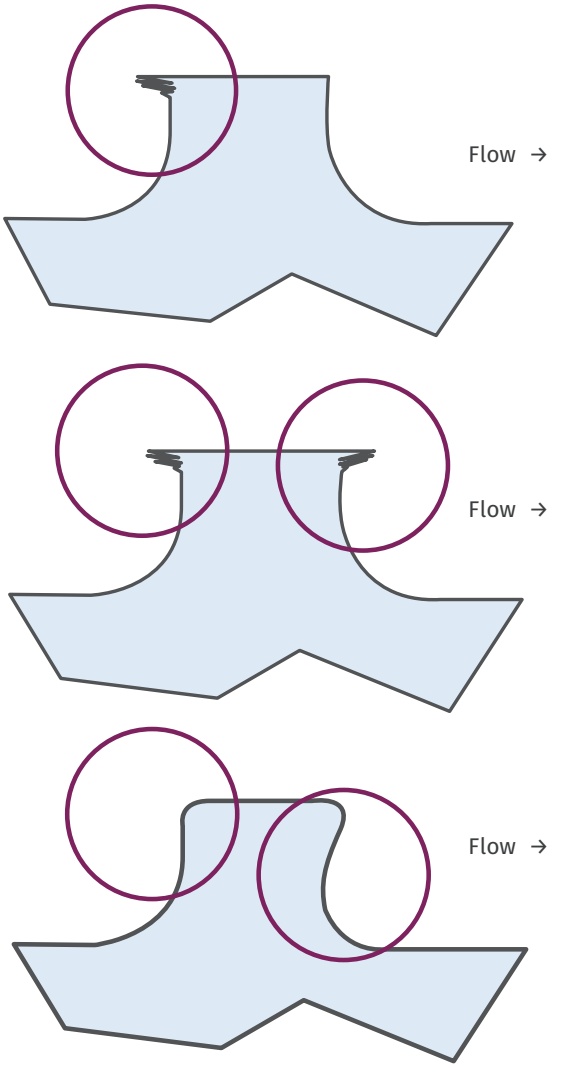
In previous columns I have noted that one of the most serious wear effects is caused by wedging, which is an unbalanced radial pressure in the screw that aggressively forces the screw against the opposite barrel wall. Wedging occurs when the melting rate is exceeded to such an extent that the screw essentially gets momentarily plugged with solid polymer. A high pressure develops on one side of the barrel, with much lower pressure on the other side. This is largely a screw-design issue and generally cannot be corrected by changing operating conditions, such as simply increasing the barrel temperatures. Slowing the rpm is about the only effective measure, and that is always undesirable due to the lost output.

I have found over the years that there are telltale signs of the cause of wear if you examine the worn screw flights.

A second cause of wear is abrasive fillers that get caught between the flight O.D. and the barrel wall. These particles—even though they are considered much softer than the flight and barrel material—can erode the screw flight and barrel, even at relatively low pressures. It's like sand washing over the rocks on a beach.

The third type of wear is related to barrel alignment. When the screw has to rotate in a cylindrical space that is not straight, it has to bend with each revolution. The bending force is enormous and again aggressively forces the barrel and screw flights together under great pressure, causing a crushing of the

What's Causing Your Screw Wear?



The causes of wear can be determined by examining worn flights. If you have a burr on the trailing side of the flight (top), wedging is most likely the cause. Wear caused by abrasion will reveal itself by a polishing or rounding of the flight corners on the pushing side of the flight surface (bottom), eroding the base screw material. Misalignment results in a tearing and a crushing action that produces a burr on both sides of the flight (center).

metal as well as a tearing away or galling of the two materials.

Since the screw is contained in the closed environment of the barrel, it's usually not obvious which or how many of these wear mechanisms is taking place. But I have found over the years that there are telltale signs of the cause if you examine the worn screw flights.

If you have a burr on the trailing side of the flight, wedging is most likely the cause. That occurs from a combination of the high compressive force and the angular motion of the flight relative to the barrel wall during rotation. Essentially, the flight surface is torn off the back of the flight. This will occur almost exclusively in the compression or barrier section of the screw.

While mineral fillers contain hard particles, even relatively soft materials can cause a degree of screw wear.

Mineral fillers often contain hard particles. However even relatively soft materials can cause a degree of screw wear through an extended combination of particle fracture, removal of lubrication, and impact. The same holds true of virtually any type of recycled material. Wear caused by abrasion will tend to reveal itself by a polishing or rounding of the flight corners on the pushing side of the flight surface, eroding the base screw material

Misalignment creates a combination of forces: One is similar to the wedging, but there is also an enormous pressure on the flight as the screw is forced to bend to follow the barrel bore. This results in a tearing and a crushing action that produces a burr on both sides of the flight. This can happen at any area on the screw, depending on the barrel support(s) and alignment with the reducer.

Determination of the cause of the wear is the first step to eliminating it. Once the cause is determined, corrective actions are pretty clear. Occasionally there can be two simultaneous causes—such as wedging and alignment or abrasive wear that masks the other two—but that is pretty rare and does not negate this analysis. PT

ABOUT THE AUTHOR: Jim Frankland is a mechanical engineer who has been involved in all types of extrusion processing for more than 40 years. He is now president of Frankland Plastics Consulting, LLC. Contact *jim.frankland@comcast.net* or *(724)651-9196*.

TOOLING

PART 1 OF 2

Tricks of the Trade on RTOs, RSOs

The more you know about these runner diverters and shutoffs, the more you'll use them. Here's how to put them to work in your mold.

By Jim Fattori

Let's start by defining what an RTO and an RSO is. An RTO is a Runner Turn-Off. It is a cylindrical mold component that can be rotated to prevent the flow of molten material from continuing down its path, or divert it to a different path, or both. RTOs are often located opposite a sprue bushing, but they are also commonly located at the intersection of a runner branch.

An RTO is a specific type of the more generic Runner Shut-Off, or RSO. An RSO can be round, square, rectangular, or any shape imaginable. If it blocks or diverts the flow of material, it's an RSO (see Fig. 1). It can be a small insert with a portion of a runner cut into it. Flip it over and it blocks the flow of material. Or it can be extremely large. Say, for example, you had two MUD inserts in an "H"-Frame and one of the inserts had a problem, or you just wanted to mold one of the inserts. You could rotate the unwanted insert 180°, which effectively makes that entire cavity and core set an RSO—preventing the flow of material from entering it.

FIG 1

A basic RSO blocks or diverts the flow of material.

RSOs are usually used in family molds, because it is common not to need all the different parts during every production run. Molding unneeded parts, and then throwing them out or grinding them up is anything but efficient. RSOs are typically used in two-plate molds, but function equally well in three-plate molds.

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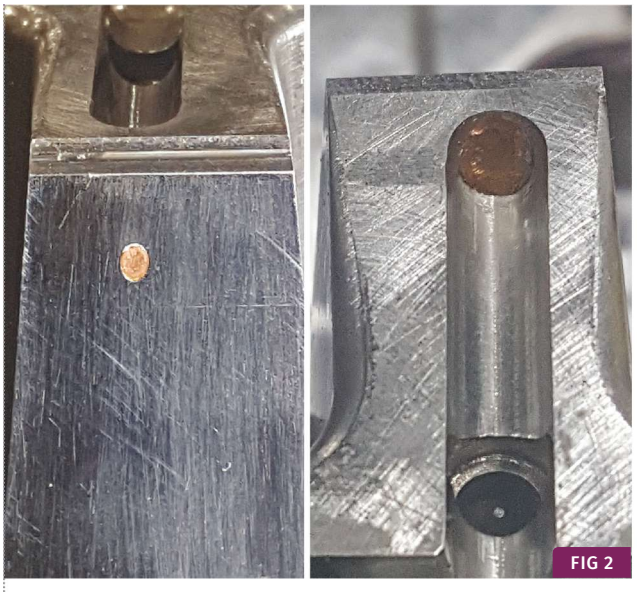


FIG 2

Shown here are subgates blocked with copper, which unfortunately is a common technique.

One advantage to RSOs is that they eliminate the need to use unhealthy methods of blocking off a gate. How many of you have ever pounded a piece of brass, copper, aluminum or electrical solder into a sub-gate hole? (See Fig. 2.) Maybe you prefer to apply cyanoacrylate (aka Krazy-Glue) onto a small portion of a molded part and strategically place it on the core near the gate. Or maybe you go as far as leaving an unwanted part in the cavity and either removing the ejector pins to that part, or drilling holes in the part where the ejector pins are located. These methods are not foolproof; they take time to install or perform and can cause damage to the mold—particularly during removal.

Before I discuss other types of RSO designs, let's briefly review the different types of cold-runner shapes. There are only three types that should even be considered for injection molds. In order of priority, they are: full round, parabolic and trapezoidal. Full-round runners are the most efficient. They have the lowest ratio of cross-sectional perimeter to cross-sectional area. If you are running only virgin material, full-round runners are the way to go (Fig. 3).

However, there are advantages and disadvantages to parabolic and trapezoidal-shaped runners. These runner shapes need only

to be machined into one side of the parting line and they have a lower pressure drop than a full-round runner. But depending on the included angle, they can use 20% to 35% more material than a full-round runner, which potentially can extend the molding cycle time—especially if the runner is removed by a robot or picker. Parabolic and trapezoidal runners can also cause aesthetic issues with certain types of gates, which is a subject for a future article.

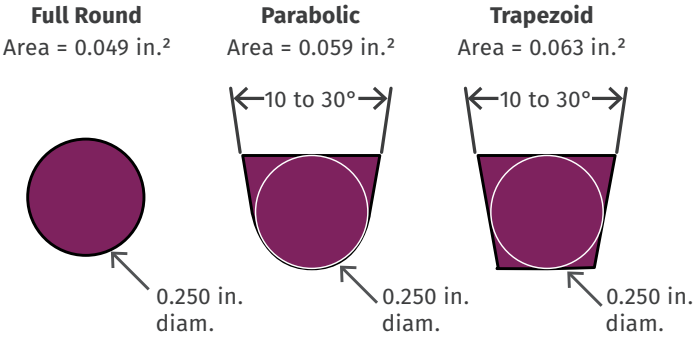


FIG 3 Flow areas of different types of cold-runner shapes.

If you have a parabolic or a trapezoidal cold-runner design, you need only one RSO. If you have a full-round runner, you will need a second, mating RSO on the opposing side of the mold. But you can be a little creative and avoid having to use two RSO's by doing either one of two things: First, you can have a parabolic or trapezoidal runner cut into the RSO, which feeds a full-round runner (Fig. 4), but you need to make sure of two critical design features. The cross-sectional area of the trapezoidal section must be equal to or greater than that of the full-round runner; and the amount of overlap must be sufficient—usually 1.25 to 1.5 times the cross-sectional area. Otherwise, you will be restricting the material flow, which causes an undesirable spike in injection pressure. As long as the material isn't shear sensitive, this design can save a few dollars—and a few headaches.

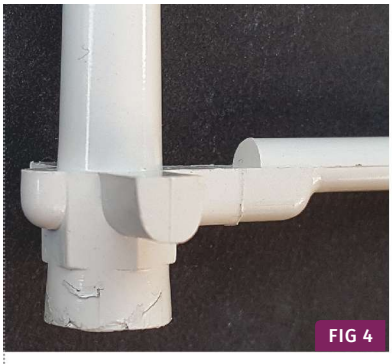


FIG 4 A parabolic RTO feeding a full-round runner.

The other thing you can do is have an RSO with a protrusion extending into the opposing side of the mold to shut off that half of the flow channel (Fig 5). In this design, #8-32 flat-head cap screws are used to secure the RSO in a pocket in the mold base. The countersinks on both sides of the RSO enable you to flip it over and re-secure it to the mold base. The half-round cutout on the bottom of the RSO has the same radius as the runner channel, which when flipped over, allows for uninterrupted material flow. The small inside diameter between both sets of countersinks is drilled with a #19 (0.166-in.) drill and then tapped with a #10-32 thread. The #19 drill is required to clear the outside diameter of the #8 screws. The reason for this #10-32 thread is so a pair of #10-32 socket-head cap screws can be used to easily remove the RSO from its pocket. The ends of the #10 screws are turned down to 0.130 in. diam. This diameter is smaller than the root diameter of the #8-32 thread to prevent any damage to the start of the threads in the pocket. The length of the threaded portion is equal to or greater than two times the height of the RSO. This modified screw is called a jack screw. It's a good idea to mount these jack screws directly to the mold. One method is to drill and tap two holes in any available location, such as an ejector-housing rail or a clamp plate. This eliminates the need to spend an untold amount of time having to hunt for them later.

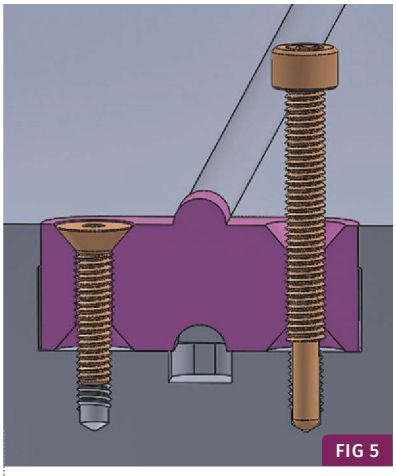
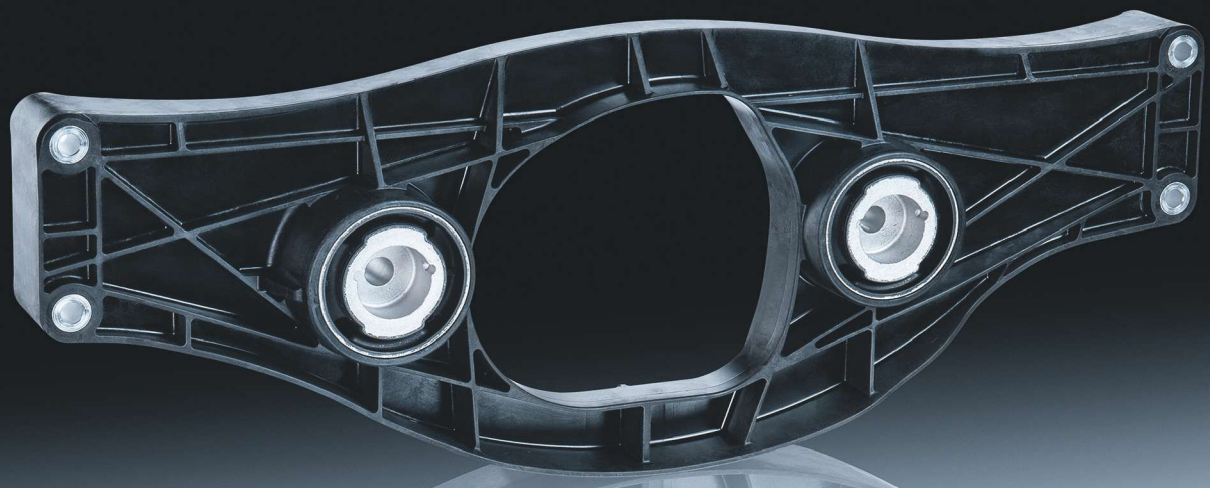


FIG 5 A one-piece RSO for a full-round runner. The jack-screw on the right is used to remove the RSO.

Even though this RSO is for a full-round runner, it can also be configured for a parabolic or trapezoidal runner. This type of RSO can be mounted on either side of the parting line, which can be very handy if a water line or other obstruction is in the way. Lastly, since mating mold components usually "seat" themselves, it is a good idea to orient the RSO. One method to ensure the RSO is always in the proper orientation is to machine the two corners on one end of the insert with a different radius than the opposing two corners. For example, if one end had a pair of ⅛-in. radii and the opposite end had ¼-in. radii, there is only one possible way the RSO can be installed in the pocket in the mold. If you look closely at Fig. 1, you can see that is exactly how those RSOs were machined. PT

ABOUT THE AUTHOR: Jim Fattori is a third-generation injection molder with more than 40 years of molding experience. He is the founder of Injection Mold Consulting LLC, and is also a project engineer for a large, multi-plant molder in New Jersey. Contact *jim@injectionmoldconsulting.com*; *injectionmoldconsulting.com*.



Nylon 66: Pricing & Supply Issues Spur Processors to Consider Alternatives

While the nylon 66 tightness may not prove long-lasting, resin suppliers, compounders, and distributors have mobilized to offer processors an array of 'replacement' materials.

By Lilli Manolis Sherman
Senior Editor

In the last couple of years, a developing global supply/demand squeeze in nylon 66 has led some engineering thermoplastic suppliers, compounders and distributors to be on the ready to address continued capacity constraints and higher prices with alternative engineering resins. Chief among these options are nylon 6, PBT, high-performance nylons like PPAs, and blends containing increased recycle content. While there are varying projections, most sources anticipate the nylon 66 tightness to continue through to at least part of 2020.

The resin constraints are related primarily to tight supplies of key precursor adiponitrile (ADN), which is produced by four major players: Ascend Performance Polymers and Invista in the U.S.; Butachemie, a joint venture of Invista and Solvay in Germany; and Japan's Asahi Kasei. An explosion in 2015 at a Chinese ADN plant took out 18% of global capacity. The ADN issue appeared to have landed prominently on nearly everyone's radar from hurricane season 2017 through 2018, starting with unplanned disruptions in production of ADN and nylon 66, all of which have been largely resolved by now, according to Brendan Dooley, global director for engineering resins at Houston-based IHSMarkit.

By midyear 2018, nylon 66 prices were up more than 50% from 18 months before. In 2018 alone, there

BASF is pursuing all options to source products along the nylon 66 value chain, including the planned acquisition of Solvay's nylon 66 business.

were price hikes of 15-20¢/lb in *both* the first and third quarters. First-quarter 2019 increases would not be surprising. Planned 2019 outages, says Dooley, include six-week shutdowns in the first and third quarters at Invista's Victoria, Texas, plant and Butachemie's German plant, each for the retrofit of new ADN technology.

The good news, according to Dooley, includes some key ADN capacity additions. At Pensacola, Fla., Ascend, the world's largest fully-integrated nylon 66 player, brought on 110 million lb of ADN in 2017; is soon slated to bring on another 80 million lb and plans a 360-million-lb expansion by 2022. The 2019 ADN plant retrofits by Invista and Butachemie will each result in a 10% output increase. And Invista Shanghai is scheduled to bring on stream a new 661-million/lb ADN unit in 2023. Dooley ventures that these actions will translate into some nylon 66 supply improvement by mid-2020. For next year, he projects a continued tight supply/demand balance and potential price relief based on either more supply or less demand.

For applications where parts are exposed to demanding loads in hot air such as charge-air ducts, BASF offers Ultramid Advance PPA.

In October, Ascend released a statement that it says was spurred by "conflicting reports on long-term PA 66 availability" in order to restate its commitment to meeting increased market demand for nylon 66 for the automotive, E/E, cable-tie, consumer and industrial markets. The statement also noted, "The fact remains that PA 66 provides the best mix of value, performance and processability among the various thermoplastics available today. Replacing PA 66 with another material has costs beyond availability and price." Conceding that nylon 66 availability is "constrained for the short term," the company noted its acquisition of Dutch plastics compounder Britannia Techno Polymers, which specializes in nylon, is running at full capacity to serve Europe. Similarly, its Foley, Ala., and Greenwood, S.C., plants are producing at optimal levels; and production at Pensacola, Fla., following the mid-July *force majeure* action, was at around 90% of capacity.

For next year, IHSMarkit projects a continued tight supply/demand balance for nylon 66 and potential price relief based on either more supply or less demand.

BASF also is committed to the nylon 66 market, according to Mark Szendro, marketing director for performance materials transportation in North America. "We are continuously pursuing all options to source products along the nylon 66 value chain. However, the reality is that demand is outstripping supply and this will continue for the next several years. This is why BASF is investing in the future with our planned acquisition of Solvay's polyamide business. The purchase would strengthen BASF's polyamide 66 value chain through increased polymerization capacities and backward integration into the key raw material ADN." He adds that BASF recognizes the need to pursue alternative materials in the interim and is working closely with customers to identify specific applications that could use alternative materials such as nylon 6, PBT or PPA.

Sources at DowDupont, while acknowledging a temporary tightness in the nylon 66 supply chain, report that they have maintained an uninterrupted supply of nylon products and remain confident in their ability to continue supplying long-term customers with Zytel nylon 66 resins. They noted that the company is the only major nylon 66 supplier with world-scale polymerization and compounding in North America, Europe and Asia.

They also note that they have developed a flexible network of suppliers for the key raw materials to ensure they are not dependent on a single upstream asset in any of their product lines. Still, added one company source, "It's possible that supply will be tight for the next year or two. We have not seen a situation as acute and long-lasting as this has been."

A sampling of these and other engineering thermoplastics suppliers, compounders and distributors were asked to weigh in, both on their view of the constrained resin situation and their readiness to assist customers with alternative materials where feasible. Nearly all concede that the automotive sector posed the most concern due to the many applications for which nylon 66 is specified and because specification of any replacement cannot occur overnight.

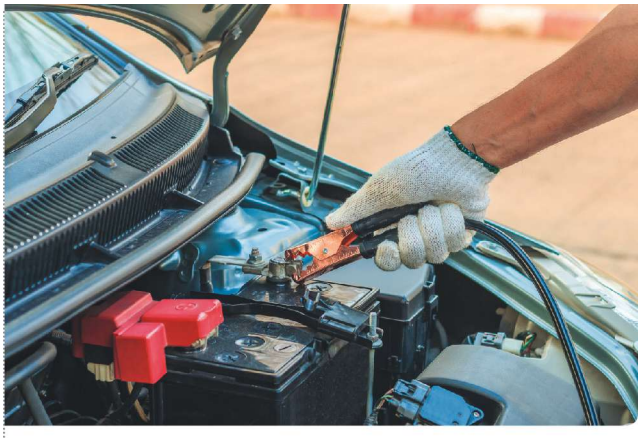
REPLACEMENT ISSUES

Although industry sources concede that several nylon 66 component manufacturers and end-use OEMs are evaluating alternative materials, actual replacement to date appears to have been quite limited. One reason, according to Chris Wilson, v.p. and head of crystalline business for Solvay Specialty Polymers, is that making a switch is no small feat. "Switching from nylon 66 to an alternative material is generally not as easy as just dropping a new resin into the machine. Oftentimes, potential impacts on dimensions, part features or the performance of the part need to be considered."

Still, nearly all industry sources concede that they have customers expressing concern about higher prices and resin tightness. Sources at PolyOne Corp. report that they saw this concern in early 2017, with customers asking for market data, price forecasts, and details on supply constraints. By the same token, PolyOne ►

sources maintain that very few customers have switched to other resins. Says one, "We have some customers who are trying nylon 6, but the more dominant switch is from prime to recycled or wide-spec nylon 66."

Adds Steve Bowen, president of PolyOne's PlastiComp business, "The supply of nylon 66 has been tightening for over a year, which has required close management to ensure there are no supply disruptions for us. Our long-term partnerships with key suppliers are helping us navigate during this critical period. We have been able secure sufficient nylon 66 material necessary to maintain our core business while also growing some additional segments."



In addition to nylon 6 for industrial and automotive applications such as underhood parts, PolyOne's PlastiComp business is also offering blends of nylon 6 and nylon 66 in long-fiber formulations.

Solvay's Wilson says, "I think the industry had taken it for granted that there would be an unlimited supply of nylon 66, and this thinking has now clearly shifted. An automotive customer commented to me that until the situation is resolved they are actively steering development projects away from nylon 66 and into other resins, even if it requires some part redesign."

According to Wilson, Solvay already has several active developments underway to help customers convert to other resins in the company's portfolio. "Typically, nylon 66 users try to substitute with products based on PP, nylon 6, or PBT. If these polymers cannot meet the technical requirements, or if costly retooling is required, they then turn to high-performance nylons such as our Omnix HPPA, Ixef PARA, or Amodel PPA." He adds that there are several advantages to moving up the performance pyramid from nylon 66 with such materials. Parts can often be made with thinner walls and therefore use less resin making parts lighter with an overall lower cost and without the need for new or modified tooling.

While PolyOne has seen few customers making a switch from nylon 66, they are increasingly asked for market data, price forecasts, and details on supply constraints.

Jose Chirino, technical director of the Americas region for the high-performance materials business unit of Lanxess, reports that for several months, the company's sales and technical teams have been engaging in frank discussions with customers about the material selection process. "We've found that many times, the chosen material is more historical than truly engineered into the application. We have questioned this approach and had success in switching customers who are seeing a surge in their part cost due to raw-material increases and are concerned as well about short and mid-term material availability. But apart from cost and availability issues, many nylon 6 and PBT grades can nowadays meet crucial requirements with regards to properties, such as mechanical or thermal performance, surface quality and flame retardancy."

Counters Alex Fung, president of resin distributor Conventus Polymers, "Customers are concerned that this could continue into 2020. Customers continue to see repeated price increases on nylon 66 and even nylon 6. Sure, there are alternative resins to use such as PBT or nylon 6, but nylon 66 offers a unique combination of properties and value that may make it difficult to replace, so you'll want make sure you account for these differences." Fung maintains that the company's extensive experience in dealing with these kind of supply issues, led it to buy ahead.

> ***"We have some customers who are trying nylon 6, but the more dominant switch is from prime to recycled or wide-spec nylon 66."***

ALTERNATIVES AND TARGET APPLICATIONS

Some sources contacted opted to give a brief summary of materials they are offering as nylon 66 replacements when warranted. Others provided a more comprehensive description of their alternative materials for specific applications:

Celanese Engineered Polymers: Jeff Helms, global automotive sales director for engineered materials at Celanese, says the firm has customers strongly considering switching to nylon 6 when the parts can function properly at slightly lower temperature limits and with slightly higher moisture uptake. Celanese is also positioning recycled nylon 66, nylon 6 and post-industrial resin (PIR) offerings.

DowDuPont: While the company is not aware of customers who have switched to alternatives, for those that do want to qualify alternative solutions for existing commercial applications in automotive, E/E, industrial or consumer markets, DuPont offers Zytel nylon 6, Zytel HTN PPA, Crastin PBT, Rynite PET, and Delrin POM acetal.

PolyOne: The company says it is offering nylon 6 for industrial and automotive applications, two industries the most open to trying alternatives. The company's PlastiComp business is also offering blends of nylon 6 and nylon 66 in long-fiber formulations.

BASF: Szendro notes three options: For parts that require good electrical properties, good heat aging, weldability, impact performance and damping, he proposes Ultradur nylon 6 as a solution. Possible uses include structural components, powertrain applications, and exterior appearance parts such as door handles and pedals.

For electrical and lighting applications such as connectors, housings for electrical control units, and sensors, where better dimensional stability is a requirement, Szendro cites Ultradur PBT grades.

For parts exposed to demanding loads in hot air, such as charge-air ducts or parts where there is a lot of wear, Szendro notes Ultramid Advance PPA grades, which boast both hydrolysis and chemical resistance plus dimensional stability.

Lanxess: Chirino gives some examples of specific replacement applications and newly developed materials to compete with nylon 66. The company supported a customer producing a shifter box in 30% glass-filled nylon 66 by showing that the mechanical properties of the component and the dimensions of the part would be the same if a 35% glass-filled nylon 6 was used with existing tooling.

Material availability and cost concerns in the household-appliances market led Lanxess to evaluate alternative materials with a customer producing oven handles in a 30% glass-filled nylon 66. In this case, after understanding the part load and impact requirements, Lanxess suggested a nylon 6 with 30% fiberglass and glass beads. The part passed all dimensional, load and impact requirements, and also had the advantage of improved appearance.

Feedback from nylon 66 customers concerned about long-term fatigue if they switch to an alternative encouraged Lanxess to develop the new Durethan-Performance "P" nylon 6 compounds. These boast improved fatigue properties and perform considerably better than standard nylon 66 grades.

A key criterion for selecting a material in the E/E market, particularly for small parts such as connectors, is cycle time. Chirino says Lanxess has seen increased interest in its Pocan XF (eXtreme Flow) PBT and PBT blends. These reportedly have shrinkage and mechanical properties very similar to nylon 66; but because of their low viscosity, these PBTs can be molded at lower temperatures, reducing cooling time in injection molding.

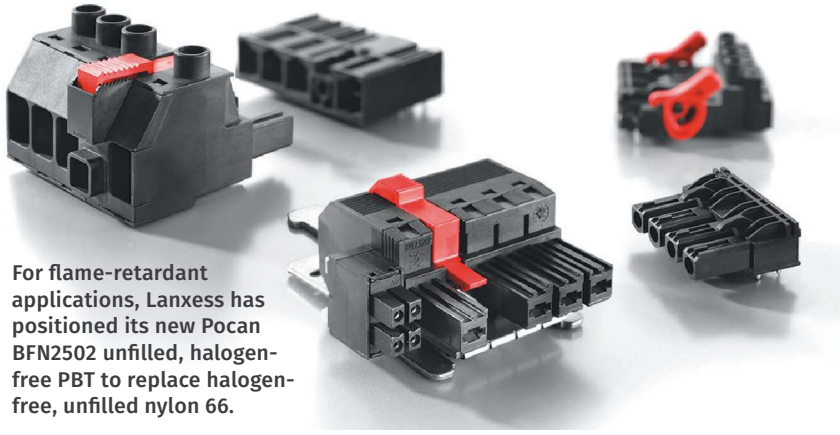
For flame-retardant applications, Lanxess has positioned its new Pocan BFN2502 unfilled, halogen-free PBT, which achieves a UL 94V-0 rating at an impressive 0.4 mm, to replace halogen-free unfilled nylon 66.

Solvay: Wilson cites Omnix HPPA, a high-performance PPA, as a clear choice to replace glass-filled nylon 66, as it provides equivalent properties under dry conditions and superior performance after moisture absorption is considered. It is targeted to structural applications in automotive and food-contact and drinking-water applications in consumer markets.

For higher-temperature applications, Wilson suggests Amodel PPA as a good alternative that will outperform nylon 66. For applications requiring high-surface quality and mechanical strength, he cites Ixef PARA polyarylamide (MXD6 nylon) as an alternative.

For applications requiring additional flexibility or better impact resistance, there are toughened and elastomer-reinforced grades in the Amodel PPA and Ryton PPS portfolios that offer potential alternatives to unfilled nylon 66 grades.

DSM Engineering Plastics: The company has positioned four polymers that could relatively easily replace nylon 66. Akulon nylon 6, with its near-equivalent performance in stiffness and strength to nylon 66—and superior performance in toughness, processability, and heat-aging up to 392 F—suits it to applications where parts are exposed to hot air such as intake manifolds and air ducts; exposed to oil such as oil pans and filters; and parts with high requirements for surface appearance, such as pedals, door handles and power-tool housings.



For flame-retardant applications, Lanxess has positioned its new Pocan BFN2502 unfilled, halogen-free PBT to replace halogen-free, unfilled nylon 66.

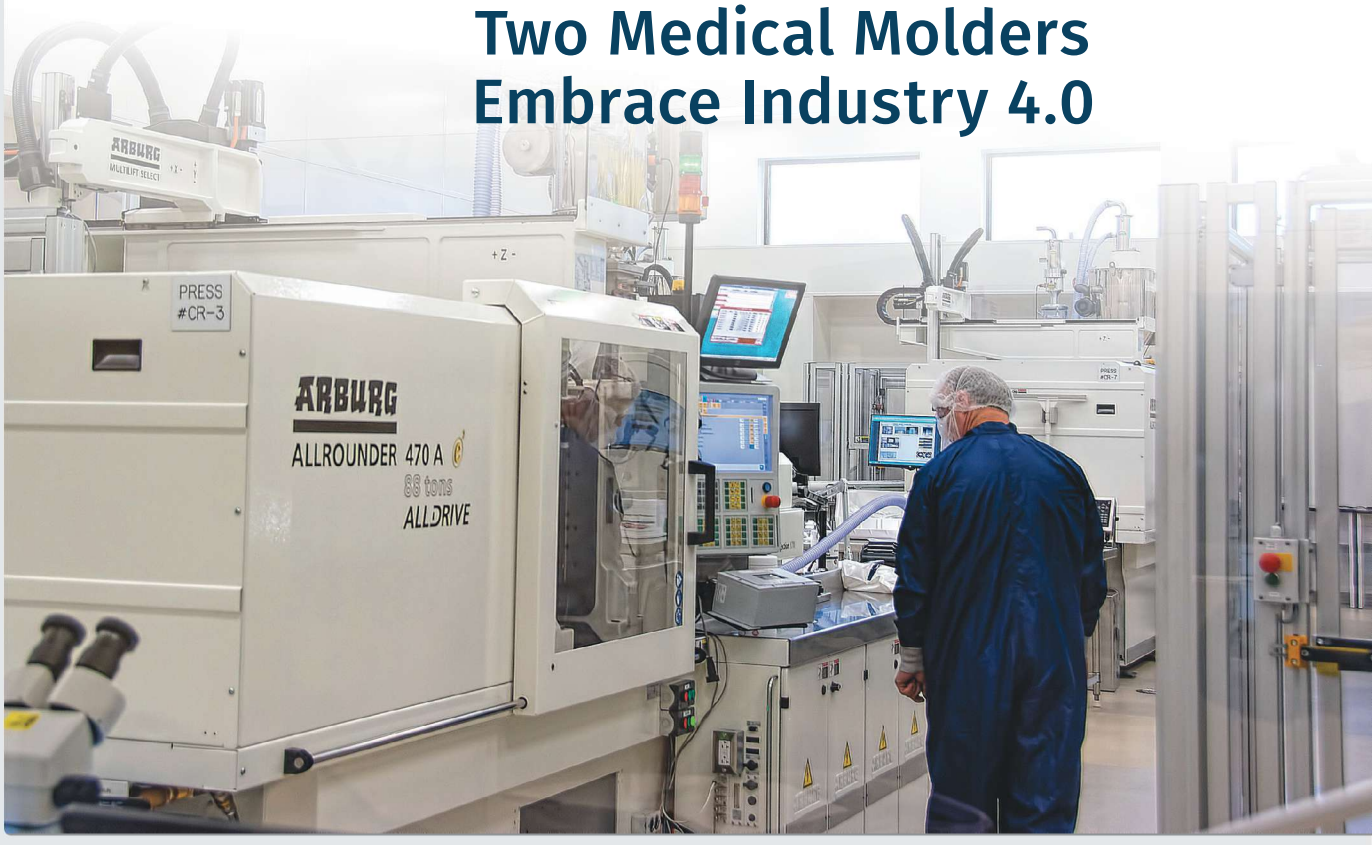
EcoPaXX nylon 410, a high-performance biobased nylon, is cited for applications where parts are exposed to water or glycol such as in automotive thermal management. It demonstrates low moisture absorption and excellent chemical resistance, fast and easy processing, and the highest melting point of all biobased nylons at up to 482 F.

Another alternative is DSM's Stanyl nylon 46 with high stiffness retention up to 554 F and excellent wear and abrasion resistance. It's positioned for parts exposed to wear and friction, or exposed to demanding loads in hot air or oil.

Arnite PBT, meantime, is said to be suitable for electrical and lighting applications such as connectors, lighting frame bezels, and LED components. PT

By Matthew H. Naitove
Executive Editor

Digital Manufacturing: Two Medical Molders Embrace Industry 4.0



‘Digitalization’ and ‘connectivity’ are loaded terms—shorthand for a whole new way of doing business. It can’t be accomplished in one go. But two Midwest molders in the sensitive medical field are already feeling the benefits of their initial steps in that direction.

While glowing predictions of an era of “smart factories” may strike some plastics processors as an imaginative exercise rather than a near-term reality, there’s no question that some pioneering firms are pursuing the avenue of “smart management” as their route toward Industry 4.0. This is particularly evident in quality-critical markets such as automotive (see April Close-Up) and medical. The latter was evident in a recent visit to two medical injection molders in the Great Lakes region that are using information management as a strategic tool for improving quality, efficiency, and costs. Comparing their “4.0” implementations may be instructive both for the similarities and the differences.

One of eight Arburg all-electric machines in a clean room at Plastikos. Each machine has two screens—the Selogica machine controller and a separate screen for the ALS central MES computer, as well as mold-protection camera images and RJG eDART quality data. In background is a shared screen (one for every eight to 10 presses) for ALS and IQMS ERP data.

HOW THEY GOT HERE

Plastikos Inc. in Erie, Pa., and Roechling Medical Rochester in Rochester, N.Y., both had their origins in moldmaking: Micro Mold was established in Erie in 1978 and launched Plastikos in 1989 to get into molding. Meanwhile, Advent Tool & Mold started up in Rochester in 1978 and

branched out into molding in the following decade. It was purchased in 2012 by Roechling Group, a German firm with global operations in industrial, automotive, and medical plastics processing.

Both operations decided to emphasize medical molding in the past 10 years. Plastikos (***plastikoserie.com***) started out molding electrical connectors, but made a serious push in medical starting around 2009, accelerated by installation of an ISO 7 (Class 10,000) clean room with eight all-electric presses in 2015. Today it retains the connector business but its revenues are 30-40% from medical devices for drug delivery, surgical eye care, fluid dispensing and orthopedics, among others. It has a 77,000 ft^2 plant with 160 employees and 35 injection presses from 88 to 220 tons. All are Arburgs, except four from Sumitomo (SHI) Demag. Thirty-four machines are all-electric. Plastikos is building a new 33,000 ft^2 medical plant nearby that will add 10 machines, with 10 more planned to follow in a second phase. At full capacity, the new facility will more than double the company's current clean-room molding area. Combined revenues with Micro Mold are above $33 million, says Rob Cooney, manufacturing manager.

"The key advantage is in program administration. We can load a qualified process from the ALS server to the machine. It saves time and reduces the risk of manual transfer or using a USB stick."

The molding business at what is now Roechling Medical Rochester (***roechling-advent.us***) was mainly automotive and business equipment until 2006, when it began to focus on medical. When acquired by Roechling, the medical share of its business was 60% and is now over 90%, according to Joe Lenhardt, v.p. of operations. It produces surgical, diagnostic and laboratory devices. Clean-room molding and assembly occupy 6500 ft^2. Part of the $2 billion+ Roechling Group with 90 locations in 23 countries, the Rochester medical plant occupies 80,000 ft^2 (plus a 30,000 ft^2 warehouse/distribution center nearby) with 260 employees and 52 injection machines from 28 to 550 tons. Upwards of 90% of those presses are Allrounders from Arburg, accompanied by some Toshiba and Engel presses. The company has some hydraulic machines—mainly two-shot presses—but has bought almost entirely all-electrics since 2003.

Plastikos medical molding manager Danielle Bentley. Upper screen shows mold thermal imaging data; it can also display ALS and eDART data.

MES HUB FOR DATA EXCHANGE

Medical molding requires extensive record keeping and strict adherence to qualified processes. So it's logical that both of these molders began their journey to Industry 4.0 with MES (manufacturing execution system) computers. And, because they are predominantly Arburg shops, they chose the Arburg ALS host-computer system as their information hub.

Danielle Bentley, a Plastikos process engineer and medical molding manager, says the ALS came to that firm in 2013 with a package of 10 selected data screens (the choices have changed over time). The most-used display is the machine overview, which shows the press layout on the shop floor, with each press colored green if running or blue if down for maintenance or setup. This screen can show each machine's OEE (overall equipment effectiveness). At Plastikos' sister company, Micro Mold, two molding machines used for mold development are also tied into the same ALS network so that process refinements can be transferred easily to Plastikos when production begins.

"Within the maintenance module, pre-warnings proactively alert technicians when machines are coming due for required maintenance. Production planning is also notified so that we can decide when it is appropriate to take the machine down for maintenance," explains Bentley.

The four Sumitomo presses are also tied into ALS, which can display machine status.

Meanwhile, at Roechling, Lenhardt says, "According to Arburg, we are their largest ALS installation outside of Germany, in both number of machines and number of software modules used." He describes the "core" of the system as production and process monitoring: "We can see at a glance what's running and get OEE for the entire shop or groups of machines, or even individual machines." As at Plastikos, another core function is loading ►

Plastikos's Bentley with shared screen for every eight to 10 presses, here showing a mold sample sheet—part of the company's push to go "paperless."

One of six shared "kiosk" screens for every seven to eight machines at Roechling Medical Rochester, showing the ALS shop overview screen. Soon each machine will have a kiosk to access ALS.

a qualified process from the ALS server to the molding machine. Roechling can do the same for its small number of Arburg robots, and potentially could do that for a range of auxiliaries—dryers, chillers, etc.—that Arburg offers under private label, Lenhardt says.

Roechling also uses the ALS maintenance module to schedule P.M. for presses, robots, dryers, etc.—even for plant utilities such as the rooftop air conditioner and central water system. The maintenance module automatically generates P.M. work orders based on operating time—except for molds, which are scheduled for maintenance based on number of cycles run.

Roechling's ALS server is connected to its Infor SyteLine ERP system, so that SyteLine "pushes out" the production schedule to ALS, and from there to each press. "In the past, we just had a master schedule for the whole plant," says Lenhardt.

In turn, the ALS tells the ERP system to reserve time for machine maintenance when formulating production schedules. Echoing Plastikos's pre-ALS experience, Lenhardt recalls, "Before, we had separate P.M. software that was monitored by the maintenance manager. He would say, 'I'll need this press today,' which caused conflicts with production."

> ***"Electronic information helps us gain insight into efficiency and what's happening on the factory floor—automatically. We didn't have that before—just handwritten records and human memory."***

The maintenance module fills in a record-keeping gap that plagues many molding shops: It logs every maintenance work order, notes when it is completed, allows maintenance personnel to add notes, and also records unanticipated maintenance. Lenhardt cites an example, "If the maintenance records show us that we had to replace a switch three times in the past year, we would start to wonder if we were getting defective switches."

Roechling also uses Engel's e-factory MES system for its handful of Engel presses. This is connected to the Arburg ALS so the ALS can send setup programs to e-factory and from there to the Engel machines. Roechling has no comparable capability for its few Toshiba presses.

Both Plastikos and Roechling have monitors strategically located throughout their plants to access and log both production and process data.

At Roechling, the Arburg Selogica machine controller offers visibility to all "the nuts and bolts of the process," as Lenhardt puts it; only selected data are sent to the ALS, based on a standard list of parameters used for all machines.

All Roechling administrators can access ALS on their PCs. The production manager can access it on his phone and receives automatic text alerts or emails if a press goes down unexpectedly. And, as at Plastikos, Roechling is installing new shared computer kiosks with ALS access for all machines. These kiosks also allow manual data input. As Lenhardt describes it, the ALS documentation module available at each kiosk ties each production job to a file folder that includes workcell setup diagrams and settings for auxiliary equipment (which must be set up manually at present).

In addition, Roechling has one large, 90-in. display on a wall in the molding shop, which displays the status of all machines, with an indicator that starts flashing if any press wanders outside its process limits.

Both firms are pushing to go "paperless" for better process control and traceability. At Plastikos, this is accomplished through having critical setup parameters and process optimization records accessible directly at each machine. Roechling accomplishes this with the new kiosk displays, where it is now implementing electronic work instructions—setup, operating,

and quality-inspection instructions, along with photos and videos. "This makes more information directly available at a single point to the people doing the work," explains Lenhardt.

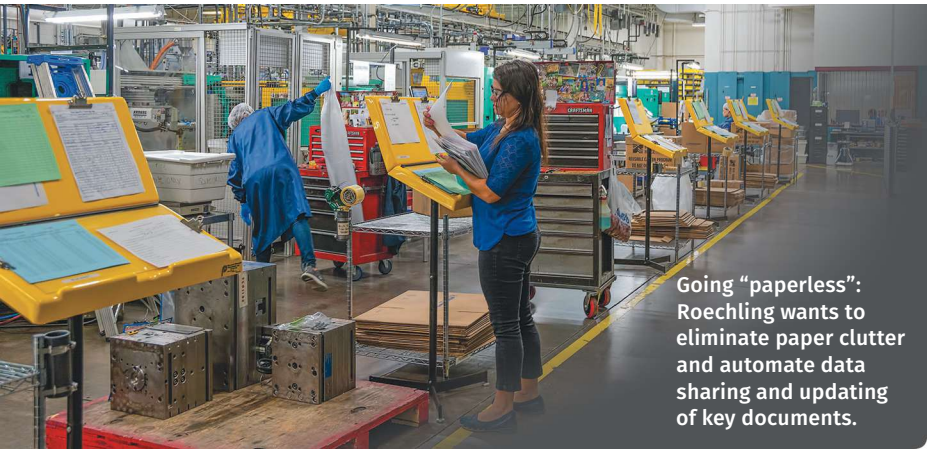
THE PAYOFFS

Plastikos and Roechling agree on one of the benefits of plantwide data exchange: "The key advantage is in program administration," says Lenhardt. "We can load a qualified process from the ALS server to the machine. It saves time and reduces the risk of manual transfer or using a USB stick."

Agrees Bentley, "It's much better than setup by hand from a printed list. You can be sure you're not missing anything, like setting the production sequence, robot program, clamp tonnage, ejector settings, etc. These aren't typically controlled using a traditional process sheet but they can sometimes be extremely critical, depending on the part and mold. All of this translates into increased efficiency, quality and uptime."

"We're doing a lot of the pieces of Industry 4.0, but it would be nice to bring it all together into one central computer."

Both firms agreed on the efficiency benefits of coordinating preventive-maintenance scheduling and production scheduling. And both agree on the value of "going paperless." Says Lenhardt, "First, I don't like to see paper clutter at work stations. Second, electronic data improves revision control, which is a large task with hard copy. Record keeping, training records—they all become more reliable and accessible in electronic form. And in our business, there is a multiplicity of forms for jobs, purchase orders, and so forth—all are audited by our medical customers. Paper forms are one of the more difficult things to maintain; but with electronic information, everything is updated automatically. And you can still print it if you want to."



Going "paperless": Roechling wants to eliminate paper clutter and automate data sharing and updating of key documents.

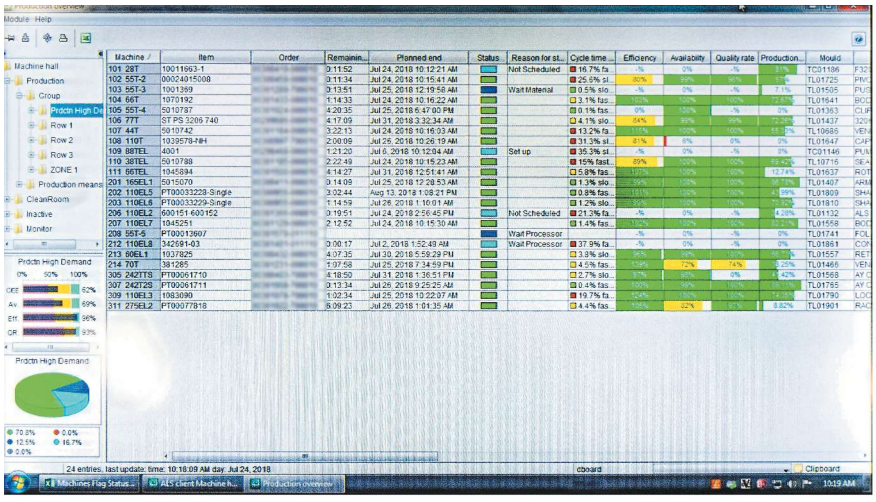
Roechling Medical's Joe Lenhardt, v.p. of operations, with screen showing electronic work instructions for a "paperless" shop.

Lenhardt continues: "Roechling is very focused on Industry 4.0—digitalization and leveraging technology to coordinate the manufacturing process. Electronic information helps us gain insight into efficiency and what's happening on the factory floor—automatically.

"All data is stored in real time. We can go back in time and look at process parameters, see how many production interruptions occurred and on which shifts. It's good for root-cause analysis. We didn't have that before the ALS—just hand-written records and human memory. The machine control stored only the last 1000 shots, but ALS allows us to view a much longer time scale. Everything from the machines goes into the server and is automatically backed up."

Production data has its value too: "Automatic recording of production quantities alerts personnel when a job is done. In the past we might have run two extra shifts worth of product because we had to rely on technicians to set and monitor the job counter. And ALS keeps track of shots that fall outside of spec limits. It knows the mold cavitation, so it tracks the number of *good* parts made toward the order quantity. In the old days, we might have shut down after thinking we had finished a job and discovered we were short because of failing to account for rejects."

Lenhardt adds, "OEE data from ALS is a key metric for us. We use it each month for management reviews. We don't use it for a snapshot of operating performance, but to keep track of it over time." One element of OEE data is particularly important to Roechling: "Our quality is typically 100%, and our cycle-time efficiency is typically very high. So machine uptime availability is most important to us, especially for machines producing high-demand products. We break down availability tracking into groups of machines; because older presses have lower availability, we group them together. OEE tracking helps us spot issues, like ►



Giant screen on wall at Roechling Medical displays ALS overview of shop performance.

why is this machine under-utilized? If others are over-capacity, can we cross-qualify? Or is that unit near the end of its useful life?"

Lenhardt's ultimate goal is to automate data acquisition from his mold shop, transferring data from CNC mills, EDM machines, etc. to ALS. He says viewing which machines are running or in setup, as well as runtime data, would jump-start continuous improvement of machine utilization.

Bentley at Plastikos notes the value of integrating different sources of process and production data. Her shop currently has plans to integrate multiple systems into one.

> ***"Paper forms are one of the more difficult things to maintain; but with electronic information, everything is updated automatically. It improves revision control, which is a large task with hard copy."***

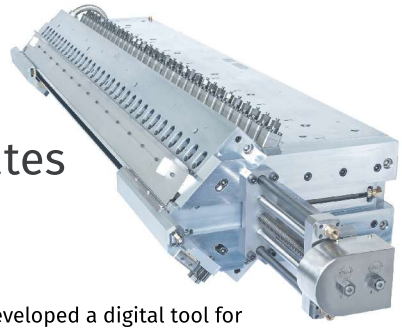
The two firms have experience with one other aspect of Industry 4.0, which is often referred to as "smart services." Recalls Lenhardt, "Remote troubleshooting by Arburg was very useful in integration of the ALS system." Bentley notes that Plastikos has used Arburg's remote troubleshooting for help in robot programming and ALS questions. PT

PT Keeping Up With Technology

PRODUCT FOCUS Extrusion

SHEET

On-Line Tool Calculates ROI For Fast-Change Sheet Die



Nordson Corp., Chippewa Falls, Wis., has developed a digital tool for comparing the cost inputs of standard sheet dies with removable lower lips and those of the EDI SmartGap mechanism for rapidly changing sheet thickness. The tool, called the SmartGap Payback Analysis, enables sheet processors to calculate the payback time for switching to SmartGap technology.

SmartGap reportedly enables processors to make changes in thickness with unprecedented speed, extend the range of thicknesses they can produce, and achieve these improvements while enhancing sheet quality. The single-point adjustment mechanism changes the lip gap while simultaneously modifying the length of the lip land to provide the most appropriate conditions for the newly adjusted thickness as the sheet exits the die. By mechanically linking the adjustment of these two key variables, SmartGap reportedly ensures proper die setup and eliminates time and guesswork to achieve desired sheet properties.

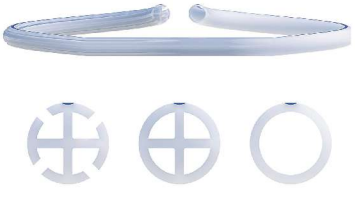
SmartGap Payback Analysis requires two types of information: 1) one-time investment costs of a standard sheet die with removable lower lip and of a new SmartGap system; and 2) process data including die length, output rate, frequency of die-gap and die-lip changes, number of working days, raw-material cost, approximate product selling price, and hourly burden cost of the sheet line.

Using these inputs, the software calculates the daily output values of the two systems, including downtime, missed production output, downtime cost, missed product gross profit, and total downtime cost; compares the time required for changing die lips vs. that needed for changing the die gap with SmartGap; and estimates the how long it would take for a complete ROI with SmartGap. Payback typically occurs in a matter of months, according to Nordson.

TUBING

Reciprocating Head Allows Tubing Profile Changes 'On the Fly'

In the new reciprocating head from Guill Tool, W. Warwick, R.I.., the typical tip and die assembly is replaced with a linear reciprocating assembly that changes the tube's profile on the fly within a given length. This process is repeated throughout an extrusion run without interruptions. As a result, only one run is needed to produce a finished product, as opposed to multiple runs requiring tooling changes and manual assembly to connect different tubing shapes. Guill's new reciprocating head also eliminates in-process inventory. As a result, there is no need to store various tubing shapes and connectors needed for assembly, order fulfillment, and replenishment of finished goods.



Moreover, the reciprocating head eliminates a connecting piece, allows JIT production and products made-to-order, and reduces total run time from receiving the order to shipping, according to Guill.

SHEET

Next-Generation System For PET

Reifenhauser, Maize, Kan. has developed its next-generation sheet extrusion line for PET packaging. The line uses the company's third-generation series of REItruder twin-screw extruders to produce sheet for direct food contact from 100% rPET meeting FDA requirements.

Lines can be furnished with various coextrusion feedblocks from Reifenhauser EDS. Reifenhauser purchased flat-die specialist EDS GmbH about a year ago. As a result, it can furnish feedblocks with fixed-layer geometries along with the more flexible REIcofeed 2.1 feedblock systems, in which material streams can be adjusted during operation. Processors can choose between internal deckling for maximum flexibility in film width, or a lip gap that can be configured during operation for fast thickness changes. Also available are either manual or automatic operation with thermal-expansion bolts.

Downstream, Reifenhauser has updated its Mirex-MT-V high-performance polishing stack with three or four polishing rolls. As an option, the roll stack can be specified with an axis crossing for the first roll to produce thin films with large widths.

The entire line has been prepared for incremental implementation of Industry 4.0 functions that are being developed group-wide by Reifenhauser Digital.

INJECTION MOLDING

High-Speed All-Electric Press Line

At October's Fakuma 2018 show in Germany, Sumitomo (SHI) Demag introduced the all-electric, high-speed IntElect S series from 50 to 180 metric tons, with injection speeds between 350 and 500 mm/sec. They are built especially for cycle times in the 3- to 10-sec range, vs. >10-sec cycles for standard IntElect machines, which have injection speeds of 50 to 200 mm/sec. To accompany the new high-speed line, Sumitomo Demag launched the SDR Speed robot series, built by Sepro.

Starting last year, the company renewed the standard IntElect line with a second-generation series and a new platen concept. This started at the small end with machines from 50 to 180 m.t. Mid-size models up to 500 m.t. will follow next year. Larger IntElect S models are also planned.

INJECTION MOLDING

Korean Servohydraulic Presses with European Controls

Woojin Plaimm of South Korea showed off its new HD-A5 series of fully hydraulic presses with energy-efficient servo pump at October's Fakuma 2018 show in Germany. Offered in sizes of 100 to 400 metric tons (U.S. office in Mount Prospect, Ill.), they are aimed at precision molding for automotive, electronics, etc. These units boast a central clamp cylinder, linear guides, swiveling injector, and new IMC 500 controller from B&R of Austria. The latter has an 18.5-in., full-HD, multi-touch screen and web connectivity that enables access via smartphone, tablet, or PC. OPC-UA communications protocol for Industry 4.0 can be implemented on this controller.

INJECTION MOLDING

Upgraded Servohydraulic Line & Two-Shot Electrics Debut at Fakuma

Two new versions of existing press lines are available from Absolute Haitian. Both were exhibited by Haitian International at October's Fakuma 2018 show in Germany.

First, the Mars II S is an upgraded version of what Haitian claims is "the world's best-selling injection molding machine." This servohydraulic toggle series ranges from 67 to 3709 U.S. tons;

200,000 of the Haitian Mars series have been installed worldwide. The new "II S" version (up to 1320 U.S. tons) boasts a redesigned clamp that reportedly provides even greater energy efficiency and faster movements. Other improvements include reduced overall footprint, increased open space at the clamp end for conveyors, and improved pivot design on the injection unit for easier screw and nozzle changes. Absolute Haitian has some models in stock for quick delivery. (The company gave a "sneak peek" at a new-generation Mars III at NPE2018, but that series will not be available until late 2019 or early 2020.)

Second, Fakuma saw the debut of the Zhafir Zeres Multi-Series, a multicomponent version of the all-electric Zeries line, which has integrated hydraulics for nozzle touch, ejector and core pulls. The second injection unit can be mounted vertically, parallel to the main injector, or in a right-angled "L" version. Zeres Multi is offered in 190 to 450 metric tons.

BLOW MOLDING

Upgraded Wheel Machine with Servo-Driven Clamps

A new version of the Series III rotary blow molder from Wilmington Machinery has servo-driven clamps that provide extreme consistency of clamp opening/closing from station to station, resulting in high bottle uniformity. Like the Series III, the new Series IIIB comes with nine to 36 stations (clamps) in four sizes from 2.5 to 10 tons. It rotates at up to 10 rpm for production of 45 to 720 bottles/min. One or more extruders and a variety of die heads—single- or dual-parison—can be supplied for bottles of one to seven layers.

Besides the servo-driven clamps, new features include more robust, modular clamp stations with air and water services pre-plumbed directly to the clamp platens, which are said to significantly reduce maintenance and setup times. Dual-cam clamp action reportedly reduces wear and allows for independent open/close control of each mold half. This feature is especially useful in ejecting and placing bottles at the discharge point.

The new wheel retains the "radial positioning" or variable-pitch feature of the earlier Series III. A change is the unique "spoke" mounting arrangement of the clamps to the axle, creating a simpler, more robust arrangement that is much faster to set up. It also retains dual water unions to the molds for improved coolant flow and reduced cycle times.

PROCESS COOLING

Variable-Speed Packaged Chillers

Expanding the range of its VS Chillers, Delta T Systems is now offering these units—previously available from 1 to 30 tons—in sizes of 40, 50 and 60 tons. They come standard with four variable-speed compressors that are said to operate effectively at 10% to 100% of rated capacity. According to the company, VS units provide up to 50% energy savings over fixed-speed chillers regulated by conventional hot-gas bypass systems (see May '17 Close-Up for more details). The units are said to pay for themselves in less than 3 yr.

Available in air- or water-cooled versions, the units have variable-frequency drives (VFD) for soft starts and reduced compressor cycling. Other features include variable-speed condenser fans; oversized stainless-steel, brazed-plate evaporators; one large central pump tank; individual redundant refrigeration circuits; and industry 4.0 controls design.

ADDITIVES

Slip Additive Masterbatch for LDPE Film

A new silicone-based slip masterbatch for LDPE film that reportedly optimizes form-fill-seal (FFS) packaging production has been launched by Dow Performance Silicones, a unit of DowDuPont Specialties Products Div. Dow Corning MB25-235 masterbatch is said to significantly reduce the coefficient of friction (COF) for LDPE film. The product is said to address the traditional drawbacks of organic additives by delivering stable, long-lasting slip performance and avoiding migration to the film surface.

MB25-235 reportedly also helps to boost production speed without affecting seal quality. This masterbatch is said to surpass the performance of traditional organic additives by delivering a consistently low, stable COF that is unaffected by time or temperature. It reportedly meets the film's critical mechanical properties like tensile and tear strength.

Unlike organics, it needs to be incorporated into just the outer (skin) layer of multilayer films, reducing the amount required. It is effective at low loadings of 2-4% and is approved for food contact under FDA, EU and Chinese regulations.

MATERIALS

TPEs Adhere Well to Nylons

New styrenic TPEs with outstanding adhesion to nylons and compliance with EU Regulation 10/2011 for food contact were recently introduced by Kraiburg TPE. The new FC/AD/PA Thermolast K series boasts excellent processability and superior surface quality that requires no finishing after leaving the mold.

These materials can be overmolded onto nylon 6 and 66 without any adhesive primer. They can be translucent or colored. With hardness between 40 and 80 Shore A, they provide tactile properties such as soft touch and non-slip grip even at low wall thicknesses. Superior tensile strength, elongation at break, and abrasion resistance are also claimed.

The FC/AD/PA series is targeted specifically at consumer products and food contact. Typical applications include tool components that comply with food regulations as well as handles and surfaces of household appliances such as coffee machines and juicers. Further possible applications include healthcare—interdental brushes, eyeglasses frames and hearing aids—along with a wide array of cosmetics and sports articles.

MATERIALS

Nylon 66 for Automotive Lightweighting

A new glass-reinforced nylon 66 with improved energy absorption is said to outperform similar materials, reducing noise, vibration and harshness (NVH), and absorbing impact energy from crashes. Launched by Ascend Performance Materials at the recent Fakuma 2018 show in Germany, Vydyne R433H is designed to reinforce downgauged steel and aluminum used to reduce vehicle weight. In electric vehicles, where lightweighting and NVH reduction are especially important, R433H also reportedly works well in battery frames and housing.

MATERIALS

High-Heat, Reinforced Nylon 66 Bridges Cost-Performance Gap

A new series of high-heat, glass-reinforced nylon 66 compounds is said to bridge the cost-performance gap between standard heat-resistant nylons and costly specialty polymers, providing injection molders with a more economical alternative for automotive and other metal-replacement parts. The Creamid 240 H7.5 Series from Teknor Apex Co. was launched at the recent Fakuma 2018 show in Germany.

These compounds reportedly boast strength and stiffness comparable to highly glass-filled engineering polymers while maintaining high levels of critical mechanical properties even after continuous service at temperatures of 240 C/464 F. Currently available grades with glass content of 35, 50, or 60% exhibit dramatically improved property retention over similar standard nylon 66 compounds. At the same time, they cost around 30% less than high-performance polymers such as polyphthalamide (PPA) or nylon 46, while providing comparable performance.

According to Teknor Apex, additional cost savings with Creamid 240 H7.5 compounds are achievable in processing. These new materials exhibit lower melt and mold temperatures than competing nylon 66 compounds and high-performance materials like PPA, providing economies in terms of energy consumption, cycle times, and tooling requirements. The new compounds have processing temperatures in the range of 280-300 C/536-572 F and mold temperatures of 80-110 C/176-230 F.

COMPOUNDING

Triple-Shaft Mixer with Custom Discharge System

A new turnkey mixing and discharging system from Charles Ross & Son Co., Hauppauge, N.Y., can extrude finished product into strands. The Ross VersaMix Model VMC-1 (photo) and Discharge System Model DS-1 are mounted on a common bench and supplied with two vessels, one for mixing and one for extrusion. An air/oil hydraulic lift raises and lowers the mixing vessel to and from the operating position. At the end of the batching procedure, while the mixing vessel is in the raised position, finished product is transferred into the extrusion vessel positioned below the mix vessel. The extrusion can is then rolled over to the Discharge System where product is pushed out by a platen through a perforated die plate, forming strands in the desired profile.

The VersaMix is a triple-shaft mixer with independently-driven low- and high-speed agitators. Capacities range from 1 to 1000 gal. The combination of low- and high-shear mixing accommodates a wide range of viscosities up to around 1 million cp. Designed for vacuum operation, the VMC-1 features a special charging tube for introducing minor ingredients sub-surface near the high-speed blades. Two high-speed shafts are each supplied with two saw-tooth type blades, doubling this model's standard shear input.

MATERIALS

'Chemically-Compliant' ABS Compounds for Consumer Products

A new line of ABS compounds under the brand Chemical Compliance (CC) for applications that include toys, cosmetic containers, and poducts that come in contact with food, was launched by Elix Polymers at the October Fakuma 2018 show in Germany.

All components in Elix ABS CC compounds have been selected to be compliant with health-related regulations like EU10/2011 (Plastic Materials for Food Contact Applications). Extra services from Elix, like migration testing, development of compliant colors, additional quality controls for these compounds, or technical support during processing, are said to add an extra guarantee that best practices are followed to ensure there is no contamination or degradation of the compounds. Elix will also conduct product quality and safety tests based on OEM requirements.

Grades have been formulated for individual applications, enabling customers to select materials based on their specific needs. Injection molding grades P2H-CC and P3H-CC are two of the many offerings that are available in the new CC line. These materials reportedly are easy to process and have a high level of brightness as well as intense colors. Single-dose coffee makers are an example of the type of application that Elix is aiming at with the CC grades.

Commodity Resin Prices End Year on Downward Path

Falling feedstock costs are one factor driving prices lower for PP, PS, PVC and PET, while PE remains flat.

As we approach the end of the year, prices for four of the five large-volume commodity resins are heading downward. Among the key drivers are lower-cost feedstocks—in the case of PP, approaching double-digit levels—as well as slowed demand, year-end destocking, and some competition from lower-cost imports. Prices of PE, though also impacted by some of these factors, plus slower export activity, were expected to remain flat despite two looming price hikes.

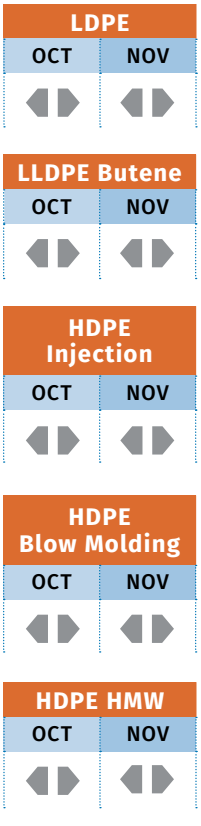
By Lilli Manolis Sherman
Senior Editor

These were the views last month of purchasing consultants from Resin Technology, Inc. (RTi), Fort Worth, Texas (***rtiglobal.com***); senior editors from Houston-based *PetroChemWire* (*PCW, **petrochemwire.com***); and CEO Michael Greenberg of the Plastics Exchange in Chicago (***theplasticsexchange.com***).

Market Prices Effective Mid-November 2018

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	101-103
LLDPE BUTENE, FILM	84-86
NYMEX 'FINANCIAL' FUTURES	43
DECEMBER	43
HDPE, G-P INJECTION	106-108
HDPE, BLOW MOLDING	96-98
NYMEX 'FINANCIAL' FUTURES	48
DECEMBER	48
HDPE, HMW FILM	113-115
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	92-94
NYMEX 'FINANCIAL' FUTURES	72.13
DECEMBER	72
IMPACT COPOLYMER	94-96
POLYSTYRENE (railcar)	
G-P CRYSTAL	108-110
HIPS	114-116
PVC RESIN (railcar)	
G-P HOMOPOLYMER	83-85
PIPE GRADE	82-84
PET (truckload)	
U.S. BOTTLE GRADE	76-78

Polyethylene Price Trends



PE PRICES FLAT

Polyethylene prices remained flat in October and November, after the September 3¢/lb price hike. Suppliers delayed their October 3¢/lb increase to November, and their November 3¢ increase to December. Mike Burns, RTi's v.p. of PE markets, ventured that prices would remain flat this month as well, but that could change early next year. "Eight out of the last 10 years, we saw PE prices move up in the first quarter due to strong exports and domestic restocking. For this coming year, it's not clear what will happen with exports. But domestic demand is likely to continue strong, so I don't expect PE prices to go down."

In fact, Burns saw domestic demand as the key driver for the next round of price increases. He did not expect feedstocks and inventory levels to be the short-term price drivers; both ethane and spot ethylene prices were lower last month. In early November, the cost to produce ethylene was near 17¢/lb, and the cost to make a PE pellet was 33¢/lb, down 5¢/lb from the end of September. He saw strong resin demand in North America as affected by tariffs: "All low-cost commodity-grade finished goods—from a broad range of bags to shrink wrap—are no longer being imported from China. Major distributors of these products have turned to domestic film processors."

Weighing in, *PCW* senior editor David Barry noted that there was no momentum to support domestic price increases, and he highlighted flat exports as one key issue. He said suppliers would need to decrease export prices and that they were initiating discussions to ramp up exports before the end of the year. There were also reports of slowed domestic demand, particularly in film sectors, as a result of destocking in the aftermath of hurricane season, forecasts of lower prices before year's end, and year-end inventory management.

The Plastics Exchange's Greenberg reported a very strong October for the spot PE market, with plenty of low-cost offers in LLDPE and LDPE film grades and HDPE injection grades. Going into November, he saw spot PE prices moving up 1-3¢/lb, helping to reduce the large gap (about 10¢/lb) between spot and contract pricing. Greenberg noted that export demand was also starting to sag as a result of sharply lower crude oil prices. "If oil continues to fall, and bearish ►

sentiment accelerates worldwide, export demand and pricing could soften and generate another wave of lower-priced offers."

PP PRICES FLAT TO SIGNIFICANTLY LOWER

Polypropylene prices remained flat in October, in step with propylene monomer contracts, but the potential for as much as a double-digit drop emerged in early November. "It was a surprise that prices did not drop as spot monomer prices were unwinding—down about 12¢/lb from end of September to end of October," said Scott Newell, RTi's v.p. of PP markets. Meanwhile, what appeared to be margin increases of 2-3¢/lb were issued by Braskem for Nov. 1 and by LyondellBasell for Dec. 1, with no apparent support from other suppliers.

Both Newell and *PCW*'s Barry expected that November monomer contracts would settle 8-12¢ lower, with PP prices dropping in kind. Said Barry, "I think it would be a bit of a stretch for suppliers to expect to get a margin increase." These sources also noted that monomer availability was trending upward, as both PDH (on-purpose propylene) units were running more smoothly and there was a bit of a shift at the cracker level toward propylene. Moreover, PP demand appeared to be down since September, with competitive PP imports growing.

Polypropylene Price Trends

Homopolymer	
OCT	NOV
◀▶	▼ 8-12¢/lb

Copolymer	
OCT	NOV
◀▶	▼ 8-12¢/lb

By the first week in November, the Plastics Exchange's Greenberg reported that spot PP trading had slowed as buyers were looking at plummeting feedstock costs and either walked away from the market or purchased lower volumes. He also cited improved availability of both homopolymer and copolymer, with spot prices dropping by as much as 3¢/lb. Added Newell, "We're seeing more than a 3¢/lb spot-market decrease. This might prove beneficial for processors in their 2019 contract renegotiations. We'll close the year with much lower pricing, which is the best defense against demand destruction." These three sources characterized the PP market as still somewhat tight to relatively well-balanced.

PS PRICES TRENDING DOWN

Polystyrene prices rolled over in October, following the previous month's 2¢/lb price hike. While November prices had yet to be determined, one supplier had signaled that prices would remain flat. "This was a surprise to the industry, as most people expected that 2¢/lb gained in September would be given back," said Robin Chesshier, RTi's v.p. of PE, PS and nylon 6 markets. Both she and *PCW*'s Barry cited the falling prices of all PS feedstocks—both domestic and global—as well as slower seasonal demand.

Moreover, Chesshier noted that lower-priced PS import volumes this year were up 17-18% so far. "Buyers are pushing for lower prices and they have the right to do so," she said, adding that this could open the door for a switch to imports as well as other plastics.

Noted Barry, "There's definitely pressure from buyers to reduce prices in November based on feedstock costs alone. Even if suppliers keep prices flat, they will have a very difficult time keeping prices flat in December; a substantial price drop in benzene contracts is expected, as evidenced by spot benzene prices." Both sources noted that spot benzene prices had dropped nearly 50¢/gal between September and early November, while early settlement of October ethylene contract prices dropped by 2.5¢/lb.

Polystyrene Price Trends

GPPS	
OCT	NOV
▼	◀▶

HIPS	
OCT	NOV
▼	◀▶

PVC PRICES FLAT-TO-DOWN

PVC prices rolled over in October and were likely to be flat to lower through the remainder of the year. This is despite the 2¢/lb October price hike that's still on the table, according to both Mark Kallman, RTi's v.p. of PVC and engineering resin markets, and *PCW* senior editor Donna Todd. Their reasoning: Market fundamentals do not support an increase—i.e., falling feedstock prices, lower resin export prices, and seasonally slower demand.

PCW's Todd reported that PVC suppliers had aimed to get their 2¢ increase in October and then keep prices flat through year's end. But an industry pundit projected failure of the October price hike and prices remaining flat or dropping by 1¢/lb in November: "Once a whiff of a possible price decrease was proposed, resin buyers leapt at it and were considering a penny price drop in November to be a *fait accompli*."

PVC Price Trends

Pipe	
OCT	NOV
◀▶	▼ 1¢/lb

Gen. Purpose	
OCT	NOV
◀▶	▼ 1¢/lb

Kallman noted that as contract negotiations were taking place, processors would aim for lower prices based on lower fourth-quarter ethylene and resin export prices, along with slowed domestic and export demand since September. "The trade war with China will continue to impact PVC finished-goods imports."

PET PRICES DROP

Prices of domestic bottle-grade PET began to fall in early fourth quarter, driven by a drop in seasonal demand and a bloated supply of imports, according to *PCW* senior editor Xavier Cronin. Prime PET for non-contract truckload/bulk-truck business dropped by 3-4¢ /lb to the high 70¢ range for both domestic and imported resin (FOB U.S. South and Midwest).

PET Price Trends

Bottle Grade	
OCT	NOV
▼ 2-3¢/lb	▼ 2-3¢/lb

Prices in November were expected to fall another 2-3¢/lb due to the typical seasonal slowdown. At the same time, a glut of PET imports is making a buyer's market. December PET prices were expected to fall on the order of 1-3¢ /lb by most estimates. PT

Custom Processors Rebound Strongly

Index of 57.9 among custom processors tops overall index.

By Michael Guckes
Chief Economist

Coming in at 54.1 in October, the Gardner Business Index (GBI) for plastics processing set the average year-to-date reading at 56.1, indicating strong economic conditions. (Values over 50 indicate expansion; values below 50 indicate contraction; 50 = no change.) Concerning custom processors in particular, the latest index reading of 57.9 revealed significant expansion. Only six times in the last five years has the index for custom processors been higher. (The index is based on monthly surveys of *Plastics Technology* subscribers.)

Of the six components that comprise the overall plastics processing index, supplier deliveries, production and new orders lifted the index. Conversely, the index was pulled lower by employment. For the month, only backlogs reported no change from the prior month, while exports reported a third consecutive month of contraction.

Gardner Intelligence's review of the index components reveals that supplier deliveries continue to be the most significant driver of the Index. Among the many manufacturing processes that Gardner covers, supply-chain bottlenecks have been frequently cited as an issue limiting production. The strong response by suppliers to resolve this problem in the second and third quarters of 2018 has done much to support higher production levels and address growing backlogs, according to survey participants.

While much attention has been given to the impact of changes in trade policies between the U.S. and its top trading partners, less attention has been given to the strengthening U.S. dollar, which has appreciated by roughly 10% against the Chinese Yuan and 4% against the Canadian Dollar in the seven months ending in early November.

Michael Guckes is the chief economist for Gardner Intelligence, a division of Gardner Business Media, Cincinnati. He has performed economic analysis, modeling, and forecasting work for nearly 20 years among a wide range of industries. He received his BA in political science and economics from Kenyon College and his MBA from Ohio State University. Contact: *(513) 527-8800; mguckes@gardnerweb.com*. Learn more about the Plastics Processing Index at *gardnerintelligence.com*.

Gardner Business Index: Plastics Processing

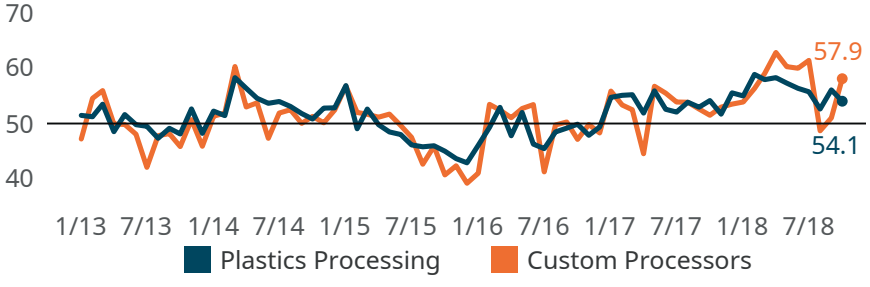


FIG 1

The Plastics Processing Index recorded another month of expansion on par with the average growth rate of prior months. Only six times in the last five years has the Custom Processors Index been higher than it was in October.

Supplier Deliveries Respond to Growing Production Demand

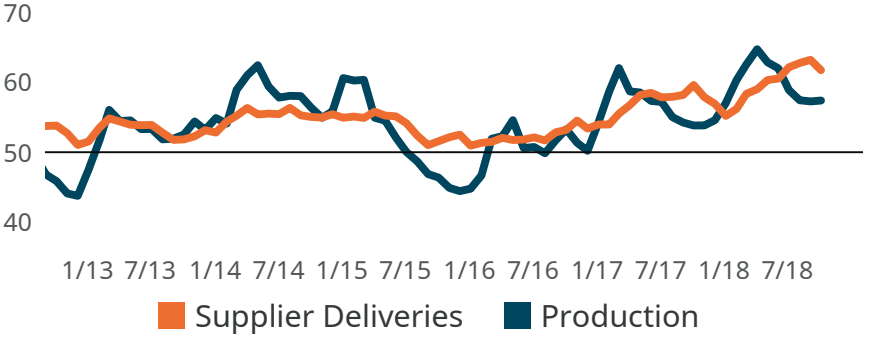


FIG 2

As production increases, supplier deliveries tend to respond in a lagged manner. As the supply network responds to the increased demand for production inputs, processors can expand their production levels to better meet current demand.

Existing Homeowners Driving Appliance Market

Construction of new homes is limited, but current homeowners are driving demand for appliances.

By Michael Guckes
Chief Economist

The limited construction of new homes may tamp demand for appliances going into new homes, but these same conditions may entice current homeowners to upgrade their appliances and home furnishings.

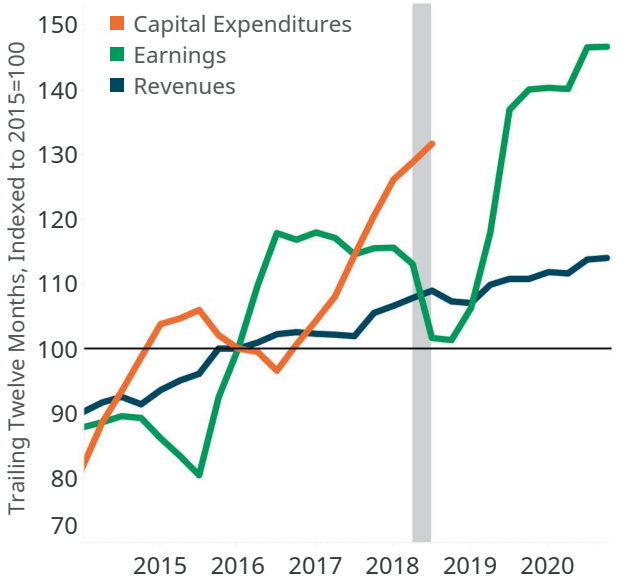
Those who watched the news about the housing market in 2018 have heard a lot of lackluster reports. Several stock indexes that track the housing sector have fallen more than 30% between their first-quarter 2018 highs and their valuations as this article went to press. Equities analysts in this sector see unaffordable home prices, rising costs for home-building materials, and rising interest rates as three of the most significant factors restricting greater growth in the market. But when we see price as merely the tool that balances supply with demand, and if we think about how limited supplies and strong demand can influence prices, then the market picture looks significantly different.

On the supply side, new housing permits during the first three quarters of 2018 averaged 111,000 units monthly, the highest level since 2007 and more than double the 2009 average. According to *Realtor.com*, the average home in September was on the market for 65 days, down 6% year-over-year, while prices are up 7% during the same time. However, in many non-rural markets the median days on market have been far shorter while median home prices have grown much faster. This data, combined with the fact that manufacturing and construction labor is in extremely short supply, is one of the greatest reasons that the volume of new homes being constructed is not higher.

U.S. inflation-adjusted residential fixed investment in home improvements has increased drastically in the last four years ending in 2017.

This leaves us with a market in which people can easily sell their home but struggle to find another, indicating that the market is not weak, but significantly underserved. This has two major implications for appliances. First, the limited construction of new home builds will dampen demand for appliances going into new homes. But these same conditions may entice current homeowners to upgrade their appliances and home furnishings, knowing that they will be in their current home longer than they may have previously anticipated. A strong labor market and increasing wage growth are two significant factors that will help support home improvements. In fact, data indicates that U.S. inflation-adjusted residential fixed investment in home improvements has increased drastically in the last four years ending in 2017, growing more than 30%.

Appliance Industry Actual and Estimated Results



Since early 2017 the home-furnishings and fixtures market has increased capital expenditures at over 10% on a TTM (trailing 12 months) basis. This suggests that the industry is seeking new ways to use technology to solve its labor shortage, one of the fundamental constraints on increased new-home construction.

Financial data from publicly traded firms in the home-furnishings and fixtures market— as opposed to data from the housing construction market—supports this underlying macroeconomic picture. Real revenue growth—calculated using a 12/12 rate of change at 4.7%—is slightly greater than the overall national growth rate. Furthermore, since early 2017 the home-furnishings and fixtures market has seen capital-expenditures growth of over 10% on a TTM (trailing 12 months) basis, suggesting that the industry is seeking new ways to use technology to solve its labor shortage, which is one of its fundamental constraints on increased new-home construction. Overall, the appliance market must realize that a more sophisticated understanding of the housing market is needed to truly understand the underlying value in the appliance space.

ABOUT THE AUTHOR: Michael Guckes is the chief economist for Gardner Business Intelligence, a division of Gardner Business Media, Cincinnati. He has performed economic analysis, modeling and forecasting work for 20 years among a wide range of industries. Guckes received his BA in political science and economics from Kenyon College and his MBA from The Ohio State University. *mguckes@gardnerweb.com*

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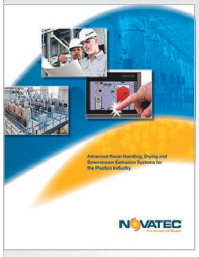

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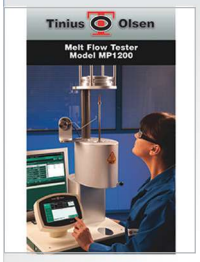

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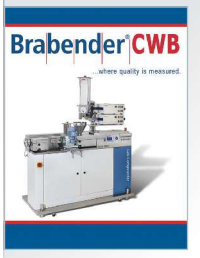

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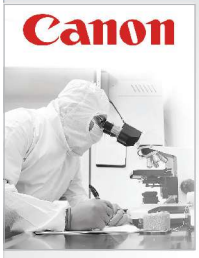

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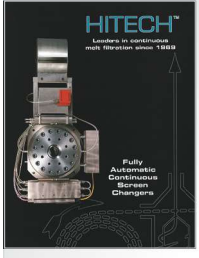

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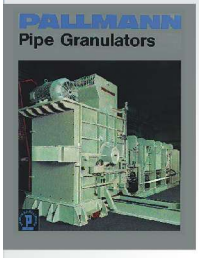

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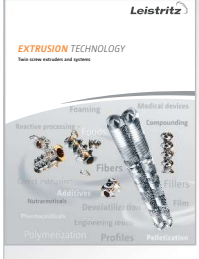

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FOURMARK — OAKVILLE, ONT.

Molder Makes Coffee Pods From Compostable Resin

Fourmark developed the expertise to mold plant-based resin into the main component of the capsules.

Fourmark relies on Niigon presses to mold coffee pod components from plant-based resins in cells like this.

By Heather Caliendo
Senior Editor

Pod coffee makers are a convenient and easy way to make coffee. But as the pods aren't typically recycled, they end up in landfills, which is resulting in fierce public backlash. Sales of coffee pods are said to exceed 9 billion units annually. While certain coffee pods are recyclable, consumers must first peel off the foil lid, compost or discard the pod's contents, then recycle the empty cup.

Canadian-based Club Coffee has close to 500 custom-label products and more than 200 Club Coffee branded products, making it Canada's largest retail roaster, contract manufacturer and distributor of packaged coffees. The company listened to consumers' concerns about the environmental impact of coffee pods and pledged to come up with a new solution: compostable single-serve pods. Club Coffee partnered with the University of Guelph on the bio-resin formulation.

But as bio-resins have far different characteristics than traditional packaging resins, it called for some innovation to ensure the package could become a reality.

The coffee pod ring accounts for about 80% of the capsule.

A challenging packaging design is right up Fourmark's alley. Fourmark is an Oakville, Ont., custom molder that offers services ranging from test tools to packaging production. "We work with companies that want to create a different packaging solution that is unique," says Adam Cruickshank, owner and CEO of Fourmark.

But turning this idea into reality wasn't simple. "This was a far cry from processing a normal resin," Cruickshank says. "Tooling, shrinkage, cooling, screw design, barrel temperature—everything was new and had to be developed."

Production procedures and techniques required experimentation and rigorous testing—all while working toward a very real go-to-market deadline. In addition, compostable products must be approved by various authorities to ensure adherence to their individual composting requirements. From 20 formulations, Fourmark created prototypes for testing and evaluation and tweaked the formulas and the mold as necessary.

Fourmark had to develop the expertise to mold proprietary plant-based bio-resin into the main component of the capsules—the ring, which is about 80% of the entire package. The natural coffee product became a key ingredient in the compostable packaging: More than 20% of the ring's resin compound is pulverized coffee chaff, the coffee-bean skin left over from the roasting process that typically sees no other use.

The company molds the rings on presses furnished by Ontario-based Niigon Machines Ltd., (formerly Athena Automation Ltd). because of the excellent control features these machines provide. Cruickshank says the Niigon injection molding machines gave Fourmark the most consistent platform for processing a challenging resin, due in part to their screw design and energy efficiency.

Thanks to Fourmark's ingenuity, Club Coffee launched the 100% certified-compostable single-serve pod, the PurPod 100. The package eventually earned Biodegradable Products Institute (BPI) certification, which requires that products be tested in approved independent laboratories and then be independently verified according to scientific standards—ASTM D6400 and D6868. The evidence from composting facilities shows PurPod100 can break down completely in fewer than 84 days.

PurPod is compatible with most Keurig-style brewing systems, including the new Keurig 2.0 brewers. Its BPI certification was earned partly because of the pod's innovative use of plant-based resins and its use of the coffee chaff in the pod's distinctive design.

Using the know-how Fourmark has developed for compostables, the molder is now working on several other applications for these bio-resins. But the molder knows new developments will not occur overnight. "The processability has to become simpler for it to achieve wider use in the industry," Cruickshank says. "And as the material becomes more widely used, the price will come down. We believe that with our expertise we can have a compostable type of food package that will become more mainstream with a price point that is accepted by major food companies." PT

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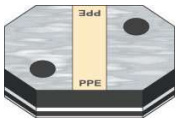

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