



Thermoforming Quarterly®

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our past. our present.
Your Future.

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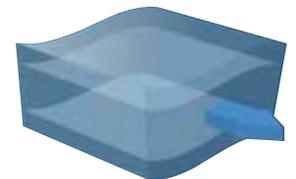
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Cover photograph courtesy of SPE Marketing Manager Sue Wojnicki. This year marks a special anniversary for SPE. Be sure to visit www.4spe.org to learn about activities and celebrations among the society's sections and divisions.

A JOURNAL PUBLISHED EACH CALENDAR QUARTER BY THE THERMOFORMING DIVISION OF THE SOCIETY OF PLASTICS ENGINEERS

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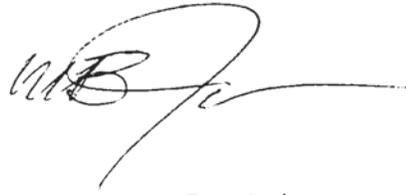
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Bret Joslyn



Planning for Orlando

Summer is just around the corner, but that doesn't mean we're taking a vacation just yet. Planning for the Orlando conference is rounding the bend into the home stretch and the Board of Directors is on the verge of creating a truly unique experience in 2017. The new location has served to inspire a number of fun and creative events including a dramatic "Blame Game" roundtable where the entire thermoforming supply chain will be brutally interrogated. This year's program will also feature a new, sponsored electric car race where competing teams have to design, manufacture and decorate a thermoformed body that will be mounted on a chassis. See p. 40 for details. We also plan to dig deep into the workforce development topic by bringing in a wide range of voices to expand the conversation. Oh, and did I mention the rum tasting and cigar rolling...?

In this issue of the Quarterly, we present new and original content (pp. 20-25) from Dr. James Throne who led the charge at ANTEC for all things thermoforming. From the business desk, our friends at Plante Moran have again provided us with their econometric insights into plastics processing, profitability and productivity. The 2017 North American Plastics Survey (pp. 14-15) contains some best practice nuggets that should be read and digested by all managers. Our globe-trotting editor reports from Chinaplas 2017 (pp. 30-31) where 160,000 people from all over the world met to buy, sell and trade across the entire plastics value chain.

At the time of writing, Penn College is wrapping up another "hands-on" heavy-gauge thermoforming seminar.

My sources tell me that there is still a thirst for knowledge on the shop floor. The program covers both theoretical concepts and practical applications of polymer science and the art of thermoforming. If you haven't been to either the heavy- or thin-gauge seminars in Williamsport, I highly recommend that you sign up and encourage colleagues to do the same.

Education is a critical component of workforce development and our division continues to lead by example. Through renewed support for the PlastiVan program, scholarships, Foundation programs and machinery grants, SPE Thermoforming is working to ensure that companies of today have access to the qualified students of tomorrow. This year marks the 75th Anniversary of SPE. The organization has launched a "Campaign for Plastics Education" to support its mission of promoting the development of young plastics professionals through the funding of quality educational initiatives, scholarships, grants and student experiences. For more details on the campaign and how individuals and companies can contribute to the future of the industry, contact Eve Vitale, SPE Foundation Director at evitale@4spe.org.

Has your company recently sponsored the PlastiVan, donated to the Foundation or invested in student activities? Let us know so that we can share the good works with industry colleagues and partners.

Here's looking forward to Orlando! |

New Members

Noah Alsteen
Backyard Swing-N-Slide
Play Systems
Janesville, WI

Jeff Apodaca
Management
Santa Fe, NM

Alexander Arsic
A. Schulman Inc.
Canton, OH

Sachin Awatade
John Deere
Magarpatta City
India

Celine Bellehumeur
NOVA Chemicals Corp.
Calgary AB

Patrick Bollar
Diversified Machine
Systems
Colorado Springs, CO

Robert Braun
Sonoco Clear Pack
Franklin Par, IL

Keith Brown
Krauss Maffei
Florence, KY

Gene Bush
Bath Fitter
Springfield, TN

Mary Calvin
Altuglas International
King of Prussia, PA

Mark Chappell
Braskem America
Pittsburgh, PA

Christian Cote
Bath Fitter
St. Eustache, QC

Steve Daigle
Mirazed
Saint-Hubert, QC

Bob Deitrick
Graham Engineering
York, PA

Jeff Ducharme
GHSP
Grand Haven, MI

Jason Fruit
John Deere
Moline, IL

Erin Garcia
Czarnowski
Denver, CO

Eric Gascon
Bath Fitter
St. Eustache, QC

Tyler Haptonstall
Aligus Packaging, Inc.
DeKalb, IL

Vincent Harris
Scantech Americas
Gaithersburg, MD

Eric Henderson
American Standard
Ft. Worth, TX

David Holcomb
Shawnee State University
Lucasville, OH

Nemat Hossieny
NatureWorks LLC
Minnetonka, MN

Eirik Jensen
Icopal Denmark A/S
Kastrup

Fred Johnson
Backyard Swing-N-Slide
Play Systems
Janesville, WI

Ryan Klein
Mid Michigan Community
College
Beaverton, MI

Chris Kowal
Kolcor Technologies LLC
Agawam, MA

Ken Kramer
Igent International
Group, Inc.
Huntington Beach, CA

David Kuethe
Cranberry Township, PA

Michelle
Lamontagne-Condon
Klockner Pentaplast
Gordonsville, VA

Russell Law
Fiber Pad Inc.
Tulsa, OK

John Lee
American Standard
Piscataway, NJ

Ming-Yung Lee
Formosa Plastics Corp.
Port Lavaca, TX

Dennis Lemmon
CK Technologies
Montpelier, OH

Terry Libera
Dart Container
Mason, MI

Brad Luddeke
American Standard
Piscataway, NJ

Simon Malcolm
SPDM
Mawdesley, UK

Scott McLane
Meyer Plastics Inc.
Indianapolis, IN

Norm Novak
K&M Manufacturing
Oxford, IA

Gunjan Patel
American Standard
Piscataway, NJ

Mark Pollo
Washington Penn Plastic
Co., Inc.
Washington, PA

Steven Priest
Sonoco Clear Pack
Franklin Park, IL

Kevin Quinn
Orscheln Products LLC
Moberly, MO

Tom Rendon
Fiber Pad Inc.
Tulsa, OK

David Schoenmann
Milliken & Co.
Spartanburg, SC

Keith Shanter
John Deere
Horicon, WI

Shawn Slone
Mytex Polymers
Jeffersonville, IN

Jeffrey Solis
Northern Plastics Inc.
Sterling Heights, MI

Rob Springer
Yanfeng Global
Automotive Interior
Systems Co.
Holland, MI

Edward Stephens
NG-Cutting Edge
Optronics
St. Charles, MO

Bradley Stroup
FCI USA, LLC
Mt. Pleasant Mills, PA

Mark Van Sumeren
American Profol
Cedar Rapids, IA

Nathaniel Wartluft
Shawnee State University
McDermott, OH

Jack Weix
General Plastics Inc.
Milwaukee, WI

Paul Wong
Sparta Plastics
High Point, NC

Martin Wright
Sparta Plastics
High Point, NC

Geoff Young
Brentwood Industries
Wernersville, PA

Coveris rolls out in-mold labeled thermoformed dairy package

by *Plastics News Europe*

MARCH 13, 2017 – Coveris Holdings Corp. Coveris developed the in-mold labeled thermoformed package introduced by Finish dairy group Valio Ltd.

Coveris Holdings Corp. and Finnish dairy producer Valio Ltd. have developed a container with thermoformed in-mold label (IML-T) that decorates the entire container.

In a March 8 statement, Chicago-based Coveris said it had initiated the development over three years ago, and that Valio later joined the efforts to create the label, which Coveris said was “first of its kind”.

The label features “360-degree illustrations” that cover the container wall all the way up to the sealing rim. This, according to Coveris, was made possible with a combination of forming and label positioning.

“These illustrations can include photorealistic illustrations, which is a development that makes the Valio container really stand out,” the company added.

According to Coveris, the new technology cuts weight by up to 20 percent by using foamed, lightweight multilayer sheets, such as Neocell or Neocell+ with a gas-injected middle layer and optional filler materials.

Additionally, the company claims that waste and operating temperatures will be lower as it will apply its in-mold labels.

Various label types are available for this project including PP, PS, hot melt paper, coated paper and recyclable paper.

Coveris said decoration is a “step up in competition,” as it is “highly visible, stands out on the shelf and is sure to get the attention of consumers.”

In addition to visual features, the IML-T technology provides oxygen barriers that increase shelf life and 100 percent UV barriers that allow preservation of the organoleptic properties of high fat products.

Say Plastics works on tooling expertise to stand out

by Frank Antosiewicz, *Plastics News*

MARCH 1, 2017 – Say Plastics Inc. Say Plastics Inc. said an investment by Ben Franklin Technology Partners is allowing it to compete in new markets, such as parts for Chicago’s Metra commuter rail system.

Say Plastics Inc. is taking steps to better utilize its tooling system in the transportation market, and is using funds from Ben Franklin Technology Partners of Central and Northern Pennsylvania to develop its abilities.

“We’re thermoformers so we have to be innovative. We find a lot of our customers come in and want short runs,” said Ron Staub, vice president and general manager of McSherrystown, Pa.-based Say Plastics.

Staub said that means the company works on the right design and approaches to find a cost-effective way to make the product.

He said that to win a contract that the company has to offer alternatives. One way is to work with composites instead of relying on aluminum tooling.

“We developed our tooling method — it’s our own way of engineering and we will look at a program to see what we can do. If we can cut our own tools, it cuts down on time and cost for the customer,” he said.

Staub said that part of the plan is to process materials carefully.

“We measure temperatures carefully with extra sensors,” he said.

Staub said the transportation area provides a niche where the company sees a lot of potential. By re-engineering parts Say Plastics can help make trucks last longer, refurbish rail cars and buses.

Staub said that some railcars may have fiberglass parts that were made 25-30 years ago and their replacements may not be available. If Say Plastics can reverse engineer the part and do a short run to provide replacements, it has value for the customer.

He said that Say Plastics does have an engineer on staff, but will use a \$125,000 loan from the Ben Franklin



REDUCE REUSE RECYCLE

Technology Partners to add engineering expertise to handle even more reverse engineering projects.

Say Plastics currently has 14 employees, with five sheet-fed thermoformers and four routers. It expects to add three to four more employees.

Staub said sales were up about 20 percent last year and that they are hoping to do the same this year. Ben Franklin Technology Partners is a state technology-based economic development program that supports start-up companies and established companies looking for ways to grow or diversify.

Inline Plastics expanding space in Georgia

by Jim Johnson, *Plastics News*

MARCH 21, 2017 – Inline Plastics Corp. Inline Plastics is adding more thermoforming production and warehousing space as it grows.

Inline Plastics Corp. is no stranger to growth. And the Shelton, Conn.-based thermoformer is at it again, with the addition of new machinery and more space to serve its customers around the country.

Inline makes PET thermoformed containers for food service, distributor and food processing customers. Business is good.

The company, over the past year, has added 157,200 square feet of manufacturing and warehouse space to its McDonough, Ga., location, and is "pursuing options" to expand existing manufacturing sites in Shelton and Salt Lake City.

Along with the added space, the company also has installed six new thermoforming lines, Jack Tilley, a market research analyst with the company, said during a March 20 interview.

"It's really just adding capacity to suit our growth," Tilley said. "We were at capacity at all three of our plants at some point, so we really needed to get capacity at all plants. It's a good problem, but when you get close, you have to increase capacity."

Part of Inline's recent investment was the installation of a mid-sized thermoforming line at the company's research and development facility in Milford, Conn.

This new equipment allows the company to test creation of new products before they reach full production.

"When we are scaling up products for a launch, that will allow us to get out prototypes quicker, production quality prototypes," Tilley said.

Adding this type of production at the R&D facility allows the company to identify any potential production issues before products are moved to larger machines. Inline has undertaken a series of expansion projects in recent years, including the construction of the Georgia facility in 2009.

"We're growing and we've been successful and we're trying to come up with innovative food container products that can meet the needs of our customers. We've been successful so far and we think that's the key ... listen to the customer and come out with innovative products to help fit their needs," Tilley said.

Jim Porcaro is vice president of operations at Inline.

"As our business continues to grow, we are committed to continuously invest in capacity to ensure we have sufficient capacity to support our customer's requirements and maintain our very high fill rates," he said in a statement.

Inline's growth includes an increase in service to the convenience store sector. "We've seen convenience stores really increase recently as they add more service to their chains. That's a pretty big growth market," Tilley said.

Patrick continues building its portfolio with Medallion acquisition

by Michael Lauzon, *Plastics News*

MARCH 21, 2017 – Patrick Industries Inc. has again expanded its thermoforming capacity for recreational vehicle and other markets with the acquisition of Medallion Plastics Inc.

Medallion designs, engineers and produces custom thermoformed products such as dash and trim panels and fender skirts for the RV market, plus complete interiors, bumper covers and other systems for automotive, specialty transportation and industrial markets. Both companies are based in Elkhart, Ind., in the heart of the RV manufacturing industry.

Medallion had sales of about \$20 million last year. Patrick paid about \$10 million in cash for the company, it announced in a March 20 news release.

Patrick CEO Todd Cleveland said Medallion's flexible manufacturing process "allows it to produce virtually any thermoformed component to meet its customers' needs." The purchase builds on Patrick's thermoforming subsidiaries and will allow synergies between the operations.

Medallion runs 18 engineered thermoforming stations that can make parts from a few square inches in size to more than 100 square feet, the company notes on its website. It uses a range of plastic sheets such as ABS and thermoplastic polyolefin, and can provide various coatings and laminations. Medallion's four facilities in Elkhart include a prototype and production tooling operation. Medallion received gold and silver awards in heavy-gauge thermoforming products in 2016 and 2015, respectively, from the Society of Plastics Engineers.

Patrick already had three thermoforming operations before the acquisition, in Elkhart and Bremen, Ind., and Munford, Tenn. It bought the Elkhart and Munford operations last year. Munford was included in Patrick's August 2016 purchase of BH Electronics Inc., a thermoformer that makes dash panel assemblies, complete electrical systems and other systems for marine markets.

Also last year, Patrick bought Parkland Plastics Inc. of Middlebury, Ind., an electronics, cabinetry, sheet metal and wire and cable businesses. Parkland is a producer of polymer-based wall panels, protective molding, flooring and related items for RV, architectural and industrial markets.

Patrick's sales to the RV industry, its largest market, grew 29 percent in the fourth quarter, propelled by acquisitions. The RV industry overall saw a 19 percent jump in wholesale unit shipments in the period. Sales to manufactured housing, the other key market, increased 28 percent in the quarter, nearly double the percentage rise in manufactured housing wholesale unit shipments.

The RV market experienced its best fourth quarter in more than 40 years, stated Patrick President Andy Nemeth in a financial news release.

Nelipak acquires medical thermoformer Computer Designs

by *PlasticsToday* staff

APRIL 4, 2017 – Nelipak Corp. (Cranston, RI) announced that it has closed on the acquisition of Computer Designs Inc., has closed on the acquisition of Computer Designs Inc., a thermoforming company based in Whitehall, PA. The business will be owned by Nelipak and operate under the name of Nelipak Healthcare Packaging. Computer Designs manufactures thermoformed rigid packaging primarily for medical device and pharmaceutical customers in the United States and Latin America. It has manufacturing operations in Pennsylvania, North Carolina, Arizona and Puerto Rico. The company's packaging products include trays, clamshells and blisters. Under the Nelipak Healthcare Packaging brand, Computer Designs will further develop its thermoformed packaging products and service capabilities for the healthcare market. The sterile medical packaging market is projected to maintain a 5.7% compound annual growth rate over the next several years, according to a report from MarketsandMarkets. Thermoforming is one of the main packaging production processes used in the medical market. This acquisition strengthens Nelipak's commitment to the North American healthcare market and will allow Nelipak to take advantage of growth opportunities in North America, Puerto Rico, the Dominican Republic and the broader Caribbean region, the company said in a press release. Computer Designs customers will have access to Nelipak's award-winning design teams and modern cleanroom manufacturing throughout its global locations.

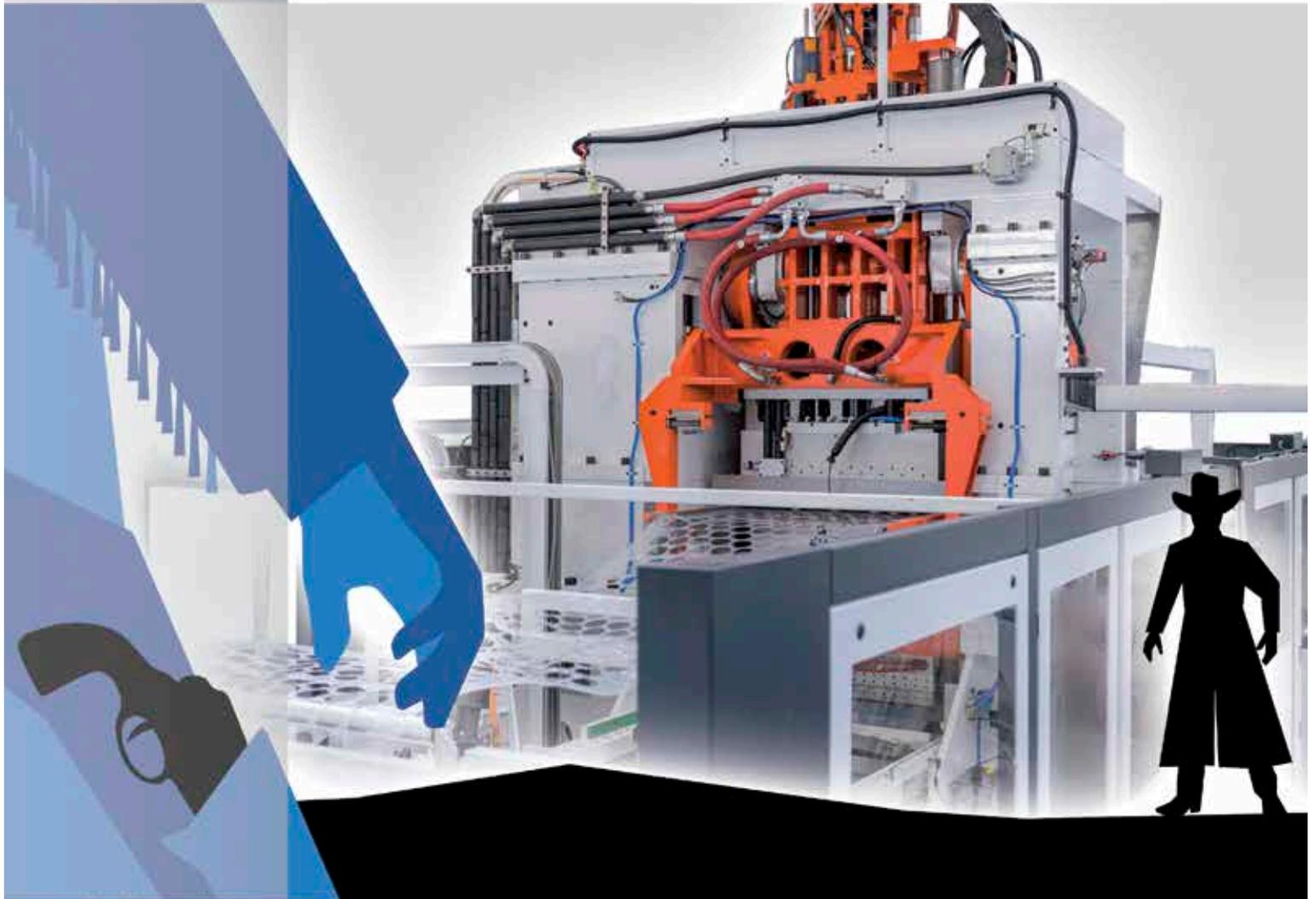
A 60-year-old brand, Nelipak operates facilities in Cranston, RI; Phoenix and Tucson AZ; Whitehall, PA; Liberty, NC; Venray, Netherlands; Galway, Ireland; Juncos & Humacao, Puerto Rico; and San Jose, Costa Rica. It designs, develops and manufactures custom thermoformed packaging for the medical device and pharmaceutical markets.

CarbonLite buys thermoformer PinnPack

by Frank Esposito, *Plastics News*

APRIL 21, 2017 – PET recycler CarbonLite Holdings LLC has made a downstream investment by acquiring thermoformer PinnPack Packaging for an undisclosed price.

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Thermoforming In The News

The deal was announced April 20 by FocalPoint Partners, an investment bank that worked with CarbonLite on the deal.

"We are excited to partner with PinnPack, one of the leading independent thermoformers on the West Coast," CarbonLite chairman and CEO Leon Farahnik said in the release, "With PinnPack, we can integrate thermoforming capabilities into our broader recycling operation to deliver the highest quality recycled PET food packaging in the United States."

He added that partnering with PinnPack "is a significant step towards realizing our long-term goals for CarbonLite."

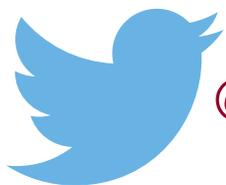
Century City, Calif.-based CarbonLite describes itself as one of the largest producers of food-grade post-consumer PET in the world. It operates a major recycling site in Riverside, Calif., and is building a similar one in Dallas.

Plastics News ranks CarbonLite as North America's 25th largest plastics recycler. The firm claims that its closed-loop recycling solution leads the market in material efficiency and purity and, according to company officials, is a leading choice for major consumer beverage companies.

PinnPack is based in Oxnard, Calif., and produces food-grade thermoformed PET packaging products. Its products include customized tubs, bowls, domes and clamshell packaging for food applications.

PinnPack serves customers in the produce, confectioneries and baked goods industries. The firm claims to be one of the only thermoformers of its size actively using food-grade recycled PET resins to create recycled packaging products. Farahnik has worked in the plastics industry for almost 40 years. He launched Hilex Poly Co., which later grew to become packaging giant Novolex. |

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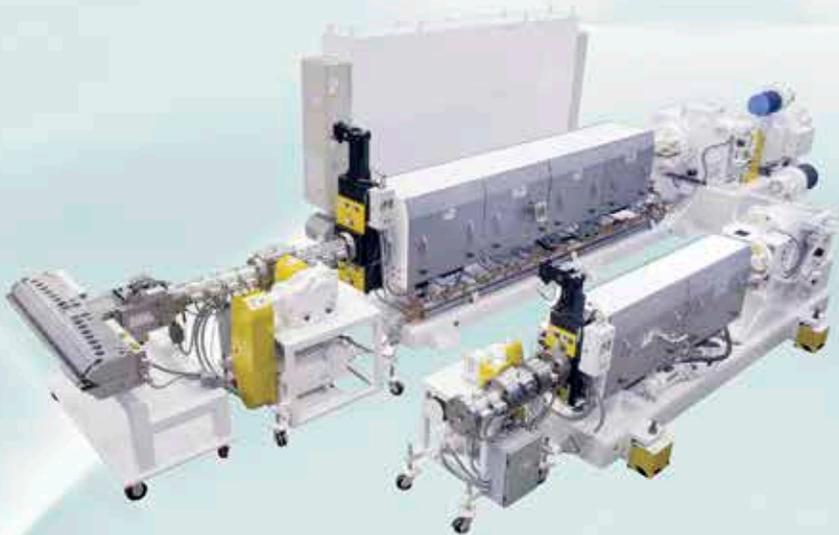
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2017 SPE Thermoformer of the Year

Robert Porsche, General Plastics

The Society of Plastics Engineers (SPE) Thermoforming Division has named Robert Porsche as Thermoformer of the Year.

The award will be presented during the Division's Thermoforming Awards Dinner, held in conjunction with the 26th SPE Thermoforming Conference®. The conference will take place September 11-13, 2017 in Orlando, FL, at the Renaissance Orlando at SeaWorld Hotel. The Awards Dinner will be held on Tuesday, September 12.

Mr. Porsche began his thermoforming industry career working in sales for Profile Plastics in 1975. In 1987, he purchased General Plastics, Inc., where he remains president and owner. At the time, General Plastics had six full-time employees housed in an 11,000 square-foot facility. Under Mr. Porsche's leadership, General Plastics now has over 75 full-time employees and recently expanded its facilities to a 93,000 square-foot building. Their modern facility contains a complete collection of the newest single station, rotary and twin sheeting formers with pressure forming capabilities, as well as two 3 axis and six 5 axis CNC routers and four of the most advanced fully robotic trimming machines.

Located in Milwaukee, WI, General Plastics is an ISO 9001 and ISO 14001 certified, full service custom plastic thermoformer. General Plastics also houses some of the largest forming equipment in the industry, allowing the company to address a diverse range of product demands. The company provides solutions for point of purchase and OEMs in bus, rail, truck, marine, office, lavatory, medical, health and wellness, gaming, arcade, food and beverage, construction, and machine guarding applications.

In February, General Plastics was presented with the Wisconsin Manufacturer of the Year Award in the small business category, an honor that it also received in 2014. General Plastics was also named as a finalist for the 2016 Plastics News Processor of the Year Award. The company has received numerous awards for its contributions to the SPE Thermoforming Division's Annual Parts Competition over the years as well.

An active member of SPE, Mr. Porsche has served in many leadership roles as a Thermoforming Division Board Member where he chaired the Finance, Machinery, and Processing Committees in addition to two SPE Thermoforming Conferences®. Mr. Porsche is a prior Division Outstanding Achievement Award Winner, and has served as a heavy gauge technical session presenter and moderator. He is also active in a variety of local Milwaukee-area business and civic nonprofit organizations.

Mr. Porsche graduated from Southern Illinois University with a B.S. in marketing and management.

"Under Bob Porsche's leadership, General Plastics has grown from a small business to a thermoforming industry success story," said Bret Joslyn, SPE Thermoforming Division Chair. "As a long-time member of the SPE Thermoforming Division's Board of Directors, Bob's leadership in a variety of roles has contributed greatly to the Division's success."

Past recipients of the Thermoformer of the Year Award may be found on the SPE Thermoforming Division website at <http://thermoformingdivision.com>. |

Roger Kipp Receives SPE President's Cup Award

PERRYVILLE, MD – Roger C. Kipp was recently announced as the SPE President's Cup recipient at ANTEC® 2017 in Anaheim. SPE President Scott Owens presented Kipp with the award.

Owens shared that over the years, Kipp has inspired many and made substantial contributions to the Society. He is a leader and teacher who values the importance of a solid educational foundation for the next generation of industry professionals. For these reasons, Kipp was honored with this year's President's Cup.

Kipp has been a member of SPE since 1985 with his primary focus on the Thermoforming Division and is also a member of the European Thermoforming Division. He served as a member of the SPE Thermoforming Division Board from 1992 to 2014. During his tenure on the Board, Kipp served as Conference Chairman, Conference Treasurer, Division Treasurer and Councilor. He also chaired the SPE Communications Committee and developed the SPE Business Plan for the PlastiVan Program. The Society honored Kipp with the Outstanding Achievement Award in 2002, Lifetime Achievement award in 2003 and the Honored Service Member Award in 2008. In 2012, he was named SPE Thermoformer of the Year.

Kipp's passion for educating the next generation of thermoformers runs deep. He's been instrumental in the development of plastics programs at vocational schools in OH, MI and PA. He serves as a member of the Advisory Board and Strategic Planning Team for the Plastics Innovation and Resource Center (PIRC) at the Pennsylvania

College of Technology, an affiliate of Penn State University. With his leadership and support, the PIRC established the Thermoforming Center of Excellence, an industry-scale lab resource for thermoform testing and development. As a member of the Plastics Pioneers Association, Kipp is active on the Education Committee and chairs the Honored Service Award Committee.

Today, Kipp continues to support his affinity for education by serving as Chairman of the SPE Foundation Board. Through student outreach programs, scholarships and grants, the Foundation focuses on providing valuable educational outreach to individuals around the globe.

As if his volunteer work doesn't keep him busy enough, Kipp also provides business development strategy consulting to clients both nationally and internationally. By reinforcing the critical elements for success – innovation, planning and follow-through – he helps position his clients for steady growth and sustainability.

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Submission Guidelines

- We are a technical journal. We strive for objective, technical articles that help advance our readers' understanding of thermoforming (process, tooling, machinery, ancillary services); in other words, no commercials.

- Article length: 1,000 - 2,000 words. Look to past articles for guidance.

- Format: .doc or .docx Artwork: hi-res images are encouraged (300 dpi) with appropriate credits.

Send all submissions to Conor Carlin, Editor, at cpcarlin@gmail.com

North American Plastics Industry Study

Published by Plante Moran

Editor's Note: Following on from our coverage of Plante Moran's 2016 report last quarter, we are pleased to offer an abridged version of the 2017 North American Plastics Industry Study (NAPIS). The study is coordinated through a survey of industry participants. This year, there were 112 surveys comprising 186 facilities exceeding \$6 billion in sales. Most are U.S.-based, however, there are also participants from Canada and Mexico.

Visit www.plastics.plantemoran.com for complete details.

Introduction

Last year, we highlighted that U.S. politics, depressed oil prices, and global geo-political issues were driving uncertainty for business leaders. Despite this, we also highlighted that North American plastics processors demonstrated overall strong operating results bolstered by several factors, including increased worker productivity and effective management of labor costs. We are pleased to announce that this year's results are very similar and, moreover, EBITDA margins are up for most processors.

Let's Dig A Little Deeper

Workforce productivity has risen to yet another 10-year high and continues to be a key driver of positive margins for processors.

As a whole (not just the top performers), the plastics processors industry became more commercially disciplined, meaning that most processors stopped pursuing low margin work and/or shed unprofitable business.

Disciplined approaches to growth led to moderate but less significant increases in year-over-year sales for the average processor.

Higher machine utilization and strong balance sheets suggest that many processors are being cautious with new capital spending and continue to work with existing machines.

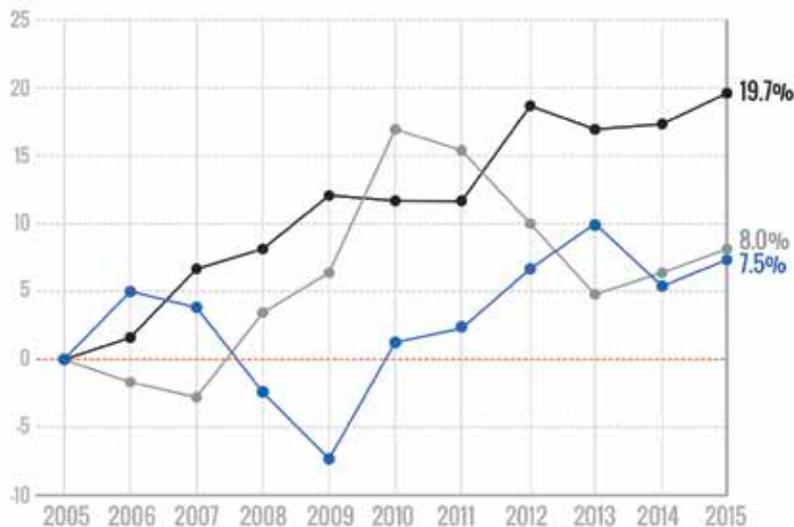
Despite some of the positive trends, there are certain issues that are creating uncertainty that will play out over the course of 2017:

- The impact of foreign trade law changes under President Trump, especially as it relates to NAFTA.
- An expected continuation of rising interest rates.
- The strong U.S. dollar value is creating more pressure for global sourcing.

Our recommendation is to understand your company's market position and to focus on your strengths to drive profitable growth. Staying focused on your top and bottom line can provide your best insulation from both the known and unknown challenges that lie ahead.

Insights

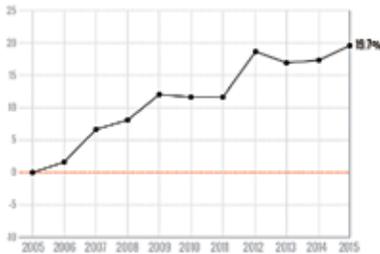
Overall health of industry continues with higher productivity, utilization, and profits. The following graph shows year-over-year adjustments to productivity as measured by value add per employee, equipment utilization percentages, and gross profit margins for the last 10 years.



Productivity

For the second year in a row, productivity is at a 10-year high. Plastic processors' ability to effectively manage their labor costs while boosting the productivity of their workforce has been a key driver to support the overall health of plastics processors in North America.

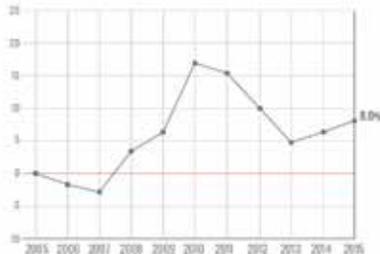
● Cum. productivity change



Utilization

Press utilization slightly rebounded compared to last year on strong overall sales in several end markets. While new equipment sales remain at healthy levels, many processors continue to leverage older assets to support operations.

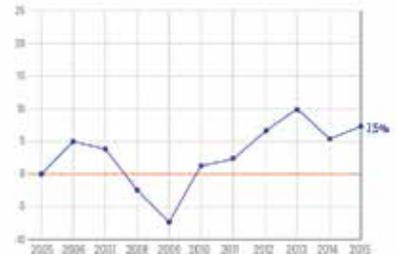
● Cum. utilization change



Profits

Gross profits slightly increased over last year. Key drivers are increased worker productivity (which is partially being offset by higher wages) and stable (and sometimes lower) resin prices.

● Cum. GP Change



So What Drives Profitable Growth?

For the third consecutive year, to answer this question, we reviewed some of the key metrics for which Successful Companies* have outstanding results.

Effective labor cost management

For years, we have looked at value add per labor dollar which is defined as (sales less materials) divided by total labor costs. This metric focuses on how a plastics processor manages its labor costs within its organization. This is critical since labor is typically a processor's second highest cost (after material cost). In addition, the average processor has more control over its labor costs than material costs.

Commercial discipline

Historically, successful companies are less likely to take on low margin work with less than 10 percent gross margins. While this held true in this year's report, you can see that

the median processors showed nearly the same level of commercial discipline as did the successful companies, which also contributed to margins increasing for the industry as whole.

Take care of your balance sheet

Successful Companies' ROA and RONCE metrics far outperform median processors, driven by strong earnings coupled with an excellent balance of asset utilization and investment. Altman Z scores (a composite financial health metric used by many financial lenders) average more than 40 percent higher for successful companies than median processors over the past three years.

As we conclude our analysis, take time to reflect on the following questions:

What are the key drivers of profitable growth at your company? What are your profit pitfalls? Are you positioned to sustain profitable growth?

Value add per labor dollar for Successful Company averages 10% higher compared to Median Processor

2015 SUMMARY REPORT		2016 SUMMARY REPORT		2017 SUMMARY REPORT	
Successful Company	Median	Successful Company	Median	Successful Company	Median
\$2.57	\$2.28	\$2.31	\$2.26	\$2.60	\$2.27

Percentage of business that has less than 10% gross margins

2015 SUMMARY REPORT		2016 SUMMARY REPORT		2017 SUMMARY REPORT	
Successful Company	Median	Successful Company	Median	Successful Company	Median
8%	14%	6%	12%	7%	8.1%

A Brief Discussion of Fillers to Use in Compounds for Thermoforming: Talc vs. Calcium Carbonate

By Dr. Amit Dharia, Ph.D, Transmit Technology Group, LLC, Irving, TX and Noel Tessier, CMT Materials, Inc., Attleboro, MA

Thermoforming is inextricably linked to extrusion so it is critical that thermoforming operators understand how sheet extrusion affects their final parts. Among the important criteria for extruded sheet are cost, output rates, energy efficiency, scrap rate, recyclable content, lower thermal and mechanical stresses, and even thickness. During the forming step, rapid and uniform sheet heating, melt strength, melt elasticity, even thickness distribution, and even shrinkage are critical. From the application viewpoint, specific strength and stiffness, dimensional stability, material content and weight per part are important. Adding fillers can help to achieve many of these criteria.

CaCO₃ and talc are widely-used fillers in thermoplastic and thermoset sheet compounds. They are mainly used to reduce cost and to increase recyclable contentⁱ. For instance, consider that the price of polypropylene is around \$0.80/lb and the cost of calcium carbonate (CaCO₃) is \$0.15/lb and of Talc \$0.27/lb. If we compound 30% by weight of filler into PP (which is typical for sheet), the raw material cost is cut to \$0.61/lb, or about 25% in case of CaCO₃ and \$0.68/lb, or about 20% in case of talc. However, for equivalent stiffness, a lower amount of talc will be required than CaCO₃. The cost per unit volume will also be slashed, but not by as much, because the density of fillers is higher than that of PP.

Most extrusion operations are rate-limited by heat transfer. Higher thermal conductivity improves heat transfer. As a result, filled polymers generally can be extruded at higher rates than neat polymers. Filled plastics often allow longer run times between shutdowns for cleaning, for instance in blown film. The longer runs are attributed to the mild scrubbing action of the filler particles.

Besides reducing the cost of the compound, incorporating fillers can improve extrusion and save energy. In sheet and pipe extrusion, adding fillers results in lower die swell, sag, and better dimensional control. Fillers have lower specific heat and higher thermal conductivity than polymer melt. Filled plastics have a lower specific heat than that of the

neat polymer. This means that the energy consumed in extrusion can be reduced correspondingly. As a result, filled polymers will melt more quickly in the extruder and will achieve more uniform melt temperatures at the discharge end. The latter will result in more uniform flow through the die and a more consistent extruded productⁱⁱ. In thermoforming, sheet with filler will heat faster and more uniformly and will retain heat for somewhat longer time. All in all, this will result in more uniform wall thickness and increase in production efficiency. The higher stiffness of filled compounds will also make trimming much easier than sheet with the unfilled compound.

In addition to lowering raw material cost and improving process economics, fillers also contribute to mechanical and rheological properties. Talc and CaCO₃ are most commonly used fillers in making extruded sheets for thermoforming. It is important to understand which one to use. The size, shape, surface area, and surface treatment will determine the ultimate property. Table 1 shows a comparison between Talc and p-CaCO₃ at equivalent particle size (5 microns)ⁱⁱⁱ.

As can be seen from the table, calcium carbonate is an isotropic filler of more or less spherical shape while talc is platy and is an anisotropic filler. The packing factor for CaCO₃ is much higher than that of talc, so larger amounts of CaCO₃ (up to 80 % in olefins) can be incorporated compared to talc.

Being anisotropic (aspect ratio 2:1 to 15:1), talc also has a much higher surface area than CaCO₃ so it acts as a reinforcement agent. Talc results in much higher stiffness and heat deflection temperature (HDT) but lower impact strength. At low loadings, CaCO₃ actually increases toughness. Due to anisotropy, sheet produced from talc-filled compounds will have different strength across and along the web. Talc also acts as nucleating agent for Nylon, PP, and PET and will reduce crystallite size and therefore reduce cooling times which speeds up production.

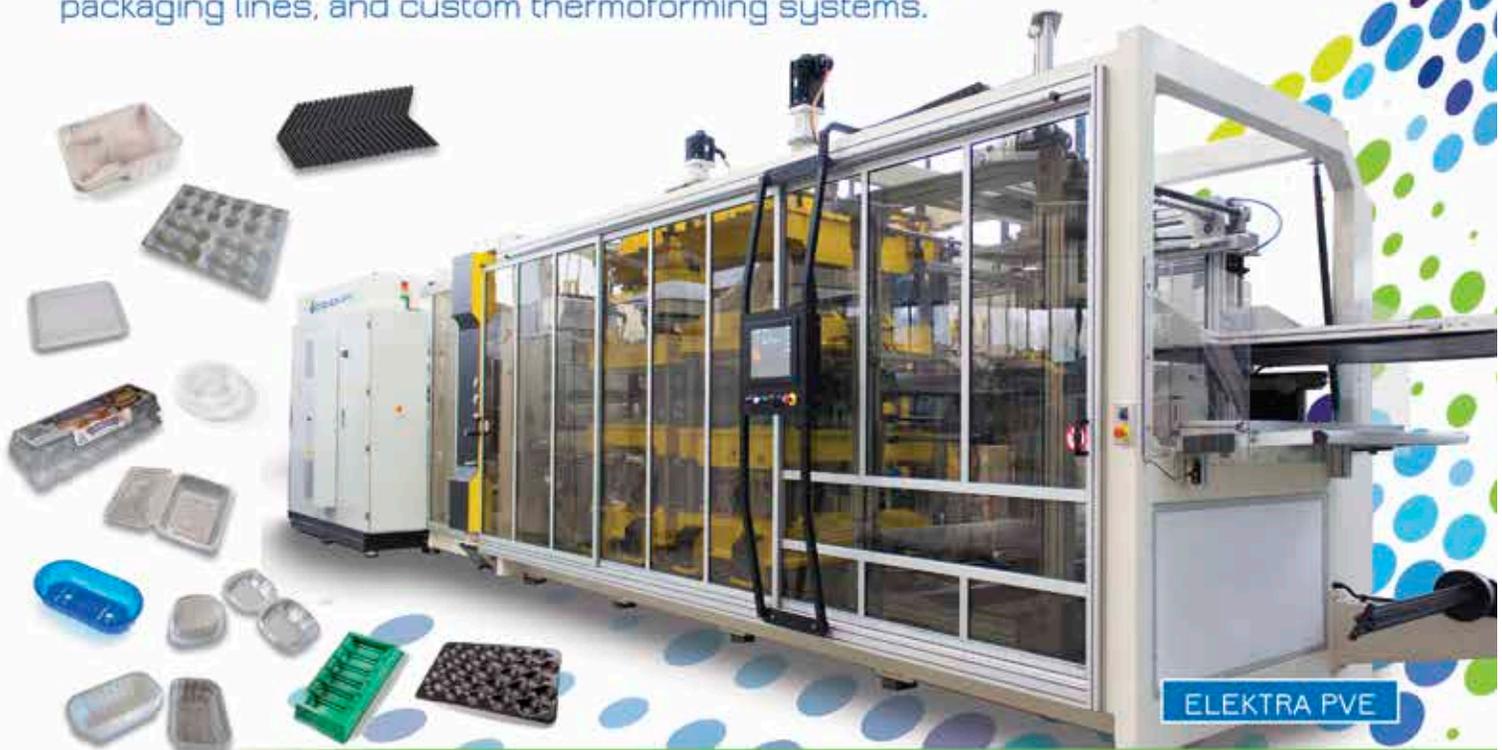
Even at very high loadings, due to its spherical shape, the melt viscosity of CaCO₃-filled compounds show smaller increase in the low shear viscosity. Talc, on the other hand, will affect melt viscosity. Adding a lower amount of fillers



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(<30%) will increase melt strength and hence reduces sag. At the higher loading there will be increase in sag due to increase in the melt density and weight.

Talc is much softer than CaCO₃. Talc is therefore less abrasive and more forgiving on compounding and processing machinery. Being plate-y (plates orient parallel to surface), talc also produces surfaces with lower static and dynamic coefficient of friction (COF) than CaCO₃ under equivalent pressure (load). Therefore, at equivalent mean particle size the release will be better for talc-filled material than for CaCO₃-filled compounds^{IV}. Talc filled materials also have lower permeability and less free volume than CaCO₃ filled compounds.

As they pertain to thermoforming, the processor should consider the impact these fillers can have on tool design

and in particular, the longevity of the plug assist. The strength and durability of plug material varies according to the base resin or matrix. Because filled polymers have higher stiffness and possibly more abrasion, the thermoformer will need a stronger, more abrasion-resistant material to prevent plug wear and loss of edge definition from the higher stresses on the plug. Syntactic foam plugs contain hollow glass microspheres with a rating of 5.5 on the Mohs scale of mineral hardness. For reference, talc has a hardness of 1 and calcium carbonate has a hardness of 3 (see table). Glass-filled plugs will be much more resistant to said minerals than solid polymer plugs. Basic epoxy syntactic plugs that perform well on unfilled PP will not perform well if the converter switches to 50% talc-filled PP. Co-polymer and thermoplastic syntactics have high compressive strength and are able to push and stretch the filled polymer effectively.

Table 1 Comparison of CaCO₃ and Talc

	pCalcium Carbonate CaCO ₃ Vicron 2511	Talc Mg3Si4O10(OH)2 C-400
Mean particle size, micron	5	5
Shape	Isotropic	Platelet
Aspect Ratio	1	Varies
Packing Fraction	0.76	0.54
Sp. Gravity g/cm ³	2.71	2.8
Surface Area m ² /g	1.2	6 to 10
Dispersibility in organics	Excellent	Excellent
Surface treatment	Stearic acid	Silanes
Thermal Conductivity (cal/cm ² .C.s)	5.6	5
Specific Heat Cal/g.C	0.205	0.208
Refractive Index	1.49	1.57
Color	White	White
Mohs Hardness	3	1
Modulus Dyn/cm ² x 10E11	2.6	2
Flexural Modulus of 30% filled PP	450	670 Kpsi
Izod Impact strength of 30% PP	0.900 ft-lb/in	0.6
Drop Impact strength ft-lb, 30% PP	13.3	1.33
HDT, 66 psi, F	215	260
Water absorption 24 hrs, 1/8"	0.05	0.03
Permeability	high	low
Shrinkage in/in	0.018	0.022
Price \$/lb in TL	0.15-0.20	0.27-0.30

I. *Tips and Techniques: Boosting Extrusion Productivity - Part III of III: Trim Your Material & Energy Costs*, PTO Online, 1/4/2011, Chris Rauwendaal, President, Rauwendaal Extrusion Engineering Inc.

II. *Rheological Behavior of Talc And Calcium Carbonate Filled Polypropylene Hybrid Composites*, Mohd Shamsul Farid Samsudin, Thesis

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How Important is the Volumetric Absorption Concept? Part 1: Model Building

By Jim Throne, Consultant, Dunedin, FL

Abstract

I lay the groundwork for a thorough comparison of radiopaque and volumetric absorbing heat transfer models. I define the technical models for thin-gauge thermoplastic sheet through what I have called the Lumped Parameter Model (LPM) where conduction through the plastic plays no role. And I define the radiopaque and volumetric absorbing models for thick-gauge thermoplastic sheet. I call these models the Distributed Parameter Models (DPM) where conduction plays an important role in energy transfer from sheet surface to core. This is preparatory to my solving the arithmetic for these models. In Part 2, I present solutions to the LPMs. In Part 3, I present solutions to the DPMs.

Introduction

For some time now I have touted the importance of volumetric absorption of inbound radiant energy on the temperature profile in thermoformable plastic sheet (1, 2, 4-6). The source of this touting is far infrared spectra of thin films of common plastics. In doing so, I have raised the specter that the traditional model for predicting time-dependent temperature profiles is technically wrong. The reason behind this is that the arithmetic requires all thermal energy to the sheet is absorbed at the sheet surface. I've referred to this as the radiopaque model.

The important question remaining is: How significant is this error? As I see it, there are three general sheet categories in which the concept of volumetric absorption of radiant energy needs to be considered:

- Thin monolithic sheet
- Thick monolithic sheet
- Multi-layer or multi-ply sheet, both thin and thick

In this paper, I establish the basis for contrasting the traditional models for the first two classes with models that include volumetric absorption. My standard approach for each of these is backward finite difference solutions. Keep in mind that there are three modes of energy transfer that are in effect – conduction, convection, and radiation. Again, conduction is solid-solid energy transmission,

convection is fluid-solid energy transmission, and radiation is electromagnetic energy interchange at a distance.

Because multilayer interfacial models are more complex, I'll save them for another time.

Thin-Gauge Thermoformable Sheet

For this example, I use the Lumped Parameter Model I described in (5). For this model, I consider the only important energy transfer effects to be radiation and convection. Conduction is instantaneous throughout the sheet. The general form for the LPM is the transient one-dimensional thermal response of the plastic sheet to convection and radiation¹:

$$\frac{dT}{f(T_{\infty}, T)} = \left(\frac{1}{x\rho c_p} \right) d\theta \quad (1)$$

Where T is the time-dependent sheet temperature, T₀ is the initial sheet temperature, T_∞ is a measure of the environmental temperature, θ is time, ρ and c_p are the density and specific heat of the plastic, respectively, x is the sheet thickness, and f(...) is the energy exchange term.

The function f(...) for both convection and radiant interchange is given as:

$$f(\dots) = h(T_{air} - T_{plastic}) + G(T_{heater}^{*4} - T_{plastic}^{*4}) \quad (2)$$

Where h is the convective heat transfer coefficient between T_{air} and T_{plastic}. The second term on the right is the radiant interchange between T_{heater} and T_{plastic}, where these temperatures are absolute values. G is a measure of the radiant efficiency and the relative geometries of the heater and sheet. I'll define G shortly.

Because f(...) is nonlinear in temperature, direct integration of the first-order equation is not possible. I solve this equation using backward finite difference:

$$T_{\theta} = T_{\theta-1} + \frac{\Delta\theta}{x\rho c_p} [h(T_{air} - T_{\theta-1}) + G(T_{heater}^{*4} - T_{\theta-1}^{*4})] \quad (3)$$

Now I come to defining G as the product of a geometric term, F, called the view factor (x), a measure of the emissivities of both the heaters and the sheet, F_g, the Stefan-Boltzmann constant, σ, and a measure of volumetric

absorption, A. Consider the units on the equation. Here's the equation for G:

$$G = \sigma A F F_g \quad (4)$$

Okay, what is emissivity? It is a measure of radiant efficiency from the heating source or its sink. As an aside, most heaters and plastics are very good but not absolutely efficient emitters or absorbers. So-called grey-body sources have emitting/absorbing values less than one. Each is assigned an emissivity value, e. The function, F_g , called the grey-body correction factor is given as:

$$F_g = \left[\frac{1}{e_h} + \frac{1}{e_p} - 1 \right]^{-1} \quad (5)$$

Where e_h and e_p are the emissivity values for the heater and sheet, respectively. For this paper, I assume that $e_h = e_p = 1$, viz, black body radiators. Thus $F_g = 1$.

What about F, the view factor? For this and subsequent papers in this series, I assume that both the heater and the sheet are infinitely parallel planes. So $F = 1$.

What about A, the absorption factor? If the plastic absorbs all inbound radiant energy (whether volumetrically or on its surface), $A = 1$. In other words, the plastic sheet is radiantly opaque. In my terms, it's radiopaque. For this case, $G = \sigma$. So what is σ ? It is the Stefan-Boltzmann constant, defined below. For volumetric absorption, $G = A\sigma$. I'll plot this equation with and without absorption factors in Part 2.

Can Equation be Simplified?

If hot air is the only means of heating the sheet, the second term in $f(\dots)$ is zero. The resulting differential equation is:

$$\frac{dT}{T_{air} - T_{plastic}} = \left(\frac{h\theta}{L\rho c_p} \right) \quad (6)$$

Integrating, I get a closed form for the time-dependent temperature:

$$\frac{T_{air} - T}{T_{air} - T_0} = e^{-\frac{h\theta}{L\rho c_p}} \quad (7)$$

Okay, but what can I do about the radiation term? Consider the arithmetic expansion of the fourth-power term in Equation 3.

$$(a^4 - b^4) = (a^2 - b^2)(a^2 + b^2) = (a - b)(a + b)(a^2 + b^2) \quad (8)$$

If I assume that $T_{heater} > T_{plastic}$, I can assume that $a^2 \gg b^2$ and even $a > b$. Thus $(a^4 - b^4) \approx a^3(a - b)$.

What have I done? I just linearized the fourth-power term. Now I can write:

$$G[T_{heater}^{*4} - T_{plastic}^{*4}] \approx h_{radiation}(T_{heater}^* - T_{plastic}^*) \quad (9)$$

But the absolutes of the temperature terms cancel. So I can write the following linearized differential equation:

$$\begin{aligned} dT &= \left(\frac{\theta}{L\rho c_p} \right) [h_{air}(T_{air} - T) + h_{rad}(T_{heater} - T)] = \\ &\left(\frac{\theta}{L\rho c_p} \right) [(h_{air}T_{air} + h_{rad}T_{heater}) - (h_{air} + \\ &h_{rad})T] = \\ &\left(\frac{\theta}{L\rho c_p} \right) (h_{air} + h_{rad}) \left[\frac{(h_{air}T_{air} + h_{rad}T_{heater})}{(h_{air} + h_{rad})} - T \right] \end{aligned} \quad (10)$$

I write $\frac{(h_{air}T_{air} + h_{rad}T_{heater})}{(h_{air} + h_{rad})} = C_1$ (with the units of temperature and $(n_{air} + n_{rad}) = C_2$ and get an approximate closed equation:

$$\frac{C_1 - T}{C_1 - T_0} \cong e^{-\left(\frac{\theta}{L\rho c_p} \right) C_2} \quad (11)$$

I'll plot a form of this equation as well in Part 2. What about volumetric absorption in this approximate equation? It is imbedded in the artificial radiant/conductive term h_{rad} .

Distributed Parameter Models for Thick Gauge Sheet

So now I have two forms for the LPM to consider. How about a similar analysis for thick-gauge sheet?

I return to the earliest paper in an earlier serial (1). In order to compare radiopaque DPM with volumetric absorbing DPM, I need to present the nubs of the two models. First, radiopaque: The general heat conduction equation:

$$\rho c_p \frac{\partial T}{\partial \theta} = k \frac{\partial^2 T}{\partial x^2} \quad (12)$$

With traditional boundary conditions:

$$k \frac{\partial T}{\partial x} (x = L, \theta > 0) = h(T_{air} - T) + G(T_{heater}^{*4} - T^{*4}) \quad (13a)$$

$$-k \frac{\partial T}{\partial x} (x = 0, \theta > 0) = h(T_{air} - T) + G(T_{heater}^{*4} - T^{*4}) \quad (13b)$$

And the initial condition:

$$T(0 \leq x \leq L; \theta = 0) = T_0 \quad (14)$$

The method of solution for me is through explicit finite difference equations:

$$\frac{T_i^{n+1} - T_i^n}{\Delta\theta} = \alpha \frac{T_{i-1}^n + T_{i+1}^n - 2T_i^n}{(\Delta x)^2} \quad (15)$$

Where α is thermal diffusivity, $\alpha = k/\rho c_p$, $i=1,2,3\dots N-1$, and $n=0,1,2,3\dots$

If I let $r = \frac{\alpha \Delta\theta}{(\Delta x)^2}$ can write equation 15 as:

$$T_i^{n+1} = rT_{i-1}^n + (1 - 2r)T_i^n + rT_{i+1}^n \quad (16)$$

As another aside, the term r is often called the differential Fourier number, ΔFo .

I now write the boundary condition at $x=0$ as a forward difference equation

$$-k \frac{T_i^{n+1} - T_0^{n+1}}{\Delta x} = f(T_{air}, T_{heater}, T_0^{n+1}) \quad (17a)$$

And the boundary condition at $x=L$ as a backward difference equation:

$$k \frac{T_N^{n+1} - T_{N-1}^{n+1}}{\Delta x} = f(T_{air}, T_{heater}, T_N^{n+1}) \quad (17b)$$

Note that $f(\dots)$ in these equations is the differential form for that in equation 2. The initial condition is $T_i^0 = F(i \cdot \Delta x)$ for $1 = i = N-1$. Okay, I'm now ready to solve the traditional radiopaque equation. This will be the subject of Part 3.

In order to contract the radiopaque model, equations 16, 17a, 17b, and the initial condition, I need to determine what changes are needed to include the volumetric absorption terms. Again I refer back to (1).

The functional equation is:

$$\rho c_p \frac{\partial T}{\partial \theta} = k \frac{\partial^2 T}{\partial x^2} + Q(x; \theta) \quad (18)$$

Where $Q(x; \theta)$ is the volumetric absorption term. As I note in (1), if β is the extinction coefficient from the Beer-Lambert-Bouguer equation, I can write the volumetric absorption term as:

$$Q(x; \theta) = G(x)(T_{heater}^{*4} - T^{*4})(1 - e^{-\beta x}) \quad (19)$$

Where G is the same term as given in the earlier equation

except that now $A = (1 - e^{-\beta x})$. I write $Q(x; \theta)$ in difference form as:

$$Q(x; \theta, i) = G(x)A(T_{heater}^{*4} - T_i^{*4, n}) \quad (20)$$

The functional equation becomes:

$$T_i^{n+1} = rT_{i-1}^n + (1 - 2r)T_i^n + rT_{i+1}^n + \frac{GA\Delta\theta}{\rho c_p} (T_{heater}^{*4} - T_i^{*4, n}) \quad (21)$$

What about the boundary conditions?

$$-k \frac{T_i^{n+1} - T_0^{n+1}}{\Delta x} = h(T_{air} - T_0^{n+1}) \quad (22a)$$

$$k \frac{T_N^{n+1} - T_{N-1}^{n+1}}{\Delta x} = h(T_{air} - T_N^{n+1}) \quad (22b)$$

In other words, the convective terms are all that remain at the surfaces of the sheet.

Setting the Table

I am about ready to graph these equations. But first, here's my protocol. I will plot the temperature profiles for two plastics – Polyethylene that is visually translucent but somewhat radiotransparent and Polystyrene that exhibits substantial absorption (1). The physical properties for these two plastics are given in Table 1.

As I discussed in (6), I extracted the extinction coefficient data for these two plastics from FTIR Spectra in two ways. First I just drew a horizontal best-line through the data in the range of 4 μm to 7 μm , the traditional thermoforming

Extinction Coefficient Values for Three Plastics - Data Extracted from FTIR Scan

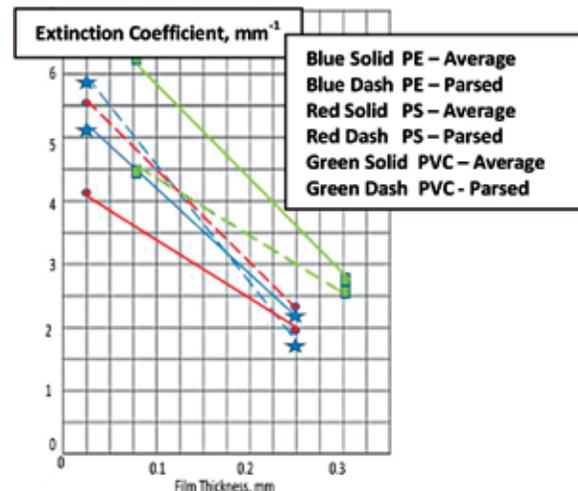


Figure 01: Extinction coefficients for three plastics (6).



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Table 1

Thermophysical Properties For PE and PS

Property	cgs units	Polyethylene	Polystyrene	US units
		US units	cgs units	
Density, ρ	0.96 g/cm ³	60 lb/ft ³	1.05 gm/cm ³	65.5 lb/ft ³
Heat Capacity, cp	1.0 cal/gm C	Btu/lb F	0.54 cal/gm	C 0.54 cal/g C
Thermal conductivity, k	10 x 10 ⁻⁴ cal/s cm	C 0.25 Btu/ft h F	4.3 x 10 ⁻⁴ cal/s cm C	0.105 Btu/ft h F
Thermal difussivity, a	13 x 10 ⁻⁴ cm ² /s	50 x 10 ⁻⁴ ft ² /h	7.7 x 10 ⁻⁴ cm ² /s	30 x 10 ⁻⁴ ft ²

Additional Important Values

Stefan Boltzmann constant	0.1714 x 10 ⁻⁸ Btu/ft ² h R ⁴	1.35 x 10 ⁻¹² cal/s cm ² K ⁴
Convective heat transfer coefficient, air	2 Btu/ft ² h F	1 cal/cm ² h C

Table 2

**Extinction Coefficient Values, β , mm⁻¹
For 0.254 mm thick films
FTIR-data based (6)**

Plastic	Averaged (1)	Parsed (6)	Average Value
PE	2.22	1.76	1.95
PS	1.8	2.28	2.05

Table 3

**Absorptivities for PE and PS
For Three Thicknesses [Low-Average-High]
A, % absorbed**

Plastic	0.254 mm	0.508 mm	1.016 mm
PE	36.0/39.1/43.1	59.1/62.9/67.6	83.3/86.2/89.5
PS	36.7/40.6/44.0	59.9/64.7/68.6	83.9/87.5/90.1

heater temperature range. Then I parsed the data at 4 wavelength values. As it apparent from Table 1, the extinction coefficients for the two plastics appear to be dependent on sheet thickness.

It would appear that the extinction coefficients are thickness dependent. But because of the paucity of data (only two thicknesses for each plastic), I cannot determine the functional relationship of the coefficient with thickness. For the analyses that follow, I have assumed the extinction coefficient value for the thicker of each plastic sheet, Table

Table 4

General Properties in Equations

■ h , convective heat transfer coefficient units \rightarrow (energy/length² * time * temp)

■ σ , Stefan-Boltzmann constant, units \rightarrow (energy/length² * time * temp⁴)

■ Units on extinction coefficient units \rightarrow 1/length

■ Units on $r = \frac{a\Delta\theta}{(\Delta x)^2} \rightarrow$ (length²/time)*time/length² = null

■ Units on $G \rightarrow$ energy/(length³ * time * temp⁴)

■ Units on $\frac{G\Delta\theta}{\rho c_p} \rightarrow$ [(energy / length³ * time * temp⁴) * time]/[wt/length³ * (energy/wt*temp)] = (1/temp³)

■ Units on $r = \frac{a\Delta\theta}{(\Delta x)^2} \rightarrow$ [(cm²/s)*s]/cm² = null

■ Units on $\frac{h\theta}{\rho c_p} \rightarrow$ [(energy / length² * time * temp) * time]/[length³*(wt/length³) * (energy/wt*temp)] = null

2. Table 3 gives the range of absorptivity values, A , for three thicknesses of the two plastics.

I am using the average extinction coefficients of Table 2 and the average absorption values of Table 3 for further calculation. I give some additional required properties needed in the requisite equations in Table 4. These are references for the units-challenged folks like me. Other values are given in Table 2.

Conclusion

In this, the first of a three part-series of papers, I have defined the equations and parameters necessary to compare traditional radiopaque transient heat transfer models with volumetric absorbing models. In Part 2, I examine thin-gauge sheet response to inbound energy in the so-called Lumped Parameter Model, In Part 3, I compare traditional Distributed Parameter Models for thick-gauge sheet.

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Footnote 1. Mathematical models for thick plastic sheet contain the thermal conductivity property of the sheet. It is absent in this model simply because conductivity is instantaneous. |

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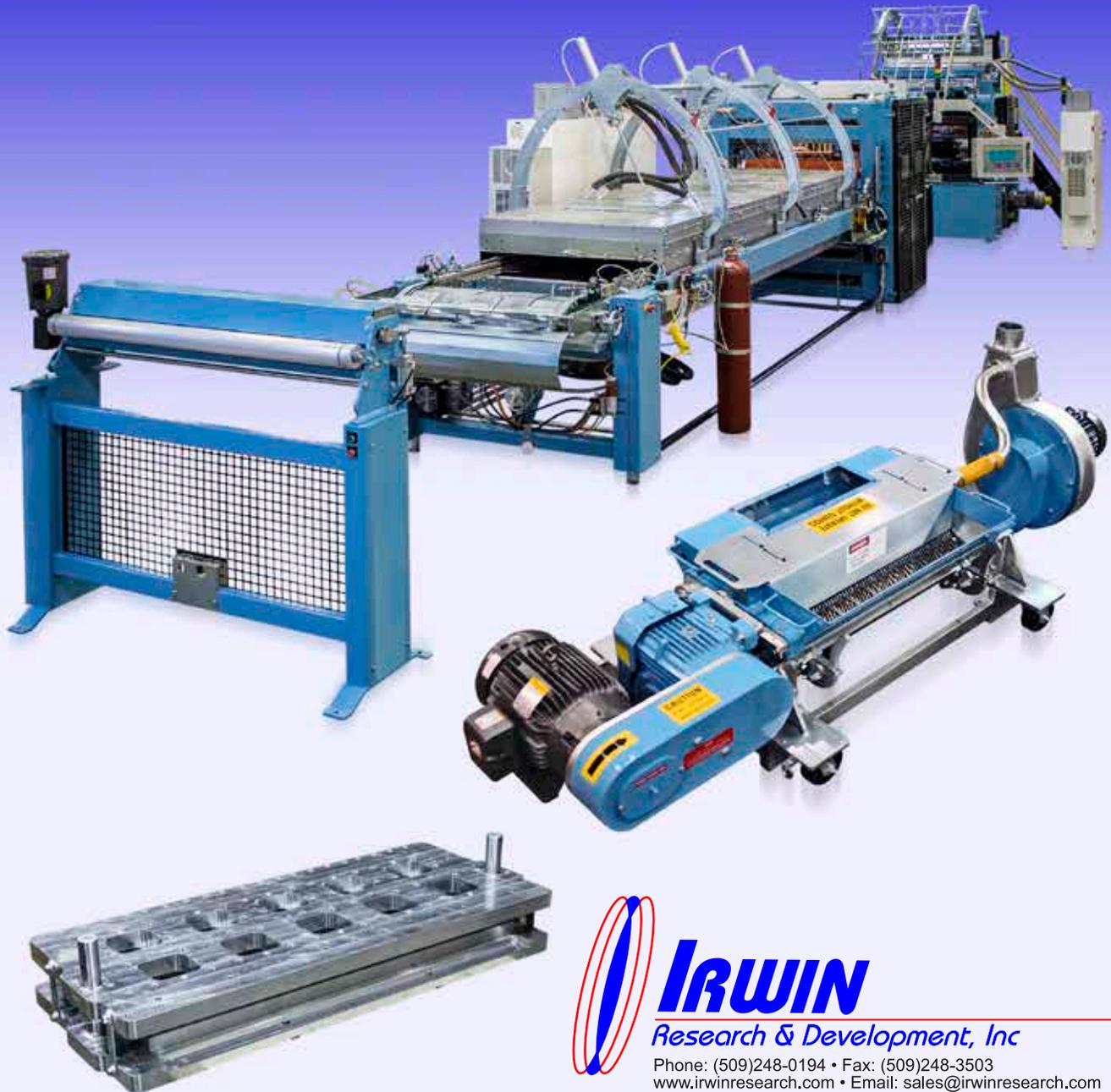


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Chinaplas 2017

By Conor Carlin, Editor

The plastics industry's second biggest exhibition returned to Guangzhou (pop. 14MM) in the Dongguan region of Southern China. This was the 31st Chinaplas Fair and with 13 halls and the organizers were delighted to announce a new record of 155,000 visitors, up 4.5% from last year and 21% from 2015. Similar to 2016 when the fair was in Shanghai, major show themes were Industry 4.0 and Smart Manufacturing Technology; Greenovation, which included a Bioplastics Zone and recycling technologies; "Design x Innovation" for smarter living; and a co-located Medical Plastics Conference. The strong German showing was led by BASF and their "Smarter Living Initiative" which highlighted new and novel applications of chemistry to all walks of life from automotive, to robotics to medical devices.

Each morning on the bus ride to the show, I read the China Daily newspaper which had intensive coverage of China's Belt & Road Initiative, billed as the largest infrastructure project in history, with over \$1tn pledged among 68 countries. Later in the week, the paper ran an interview with the CEO of Dow Chemical, Andrew Liveris. It was relevant to get his perspective and understand the scale of opportunities for chemicals and plastics in China. The company has 17 manufacturing sites and 10 offices in the country, and not just in the major cities like Beijing, Guangzhou and Shanghai.

Thermoforming Coverage

Unlike the K show where the thermoforming industry tends to congregate in Hall 3, at Chinaplas you had to cover quite a bit of real estate to visit all of the players. In total, there were approximately 30 thermoforming-related companies scattered around the exhibition center, though many Chinese OEMs could be found in Halls 2 and 10, while their European counterparts were based in their respective country pavilions (Germany and Italy, predominantly).

The following is a high-level summary of some of the machinery displayed this year:

■ **AMUT** (Novara, Italy) ran their ACF 820 3-station inline machine at over 50 cpm. This model featured an extended oven a new graphical interface set up to display the low

power consumption. A 15-up mold with HYTAC FLX plug assists was provided by a Turkish supplier to run shallow APET trays at 350 micron. By the end of the 3rd day, the machine boasted a "SOLD" sign to a buyer in Malaysia.

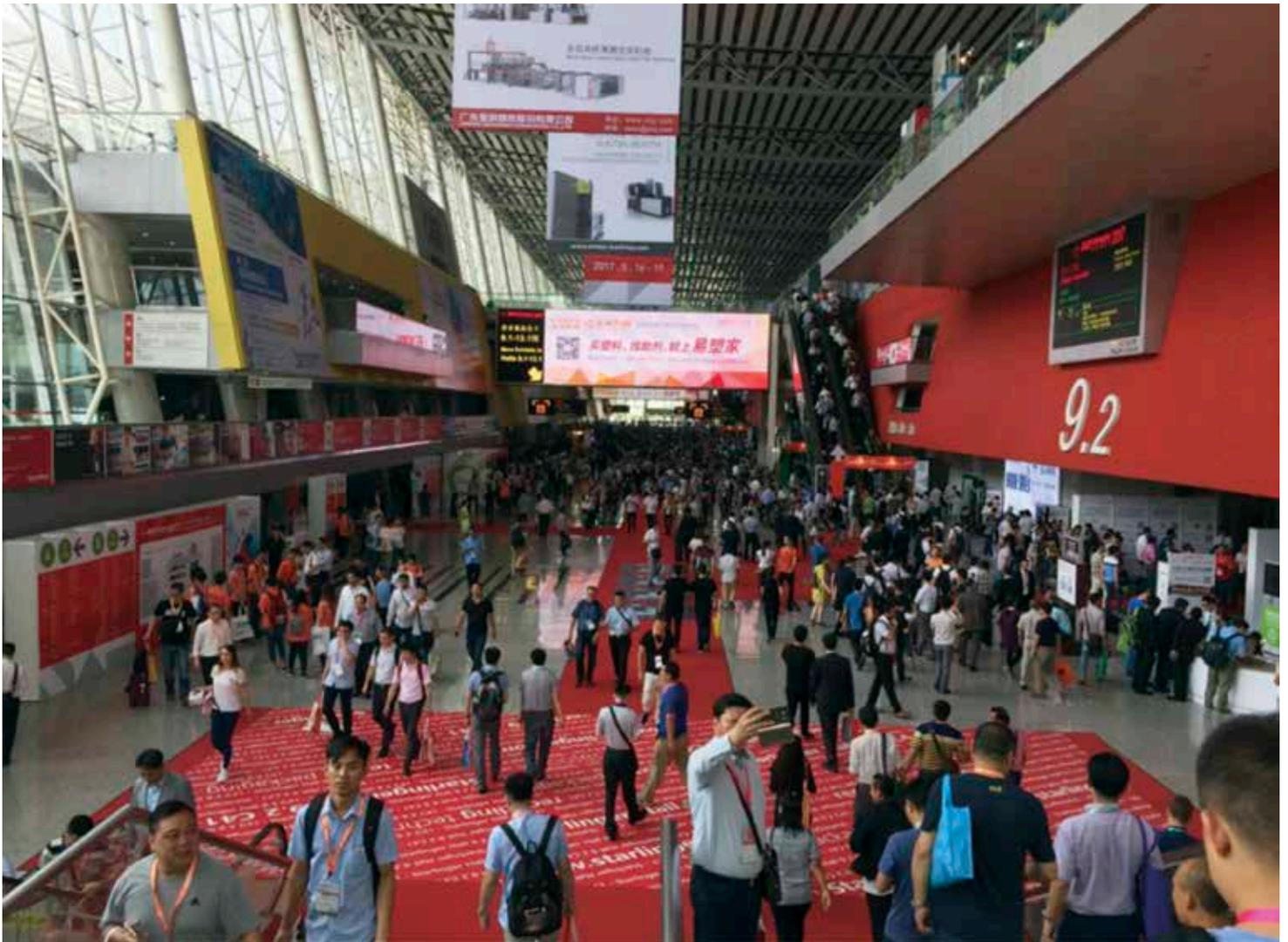
■ **Illig** (Heilbronn, Germany) demonstrated 2 machines: IC-RDM 70K with 18-up cavity mold with HYTAC B1X plugs producing a lightweight APET cup; the second machine was a IC-RDK 80 with SZA73 stacking system to produce a 12-up PP tub with tight-locking lid. Both molds were made by the company. This particular configuration was announced in their pre-show marketing campaign as a solution to packaging more noodle-based Asian dishes where liquids are securely stored inside the container.

■ **Kiefel** (Freilassing, Germany) featured a Speedformer KMD78 3-station former with a 12-up tool supplied by a local China-based moldmaker.

■ **Sunwell Global** (Taipei, Taiwan) showed their vertical trim press, designed for difficult-to-trim materials. It is a continuous web, vertical-actuating, matched-metal punch and die press. The system also has adjustable stroke settings for 100mm and 150mm part heights up to 150cpm trimming speed.

■ Other suppliers such as **Meaf** (Netherlands), **Asano** (Japan), **VFK Corp** (Korea), **Vulcan Plastics/GN Machinery** (China / Canada), **CMT Materials** (USA), **Polytype** (Switzerland), **Guven Teknik** (Turkey), **WM** (Switzerland) and **Gabler** (Germany) had informational booths only.

Generally speaking, the mood was upbeat, if not as buoyant at the K show. Several of the majors including Eastman Chemical and DuPont from the US announced new product releases. The China market dominates conversation here, but there was no shortage of buyers from India, Pakistan, Saudi Arabia and Eastern European countries. In conversations with attendees, exhibitors and company owners, most of the China-based OEMs are selling equipment to lower-cost countries such as Vietnam and Bangladesh. A few of the local machinery builders have markedly improved their quality over the past few years, though they still have not achieved the same level of technological sophistication as their Western rivals. It is questionable, however, as to whether or not they actually need to reach the same levels of engineering excellence



The halls were packed on Day 2 of Chinaplas 2017

as Germans and Italians in order to grow and be successful in a majority of global markets. The continued rise of the middle class China and ASEAN, associated labor rate increases and market trends that favor thermoformed packaging means that the pie is expanding.

Tracking Trends

With increased wealth comes demand for higher quality items, including convenience foods. The proliferation of stores like Walmart and Sam's Club means that products that were once loosely bagged in polyethylene sacks or nylon mesh are now packaged in rigid thermoforms. Even in the hinterlands of China's remote provinces, the role of packaging is changing and is looking more like what one would see in developed markets around the world. Converters are also stepping up their quality control procedures for inputs and outputs as demand from

Chinese OEMs, not just the multinationals, force their hand in a dynamic marketplace.

The subject of rising labor costs in China has been well-documented in industry press. At least one local OEM was using a robotic stacking mechanism in an attempt to improve efficiencies. According to several sources, it still requires 4-6 units of labor to be as productive as 1 unit in Europe or North America. Removing packers from the end of a production line is one way to manage labor costs while addressing the productivity gap.

Next year the show returns to Shanghai, though it will be moving to a new venue, the National Exhibition and Convention Center in Hongqiao. Twelve months is not a long time to wait and see if any major new developments come to market in 2018. |

Greetings from ANTEC 2017

(This report is a composite based on input from Juliet Goff, Brian Winton and Roger Kipp.)

Council convened during the recent ANTEC in Anaheim. The first order of discussion was 2017 election results. The new officers are as follows:

- Brian Grady – President-Elect
- Jeremy Dworshak – Vice President-Business
- Conor Carlin – Vice President- Marketing and Communications
- Jaime Gomez – Vice President-Events
- Craig Bowland –Vice President- Divisions

CEO Wim Devos reported that negotiations have been completed with Wiley Publications earning a new contract for Plastics Engineering and the SPE Journals. The following details were presented to Council:

- There were two competitive bidders
- The agreement increases the royalty SPE earns on the magazine from 12% to 20% and on the Journals from 40% to 42.5%
- Editorial support to SPE will be reimbursed \$195K plus an additional \$5K annually
- The signing bonus on the previous contract was \$50K for the magazine and \$250K for the Journals. The new agreement paid SPE \$1.5 Million as a combined signing bonus. This bonus has been received and is in the bank.

Financial Review

SPE's cash position at the end of April was \$229k. The \$1.5 million from Wiley came in May and will increase the cash accordingly. Since April, the Finance Committee reports that \$200k has been paid toward an outstanding loan with the balance being invested.

On the subject of ANTEC, leadership reported that the number of exhibitors was down from 2016 (105 vs. 70). This is mainly attributed to increased costs associated with traveling to Southern CA more difficult for travel. While exhibitor-based revenue decreases, attendee-based



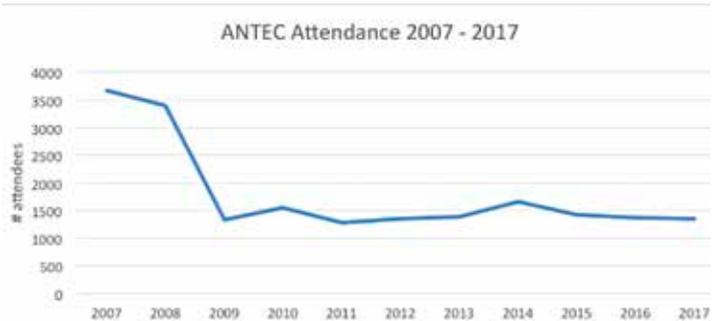
James Waddell



revenue increased. ANTEC is still a very profitable event but revenues continue to slowly decline.

There was some discontent with the lack of ANTEC registration fee discounts for Group Board Members. Feedback included the continued need to focus on content and value so that attendees can bring back value to their companies. Discounts not as important as value. With slipping exhibits and registration numbers, SPE needs to look at all avenues relating to value and perceived value.

CEO de Vos Wim noted ANTEC attendance over the past 10 years:



Since 2008, 1320 – 1420 people attended with 90% company paid. With cost to go about \$2500 how much impact does a \$150 - \$200 discount have? A motion to establish a task force to consider discount pricing for ANTEC was passed.

Awards

"PIN" is a new award designed to replace the Pinnacle Award. The new award will pinpoint specific areas of outstanding achievement for groups and be awarded at venues local to the groups in questions. Outreach, Education, Communications, Programming, Student Support are the areas of excellence where a group can earn the award.

Council of the Whole Meeting

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proposal has been made to update SPE mission. Council discussed the proposal and asked what the end goal should be. A task force led by VP Sections, Monica Verheij, will review and propose recommendations.

Election Process

There was some negative feedback regarding the electronic process used to elect the SPE officers. Some of the comments included the following:

- No opportunity to meet the candidates – need to get to know them
- This is very difficult to provide equal time for all
- Very expensive
- It was agreed that the process provided an excellent equal opportunity for all to be introduced

Council II Meeting

- New VP of Divisions: Creig Bowland
 - SPE Headquarters needs to expand its resource support for Divisions
 - Manage and modifications will be made for the Divisions Committee
 - Need committed volunteers – 1 year, with no term limits
 - Provide help if requested with Technical Conferences
 - Help connect Divisions for joint conference events
 - Help connect with outside organizations
- Comments from President Dr. Raed Al-Zu'Bi
 - We must maintain awareness of who we serve
 - Priorities
 - Support the changes made on SPE governance
 - Support the "onboarding" of the new CEO Patrick Farrey
 - Support NGAB
 - 3 YOP Methodology: a set of strategic projects and programs to meet the business plan objectives which can be found on The Chain
 - **Improve financial performance**
 - Disciplined financial budgeting
 - Expand nonmember revenues
 - Investment in infrastructure
 - Develop HQ organization capacity
 - Expansion of The Chain
 - Higher value content creation
 - **Protection of brand both internally and eternally**
 - SPE needs to communicate pride in who we are and where we are and develop effective execution

of leadership deployment

- Email blasts – HQ will e-blast promotion for Divisions and Sections
- Rebate program is still in place – groups should be receiving rebates
- By-laws
 - None to review
 - Committee is putting together a glossary of terms
 - Committee is creating, updating, and publishing operating policies Finance Committee, Divisions and Sections Committee, etc.

The next Council meeting is scheduled for August 24-26 in Detroit to coincide with the 75th Anniversary Gala celebration. |

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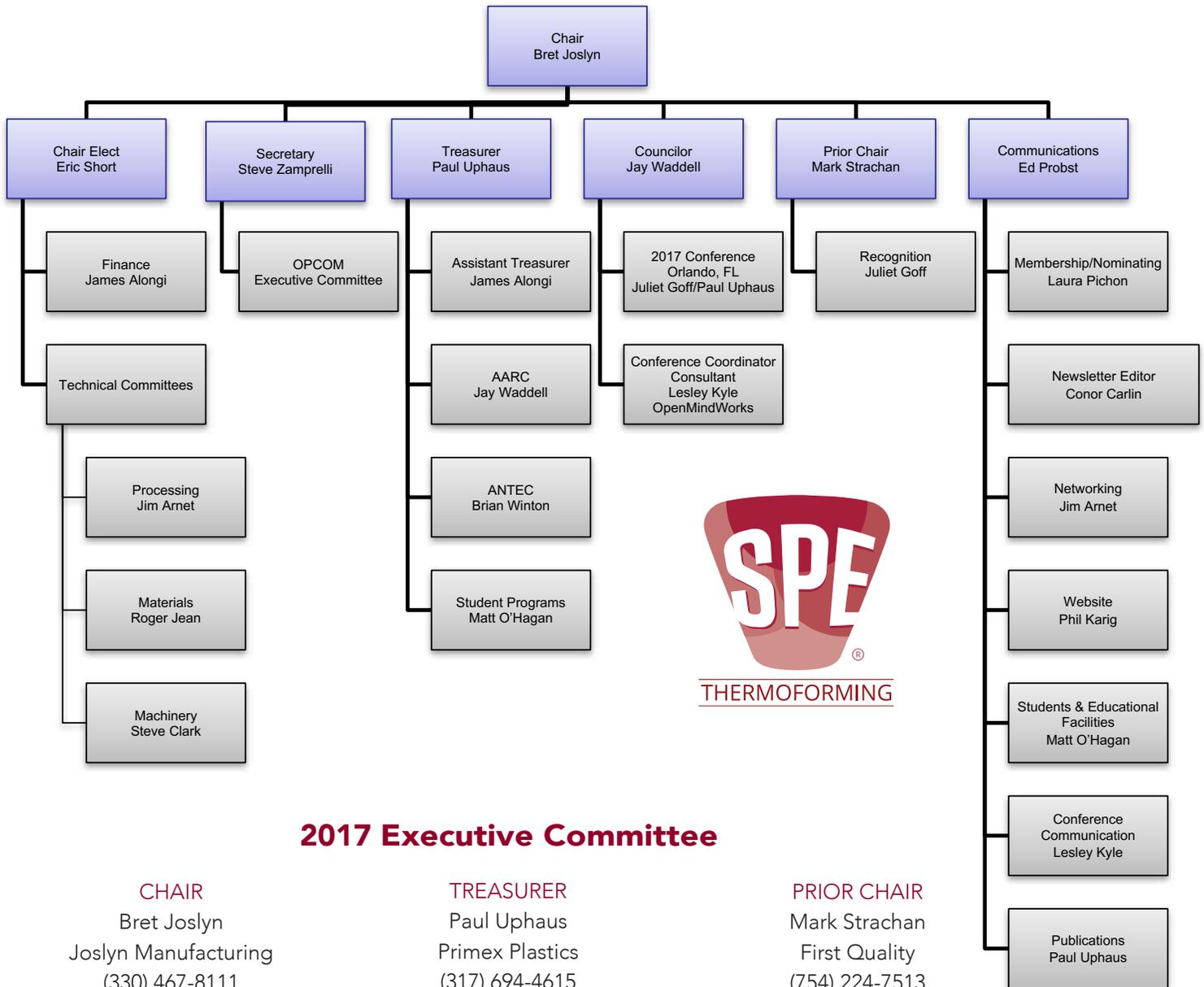
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Questions?

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- Each Entrant will be supplied with an Electric RC Car by a participating sponsor
- Each Entrant must design, manufacture and decorate their own car body to be mounted on the sponsor provided chassis
- Car body must be formed using clear plastic such as PET, PETG, Acrylic or Polycarbonate
- The body must be produced using the vacuum/thermoforming process
- The cars will be judged for presentation and complexity of thermoforming
- A race track will be built at the conference where the entrants will race each other
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The PlastiVan™ Program is a great way to excite young people about the science and the vast opportunities the plastics industry has to offer. The program travels to schools and companies throughout North America, educating middle- and high-school students about plastics chemistry, history, processing, manufacturing, sustainability and applications. Corporate sponsors have a unique role to play in this community outreach program, linking the wonders of plastics to applications and jobs in the real world.

● **COSTS OF SPONSORSHIP**

The fee for the PlastiVan™ program is \$1500 a day. Your sponsorship covers travel & expenses for educators as well as all materials. SPE coordinates all scheduling and communication with schools. This allows more students greater access to the wonders of plastics in their own communities. Sponsorship of the PlastiVan™ Outreach Education Program is a tax-deductible donation.



● **BENEFITS OF SPONSORSHIP**

As part of the sponsorship package, companies gain access to students, parents and educators in local communities. Sponsoring companies can choose to provide a list of local schools or SPE staff can work with you to select schools and arrange schedules. Many companies choose to send a representative to speak directly to the audience about products and career opportunities. In addition, SPE can help coordinate PR with local press to craft stories about the PlastiVan™ visit. These stories are then added to SPE's library of testimonials highlighting the success of the PlastiVan™ program.

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For more information or to schedule a school visit, contact:

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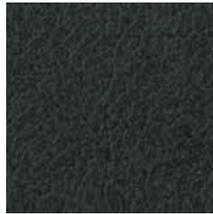
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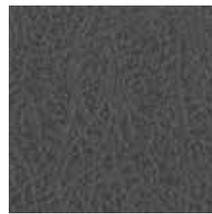
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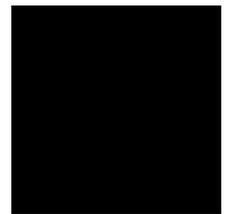
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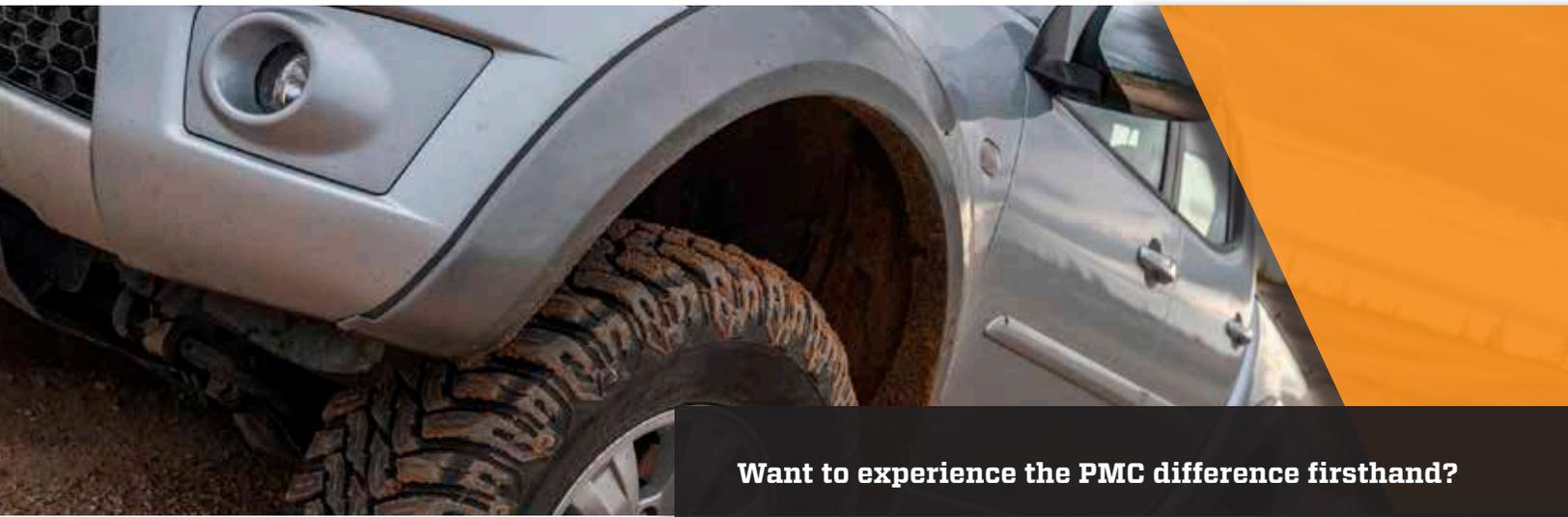
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