IN THIS ISSUE:

- Collaborative Trials Using Virtual Tools
- LCA for PLA, PET, PP Thermoforms

SMART Manufacturing is Here
Genesis

Genesis is a comprehensive inventory of stock machines, parts and sub-assemblies that represents a multi-million dollar inventory investment enabling expedited delivery of complete sheet extrusion systems. All systems are current model years and PTI's latest state of the art technology.

Represented within the scope of the program are ancillary components, including: individual extruders, roll stands, die supports, winders and pelletizers, all of which are available for complete line configuration and delivery within three months.

This unique offering better serves sheet producers by providing quick deliveries on a variety of standard machinery platforms. The Genesis Program results in the immediate availability for a variety of sheet extrusion system configuration combinations, in which the reduction in lead time for these systems represents a significant factor for expediting the product-to-market timing and the pathway to financial success.

PTI also offers a comprehensive portfolio of sheet extrusion machinery technologies and sizes well beyond the scope defined within the Genesis Program.

GENESIS SYSTEMS FEATURE 3 MONTH EXPEDITED DELIVERIES!* Complete systems are available to meet your exact processing needs. Individual lines sized by process, sheet specifications and output are immediately available and summarized below:

<table>
<thead>
<tr>
<th>Process</th>
<th>Resins</th>
<th>Gauge</th>
<th>Structure</th>
<th>Rates</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>INLINE THERMOFORMING</td>
<td>Sheet Extrusion/Thermoforming</td>
<td>9 – 90 MILS</td>
<td>Mono- and/or Co-extrusion</td>
<td>1000+, 2000+, 3000+, &amp; 4000+ pph</td>
<td>36 – 68 inch sheet widths</td>
</tr>
<tr>
<td>ROTARY THERMOFORMING</td>
<td>Inline Rotary Sheet Extrusion or Thermoforming</td>
<td>9 – 25 MILS</td>
<td>Mono- and/or Co-extrusion</td>
<td>1000+, 2000+, 3000+, &amp; 4000+ pph</td>
<td>up to 55 inch sheet widths</td>
</tr>
<tr>
<td>ROLL STOCK</td>
<td>Sheet Extrusion</td>
<td>9 – 60 MILS</td>
<td>Mono- and/or Co-extrusion</td>
<td>1000+, 2000+, 3000+, &amp; 4000+ pph</td>
<td>36 - 68 inch sheet widths</td>
</tr>
<tr>
<td>RECYCLING</td>
<td>Extrusion Pelletizing</td>
<td></td>
<td>Rigid and Film Fluff</td>
<td>1000+, 2000+, &amp; 3000+ pph</td>
<td></td>
</tr>
</tbody>
</table>

Complete systems BUILT & SHIPPED in as little as 3 MONTHS!*

*Contact PTI to determine whether your project qualifies for a Genesis Program Expedited Delivery!

Discover more about PTI products and services. Visit us at one of these upcoming events:

- **Thermoforming Expo**: Booth 525
  - Sept. 20-22
  - Grand Rapids, MI

- **Extrusion 2021**: Booth E-213
  - Sept. 21-23
  - Rosemont, IL

- **Plastics Extrusion World Expo**: Booth N-9318
  - Sept. 27-29
  - Las Vegas, NV

- **Booth C423**: Nov. 3-4
  - Cleveland, OH

www.ptiextruders.com
Departments

Chairman’s Corner | 4
Thermoforming in the News | 6-7
University News | 10

Features

Thermoforming 2.0: ILLIG – Sekisui KYDEX Anti-Microbial Sheet Trials | 12-15
Cradle-To-Grave Life Cycle Assessment of Single-Use Cups Made From PLA, PP & PET | 17-26
Microalgae Thermoformed Packaging | 30

In This Issue

Thermoformer of the Year | 16
SPE News | 34

Cover image courtesy of ILLIG Maschinenbau GmbH & Co. KG
The 3rd quarter issue of our magazine is probably my favorite. Not only do we get to award our prestigious Thermoformer of the Year prize, we also celebrate the future of our industry by delivering scholarships to students. This is also the time of year when we come together as an community at our conference. Despite all the challenges we’ve faced, I am convinced that we are stronger, leaner, and more innovative than ever.

I’m thrilled to announced that Hal Gilham is our 2021 Thermoformer of the Year (see p. 16 for full bio). Hal was a long-time former Board Member, having joined SPE in 1991, and has now joined the esteemed rank of emeritus member of SPE. During his tenure on the Board, Mr. Gilham served as Chairman of the Materials Committee, the Processing Committee, the Machinery Committee, as well as volunteering to be the Parts Competition Chair at several conferences. Congratulations, Hal!

Our division has a long history of supporting education, especially through scholarship recognition programs. This year is no different as we disburse two prizes to college seniors, Olivia Ferki and Isabella Gayoso, both with ties to the Keystone State (see full story on p.10).

The link between theoretical knowledge in the classroom and hands-on training in the factory must be nurtured and strengthened, especially as we continue to face aging demographics and long-standing hiring challenges. The companies that are most likely to attract new talent are those that can capitalize on new and growing trends. In thermoforming, arguably two of the biggest trends are the increasing applications for additive manufacturing / 3D printing, and developments related to sustainability. In the case of the latter, this can include bio-based materials, energy efficient devices, and resource reduction strategies. In both the heavy gauge and thin gauge sectors, we can see these developments at play, but we cannot take it for granted that a new generation will simply find us via Google searches. We must be active recruiters – all of us – for the industry at large.

It is sometimes said that if you don’t know where you’ve been, you won’t know where you’re going. Our editor has delved into the TQ archives to share a magazine cover from 25 years ago (that’s a quarter of a century!!). Check out the grainy images of the 1996 Parts Competition showing how the industry was keeping up with market demands in the days of paisley ties, pleated pants, and questionable font choices.

If you’re coming to Grand Rapids in September, you won’t be disappointed by the bevy of new advances in thermoforming materials, tooling, machinery, and processes. In particular, there will be a focus on how new remote technologies such as virtual reality are enabling collaboration beyond the endless Teams or Zoom meetings (see story about ILLIG and KYDEX on pp. 12-15. And it’s not just about the OEM supply chain; it’s about the benefits that our processors deliver to their end customers, whether life-saving medical devices or light-weighting agricultural components. We’ve had some ups and downs over the last 25 years, but thermoforming is going from strength to strength. Let’s see what we can do together between now and 2046! |
CUSTOMIZATION CREATED THROUGH INNOVATION

THE JOURNEY BEGINS WITH KYDEX® THERMOPLASTICS

Sculptured Pressure Formed KYDEX® 6565

KYDEX® THERMOFORMING CONFERENCE
BOOTH #501/503

kydex.com
Pinnpack President Buys Company out of Bankruptcy

By Steve Toloken, Plastics News

June 24, 2021 - California thermoformer PinnPack Packaging LLC is being bought out of bankruptcy court for $9.6 million by a new company formed by PinnPack President Ira Maroofian.

A federal judge in Delaware approved the purchase June 22, as part of the bankruptcy of PinnPack’s parent company, PET recycling firm CarbonLite Holdings LLC. Maroofian is also on CarbonLite’s board of directors and is a longtime packaging industry executive.

Maroofian is listed in court documents as the “managing member” of PinnPack Capital Holdings LLC, the new owner of PinnPack and its PET thermoforming plant in Oxnard, Calif. Maroofian has been president of PinnPack since 2016, court documents show.

He told the court in a June 21 filing that PCH has an initial investment of $12 million, including $2.4 million in working capital, from Iraj Barkohanai and family trusts, which would hold 90 percent ownership of PCH, court documents show.

According to a filing from CarbonLite’s court-appointed restructuring officer, PHC presented the only viable offer for PinnPack, which did not have the cash flow to continue and would have been forced to liquidate its assets and lay off its 190 employees.

Court filings also said PCH has an agreement with the state agency CalRecycle to borrow up to $3.25 million from the agency, after the court said it would dismiss a previous $2.6 million CalRecycle loan to PinnPack as part of the bankruptcy.

Los Angeles-based CarbonLite bought PinnPack in 2017, seeking to integrate the company’s production of food-grade thermoformed packaging with CarbonLite’s PET recycling operations.

All three of CarbonLite’s PET recycling plants were sold in earlier rounds of the bankruptcy proceeding. Its Riverside, Calif., plant was sold to Houston private equity firm Sterling Group, its Dallas plant is now owned by PET resin supplier Indorama Public Ventures Ltd., and its Reading, Pa., plant is being sold to DAK Americas LLC.

Sonoco Products Closing Wilson, NC, Thermoforming Plant

By Don Loepp, Plastics News

July 30, 2021 - Sonoco Products Co. plans to close a thermoforming plant in Wilson, N.C., impacting 138 jobs, according to a layoff notice filed with the North Carolina Department of Commerce.

The Hartsville, S.C.-based company filed the notice on July 27 and plans to permanently close the plant by Sept. 30. A spokesman said Sonoco decided to consolidate its perimeter-of-the-store thermoforming operations on the East Coast into its primary operation in Plant City, Fla.

“The Wilson, N.C., thermoforming operation served as a satellite operation to Plant City and forecasted sales did not support maintaining the Wilson facility,” he said.

In April, the company announced plans to expand its Waynesville, N.C., thermoforming plant by investing $2.6 million to add a new production line and create 15 jobs. The spokesman said the Wilson closure is unrelated.

“The Waynesville facility produces dual-ovenable and microwave thermoformed trays and bowls for frozen and prepared foods. The Wilson satellite thermoforming facility produced clear PET clam shell trays for berries, salads and tomatoes,” he said.

Sonoco is encouraging workers to relocate to other facilities in North Carolina, or to Plant City, he said.

Two thermoforming machines will move to Plant City, and a third will move to Sonoco’s Exeter, Calif., plant.
Sonoco ranks No. 3 in Plastics News’ survey of North American thermoformers with estimated sales of $600 million. When the Wilson plant closes, Sonoco will have six thermoforming plants in North America.

Sonoco is publicly traded and has total sales of about $5 billion.

ILLIG Marks 75 Year Anniversary, Sets Goals for “Next 75”

Company Release

Heilbronn, Germany — Thermoforming technology pioneer Illig Maschinenbau GmbH & Co. KG is celebrating its 75th anniversary this year with an eye to the future.

The anniversary motto for the family-owned company, which is in the third generation, is “Next 75.”

CEO Carsten Strenger and Jürgen Lochner — chief sales officer and chief technology officer — who were appointed managing directors by the Illig and Schäuble families in 2020, said they will continue to align the company with sustainable solutions called for by circular economy principles.

Illig was founded as a mechanical repair shop on May 27, 1946, by Adolf Illig. The shop grew into a company that focused on thermoforming technology and tooling systems for packaging. The company took off in 1956 after building the first Illig UA 100 model vacuum forming machine.

Other developments followed in the 1960s, including the world’s first roll-fed automatic vacuum forming machine to produce lids from pre-printed film and the first automatic pneumatic quick-forming machine for combined forming and die-cutting operations.

In the 1970s, Illig expanded the machine program with the first packaging line that integrated the forming of basic packages with subsequent filling and sealing to produce finished consumer packaged goods.

In the 1980s, Illig invented mold tilting technology, which it says created a new standard for hygiene in packaging.

The company also developed programs to automatically calculate basic settings for vacuum thermoforming machines for simpler operation.

The 1990s brought in-mold labeling decoration technology and the first fully aseptic form, fill and seal (FFS) machine with a daily capacity of 700,000 yogurt cups — a world record at the time.

In the new millennium, Illig increased machine productivity and the quality of formed parts through advanced servo-motor drives and motion control techniques, which also improved energy efficiency.

In this anniversary year and beyond, new developments are expected to set milestones in the thermoforming industry, company officials said.

Have an idea for an article?

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 cpcarlin@gmail.com

ALL FINAL COPY FOR EDITORIAL APPROVAL
FEBRUARY 15 Spring
MAY 14 Summer
AUGUST 2 Fall
NOVEMBER 15 Winter

All artwork to be sent in .eps or .jpg format with minimum 300dpi resolution.
12th EUROPEAN THERMOFORMING CONFERENCE

31 March – 1 April 2022 | NEW VENUE: VIENNA | Austria

MARK YOUR CALENDARS AND DO NOT MISS THE ONLY EVENT THAT IS DEDICATED TO EUROPE’S THERMOFORMING INDUSTRY.

The European Thermoforming Division invites you to the 12th European Thermoforming Conference to be held in Vienna from 31st March till 1st April 2022.

CONFERECE HIGHLIGHTS
- Keynote Presentations
- Technical Sessions
  - Thin & Heavy Gauge
- Workshops
- Exhibition
- Networking Events
- Parts Exhibition

Who should attend? Thermoformers, OEM’s, Machinery & Tooling Producers, Film and Sheet Suppliers, Resin Producers, Recyclers … Venue: Hilton Vienna Park in Vienna welcomes you.

Further information about this event:
Society of Plastics Engineers, Thermoforming Europe Division
T +43 670 55 79 714, info@thermoforming-europe.org
www.thermoforming-europe.org
Editor’s Note: Do you remember where you were in 1996? Still in grade school, perhaps?! Or cutting your teeth on some early versions of servo technology? This blast from the past shows that many converters are still going strong and still submitting parts to the Parts Competition in 2021!

**Most Innovation Application Award**
Prestige Plastics (Below)

**People’s Choice Award**
Freetech Plastics (Below)

**Heavy Gauge Pressure Forming Award**
Profile Plastics (Below)

**1996 Thermoformer Parts Competition Winners**

**Thin Gauge Vacuum Forming**
Universal Protective Packaging, Inc. (Below)

**Heavy Gauge Twin Sheet Award**
Spencer Industries (Above)

**Value Added Assembly Award**
McClarin Plastics (Above)

**Heavy Gauge Vacuum Forming Award**
Paramount Plastics (Below)

---

**DIVISION NEWS**
Chairman’s Corner 2
Membership Memos 2
Council Summary 3
Thermoformer of the Year 3

**DIVISION NEWS**
International Report 4
Student Affairs Report 5
ANTEC’97 16
Thermoforming Shirts 18

**CONFERENCE RECAP**
A Job Well Done 7
Parts Competition Awards 11
Photos 12-13
1997 Conference 19
Olivia Ferki is a graduate student and research assistant studying plastics engineering at the University of Massachusetts, Lowell. She graduated with a 4.0 GPA from Pennsylvania College of Technology with a B.S. in Plastics and Polymer Engineering Technology and a minor in Mathematics in May 2021. During her time at Penn College, Olivia was an active four-year member of the SPE student chapter and served as Secretary and Vice President (twice). She has also been a member of the Alpha Chi Honors Society since April 2019.

While completing her undergraduate degree, Olivia worked as a resident assistant, a student college relations assistant, a research assistant, and a writing, economics, and mathematics tutor. She enjoyed playing violin in the Lycoming County Community Orchestra and led tours for prospective Penn College students. Olivia was also selected to deliver a speech as the student commencement speaker.

During the Summer of 2019, Olivia worked as a Research and Development Intern at SEKISUI KYDEX where she executed a product study for an aerospace formulation, conducted material re-formulations to minimize known defects while conforming to ISO low heat release standards for aviation interior specific materials, processed thermoformable sheet using twin conical screw extruders, and performed mechanical and thermal properties tests. During the Summer of 2020, Olivia worked as an Intern and Research Assistant for the Plastics Innovation and Resource Center (PIRC). There she completed her senior project, which consisted of validating and qualifying processing conditions for a new rotational mold. She also assisted in providing educational material and coursework to plastics professionals while also performing materials testing projects.

Isabella Gayoso, from Moon Township, PA, is a rising junior at Penn State University. She is a double-major in Mechanical and Aerospace Engineering with minors in Entrepreneurship and Innovation and IST for Aerospace Engineers.

During Summer 2020, Isabella interned as a Build Reliability Intern at SpaceX in Hawthorne, CA. Isabella is interested in how thermoformed plastics can be used in aerospace applications, and hopes to use her experiences to positively impact both industries.

During the school year, Isabella is actively involved in the Society of Women Engineers, Women in Engineering Program Orientation, Phi Sigma Rho (engineering sorority), Engineering Ambassadors, and Undergraduate Research. Isabella is passionate about empowering women to pursue and stay in engineering.
HAVE YOUR CAKE AND EAT IT, TOO!

They say you have to sacrifice quality for quantity.
We believe otherwise.

ILLIG’s Intelligent Control concept (IC) combined with >90% uptime* means you get the best of both worlds.

Q² – it’s just how we do it!

* time machine is actively producing parts; across all machinery groups; based on data gathered from ILLIG worldwide customer base

ILLIG North America
Technical Service Center  Indianapolis, IN
www.illig-na.com

ILLIG Maschinenbau GmbH & Co KG
Headquarters  Germany
www.illig-group.com
Whether it’s Zoom, Teams, Webex, or any other online platform, the ability to meet remotely is a trend that accelerated during the pandemic and shows no sign of relenting. Rapid adoption of new digital tools has allowed companies large and small to stay engaged with colleagues, customers, and partners through lockdown and across time zones. And though “Zoom Fatigue” is a real issue as we see glimmers of light on the business travel horizon, few could argue that we didn’t make the most of a bad situation. In this article, we illustrate one approach to transatlantic cooperation using the latest in remote technologies.

Transatlantic Cooperation

In March 2021, the technical teams at SEKISUI KYDEX, LLC (Bloomsburg, PA & Holland, MI) and ILLIG Maschinenbau GmbH & Co. KG (Heilbronn, Germany) began discussions about thermoformability of different grades of KYDEX® Thermoplastics anti-microbial (AB) materials. KYDEX recently launched premium KYDEX ION Technology™ leading to ILLIG & KYDEX setting out to prove that KYDEX® T, KYDEX® T-MB and new KYDEX® T-ION all perform similarly during the thermoforming process.

In September 2020, when it was clear that lockdowns were becoming the new normal, ILLIG decided to invest in virtual reality technology. Given global restrictions on travel, it was imperative that companies find a way to conduct final acceptance tests for capital equipment. With manufacturing in Germany and customers across 80+ countries, it was clear that a substitute for in-person testing must be found. Like many others in manufacturing industries, ILLIG had to navigate a number of augmented- and virtual-reality technologies before deciding on a platform. The company ultimately decided on a Microsoft platform – HoloLens – and built a new TV studio / green screen in the company’s showroom. Described as “an immersive mixed reality experience”, HoloLens offers a wireless and ergonomic tool that enables a more comprehensive view of remote monitoring than simple phone or desktop software tools.

The ultimate goal was to compare standard AB sheet against new premium AB offerings. KYDEX provided 3 different sheet types while ILLIG provided access to a thermoforming machine and an in-house mold. Participants included engineers and designers from both companies. All trials were conducted in English with data collected and summarized by the ILLIG Technology Center (ITC).

ILLIG – SEKISUI KYDEX Anti-Microbial Sheet Trials: A Virtual Collaboration

By Conor Carlin, ILLIG North America & Heather Coyle, SEKISUI KYDEX

The Design of Experiment

The groups decided that a rigorous DOE approach would be best given the need for control samples and multiple iterations of premium AB product. (See tables below.)
Table 1: KYDEX materials tested on 3/24/2021

<table>
<thead>
<tr>
<th>KYDEX® Product</th>
<th>Product</th>
<th>Thickness</th>
<th>Blank Dimensions</th>
<th>Blank Qty</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>KYDEX® T</td>
<td>Control</td>
<td>0.125” / 3.2mm</td>
<td>27.2” x 15.0” / 690mm x 380mm</td>
<td>20-25</td>
<td>Established fire-rated KYDEX® thermoplastic sheet used in aviation, mass transit, medical, and building applications for over 25 years.</td>
</tr>
<tr>
<td>KYDEX® T MB</td>
<td>Standard AB</td>
<td>0.125” / 3.2mm</td>
<td>27.2” x 15.0” / 690mm x 380mm</td>
<td>20-25</td>
<td>Established fire-rated KYDEX® thermoplastic sheet with anti-microbial protection, used for over 10 years. Cost-neutral compared to control.</td>
</tr>
<tr>
<td>KYDEX® T ION</td>
<td>Premium AB</td>
<td>0.125” / 3.2mm</td>
<td>27.2” x 15.0” / 690mm x 380mm</td>
<td>20-25</td>
<td>New and advanced anti-microbial protection for KYDEX® thermoplastic sheet. KYDEX ION™ technology incorporates an anti-microbial treatment in the sheet. 99% effective at inhibiting the growth of stain and odor-causing bacterial</td>
</tr>
</tbody>
</table>

Table 2: Test execution with different iterations

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Material</th>
<th>Adjusted surface temp / pyrometer</th>
<th>Heating Time</th>
<th>Cooling Time</th>
<th>Mold Temperature</th>
<th>Speed Lower / Upper Forming Table</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Preliminary | KYDEX® T ION | 392F / 200C | 44.0 s | 48 s | 185F / 85C | 90% | - High repeatability  
- Good definition  
- Little gloss  
- Little deformation after forming |
| 1           | KYDEX® T  | 392F / 200C | 74.8 s | 48 s | 185F / 85C | 90% | - High repeatability  
- Good definition  
- No gloss  
- Little deformation after forming  
- Heater set-up |
| 2           | KYDEX® T MB | 392F / 200C | 74.2 s | 48 s | 185F / 85C | 90% | - High repeatability  
- Good definition  
- No gloss  
- Little deformation after forming  
- Comparable to no. 1 |
| 3           | KYDEX® T ION | 392F / 200C | 68.0 s | 48 s | 185F / 85C | 90% | - High repeatability  
- Good definition  
- No gloss  
- Little deformation after forming  
- Comparable to nos. 1 & 2 |

Why Join?

It has never been more important to be a member of your professional society than now, in the current climate of change and global growth in the plastics industry. Now, more than ever, the information you access and the personal networks you create can and will directly impact your future and your career. Active membership in SPE – keeps you current, keeps you informed, and keeps you connected. Visit www.4spe.org for details. The question really isn’t “why join” but ...

Why Not?
Examples of formed parts during the KYDEX-ILLIG trials. Participants from the US were able to watch production and machine settings via HoloLens in real time.
Conclusion

There are two sets of conclusions to be drawn from these remote, collaborative trials: firstly, the actual forming trials showed that forming standard KYDEX® material and AB-equipped material on ILLIG Series UA 100G thermoformer with defined settings resulted in little to no variation across material types. The KYDEX® T-ION reached the adjusted pyrometer temperature faster than the control and standard sheet. This variance is related to a combination of the additive that makes up the advanced antimicrobial properties and was the third one to run, so the machine could have increased starting heat.

Secondly, the trials proved that value chain partners on both sides of the Atlantic can engage in meaningful cooperation to drive thermoforming innovation. Though KYDEX and ILLIG had not attempted such remote testing before, the first trials worked very well. The virtual nature allowed a visual way to optimize processing adjustments for heating profiles in real time, reducing the time needed between pulling parts and or the potential for a second trial. The Microsoft HoloLens camera system in conjunction with Microsoft Teams will be improved for future trials, but in general, both parties were pleased with the ability to get trial data in real time with visual inspection tools integral to the final conclusions.

Figure 2: The groups decided that a rigorous DOE approach would be best given the need for control samples and multiple iterations of premium AB product. See tables below.

Figure 3: Comparing KYDEX® T-ION with preliminary experiment with non-heated blank material to high heating temperature which results in more glossy surface on formed part.
As a young adult, Hal Gilham began his informal education by working at Productive Woods, his father’s wood pattern shop. Mr. Gilham graduated from Lynchburg College with a degree in political science and for a short time he successfully entered corporate sales in the greater New York City area. However, motivated by the freedom and opportunity he saw in his father’s small business, Hal joined the company and quickly made an impact by bringing in modern accounting, job costing, and business operations analysis. It wasn’t long before more business came in, including thermoforming tooling. After working with a team reworking a fiberglass mold, Hal saw an opportunity and decided to expand the business into plastics processing. He purchased his first machine, and Productive Woods became Productive Plastics.

As the business grew with a steady flow of heavy gauge work, Mr. Gilham sought ways to expand his business, which included providing ‘value added’ services. By offering information on the materials, design, and the thermoforming process to his customers, Mr. Gilham expanded the business into more active markets. The electrical device market in the New York Metropolitan Area and the introduction of pressure forming as an alternative to injection molding created even greater opportunity.

In the 1990s, the company continued to expand into other markets. Under Mr. Gilham’s leadership, Productive Plastics increased its pressure forming capabilities and began serving the medical device industry, utilizing more heavily engineered materials that required specifications above the usual ABS or HDPE. As new technologies were used in 5 Axis CNC machining and tooling techniques with loose pieces, process improvement became a core value and a catalyst for running the business. During this time Hal’s father James, the founder of the company, retired and Hal gained complete control of Productive Plastics.

Toward the end of 2010, Productive Plastics conducted numerous projects where plastics purchases were equal to those in metal in cost, which was highly unusual for a small thermoformer. In the same time period, Productive Plastics reduced its machinery from 12 thermoforming machines and 15 CNC machines to six thermoformers and six CNC machines while more than doubling their output.

A former SPE Thermoforming Division Board Member, Hal joined SPE in 1991 and is now an emeritus member of SPE. During his tenure on the Board, Mr. Gilham served as Chairman of the Materials Committee, the Processing Committee, the Machinery Committee, and Parts Competition Chair at a few SPE Thermoforming Conferences. In addition, he served on the Division’s Awards and Nominating Committees. Mr. Gilham is now retired but remains engaged in the industry where he spent most of his 40+ year career. His son, Evan Gilham, is now Chief Operating Officer of Productive Plastics.

“Hal Gilham’s career is an inspiration to us all. From the next generation of plastics professionals to those who carry the entrepreneurial torch – in spirit or in practice – Hal’s accomplishments motivate us all to think big,” said Steve Zamprelli, SPE Thermoforming Division Chair. “The SPE Thermoforming Division Board is honored to name Hal Gilham as the 2021 SPE Thermoformer of the Year.”

Past recipients of the Thermoformer of the Year Award may be found on the SPE Thermoforming Division website at https://thermoformingdivision.com/awards-recognition/thermoformer-of-the-year/past-winners/.

More information is available at https://thermoformingdivision.com or by contacting Lesley Kyle at 1-914-671-9524 or lesley@openmindworks.com.

THE SPE THERMOFORMING DIVISION is a technical division of the Society of Plastics Engineers, based in Danbury, CT. The Thermoforming Division’s mission is to facilitate the advancement of thermoforming technologies through education, application, promotion and research. The Division hosts an annual educational conference and publishes an award-winning technical journal, SPE Thermoforming Quarterly®. The Division has also funded over $275K in equipment grants and tens of thousands of dollars in undergraduate scholarships since it was first formed. For more information, please visit https://thermoformingdivision.com.
Cradle-To-Grave Life Cycle Assessment of Single-Use Cups Made From PLA, PP & PET

By Christian Moretti a,*, Lorie Hamelin b, Line Geest Jakobsen c, Martin H Junginger a, Maria Magnea Steingrimsdottir c, Linda Høibye d, Li Shen a

a Utrecht University, Copernicus Institute of Sustainable Development, Utrecht, the Netherlands
b Toulouse Biotechnology Institute (TBI), Federal University of Toulouse, Toulouse, France
c COWI A/S, Department of Waste and Contaminated Sites, Lyngby, Denmark
d COWI A/S, Department of Environment, Health and Safety, Lyngby, Denmark

Editor’s Note: The following is an abridged version of a full-length article that originally appeared in the journal “Resources, Conservation & Recycling”, published by Elsevier and made available via Science Direct under a Creative Commons license. The complete article can be found here: https://doi.org/10.1016/j.resconrec.2021.105508

Abstract
Polylactide (PLA) is both bio-based and biodegradable and has therefore attracted increased attention for single-use plastics applications. Under the context of the recent EU Plastics and Bioeconomy strategies, this study uses life cycle assessment (LCA) to assess the environmental footprint of single-use drinking cups made from PLA, including 13 environmental impact categories. Land use changes (LUCs) were assessed based on a deterministic model. The manufacturing phase was modeled based on primary production data stemming directly from the industry. The end-of-life (EoL) impacts were assessed using the EASETECH. PLA cups were then compared with their petrochemical counterparts polyethylene terephthalate (PET) and polypropylene (PP) cups. Based on the available data quality of the petrochemical polymers, six impact categories were compared. For PLA cups, the process energy use in the conversion from biomass to PLA polymer was identified as the main environmental hotspot, followed by the electricity consumption of thermoforming of the cups. It was found that the biomass acquisition phase has a limited overall impact. LUCs contribute to a negligible impact in all impact categories except for climate change and photochemical ozone formation. Compared to PET cups, the current PLA cups offer environmental impact savings for climate change even including the impacts of LUC. Compared to both PET and PP cups, PLA cups offer savings for fossil fuels resource use but lead to higher impacts for photochemical ozone formation, acidification and terrestrial eutrophication.

Introduction
In 2015, the global plastic production amounted to approximately 380 Mt (million metric tonnes) (Geyer et al., 2017), requiring approx. 6% of the global crude oil production (World Economic Forum, 2016) and generated an annual waste equivalent to the annual production due to the streams from previous years (Jambeck et al., 2015). In addition, the global demand for plastics is expected to double in the next 20 years (European Commission, 2018a). To achieve such increased demand while combating climate change and plastics littering, novel polymers that are both bio-based and biodegradable, such as PLA (polylactic acid), have attracted much attention for single-use plastics applications. However, it is still to be questioned whether PLA is really a solution for the environmental issues caused by single-use plastics application from a policy perspective (European Commission, 2019). For this type of policy-context decision-makings, environmental Life Cycle Assessment (LCA) (ISO14040:2006; ISO 14,044:2006) is a typical and widely applied tool (Finkbeiner, 2014; European Commission, 2010).

To completely abandon the use of single-use cups is difficult in the short term, especially in the applications with stringent hygiene requirements. For this reason, there is still need to search for the alternatives for a more sustainable solution for single-use cups. LCAs on PLA cups have been extensively published in the last decade. The major peer-reviewed studies are summarized in Table 1. For single-use cups, most studies consider PET, PP and PS as the main petrochemical counterparts of PLA. All studies considered cradle-to-grave comparisons. The common key conclusions of these studies can be highlighted as follows:

• compared to PET cups, PLA cups offer lower environmental impacts in terms of fossil fuels depletion and climate change (Binder and Woods, 2009; Potting
and van der Harst, 2015; Uihlein et al., 2008); PLA cups generally perform worse than their petrochemical counterparts for many impacts other than fossil fuel depletion and climate change (Potting and van der Harst, 2015; Uihlein et al., 2008; Ver-calsteren et al., 2010); and

- the conversion steps from biomass to PLA polymer dominate the overall environmental impact of PLA cups from cradle to grave (Binder and Woods, 2009; Potting and van der Harst, 2015); and

- from an environmental point of view, composting is worse than recycling and incineration for PLA cups, because 1) it does not lead to the displacement of products like energy and virgin plastic materials whose production is highly impacting on the environment (Potting and van der Harst, 2015; van der Harst et al., 2014) and 2) PLA does not contain nutrients, and therefore the production of the fertilizers avoided by the produced compost cannot be credited (van der Harst et al., 2014).

Material & Methods

ISO 14,040 and ISO 14,044 (ISO, 2006a, 2006b) were followed for this LCA. The recommendations of the latest version available of PEFCR guidance by the time the study was prepared (European Commission, 2018b) were also followed as closely as possible.

Goal and scope definition

The targeted audience of this LCA is EU policy makers, who are interested in an environmental sustainability assessment of innovative single-use bio-based products to be used as the basis for possible future policy intervention (European Commission, 2019). In particular, such a policy decision needs scientific evidence about the main sources of environmental impact caused by bio-based materials and the potential reduction of environmental impact allowed by replacing the conventional materials currently used for the same applications (Moretti et al., 2020; Vera et al., 2020).

Accordingly, this study aims to support policy makers by 1) high-lighting the environmental hotspots of PLA single-use cups and 2) comparing the environmental performances of single-use plastic cups made from PLA and its fossil fuel counterparts. To reach these two objectives, it is important to consider the entire life cycle of the product and, therefore, a cradle-to-grave LCA is performed.

For PLA cups, the LCA is modeled considering a short-term decision context (current/near-future situation) and therefore, the next 5–10 years are selected as temporal scope. It is assumed that the cups are sold, used and disposed of in Europe. The supply chain can, however, be global. The technological scope is the market-weighted average mix of the near future commercialized technology.

The goal of the study requires to identify the main materials currently employed for single-use cups, which PLA could potentially replace in the near future. Based on the interview with the industrial partners, PLA cups are mainly designed to compete with PP and PET. The comparison is therefore carried out considering cups made from these two materials as petrochemical counterparts. Based on the targeted audience and the geographical scope defined, the European production of PET and PP is considered.

The functional unit (FU) is defined as 1000 single-use cups with 200 ml volume used to contain cold drinks. Based on the market survey conducted in the EU BIOSPRI project (European Commission, 2019), the volume of 200 ml is chosen as one of the most common volumes offered on the market for single-use cups.

The determination of the weights of the cups and, therefore, the reference flow of each product system is one of the main critical assumptions in a comparative LCA for single-use cups (Van der Harst and Potting, 2013). Based on the market survey (see appendix for more details), a 200-ml cup is the lightest when made from PP (2.9–3.5 g), followed by PLA (4.1–4.7 g) and the heaviest for PET (5.5–6.4 g). However, these weights are not directly operational in defining the functional unit. Large ranges were observed for all three cups, possibly not only due to specific market demand but also the constraints of processing technologies, which are not directly associated with technical performance of the material.

In this LCA, a theoretical approach is adopted to estimate the weight required for a single-use drinking cup made from different materials. The theoretical estimation is preferred to measure the weights of the real products for two reasons: 1) it avoids the selection of a value in the range observed in the market, which may not be caused the material properties but rather by the limitation of the processing equipment and techniques; and 2) it allows comparison based on the same functionality performance for a primary property, e.g. stiffness or strength of the material.
Plug assist materials that even our interns couldn't break.

HYTAC®. Unmatched Durability. Unmatched Results.
We assumed a stiffness-constraint design for the cup because stiffness is the primary desired property for a cup (Engelmann, 2012). Material stiffness is a measure of how a material resists deformation when a force is applied: stiffer means less flexible. The axial stiffness of an element in tension is the ratio of the cross-sectional area times Young’s modulus and divided by the length of the element. Accordingly, Ashby (2005) proposed a so-called Material Index (MI) to indicate the stiffness performance of a material as a function of both Young modulus E and density $\rho$ of that material (see Eq. (1)). The higher the MI, the better (stiffer) the material, which in turn leads to a lower mass requirement.

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Unit</th>
<th>Comparison with PP / PET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change</td>
<td>Kg CO2 eq</td>
<td>Yes</td>
</tr>
<tr>
<td>Ozone depletion</td>
<td>Kg CFC-11 eq</td>
<td></td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Kg PM2.5 eq</td>
<td>Yes</td>
</tr>
<tr>
<td>Ionizing radiation Human Health</td>
<td>kBq U235 eq</td>
<td></td>
</tr>
<tr>
<td>Photochemical ozone formation</td>
<td>Kg NMVOC eq</td>
<td>Yes</td>
</tr>
<tr>
<td>Acidification</td>
<td>Molc H + eq</td>
<td>Yes</td>
</tr>
<tr>
<td>Terrestrial eutrophication</td>
<td>Molc N eq</td>
<td>Yes</td>
</tr>
<tr>
<td>Freshwater eutrophication</td>
<td>Kg P eq</td>
<td></td>
</tr>
<tr>
<td>Marine eutrophication</td>
<td>Kg N eq</td>
<td></td>
</tr>
<tr>
<td>Land transformation</td>
<td>Kg C deficit</td>
<td></td>
</tr>
<tr>
<td>Water use</td>
<td>$m^3$</td>
<td></td>
</tr>
<tr>
<td>Resource use, minerals and metals</td>
<td>Kg Sb eq</td>
<td></td>
</tr>
<tr>
<td>Resource use, fossil fuels</td>
<td>MJ</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 1: Environmental impact categories assessed and the impact assessment models. Categories marked with “X” are selected for comparison with PET and PP.
LOW FLEX™ FORMER SERIES
- LF5.0 Shown – 190 Ton
- Numerous quick change features
- Easy maintenance access

LINEAR RAIL TRIM PRESS
- LR5 Shown - 45 Ton
- Side Loading of Tool
- Numerous quick change features
- Precise tolerances via linear rails

TECHNOLOGY
Flat Bed Formers
Form-Trim Models
Linear Trim Presses
Linear Vertical Presses
Heavy Duty Presses
Tilt Bed (IML)
Linear Pre-Punch
Linear Scoring Station
Rotary Drum Former

PROCESSES
- PP, PET, HIPS, OPS
- PLA, HDPE, PS Foam
- In line/Roll Fed
- Cups, Car Cups, Lids
- Retort Products
- Tamper Evident
- Hinged Trays
- Storage containers
- TML

VALUE
- Energy Efficient
- Production Rates
- Move Times
- Ease of Access
- Reliability

SERVICE
- Training Classes
- On line help
- Process Training
- After hours help
- Included start up service

 tslusa.biz
davis-standard.com
WE MAKE your ideas POSSIBLE

Together with our industry partners, we can support your ideas from concept to creation with an enhanced TPO and Styrenic portfolio backed by a team of creative solution providers.

Visit lyondellbasell.com to learn more or visit us at Booth 526 at the SPE Thermoforming Show.
From crude oil to PET and PP cups

In the EU, these two polymers are mainly derived by cracking naphtha, which is a byproduct of from crude oil refinery. According to the goal of assessing cups for the European market, the petrochemical polymers are assumed to be both distributed and thermoformed into cups in Europe.

LCI data of PP and PET are limited in the public domain. In the reviewed LCAs of cups in the scientific literature, the petrochemical PP and PET data are usually retrieved from either PlasticsEurope’s Eco-Profiles or Gabi. In our study, the data for European average petro-chemical polymers production are retrieved from PlasticsEurope (2014, 2012). We compared the LCA results of PET and PP polymers published by PlasticsEurope’s and GaBi 2017 database to evaluate the consequences of choosing the other database i.e. Gabi. The geographic scopes of the two datasets are not the same (average Europe for PlasticsEurope vs. Germany for Gabi). The comparison has highlighted that the differences in the impact assessment results between the two LCI datasets are significantly large. This fact cannot be linked only to the different geographical scope (also resulting in different order of magnitude for several impact categories; see Appendix). On this basis, it was decided to exclude the impact categories affected by large and unexplainable variability. The comparisons with PET and PP cups are therefore only carried out for the following six impact categories: climate change, particulate matter, photochemical ozone formation, acidification, terrestrial eutrophication and resource use of fossil fuels (for impact assessment models adopted, see Table 3). The large variability observed shows that there is a lack of harmonization in the adopted inventory modeling and data categorization by Gabi and PlasticsEurope. Hence, for the categories presenting these largest variations, the comparison performed in the reviewed LCAs might change if the other main data-base was chosen to retrieve the impact of the petrochemical polymer.

Since the precise data for the average European distribution of PP and PET polymers used for cups were not available, the transportation of PP and PET polymers is modeled according to PEFCR default scenario. Hence, it was assumed as follows: 230 km by freight 32-t lorry plus 280 km by freight train and 360 km by freight inland waterways barge.

The polymers are then thermoformed into cups. The process Extrusion of plastic sheets and thermoforming, inline (FR) processing of Ecoinvent 3.3 was used. To account for the different geographic scope and the specific polymer processed, the electricity input was modified as follows. First, the electricity consumption was adjusted to 1.41 and 1.03 kWh per kg of polymer respectively for PP and PET, based on the literature (Wilkinson, 2007). Second, the electricity dataset representative of France was changed to the Ecoinvent 3.3 one named Electricity, medium voltage {Europe without Switzerland}. The distribution of the cups was assumed to be the same as for PLA cups.

Modeling end-of-life

After the cups are used, it was assumed that they are managed the same way as all mixed plastics waste in Europe. In particular, the 2018 European EoL mix for plastic wastes was made of 30% mechanical recycling, 39% incineration and 31% landfilling (European Commission, 2018a). The share of (mechanical) recycling is representative of PP and PET cups, but not for PLA cups, which are still a niche product. Mechanical recycling of PLA cups is feasible at a small scale but there is a lack of proper infrastructure for its recycling at large scale (Hottle et al., 2017). Moreover, PLA is developed under the intention to be disposed of by industrial composting. It was, therefore, assumed that a near-future package of the waste management of PLA could consist of 15% industrial composting, 15% mechanical recycling, 39% of incineration and 31% landfilling.

Results

Impact assessment and interpretation of PLA cups

The overall breakdown for the cradle-to-grave impact of 1000 single-use cups is presented in Fig. 4 and numerically in the Appendix. Table 5 shows the detailed contributions to the environmental impact at both activity and elementary flow levels.

The production of lactic acid and PLA represents the major environmental burden in the cradle-to-grave life cycle of PLA cups. In particular, it causes 59% of climate change, 55% of particulate matter, 53% of resource use (minerals and metals) and 77% of fossil resource use. These impacts are largely caused by the production of the process heat and electricity required for fermentation, purification and poly-merisation.
Providing Thermoform Tooling for all Machine Makes and Models

- Thermoform Form Stations and Trim Tooling
- Form-Fill-Seal Tooling
- Trim-In-Place Thermoform Tooling
- Cut-In-Place Thermoform Tooling
- Thermoform Molds— Rotary and Twin Sheet
- Post Trim Tooling with Pre-punch Tooling
- Pre-punch and Mid Station Trim Tooling
- Cut Knife Trim Tooling
- Flat Bed Heavy Sheet Gage Tooling
- Flat Bed Thin Sheet Gage Tooling
- Thermoform Product Development & Sampling
- Matched Metal Foam Tooling

Contacts

Robert Borse
Office 630-325-0200 ext 222
email R.Borse@AngleToolWorks.com

Michael Borse
Office 630-325-0200 ext 224
email MBorse@AngleToolWorks.com

Joseph Borse
Office 630-325-0200 ext 225
email JBorse@AngleToolWorks.com

Building Tooling for the Plastics Industry Since 1961
Thermoforming of cups is the second major source of impact. It is responsible for 53% of ozone layer depletion, 35% of ionizing radiation, 27% of freshwater eutrophication and 20% of fossil resource use. The electricity production dominates (80% - 100%) these impacts (see Table 5).

Biomass production has a relatively small contribution in most impact categories but not for marine eutrophication (66%), land use (76%), water use (52%), terrestrial eutrophication (33%) and photo-chemical ozone formation (25%). The eutrophication impacts are mainly caused by the production of the fertilizers and their application, which lead to ammonia, phosphate and nitrate emissions.

From an environmental point of view, the two transportation steps, even if different for distance and mode of transport, are equally important and their environmental relevance depends on the impact category considered. The transportation of PLA polymer from US or Asia to Europe is an important source of impact in the following categories: photochemical ozone formation (21%), terrestrial eutrophication (19%), acidification (18%), ozone depletion and particulate matter (14%), climate change and marine eutrophication (11%). The distribution of cups generates more than 10% impact only in ozone depletion (22%) and use of minerals and metals (23%). For all these impact categories, the main cause of impact is identified in the emissions caused by the combustion of petroleum fuels.

PP and PET cups

As detailed in the methodology section, only six impact categories are in focus for the petrochemical cups. The breakdown for the cradle-to-grave impact of PP and PET cups is presented in Fig. 5 and, numerically, in Appendix. The impacts of the petrochemical cups are dominated by the production of the polymer (more than 60% and 45% of impact respectively for PET cups and PP cups in all the six impact category considered). Thermoforming is the second most important environmental hotspot (due to electricity consumption). In particular, for PP cups, the impact of thermoforming is significant for particulate matter and acidification, where it represents 43% and 37% respectively. EoL is impacting relevantly only on climate change (24% and 19% respectively for PP and PET cups) mainly due to incineration.

Comparing PLA cups with PP and PET cups

Compared to their petrochemical counterparts, PLA cups offer environmental benefits in terms of fossil fuels depletion: 41% lower than PP and 51% lower than PET. In all other five impact categories compared, PLA cups offer environmental impact savings compared to PET but they are less favorable compared to PP.

Compared to PET cups, PLA cups are more favorable for climate change, by offering 22% lower GHG emissions. By adding the impact of LUC to PLA cups, this figure becomes 12%. Compared to PP cups, PLA cups have slightly higher climate change impact, but the difference is marginal (5%). However, once LUC is accounted for PLA cups, this difference becomes substantially higher (15%).

In the remaining four impact categories, petrochemical PP cups have significantly lower environmental impacts compared to both PLA and PET cups. From Fig. 6, it can be seen that PP cups have about 40–60% lower impacts compared to PLA cups and 20–60% compared to PET cups in the remaining four impact categories. PP cups outperform PET in all the six impact categories and outperform PLA in four impact categories.

One of the major environmental advantages of PP cups is attributed to the low density, resulting in a lower mass requirement to fulfill the functional unit. As a consequence, a lower impact is observed in all life cycle stages for PP, i.e. polymer manufacturing, processing, transportation, and EoL waste management.

Conclusions

In this study, the cradle-to-grave environmental footprint of PLA cups was assessed for thirteen impact categories. The lactic acid fermentation and PLA polymer production processes were identified as the main source of environmental impacts that are responsible for about 60% of climate change, 43% of ionization radiation, 40% of acidification, 45% of freshwater eutrophication, 53% of resource use of minerals and 77% of resource use of fossil fuels. A lion’s share of these environmental impacts are caused by the process heat and electricity consumption. Biomass production (cultivation and harvesting) contributes substantially (more than 50%) to three impact categories: namely marine eutrophication, land use and water use. However, it does not have a determining role in the remaining ten impact categories. The impact of LUC
is negligible overall but significant for climate change and photo-chemical ozone formation, where it represents 13% and 10% of the cradle-to-grave impact, respectively.

It is not possible to assess all 13 impact categories for petrochemical PP and PET due to large variability of the impacts reported by literature and databases that cannot be justified straightforwardly. The comparison of PLA cups with its petrochemical PP and PET cups was limited to six of impact categories. Nevertheless, the current study confirmed that, even by taking into account LUC and potential contaminations in the waste, PLA cups offer better performances in terms of climate change (22% lower impact) compared to PET cups and offer less fossil resource depletion compared to both PET cups (52% lower) and PP cups (41% lower). However, PLA cups have significantly higher impacts compared to PET and PP cups for photochemical ozone formation, acidification and terrestrial eutrophication. PP cups have better performance than PET cups in all the six impact categories compared.

We conclude that current PLA cups can be considered environmentally better than PET cups, but still not yet outperform PP cups. The main reason can be found in the low weight of the PP cups due to low density of the material. Two tipping points could be a better waste management of PLA by only composting and recycling, and the use of renewable electricity in the lactic acid production phase. Together, these measures could offer PLA to be environmentally preferably also compared to PP cups even including the impacts of LUC. Although, the full implementation of recycling and composting PLA on a large scale is still limited by many technical and governance hurdles.

The comparison was limited to a much more restricted spectrum of impact categories than the comprehensive one recommended by the PEFCR guidance. Using more transparent datasets would allow to increase the completeness of the comparison e.g. by implementing more consistent assumptions for both bio-based and petrochemical materials. To broaden the analysis to more environmental impact categories, we recommend therefore that more consistent LCI data are urgently needed for the petrochemical counterparts, especially in the context of benchmark establishment for the future policies of biobased economy.
Extrusion Solutions
Built Custom for Your Needs

Sheet extrusion is what our companies do best! Our team of experienced operators and engineers utilize the latest extrusion equipment and process conditions to ensure your sheet meets expectation each and every time.

PVC, ABS, TPO, Acrylic, ASA, PC/ABS, Soft-touch, textures, metallics, pearls, prints and more!

Visit us at the SPE Thermoforming Conference in booth #308.

Work together. Grow together.
PlastiVan® has shifted gears to PlastiVideo™!

If you’d like to sponsor a visit or bring virtual plastics education to your community contact us.

Julie Proctor, PlastiVan Program Coordinator
jproctor@4spe.org

www.plastivideo.org

Looking for opportunities to promote your company and reach our targeted audience?

✓ Learn how to reach suppliers, processors, engineers, designers, CEOs and key decision makers.
✓ Check out the brand new SPE Thermoforming Division Media Kit!
✓ SCAN THE QR CODE TO LEARN MORE!

- Print and website opportunities on https://thermoformingdivision.com/
- Sponsored e-newsletter advertising opportunities! NEW
- Sponsored email blasts NEW
- Sponsored webinars NEW
- Promoted social media posts NEW
If you are an educator, student or advisor in a college or university with a plastics program, we want to hear from you! The SPE Thermoforming Division has a long and rich tradition of working with academic partners. From scholarships and grants to workforce development programs, the division seeks to promote a stronger bond between industry and academia.

Thermoforming Quarterly is proud to publish news and stories related to the science and business of thermoforming:

- New materials development
- New applications
- Innovative technologies
- Industry partnerships
- New or expanding laboratory facilities
- Endowments

We are also interested in hearing from our members and colleagues around the world. If your school or institution has an international partner, please invite them to submit relevant content. We publish press releases, student essays, photos and technical papers. If you would like to arrange an interview, please contact Conor Carlin, Editor, at cpcarlin@gmail.com or 617-771-3321.
Microalgae are used in products for food, animal health, etc. and also for tertiary wastewater treatment where the biomass produced can be valorized. Success stories are accumulating on their production in cohabitation with agri-food or industrial plants whose wastewater is used as a source of nutrients for their cultivation while the algae-based products can be consumed on-site or locally. The cohabitation approach allows for a steady supply of cheap local nutrients, (wastewater, potentially mixed with other nutrient sources) as well energy (waste heat from plants), which contributes to the profitability of the microalgae biomass products produced. The strategy of cohabitation and valorization of co-products on-site or locally fits harmoniously with the concept of circular economy in a given territory.

It is in this perspective that Simon Barnabé’s team from the University of Quebec in Trois-Rivières (UQTR) (Quebec Canada) had started the VERTECH project in 2014 in Victoriaville in the Fidèle-Édouard-Alain Industrial Victoriaville park. Waste-water from the Parmalat Victoriaville and Canlac Group - Abbott Laboratories plants and from the Sani-Marc Plant, available in this industrial park, was mixed and used as a cultural medium to produce a lipid-rich microalgae biomass. Short-chain C12:0 and C14:0 fatty acids were then extracted and chemically converted into amine oxides for Sani-Marc’s industrial cleaning product formulations. The post-extraction biomass could be converted thermochemically into biofuels for the heavy vehicle fleets of the City of Victoriaville and Gaudreau Environment.

At the end of the project, it was demonstrated that it was possible to produce microalgae in the wastewater of the Victoriaville industrial park (Bélanger-Lépine et al., 2018, 2019) but the low extraction and chemical conversion yields of C12:0 and C14:0 resulted in a significant costs that did not justify the continuation of the project. At the same time, the team of Innofibre, the college centre for technology transfer of the Cégep de Trio-Rivietés, successed in incorporating algal biomass into a thermoformed cellulose fibre pulp as part of the activities of its NSERC College Industrial Research Chair in Eco-design for a Circular Economy of Thermoformed Cellulose Pulp Packaging EcoPACT.

Indeed, the thermoformed cellulose fibre ecoproducts are a way to replace plastic containers in a circular economy perspective, for example, thermoformed pulp bottles are currently being developed by the EcoPACT Chair for the packaging on solid or liquid products marketed by Sani-Marc. In order to find a products that can make the production of microalgae in the wastewater of the Victoriaville industrial park profitable, the Municipal Research Chair for Sustainable Cities of the UQTR and the EcoPACT Chair on Innofibre are working in synergy to explore the circular economy scenario of using microalgae, cultivated in Sani-Marc’s wastewater, in the recipe of cellulose pulp. This recovery pathway does not require extraction steps and thus could contribute to the profitability of the process.

The development of the thermoformed cellulosic fibre products to replace plastic containers is an avenue in which many companies around the world wish to position themselves. However, the manufacturing process for these types of containers still need to be optimized. In the Quebec, Innofibre has this know-how and it the only college centre for technology transfer to have a pilot machine for manufacturing thermoformed fibre products on a semi-industrial scale (45 kg/h) for the development of innovative products and the advancement of fibre thermoforming technology. It features:

- A heating and recirculation system for the fibrous suspension
- A server-controlled rotary head moulding system with vacuum system
- A server-controlled y-axis and z-axis adjustable transfer system with suction and blowing
- An adjustable multi-area heating system for thermoforming moulds
- A server-controlled multiposition z-axis thermoforming system with vapour moulds

The Innofibre team is currently working in collaboration with Sani-Marc to develop environmentally friendly thermoformed cellulose and microalgae packaging for their products.
Since 1965, our mission:
The design and manufacture of the most advanced and energy efficient thermoforming machines in the world, for the processing of thermoplastic materials.

O.M.G. srl currently offers a wide variety of standard series machines for both thin and heavy gauge applications, as well as highly customized complete packaging lines, and custom thermoforming systems.

ENERGY EFFICIENT, ALL ELECTRIC SERVO DRIVE MOVEMENTS

From large to small size inline machines, Cut-in-place machines, to custom thermoforming lines and systems for the processing of all types of thermoformable plastics, including PET, PLA, PS, EVOH, OPS, HIPS, EPS, PE, PVC, PC, HDPE and many more...

O.M.G. can provide a cost effective solution for your everyday challenges!!

OPTIONS:
Edge preheater system, drum pre-heaters for running PP, material grinders, cut-in-place presses, punch & die presses, additional modules for after the press automation, single or double sided A/B stacking robots, complete tooling packages and much more...

Call O.M.G. for all your thermoforming application needs!!
Brown Machine Group is now BMG

While our name has changed, our commitment to innovation and industry leadership has not. We bring you more experience, more innovation and more services to deliver turnkey solutions designed to fuel your success.

BMG is the world’s leading provider of forming, tooling and automation solutions. We are dedicated to determining and delivering the best solutions, whether it’s new materials, faster setup times, higher output or improving part quality. We work with you to identify your needs, challenges and priorities. We listen closely, understand your situation and deliver the optimal solution to achieve your desired results while improving consistency, speed and profitability – so you can Run With Confidence.

brownmachinegroup.com
Delivering Optimal Results With Turnkey Forming, Tooling and Automation Solutions

BMG is the global leader in thermoforming solutions. Brown, Lyle and GN provide the most innovative, durable and dependable equipment in the industry, from entry-level machines to the most technologically-advanced turnkey systems.

Forming Solutions

Brown, Lyle and GN provide the most innovative, durable and dependable equipment in the industry, from entry-level machines to the most technologically-advanced turnkey systems.

Tooling Solutions

GN and Freeman tooling is built to precise specifications with the tightest tolerances in the industry. With multiple full-scale tooling plants we have the bandwidth to expedite your orders or emergency repairs so you can expect faster delivery, lower costs, and high performance.

Automation Solutions

NAS: Nalle Automation Systems and aXatronics rely on innovation and the latest technology to provide our customers with the most efficient, reliable, and easy-to-maintain counting and packaging automation machinery in the industry.

To see how BMG’s innovative turnkey solutions can help your business, reach out today.

sales@brownmachinegroup.com  877.702.4142
SPE 2021 PRESIDENT’S CUP RECIPIENT ANNOUNCED

Honors & Awards Ceremony also presented the Passing of the Gavel and celebrated SPE’s 2021 Fellow and HSM award winners

Conor P. Carlin, SPE’s VP Sustainability, was recently named as the 2021 recipient of the Society’s President’s Cup Award. Dr. Jaime Gómez, SPE’s 2020-2021 President, presented the award to Carlin during SPE’s Honors & Awards Ceremony, which took place virtually on June 29th.

“Conor’s dedication to SPE has been selfless and inspiring,” said Dr. Gómez. “He has served as an SPE volunteer for many years. Conor is committed to focusing on and promoting the important work that is happening at the nexus of plastics and sustainability, a key driver in 21st century manufacturing. SPE has been consistently impressed by his approach and commitment to broad sustainability goals. As SPE’s outgoing President, it is my privilege to especially honor Conor Carlin with the SPE President’s Cup award.”

Carlin is Managing Director of ILLIG LP, the North American subsidiary of ILLIG Maschinenbau GmbH & Co., a Germany-based designer and manufacturer of thermoforming, tooling, and packaging systems. A member of Society of Plastics Engineers since 2000, he serves as editor for SPE Thermoforming and Recycling Division publications. Carlin has contributed articles on plastics and sustainability for international industry press in the US, Europe, and Asia. In 2017, he was elected to the SPE Executive Board as VP of Marketing and Communications, and re-elected in 2020 as the first VP of Sustainability. For 10 years he was an active mentor to cleantech startups in the Boston-Cambridge area, focusing on energy efficiency and biofuels. Carlin has a BA from Boston University and an MBA from Babson College. Carlin is editor and co-author of Plastics and Sustainability: Grey is the New Green: Exploring the Nuances and Complexities of Modern Plastics (2nd Edition), which was published by Wiley in April 2021.

“This is a wonderful honor,” said Carlin. “I am grateful to so many great colleagues over the years from my first meetings of the Thermoforming Division to the SPE Foundation and now to the Executive Board. I’m looking forward to the next chapter of SPE volunteerism as sustainability becomes central to much of our work.”

The SPE President’s Cup was first awarded by Peter Simmons in 1958 and continues to be awarded each year by the SPE President for outstanding and meritorious service to the Society. This honor is decided solely by the SPE President.
Accelerate your plastic recycling knowledge, training, and network.  
*All in one event!*

<table>
<thead>
<tr>
<th>BENEFITS OF ATTENDING</th>
<th>KEY FEATURES</th>
<th>KEY FOCUS AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 days of networking, knowledge sharing and ideation across plastics ecosystem</td>
<td>Cross value chain collaboration within the recycling industry</td>
<td>Plastics Recycling: Challenges and Opportunities</td>
</tr>
<tr>
<td>Exhibitors within the plastics supply chain from suppliers to traders</td>
<td>Talks &amp; discussions from industry leaders within the waste and recycling management space</td>
<td>Circular Plastics for Packaging</td>
</tr>
<tr>
<td>Overcoming challenges during the pandemic and complexities within the recycling industry</td>
<td>Barriers, roadblocks and overcoming challenges faced by the complexity of the recycling industry</td>
<td>Advanced Recycling: Physical &amp; Chemical</td>
</tr>
<tr>
<td>Discussions on the best recycling practices</td>
<td></td>
<td>Circular Economy for Textiles: Impact on Global Fashion Industry</td>
</tr>
</tbody>
</table>

**ASIA**  
July 15-16, 2021  
**AMERICAS**  
October 7-8, 2021  
**EUROPE**  
January 20-21, 2022  

Organised by

---
Board of Directors

MACHINERY COMMITTEE

James Alongi
MAAC Machinery
590 Tower Blvd.
Carol Stream, IL 60188
T: 630.665.1700
jalongi@maacmachinery.com

Steven Clark
Monark Equipment
PO Box 335
4533 S. Garfield Road
Auburn, MI 48611
T: 989.662.7250
sclark@monark-equip.com

Brian Golden
SencorpWhite
400 Kidd’s Hill Road
Hyannis, MA 02601
T: 508.771.9400
bgolden@sencorpwhite.com

Todd Harrell (Chair)
Plastics Machinery Group, Inc.
5455 Perkins Road
Bedford Heights, OH 44146
T: 440.498.4000, ext. 117
toddh@plasticsmg.com

Brian Winton
PTi
2655 White Oak Circle
Aurora, IL 60502
P: 630-585-5800
E: bwinton@ptiextruders.com

MATERIALS COMMITTEE

Juliet Goff
Kal Plastics
2050 East 48th Street
Vernon, CA 90058-2022
T: 323.581.6194
juliet@kal-plastics.com

Roger P. Jean
Simona PMC
PO Box 1605
2040 Industrial Drive
Findlay, OH 45840
T: 567.208.9758
Roger.Jean@simona-pmc.com

Phillip Karig
Mathelin Bay Associates LLC
11939 Manchester Road #148
Saint Louis, MO 63131
T: 314.630.8384
karig@mathelinbay.com

Dennis Lemmon
Cascade Engineering
1701 Magda Drive
Montpelier, OH 43543
T: 419-485-1110, ext. 7380
Dennis.Lemmon@cktech.biz

Ian Munnoch (Chair)
MSA Components, Inc.
6556 County Road KP
Mazonamic, WI 53560
T: 812.322.5080
imunnoch@msacomponents.com

Matt O’Hagan
LyondellBasell
1317 Battalion Drive
Charleston, SC 29412-9616
T: 843.760.8590
matt.ohagan@lyondellbasell.com

Laura Pichon
Ex-Tech Plastics
PO Box 576
11413 Burlington Road
Richmond, IL 60071
T: 847.829.8124
lpichon@extechplastics.com

Ed Probst
Probst Plastics Consulting
PO Box 26365
Wauwatosa, WI 53226
T: 414.476.3096
ed.probst@probstplastics.com

Eric Short
SIMONA PMC
2040 Industrial Drive
Findlay, OH 45840
T: 567-525-4924
eric.short@simona-pmc.com

Paul Uphaus
Primex Plastics
4164 Lake Oconee Drive
Buford, GA 30519
T: 1.800.935.9272
puphaus@primexplastics.com

JULIET GOFF
Kal Plastics
2050 East 48th Street
Vernon, CA 90058-2022
T: 323.581.6194
juliet@kal-plastics.com

Dennis Lemmon
Cascade Engineering
1701 Magda Drive
Montpelier, OH 43543
T: 419-485-1110, ext. 7380
Dennis.Lemmon@cktech.biz

IAN MUNNOCH
MSA Components, Inc.
6556 County Road KP
Mazonamic, WI 53560
T: 812.322.5080
imunnoch@msacomponents.com

MATT O’HAGAN
LyondellBasell
1317 Battalion Drive
Charleston, SC 29412-9616
T: 843.760.8590
matt.ohagan@lyondellbasell.com

LUCY PITCHON
Extech Plastics
PO Box 576
11413 Burlington Road
Richmond, IL 60071
T: 847.829.8124
lpichon@extechplastics.com

ED PROBST
Probst Plastics Consulting
PO Box 26365
Wauwatosa, WI 53226
T: 414.476.3096
ed.probst@probstplastics.com

PAUL UPHAUS
Primex Plastics
4164 Lake Oconee Drive
Buford, GA 30519
T: 1.800.935.9272
puphaus@primexplastics.com

PROCESING COMMITTEE

Jim Arnet
Hagans Plastics Co.
121 W. Rock Island Road
Grand Prairie, TX 75050
T: 972.974.3516
jarnet@hagansus.com

Robert Browning
McConnell Company
P.O. Box 450633
Atlanta, GA 31145
T: 770.939.4497
robert@thermoformingmc.com

Evan Gilham
Productive Plastics
103 W. Park Drive
Mt. Laurel, NJ 08054
T: 856-778-4300, x225
EGilham@productivecompanies.com

Travis Kieffer (Chair)
Plastics Unlimited, Inc.
303 1st St. N.W.
Preston, IA 52069
T: 563.589.4752
TravisK@plasticsunlimited.com

Jay Kumar
Universal Plastics
5 Whiting Farms Road
Holyoke, MA 01040
T: 607.227.1034
kumarj@universalplastics.com

Stephen Murrill
Profile Plastics
65 S. Waukegan
Lake Bluff, IL 60044
T: 847.604.5100 x29
smurrill@thermoform.com

Steve Zamprelli
Formed Plastics, Inc.
297 Stonehinge Lane
Carle Place, NY 11514
T: 516.334.2300
s.zamprelli@formedplastics.com

DIRECTORS EMERITI

Lola Careere
302 Sable Trace Ct.
Acworth, GA 30102-7617
T: 770.883.7055
carerelola@comcast.net

Richard Freeman
221 Coldbrook Lane
Soquel, CA 95073
T: 510.651.9996
rfree@freetechplastics.com

Steve Hasselbach
CMI Plastics
222 Pepsi Way
Aydin, NC 28513
T: 252.746.2171
steve@cmiplastics.com

Donald Hylton
McConnell Company
646 Holyfield Highway
Fairburn, GA 30213
T: 678.772.5008
don@thermoformingmc.com

Roger Kipp
Roger C. Kipp Consulting
3C Owens Landing Court
Perryville, MD 21903
T: 717.521.9254
srkipp@msn.com

Gwen Mathis
6 S. Second Street SE
Lindale, GA 30147
T: 706.346.2786
gmathis224@aol.com
Thermoforming Division Membership Benefits

- Access to industry knowledge from one central location: www.thermoformingdivision.com.
- Subscription to Thermoforming Quarterly, voted “Publication of the Year” by SPE National.
- Exposure to new ideas and trends from across the globe.
- New and innovative part design at the Parts Competition.
- Open dialogue with the entire industry at the annual conference.
- Discounts, discounts, discounts on books, seminars and conferences.
- For managers: workshops and presentations tailored specifically to the needs of your operators.
- For operators: workshops and presentations that will send you home with new tools to improve your performance, make your job easier and help the company’s bottom line.

Join today!
These sponsors enable us to publish *SPE Thermoforming Quarterly*

- Angle Tool ............................................. 24
- Assured Automation ................................. 38
- Brown Machine ....................................... 32-33
- CMT Materials ........................................ 19
- ILLIG ...................................................... 11
- LyondellBasell ......................................... 22
- MAAC Machinery ...................................... 26
- OMG ...................................................... 31
- Plastics Machinery Group ...... Inside Back Cover
- PTi Extruders ................................. Inside Front Cover
- SEKISUI KYDEX ......................................... 5
- Senoplast .................................................. 38
- Simona-PMC ........................................... 27
- Solar Products .......................................... 26
- Thermoformer Parts Suppliers .................. 34
- TSL .......................................................... 21
- Vulcan Plastics ........................................ Back Cover
- Wisconsin Engraving ............................... 15

**Senoplast**


Senoplast - globally successful with innovative and high quality plastic sheets and films. Thermoformed senosan® products are used in diverse industries and applications - such as in automobiles and refrigerators, as well as for sanitary, agriculture, furniture and watercraft industries.

www.senoplast.com

**Assured Automation**

We Make Valve Automation Easy

Reduce Downtime & Maintenance with Compact, Fast-Acting, High-Cycle Valves

VA Series  
Angle Valves  
VAX Series

Thermoforming OEM’s and factories all over the world are turning to Assured Automation’s Compact On/Off Valves to improve their machines’ reliability and increase productivity.

For complete product information visit: assuredautomation.com/SPE

**Reduce Reuse Recycle**
EXCLUSIVE USA distributors for the AMUT-COMI Company

NEW AMUT COMI ACF 980 Roll Fed Thermoformer
*2*(IN STOCK!!!)

Form, Trim, Robotic Stacker, In mold cut capable, Deep draw, and Large forming size

Currently Available machines

2018 MAAC 5’ x 8’
Double Ender
Thermoformer Pressureformer

2006 MAAC ASP
30” x 36” Cut Sheet
Thermoformer

2000 MAAC 4’ x 5
Single Station
Pressureformer

CNC Router DMS
5 Axis Single
5’ x 10’ Table

“HIGHEST QUALITY EQUIPMENT AND SERVICES IN THE INDUSTRY”
DEDICATED THERMOFORM TOOLING MANUFACTURER

VULCAN
Plastics Technology Co Ltd

COMPETITIVE ADVANTAGE WITH A GLOBAL PRESENCE

DESIGN
Full design services provided

PROTOTYPE
Rapid prototype services

MASS PRODUCTION
Modern facility, latest equipment, skilled workforce

VULCANPLASTICS.COM
VULCANPLASTICS-NA.COM