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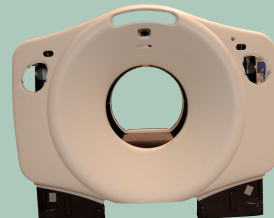
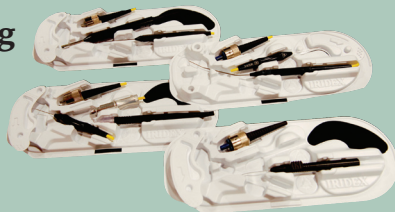
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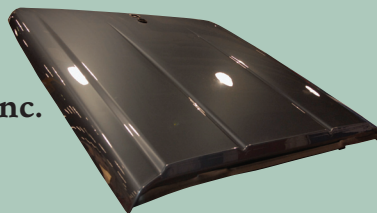
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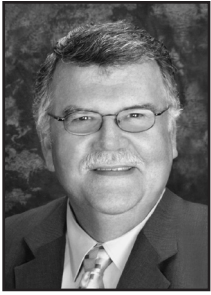


▶ LEAD TECHNICAL ARTICLE

THERMOFORMING HDPE – PART TWO

"IF YOU CAN'T MEASURE IT, YOU CAN'T CONTROL IT"

BY BILL McCONNELL.....see page 15



The Measure of Our Success

► By Walt Walker, Chair

Conference Highlights

Our 17th Annual Thermoforming Conference was a tremendous success – on many levels.

- **Cutting Edge Content:** If you rate success in terms of Content and Substance, then we heard glowing reports about the depth and breadth of our Technical Program. From design and engineering breakthroughs, to the latest in films and bio-materials, to the newest in robotic technology – presenters from throughout the thermoforming industry shared their knowledge and skill. A warm thank you to all the presenters who gave us truly cutting edge sessions.
- **Innovative Presentations:** If one rates success on Innovation, then a new remote learning technique proved to be the wave of the future. During "Live from the Exhibit Floor," session participants got up close and personal as they interacted with skilled set-up mechanics and machine operators of a state-of-the-art heavy gauge former running on the exhibit floor-while they comfortably sat in a convention hall room. The session was a big hit and we plan to do more live interactive technical sessions like this in the future. Special thanks to Brian Winton of Modern Machinery who was on the floor and Brian Ray of Ray Products who acted as moderator in the technical session.
- **Positive Leads:** If success can be rated in terms of leads, many of our 100 plus exhibitors are already reporting it was an excellent show and they received many positive leads.
- **Training the Next Generation:** If success means nurturing our professionals of tomorrow, then we can take pride in bringing students and professors to our conference. This year we paid the travel and housing expenses for 27 people including three 2007 SPE scholarship recipients, eight professors and 16 students from various universities.
- **Sponsor Commitment:** If success can be measured as commitment, then we are indeed grateful to our 24 sponsors for their unwavering financial support. Without them, this conference wouldn't be possible. As you run across these corporations during your professional lives, please thank them for their commitment to our industry.
- **Strong Leadership:** But, success doesn't happen without leadership. A huge "thank you" goes to our 2007 Conference Chair Ken Griep, President of Portage Casting & Mold, Inc. and a Division Board Member, and Conference Coordinator (Super Star) Gwen Mathis for their hard work, dedication and leadership.

Grants, Scholarships and Donations Top Board Agenda

During our conference business meeting, the Board of Directors focused on growing our industry through support of students and educational programs. Over the years, thanks to the success of our annual conferences, we've been able to fulfill our mission statement and proudly report:

- In the past eight years, we've awarded in excess of \$160,000 in student scholarships.
- In the past five years, we've supported PlastiVan with more than \$60,000.
- Since 2000, we've approved over 27 matching grants to universities totaling \$146,000.
- This year we contributed \$30,000 to the Center for Plastics Processing Technology at the University of Wisconsin-Platteville for the purchase of a ZED roll fed, high speed, inline, thin gauge thermoformer. The ability to purchase such a piece of equipment – with a market value estimated at nearly \$400,000 – came largely through the efforts of two men: Platteville's program director, Dr. Majid Trabrizi who tirelessly solicited donations from many generous corporations, and Mark Zelnick, President of ZED Industries, Inc., and his suppliers who donated or discounted parts and labor.

Now It's Your Turn to Educate

If you know about a thermoforming educational program in your area that needs support, remember SPE has a \$10,000 matching grant program you could help them apply for. And don't forget we also have a scholarship program worth up to \$7,500 per recipient.

Hats Off to Our Award Winners

Last – but most certainly not least – hearty congratulations to our "2007 Thermoformer of the Year" Curt Zamec, President & CEO, Wilbert Industries, Inc., and our "Lifetime Achievement" recipient, Jack Pregont, Founder and CEO Emeritus of Prent Corporation. With gentlemen like these in positions of leadership, it's no wonder the thermoforming industry has enjoyed unparalleled success over the years.

It's a Great Day in Thermoforming! ◀

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A NOTE TO PROSPECTIVE AUTHORS

TFQ is an "equal opportunity" publisher! You will note that we have several categories of technical articles, ranging from the super-high tech (sometimes with equations!), to industry practice articles, to book reviews, how to articles, tutorial articles, and so on. Got an article that doesn't seem to fit in these categories? Send it to Barry Shepherd, Technical Editor, anyway. He'll fit it in! He promises. [By the way, if you are submitting an article, Barry would appreciate it on CD-ROM in DOC format. All graphs and photos should be black and white and of sufficient size and contrast to be scannable. Thanks.]

Thermoforming[®]

QUARTERLY

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

Editor

Gwen Mathis

(706) 235-9298 • Fax (706) 295-4276
gmathis224@aol.com

Technical Editor

Barry Shepherd

Shepherd Thermoforming &
Packaging, Inc.
5 Abacus Road
Brampton, Ontario L6T 5B7
CANADA

(905) 459-4545 Ext. 229

Fax (905) 459-6746

bshep@shepherd.ca

Sponsorships

Laura Pichon

(847) 829-8124

Fax (815) 678-4248

lpichon@extechplastics.com

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Reviewing Our Numbers

➤ By Conor Carlin, Chair

The end of the year provides a good opportunity to review the numbers. The membership ranks are holding steady as the Conference gave us a good boost going into the fourth quarter. With about 900 people in attendance in Cincinnati, I was able to meet a lot of the new attendees. Once again, new members are coming in from different industries and countries. This is a sure sign that the thermoforming industry is making great strides against competitive processes.

Word of mouth continues to be an important factor in the growth and development of membership. Think of the people you talk to during the course of the week that have some impact on your job or on your current project. Would they benefit from joining our division? Would the division benefit from having them join? The advantages go both ways. An easy way to get involved to help grow the division is to use the AIM Program: Action Increases Membership. Visit this link to learn more and enter your prospects online: <http://www.4spe.org/communities/ld/aim/index.php>.

SPE national recently completed an in-depth Membership Marketing Study that brought into relief two key points: members "... join and remain with SPE for its technical information resources ... and indicate a strong interest in general industry information." As the Society

strives to maintain and improve membership benefits, each division is responsible for providing suggestions, comments and criticisms. Even if you are content with the current level of information and support from SPE and D25 in particular, please let us know. Your comments allow us to make any necessary changes and improvements.

The global market continues to provide increased opportunities for thermoformers. The massive K-Show takes place this year and with over 280,000 attendees, it can make your head spin. We will certainly have a report on the show early next year in the new, revamped *Quarterly*.

Next year is also the year that the European Thermoforming Division holds their bi-annual conference. Berlin has been chosen as the venue and we expect to see increased attendance from Eastern Europe and Russia.

For more details you can visit the SPE Europe website: www.e-t-d.org. ◀

Comments?

Questions?

Email me:

conorc@stopol.com

WELCOME, NEW MEMBERS!

Anuj Agarwal
Par Pak Ltd.
chuck@parpak.com

Chris J. Anthony
chris@epicboats.com

Jeff Apodaca
SF Custom Skylights

Diego Avelar
Grupo Janfref SA De CV
diego@gupianfref.com

Joost Baelden
Joost.baeiden@skynet.be

Alejandro Barraza
Takata
Alejandro.barraza@takata.com

Steven J. Billmeier
Stopol, Inc.
steveb@stopol.com

Claudio Bottos
Morphogic Srl
info@morphogic.it

Chad Bross
Jackson, Michigan

Brian Buck
Gardner Denver Hanover
Brian.buck@gardnerdenver.com

Neil Carsi Carsi-Cruz
Vitalo USA
Neil.carsi-cruz@usvitalo.snet

Kimberly A. Christian
Kim_c2000@hotmail.com

Fred W. Cieri
Bo-Mer Plastics
fcieri@bo-mer.com

Rick Claypool
Gold Shield of Indiana, Inc.
Decatur, Indiana

Ronald W. Cobb
Tucker, Georgia

Chris Corona
Boltaron Performance Products
ccorona@boltaron.com

John D'Alessandro
Brentwood Industries, Inc.
Reading, Pennsylvania

Marianne Danielsen
Innovative Plastech
mdanielsen@inplas.com

Colin Dhillon
ABC Group
colind@abcgroup.com

Ryan DuMonte
Premier Material Concepts
ryand@rowmark.com

Doug Endres
Placon
dendres@placon.com

Dave Felicella
Thermoforming Connection LLC
sales@tccyl.com

Kenzie Fernholz
Ford Motor Company
kfernhol@ford.com

Micah Freeman
Freotech Plastics, Inc.
micah@freotechplastics.com

David Fry
Brentwood Industries, Inc.
David.fry@brentw.com

Enrique Galiano
Thermo King Areclub PR
Enrique_galiano@irco.com

Mark Gerko
Fabri-Form Company
mjgerko@fabri-form.com

Hallie Good
Stopol, Inc.

Kimberly Gotte
Innovative Plastech, Inc.
lgppte@inplas.com

Julie Griswold
WR Sharples Company
Julie@sharplesdie.com

Dan J. Haas
Total Industries International
danhaas@totalindustries.com

Eric Hausserman
Premier Material Concepts
ehausserman@rowmark.com

David Hawks
Invibio, Inc.
dhawks@inbibio.com

Doug Hawkins
Plastics Package, Inc.
doughawkins@plastic-pack.com

Dee Henson
Associated Packaging Technologies
Henson@aptechnologies.com

Becca Hill
McClarin Plastics
bredding@mcclarinplastics.com

Greg Horton
Select Plastics
greghortonselect@aol.com

William J. Huribut
Kohler
William.huribut@kohler.com

James Hutter
J_hutter@msn.com

Mike Karr
Kleerdex Company
karrm@kleerdex.com

Nathan J. Kellogg
C & M Fine Pack, Inc.
nkellogg@cmfinepack.com

Sang-Kook Kim
LG Electronics
dodgers@lge.com

Raymond Kolodziej
Wilbert, Inc.
lhoranzei@wilbertinc.com

Thomas J. Kuehn
Plastic Ingenuity, Inc.
tom@plasticingenuity.com

James Lanman
Tasus Corporation
jlanman@tasus.com

Leon Liu
Yomura
lliu@yomura.com.tw

Greg Lofgren
Madison, Wisconsin
Greg.Lofgren@sbcglobal.net

Pablo Lozano
Grupo Janfres SA de CV
Pablo@grupjanfref.com

Ron Magee
Brentwood Industries, Inc.
Reading, Pennsylvania

Stanley McDonald
Innoware
Thomaston, Georgia

Blake McCarthy
Plastic Works, Inc.
blake@plasticworksinc.com

Don Mebius
McClarin Plastics
dmebius@mcclarinplastics.com

Jon Melchiori
Octal
jjmelchi@comcast.net

Craig S. Miller
Plastic Solutions
Csmiller184@aol.com

Dan Miller
Plastics Unlimited, Inc.
dmiller@plasticsolutions.net

Giovanni Morandi
Melco SRL
sales@meico.it

David W. Morris
SupplyOne Plastics, Inc.
dmorris@supplyone.com

Sal Moretti
Trans Form Plastics
Danvers, MA

Corey Newson
Dow Chemical Company
cnewson@dow.com

Adam Norrington
Plastics Works, Inc.
adam@plasticworksinc.com

John C. Noruk
Faurecia Interiors
John.noruk@faurecia.com

Craig Ogilvie
Gregstrom Corporation
cogilvie@gregstrom.com

Cleophas Omondi
Medtronic, Inc.
Cleophas.omondi@medtronic.com

Raymond Pidock
Reynoldsburg, Ohio
rpidock@efpcorp.com

Carlo V. Porretta
Woodbridge, ON Canada
Carlo_porretta@magna.on.ca

Edward Rosingana
WECO International
tedr@wecoproducts.com

Michael Rossi
Oakwood Group
mrossi@theoakwood-group.com

Keith Ruedisuell
Peninsula Plastics Company
Kruedisuelli@PeninsulaPlastics.com

Stephen Schreiner
Perfect Shutters
sschreiner@perfectshutters.com

Dave Shonebarger
Premier Material Concepts
dshonebarger@rowmark.com

Scott Slovacek
Carlisle Foodservice Products
Scott.slovacek@sbcglobal.net

Steven J. Sparks
Carolina Materials
ssparks@carolinamaterials.net

Clark Stoel
Fey Industries
travel@fevindustries.com

Matt Tucker
Hooser Plastics
Terre Haute, IN

Mattijs Van De Liefvoort
Bery Plastics
mattijsvandeliefvoort@beryplastics.com

Michael Wenzel
Wilbert, Inc.
mwenzel@wilbertinc.com

Corey Williams
Milliken
Corey.Williams@milliken.com

Jeremy Williams
Display Pack, Inc.
jwilliams@displaypack.com

Jerry Witt
The Witt Group
Jwitt5@cfl.rr.com

Charles Woolridge
Freotech Plastics
charles@freotechplastics.com

Jason Zajicek
Penda Corporation
jasonzajicek@penda.com

**THERMOFORMING
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WINTER BOARD
MEETING SCHEDULE**

**February 6th - 9th, 2008
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Wednesday, February 6th, 2008

Executive Committee Arrives

Thursday, February 7th, 2008

- 7:30 – 8:00 am – Breakfast – Executive Committee
- 8:00 am – 4:00 pm – Executive Committee Meeting, Orchid House
- 12:00 – 1:00 pm – Lunch, Executive Committee
- 2:00 – 3:00 pm – Finance Committee meet Executive Committee
- 3:00 – 4:00 pm – Technical Chairs meet with Executive Committee

Friday, February 8th, 2008

- 7:30 – 9:00 am – Continental Breakfast, All Committees
- 7:30 – 9:00 am – Materials Committee, Tent on Lawn
- 7:30 – 9:00 am – Processing Committee, Tent on Lawn
- 7:30 – 9:00 am – Machinery Committee, Tent on Lawn
- 7:30 – 9:00 am – 2008 Minneapolis meet with Technical Committees
- 8:45 am – 12:15 pm – Other Committees, Tent on Lawn or Orchid House
- 8:45 – 9:15 am – ARRC, Rich Freeman; Students, Ken Griep
- 9:45 – 10:15 am – Website, Rich Freeman; Recognition, Hal Gilham
- 10:15 – 10:45 am – Marketing, Roger Fox; Membership, Conor Carlin; Antec, Don Hylton
- 10:45 – 11:15 am – Newsletter, Conor Carlin/Barry Shepherd; Publication, Laura Pichon
- 12:15 – 1:00 pm – Lunch, Board of Directors, Pool Deck
- 1:00 – 4:00 pm – Board of Directors Meeting, Orchid House
- 6:00 – 7:00 pm – Reception, Beach**
** Weather Permitting
- 7:00 – 9:00 pm – Florida Keys Seafood Festival, Beach**
** Weather Permitting

Saturday, February 9th, 2008

On Your Own / Fishing or Golf
6:00 – 7:00 pm – Reception, Pool Deck

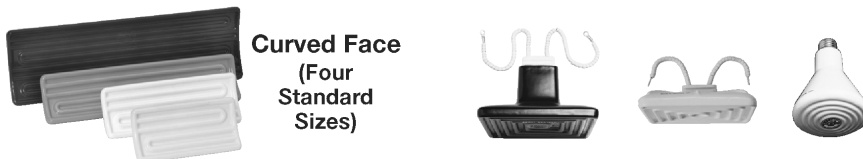
Sunday, February 10th, 2008

Depart

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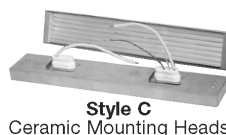


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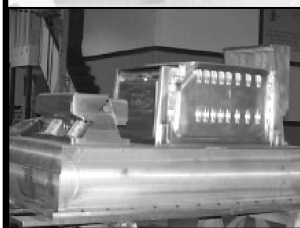
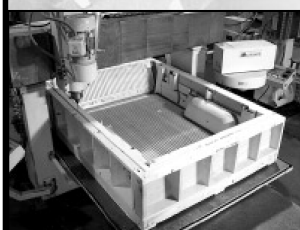


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Start by completing the application forms at www.thermoformingdivision.com or at www.4spe.com. The deadline for applications is January 15th, 2008. ■



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➤ Thermoformer of the Year Criteria for 2008

Every year the SPE Thermoforming Division selects an individual who has made an outstanding contribution to our industry and names them "Thermoformer of the Year."

The award in the past has gone to industry pioneers like Bo Stratton and Sam Shapiro, who were among the first to found thermoforming companies and develop our industry. We have included machine designers and builders Gaylord Brown and Robert Butzko and toolmaker John Griep, individuals who helped develop the equipment and mold ideas we all use today. We have also honored engineers like Lew Blanchard and Stephen Sweig, who developed and patented new methods of thermoforming. Additionally, we have featured educators like Bill McConnell, Jim Throne and Herman R. Osmers, who have both spread the word and were key figures in founding the Thermoforming Division.

We're looking for more individuals like these and we're turning to the thermoforming community to find them. Requirements would include several of the following:

- Founder or owner of a thermoforming company
- Patents developed
- Is currently active in or recently retired from the thermoforming industry
- Is a processor – or capable of processing
- Someone who developed new markets for or started a new trend or style of thermoforming

- Significant contributions to the work of the Thermoforming Division Board of Directors
- Has made a significant educational contribution to the thermoforming industry.

If you would like to bring someone who meets some or all of these requirements to the attention of the Thermoforming Division, please fill out a nomination

form and a one- to two-page biography and forward it to:

Thermoforming Division Awards Committee
c/o Productive Plastics, Inc.
Hal Gilham
103 West Park Drive
Mt. Laurel, NJ 08045
Tel: 856-778-4300
Fax: 856-234-3310
Email: halg@productiveplastics.com

You can also find the form and see all the past winners at www.thermoformingdivision.com in the Thermoformer of the Year section.

You can submit nominations and bios at any time but please keep in mind our deadline for submissions is no later than December 1st of each year, so nominations received after that time will go forward to the next year.

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THERMOFORMER OF THE YEAR 2008

Presented at the September 2008 Thermoforming Conference in Minneapolis, MN

The Awards Committee is now accepting nominations for the 2008 THERMOFORMER OF THE YEAR. Please help us by identifying worthy candidates. This prestigious honor will be awarded to a member of our industry that has made a significant contribution in a technical, educational or managerial aspect of thermoforming. Nominees will be evaluated and voted on by the Thermoforming Board of Directors at the Winter 2008 meeting. The deadline for submitting nominations is December 1st, 2007. Please complete the form below and include all biographical information.

Person Nominated: _____ Title: _____

Firm or Institution: _____

Street Address: _____ City, State, Zip: _____

Telephone: _____ Fax: _____ E-mail: _____

Biographical Information:

- Nominee's experience in the thermoforming industry.
- Nominee's education (include degrees, year granted, name and location of university)
- Prior corporate or academic affiliations (include company and/or institutions, title, and approximate dates of affiliations)
- Professional society affiliations
- Professional honors and awards.
- Publications and patents (please attach list).
- Evaluation of the effect of this individual's achievement on technology and progress of the plastics industry. (To support nomination, attach substantial documentation of these achievements.)
- Other significant accomplishments in the field of plastics.
- Professional achievements in plastics (summarize specific achievements upon which this nomination is based on a separate sheet).

Individual Submitting Nomination: _____ Title: _____

Firm or Institution: _____

Address: _____ City, State, Zip: _____

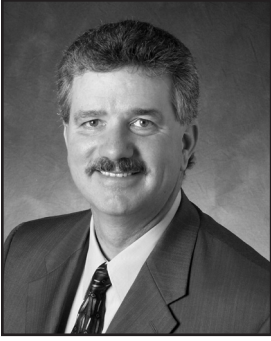
Phone: _____ Fax: _____ E-mail: _____

Signature: _____ Date: _____

(ALL NOMINATIONS MUST BE SIGNED)

Please submit all nominations to: Hal Gilham,
Productive Plastics, 103 West Park Drive
Mt. Laurel, New Jersey 08045

► 2007 Thermoforming Parts Competition Winners



► By Haydn Forward, Chair

According to Haydn Forward, Parts Competition Chairman, this was a big year for the parts competition. A total of 45 parts were entered – the most ever. He said one-fourth of the parts came from original equipment makers, NOT SPE Thermoforming Division members. Forward said, “People are beginning to see the value of this competition.”

Some changes were made this year. For the first time, the contest solicited student entries and four were on display on the show floor. The division gave scholarships to the top three winners.

Division officials also reduced the number of categories, but made them broader, covering two categories each in roll-fed and heavy-gauge parts. They issued first, second and third place in each category, instead of a single winner, as in years past.

Products are judged for creativity, originality, design complexity, surface finish, secondary operations, technical difficulty, and innovation.

STUDENT



1st Place – AIR CONDITIONER ROOF. \$2,500.00 Scholarship. Brian Pillay, University of Alabama. 205.996.5797. Contact e-mail: pillay@uab.edu.

2nd Place – CARGO BOX. \$1,500.00 Scholarship. Robbin Forsyth, San Jose State University. Contact e-mail: robbinforsyth@gmail.com.

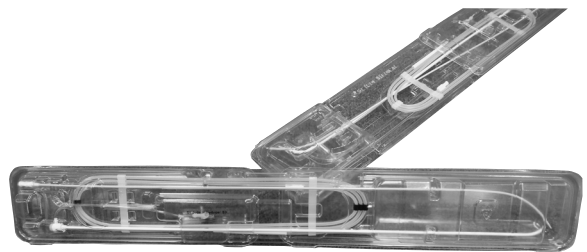


3rd Place – CARGO BOX. \$750.00 Scholarship. Hoan Pham, San Jose State University. Contact e-mail: hoan-pham@gmail.com.



ROLL FED - MEDICAL

Bronze – ST. JUDE MEDICAL TRAY. Prent Corp., Janesville, WI. Contact Chris Courtney, 608.754.0276 x154.



Silver – ENDOGASTRIC STOMPAHY X TRAY. Prent Corp., Janesville, WI. Contact Chris Courtney, 608.754.0276 x154.



Gold – MULTI PROBE TRAY. Specialty Manufacturing Inc., San Diego, CA. Contact Jack Schrieffer, 858.450.1591. (See Front Cover.)

► 2007 Thermoforming Parts Competition Winners

ROLL FED - INDUSTRIAL

Bronze – **DIP-N-GO PACKAGE**. PWP Ind., Vernon, CA. Contact Terry Vovan, 323.513.9000.



Silver – **TAMPER-RESISTANT PACKAGE**. PWP Ind., Vernon, CA. Contact Terry Vovan, 323.513.9000.



Gold – **CONTEC VERTI KLEAN**. Prent Corp., Janesville, WI. Contact Chris Courtney, 608.754.0276 x154. (See Front Cover.)

HEAVY GAUGE - VACUUM FORM

Bronze – **RADOME**. Golden Plastics, Oakland, CA. Contact Ron Pardee, 510.569.6465.



Silver – **SEA-DOO**. Ameriform, Muskeson, MI. Contact Chris Lussenden, 213.332.1728.



Gold – **TONNEAU COVER**. Penda Corp., Portage, WI. Contact Nicole Barreau, 608.742.5301. (See Front Cover.)

HEAVY GAUGE - PRESSURE FORM

Bronze – **COVER ASSEMBLY UNIT**. Ray Products, Ontario, CA. Contact Brian Ray,, 909.390.9906 x216.



Silver – **SCAN SCOPE COVER**. Specialty Manufacturing Inc., San Diego, CA. Contact Jack Schrieffer, 858.450.1591.



Gold – **PODIATRY CHAIR**. Specialty Manufacturing Inc., San Diego, CA. Contact Jack Schrieffer, 858.450.1591. (See Front Cover.)

MULTI-PART

CT/PET COVERS. Wilbert Plastic Services, White Bear, MN. Contact Steve Munger, 651.407.4935. (See Front Cover.)

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In Memoriam

PAUL J. ALONGI

Paul J. Alongi, 82, born in Chicago, Illinois, died peacefully on October 23rd, 2007, at his home. Beloved husband of 60 years to Mary, nee Gurrieri. Proud father of Paul (Lori) and James (Kathy). Dear brother of the late Mary Cannella (the late Phil), Millie Granitelli (the late Joe), Frank Alongi (Nanci), and step-brother Joe Bondi (Kay), and Mary Gagliano (the late Dominic). Loving grandfather of eight: Christopher, Michael, Peter, Paul, Lisa Illiff (Trent), Richard, David, and James; and three great-grandchildren: Valerie, PJ, and Dominic. Loving uncle of many. WWII Coast Guard veteran. Owned and operated Chicago Taxi #3020 for 50 years. Founder of A&A Midway Delivery Service. Salerno's Funeral Home, 450 W. Lake Street, Roselle, Illinois, had charge of the service. Funeral mass was held on October 27th, 2007, at 10:00 a.m. at St. Isidore Church, 427 W. Army Trail Road, Bloomingdale, Illinois. Graveside services were at Mount Carmel Cemetery. In lieu of flowers, memorials can be sent to the Cardinal Bernardin Cancer Center and the Center for Home and Hospice of Loyola University Health System, 2160 S. First Avenue, Maywood, Illinois 60153.

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Past Thermoformers of the Year Attending 2007 Conference



Front Row (left to right): Stephen Sweig, Profile Plastics; Bill Benjamin, Benjamin Manufacturing; Bill McConnell, McConnell Company; Steve Hasselbach, CMI Plastics. Back Row (left to right): Jack Pregont, Prent Corporation; Stan Rosen, Mold Tech; Curt Zamec, Wilbert Inc.; Jim Blin, Triangle Corporation; Joseph Pregont, Prent Corporation; and Paul Alongi, MAAC Machinery. Not pictured and in attendance was Dr. James Throne, Sherwood Technologies.

➤ 17th Annual SPE Thermoforming Conference Review

➤ By Ken Griep, Chair

What a great conference! Excellent presentations, a large exhibition area, and a newly remodeled Duke Energy Center – the perfect atmosphere for discussing thermoforming.

I truly appreciate the many positive comments I received from this year's conference attendees. It is very rewarding to know that all the hard work that was done by so many people to help "Adapting to Form the Future" will continue in the years ahead.

This great conference could not happen every year without the help of our 24 Sponsors and 90-plus Exhibitors. Thank all of you for your support of the Conference, SPE, and the Thermoforming Industry.

My workload was greatly reduced with the help of my Technical Co-Chairs, Brian Winton and Conor Carlin. Thank you both for doing a wonderful job. I would also like to thank Haydn Forward, the Parts Competition Chair, for all his hard work putting together the excellent display area. Thank you to all the Presenters and Session Moderators who donated their time and made all the sessions informative.

The biggest thank you goes to the Southern Lady from Lindale Georgia –Gwen Mathis. When I needed help or advice, and I needed a lot of it, Gwen kept me going in the right direction. Gwen is one special Conference Coordinator. Thank you Gwen for all your guidance and thank you for all the hard work you do for SPE.

SURVEY WINNERS – Randy Farnsworth from Dow Automotive and John Critchley from American Catalytic won free registrations to the 2008 SPE



THANK YOU FOR A JOB WELL DONE ... Ken Griep (left), Portage Casting & Mold, accepts award for a job well done as Chair of the 2007 Conference from Division Chairman Walt Walker.

Thermoforming Conference. Their names were drawn from the group of survey forms turned in after the conference. I hope to see Randy, John, and all the rest of you at the 2008 Conference in Minneapolis, Minnesota.

Thank you all,

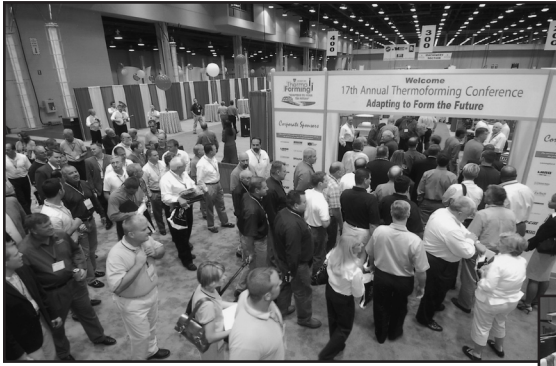
Ken Griep

2007 Conference Chair ◀



SPE International President Vicki Flaris shown cutting the ribbon to open the 2007 Conference and Exhibits in Cincinnati, Ohio.

► 2007 Cincinnati Conference



► Jack Pregont Receives Lifetime Achievement Award

Jack Pregont, Prent Corporation, Janesville, WI, was named the winner of the Lifetime Achievement Award on September 17th at the 2007 Society of Plastics Engineers' Thermoforming Conference.

Jack Pregont is retired and now serves as chief executive officer emeritus. He turned the day-to-day operations over to his son, Joseph Pregont. Both father and son have already won the SPE Thermoforming Division's top honor of Thermoformer of the Year – Jack in 1989 and Joseph in 2001.

Jack never lost the thermoforming bug and, in 1967, founded the Prent Corporation, which has become a major, global custom thermoformer and a leader in packaging for the medical and electronics markets.

During the awards dinner in Cincinnati, he was introduced by a Prent veteran, Walt Walker, executive vice president and chief operating officer.



Division Chairman Walt Walker presents Lifetime Achievement Award to Jack Pregont at the 17th Annual Thermoforming Division Conference in Minneapolis, Minnesota.

"Jack Pregont is one of the modern era's thermoforming pioneers, who pushed the envelope on every process and technique, and even invented a few himself," said Walker. ◀

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From The Editor

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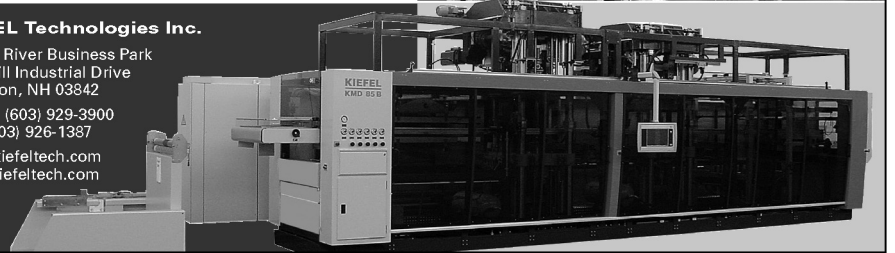


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Thermoforming HDPE – Part Two

(“If You Can’t Measure It, You Can’t Control It”)

► By Bill McConnell

(Technical Editor’s Note: Part One of this article was printed in the previous issue of the QUARTERLY. It dealt with the properties, characteristics and the extrusion of HDPE. The following completes a thorough lesson on one of the most difficult materials to thermoform.)

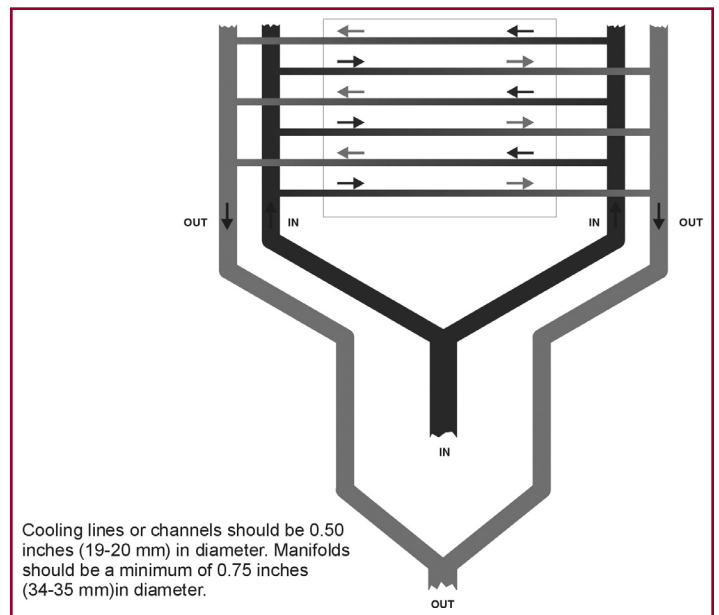
II. Tooling

Temperature control of molds is extremely important in thermoforming quality polyethylene parts at competitive prices. If you have to cut prices, do so anywhere but in the mold! **The hotter the mold, the more the final part will shrink.** A change in mold temperature can mean the formed part may not fit the trim tool. Other possible causes of different part shrinkage within a lot of material or from lot to lot are variation in melt index, orientation, draw down ratio, gage and regrind percentage or a combination of these factors.

Thin Gage (Roll-Fed) Mold Temperature

Ideal mold temperature for thin gage is HDPE 150° – 165° F. [66° – 74° C.]. This temperature gives the best physical properties in the finished part. To help in thermoforming a difficult part there may be a time mold temperature will need to run at 190° F. [88° C. +] or more, in order to produce the part with proper wall thicknesses. Because thin gages of 0.040” [1.02 mm] or less have a lower amount of mass, we find with fast vacuum and good compressed air, around 50 psi (344 kPa) for pressure forming, parts can be formed in production on 65° – 100° F. [18° – 38° C.] molds very successfully.

When using cooling plates, accurate temperature control of the cooling plate is essential for consistent, quality parts. Cooling plates should be manifolded so that no coolant line is more than 36 to 40 inches [91.44 to 102 cm] long before directing the cooling fluid back to the temperature control unit.



Cooling plates up to a size of 20” x 20” should have a minimum of four thermocouples installed on the diagonal about 6” [15 cm] from each corner, with thermocouples wedged to within 0.080” [2.03 mm] of the surface. Larger molds should have six or eight. Be sure that the mating surfaces of the cooling plate and the mold are absolutely flat and are making good, positive contact. Air is a poor conductor, having a K Factor of 0.016 BTU/hr/ft²/°F. – a great insulator. Thus tight mold contact with the cooling plate

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is necessary for proper temperature control. Prior to installing a mold for the next production run, check both mold and cooling plate for flatness after everything has cooled to room temperature.

TIP: Do not use epoxy or axle grease, etc. to fill gaps between plates without checking the K Factor (heat transfer rate) first. Remember, aluminum has close to a 90 K Factor while most greases and epoxies are less than one and will only act as insulators making matters worse. Some of the epoxies and greases used in the electronics and computer industry have silver blended in which gives very high heat transfer, but are expensive.

Heavy Gauge (Sheet-Fed) Mold Temperature

When the finished thickness of a part is in the range of 0.040" [1.02mm] or above the mold temperature must be at least 150° F. [66° C.] or greater to avoid cooling the mold side of the part too fast causing undue internal stresses. Normally the majority of these molds are internally cooled to avoid such problems. Again thermocouples should be installed on the back side of the mold and wedged to within 0.080" [2.03 mm] of the forming surface.

III. Shrinkage

Polyethylene is a crystalline material. Many extrusion and thermoforming variables greatly influence the part shrinkage. The effect of the variables is particularly important to the mold designer. The most accurate way to predict shrinkage values is to thermoform prototype parts with sheet from the extruder selected for the application. This sheet can then be formed under the same conditions anticipated for production. Measured part shrinkage values from these prototypes should be very similar to production shrinkage values because most of the variables have been eliminated.

Orientation

Shrinkage values for most high density polyethylene (HDPE) sheet resins are in the range of 2.0% (0.020 in/in) and 2.5%. Extruded sheet has its greatest orientation (stress level) and therefore its highest shrink factor in the direction of

extrusion. It appears more accurate to estimate shrinkage at 2.4% MD, the direction it traveled during extrusion and 2.1% TD in the transverse direction or across the extruded sheet. Thermoformed parts from extra high molecular weight HDPE resins shrink about 2.7% MD and 2.2% TD. This part shrinkage is much more than parts made in amorphous resins.

Mold Temperature

Mold temperature is absolutely critical! On average a change in mold temperature of 6-10° F. (3.3-5.5° C.) will change the part size about 0.1% (0.001 in/in). Parts in female cavities will shrink away from the mold resulting in smaller sizes than those formed on a male mold as much as 0.007 in/in. For example, a 100 inch (2.54 m) long part will be about 3/4 inches smaller.

IV. Vacuum Systems for Thin and Heavy Gage

Vacuum Systems: Vacuum pumps should have a minimum "rating capacity" of 29.6 inches of mercury at sea level. Surge tanks should have a volume of from 6 to 10 times the volume of air to be evacuated. Use a flexible vacuum hose with a minimum I.D. of 1" with small molds or cooling plates, and 1-½" I.D. for larger ones. Avoid 90° angles where possible as they create a turbulence that slows the speed of airflow by at least 30% for each one.

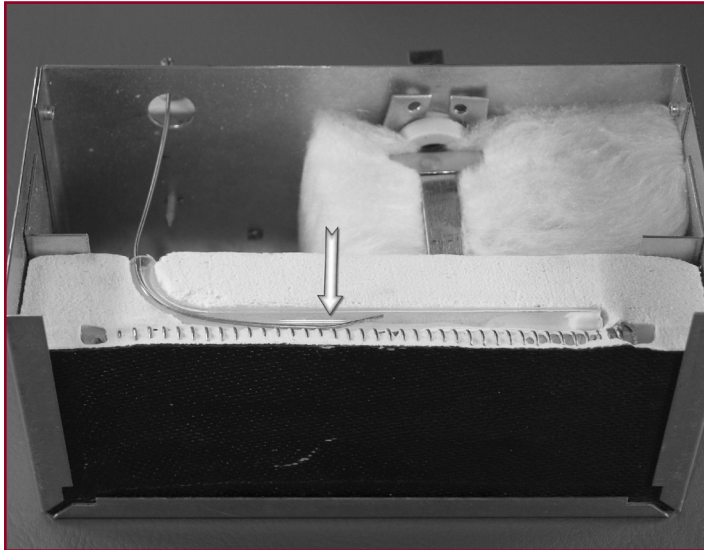


Use vacuum holes as large as possible without being objectionable to the customer and back drill to within 0.080" [2.03 mm] of the surface. Slots or races are very efficient when they can be designed into the mold.

TIP: It is very difficult to have too many vacuum holes. When in doubt drill more.

V. Heating the Sheet

As gage increases the heater element intensity will have to be decreased or moved farther away to avoid degrading the sheet surfaces. Knowing the surface temperature of at least one heating element in each zone is very important.



Polyethylene is a crystalline material with a specific heat of 0.458 cal/gm which means it takes a long time to heat and cool and has extremely high part shrinkage. Sandwich flat panel radiant heaters are the most efficient method of heating plastic sheet.

HDPE has a wide temperature forming window of 295° F. [146° C.] to 350° F. [176° C.]. A good temperature all the way through the sheet would be between 340° F. and 345° F. [171° C. and 174° C.]. When the sheet stops its wrinkling and smoothes out into a nice uniform sag, it is ready to form.

Adjust ovens for a uniform heating of the sheet. With radiant heat, if all the heaters run at the same surface temperature you will always overheat the center of the sheet because the clamping frames, or chain rails, along with the sidewalls of the oven (or the open area) and any openings where the sheet enters or exits, act as "heat sinks" drawing heat from the periphery of the sheet. The more zones your heaters have the easier this job is. Some methods to adjust these zones of heat are as follows:

Observe the Sheet

One easy way to achieve a uniform heat throughout an un-pigmented sheet of 0.080" to 0.100" HDPE is to observe the sheet while heating. When heated to 256° F. – 259° F [124° C. – 126° C.] the sheet turns water clear. By carefully observing the heated pattern of the sheet the various heating zones can be adjusted to give uniform heating of the sheet.



Infrared Thermal Scanning

By far the best and most accurate way to measure sheet temperature is with an infrared scanner. The scanners are portable so that you can also check out how the part cools on the mold or check the sheet temperature on another machine. The instrument presents on your laptop "virtually instantly" a two dimensional array of 100,000 spot readings of the whole sheet. Move the cursor on your laptop to any particular point and get that exact temperature. Thermal imaging and analysis is an excellent way to reduce scrap, improve product quality and operating economies of a thermoforming operation. This is a perfect way to check out your molds' cooling efficiency. Scan the mold as it starts to cool the part and continue the process until the part is de-molded.

VI. Forming Techniques

All thermoforming techniques can be used to form HDPE. Simple vacuum, pressure, snap back forming, billow forming or any combination of these methods can be used. Because of the high

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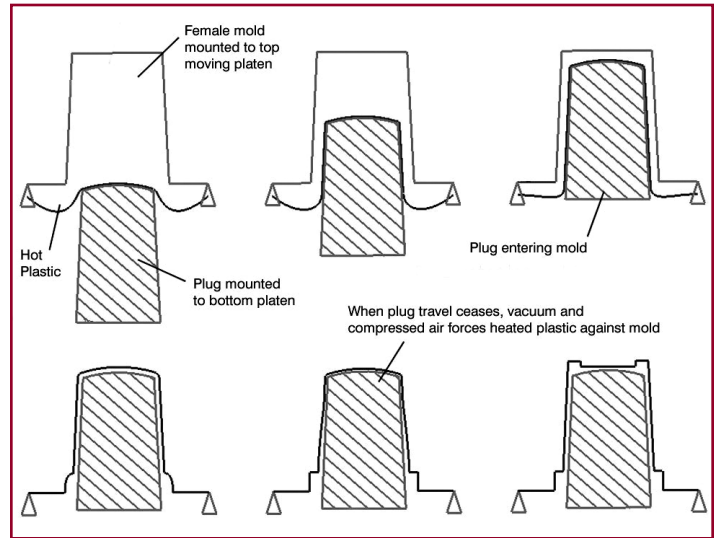
specific heat HDPE and HMWPE are ideal for twin sheet thermoforming. Use a mold speed of about 8 inches/second or less. Plug assist speeds are usually picked within the range of 3 to 8 inches/second. Cooling fixtures to help maintain shape of part right after removal from mold is very frequently used.

VII. Trimming Techniques

Thin and heavy gage can be trimmed by steel rule die, forged knife blades matched tool steel, laser, high pressure water jet, five axes robotic trimmers, routers, hot knives, shears, etc. Care should be taken to use the recommended router bits, spindle speed and travel speed when trimming on CNC routers. Generally, less force is necessary to trim HDPE than most other amorphous materials when using steel rule or forged knives.

References

1. *Understanding Plastics Testing* by Donald C. Hylton



2. Chevron Phillips Chemical Company LLC, various technical bulletins, www.cpchem.com
3. *You Can Master HDPE Shrinkage* by Jim Keesling, Chevron Phillips Chemical Company
4. *Thermoforming Technology Manual* by Wm. K. "Bill" McConnell, Jr. ◀

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Early 1950s Vacuum Forming Tooling

➤ By Stanley R. Rosen, Plastimach Corporation, Las Vegas, Nevada

(Ed. Note: This is Stanley Rosen's 8th article in his series on the History of Thermoforming and the last to appear in the QUARTERLY. For the last 3 years, a great deal of research has gone into this collection of articles on our industry which is an ongoing project for Stan. He plans to complete his work in the near future and hopes to have it published in a book that will serve as an important record of how our industry grew from its early beginnings in the 1930s. The Board of Directors of the Thermoforming Division is proud to have participated in this project and thank Stan for his initiative.)

In its infancy, the vacuum forming industry suffered from short run production orders, inefficient machines, molds, and dies. This situation required additional time and capital for the industry to become more mature. During this period the major business expenses were for plastic resin and its self-inflicted labor intensive process. The thermoforming industry advertised its low or no tool charges and rapid delivery in order to build demand for their services (see typical ad Fig. 4-10). The awful slogan, "Vacuum forming – the poor man's injection molding," unfortunately fit the situation of the times. Many of the early vacuum-forming pioneers were severely under-capitalized but compensated for it by working long hours with energy and drive.

New modern retail marketing techniques developed in the 1950s required that packaging of merchandise be clearly displayed on peg board racks to provide direct access for the consumer. This imperative assisted thin gauge thermoformers to grow rapidly. They soon received larger and more profitable orders for blisters and box

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Figure 4-10. Advantages of vacuum forming (early 1953).

inserts that provided the catalyst to modernize their plants (Fig. 4-11). Heavy gauge processors developed point of purchase (POP) signs and displays (especially money-making three dimensional (3-D) beer advertising) helping that segment of the industry to expand (Fig. 4-12). As the business of thermoforming matured, capital became available to create an efficient production environment.

Personnel within the vacuum-forming plants were mainly minimum wage machine operators, except for a few skilled setup and maintenance mechanics. However, this dead-end situation encouraged high turnover of operators and for many years the pool of experienced employees

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was shallow. Waste of expensive plastic sheet was often caused by this lack of worker experience or interest. Enlightened management developed training programs to educate and retain promising personnel. It was interesting to see that a multi-million dollar plant often was more dependent on a talented high school dropout than a Ph.D. to troubleshoot a new mold.



Figure 4-11. Blister packaging grows rapidly due to the increased demand for rack merchandise for the retail industry. (1953)



Figure 4-12. Signs in three dimensions (3-D) become popular and boosted the sheet fed thermoforming business. (1955)

The need to increase thermoforming output gave the machinery builders reason to rethink and design equipment that preheated sheet, thus completely eliminating the requirement for a heating cycle. Molds were then built that were capable of efficiently conducting all of the heat away from the cavities to keep pace with higher

speeds of the new equipment. Efficient heat transfer techniques required that high heat conductivity metals such as aluminum be specified and that the molds be liquid cooled (Fig 4-13). This stage of development set up the conditions for the future inline equipment needed for the production of high volume food and drink disposable containers in the late 1950s.

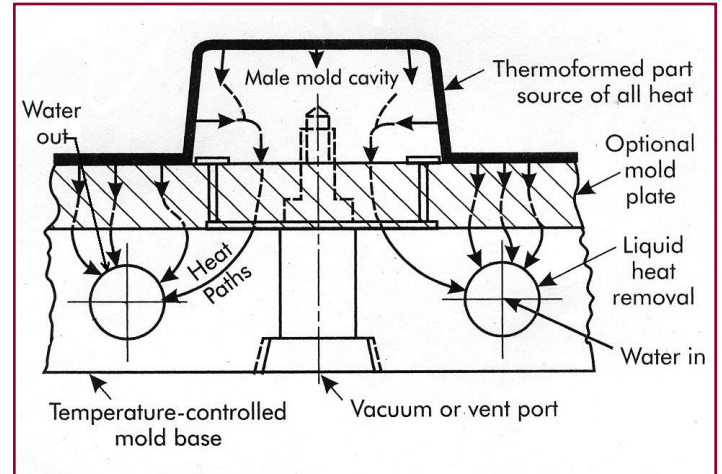


Figure 4-13. Heat transfer through the mold assembly.

Steel rule and forged die makers who supplied the paper, rubber and shoe industries had to educate their new thermoforming customers in the proper use of the dies. Their previous customers had many years of experience in the proper use of knife-like dies.

Printers and box makers with their massive trim presses knew that steel rule dies must be "made ready" or shimmed level so that every knife cut cleanly. The "make ready" procedure takes infinite patience and time, something always in short supply in a thermoforming plant. Some thermoforming plants never incorporated the "make ready" techniques and were unable to achieve clean high-grade trimming on a daily basis.

Most steel rule blades used to build dies are .937 in. (2.38cm.) to 2.00 in. (5.08 cm.) high, but thermoformed parts average 1.00 in. (2.54cm.) to 6.00 in. (15.2cm.) high requiring a method to raise the knife blade above the level of the part. An inexpensive quick fix to provide part clearance was to build up the die height with multiple wooden die boards. This is not an elegant solution due to the inaccuracy in the board flatness and thickness which can cause uneven cutting of a shot. Machined metal buildups or forged high dies are a good substitute to replace those

wooden buildups (Fig. 4-14). Parts requiring forming above and below the sheet line neces-

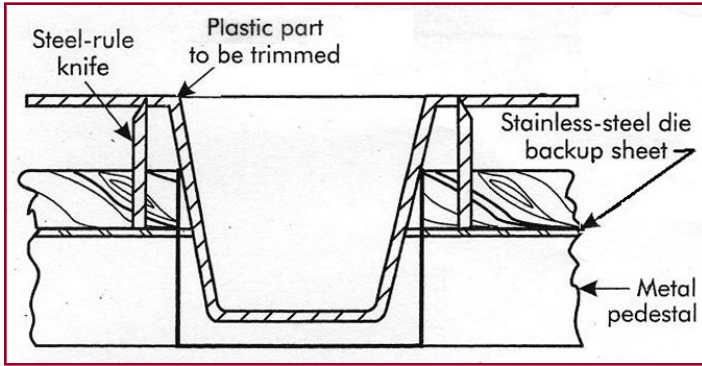


Figure 4-14. Steel-rule die built on a metal pedestal to increase its depth to clear a thermoformed part.

sitated the use of a "metal match plate." The metal match plate provides clearance to prevent the formed part from being crushed when the press platen closes to trim the shot (Fig. 4-15).

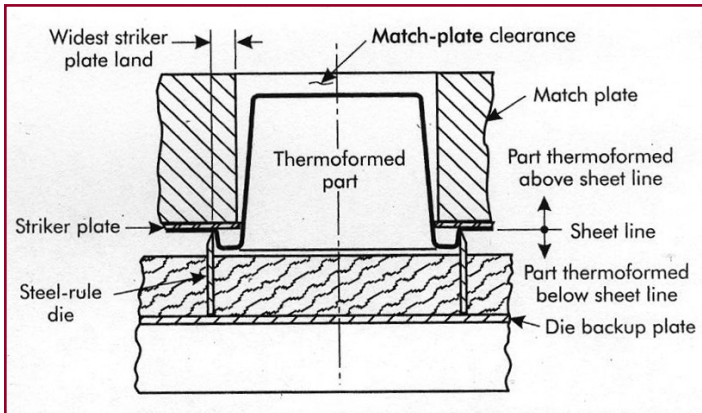


Figure 4-15. Trimming a part formed above and below the sheet line.

A high quality die cut edge feels smooth and clean to the touch. When the knife dulls, it crushes plastic fragments (contaminants) which then cling to the trimmed edge of the part and these are called "angel hair." Many customers (medical, food, etc.) will not accept trimmed formed parts with excessive angel hair. The solution to minimize angel hair requires good make ready procedure, polishing the die knife edge bevels and using minimum press pressure to avoid dulling the knife cutting edge. Thermoforming steel rule die design was able to evolve from the established die practice and find answers that suited its special applications.

Present day thermoforming processes may appear outwardly different from the practices of the early 1950s. Most of the techniques used to conserve plastic by attempting to achieve a uni-

form wall thickness were developed in the 1950s. The application of a plug and female cavity, mechanical assists for male cavities, various methods for pre-stretching the sheet, and distortion printing of decorated parts are part of this heritage. Early tooling differ from modern molds and dies mainly from the amount allocated to tooling cost and the added technological benefits that were made available by the development of the CNC and EDM machining methods.

Part 8 – References

Figs. 4-13, 4-14, & 4-15

Illustrations from book Thermoforming: Improving Process Performance. Author, Stanley R. Rosen, published by Society of Manufacturing Engineers, 2002.

Fig. 4-10

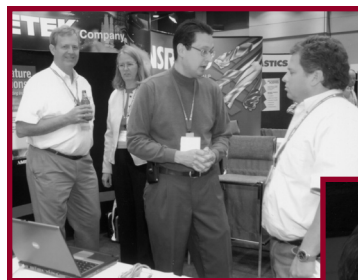
Portage Plastic Corp., Portage, WI. Advantages of vacuum forming Ad. Modern Plastics Magazine – early 1953.

Fig. 4-11

Packaging Institute 16th Annual Forum. Vacuum Formed Thermoplastics – "New, Needed, etc." Paper given by C. W. Harper of Sears, Roebuck & Co., Oct. 1954.

Fig. 4-12

Einson Freeman Co., Long Island City, N.Y. 3-D Beer Signs. Article. Modern Packaging Magazine, Mar. ◀



**2007
Cincinnati**



Irvine, California Council Meeting Highlights

► By Lola Carere, Councilor

This summary is intended to help you review the highlights of the Council Meeting held in Irvine, California, on September 29th, 2007.

The meeting was called to order by SPE President Vicki Flaris. President Flaris honored Councilor Scott Peters of the Mold Making and Mold Design Division for his induction into the Plastics Pioneers Association. Mr. Peters was also honored by his Division as Mold Designer of the Year. President Flaris also announced that SPE Vice President James Griffing has been named a Fellow of the Boeing Corporation.

Executive Director Susan Oderwald reported that SPE has been working on a number of new initiatives and programs in response to the findings of the all-member value survey that was completed earlier this year. The New Technology Committee has agreed to support SPE's efforts to produce a New Technology Symposium on a variety of topics in Philadelphia early next November. We are also working with the new Biopolymers SIG and the Plastics Environmental Division to develop a Green Building Symposium in the near future.

Past President Lance Neward gave an informative report on Parliamentary Procedure in which he explained the importance of Robert's Rules of Order.

Budget

The major Council action was the approval of the 2008 calendar-year budget. A full write-up on the budget was distributed to Councilors and to all Section and Division Board members in preparation for this meeting. The budget that was approved calls for gross income of \$5,495,000, direct expenses of \$3,331,750, staff & overhead expenses of \$2,086,850 and a net income of \$76,400. Council approved the budget unchanged from the original presentation. A full area-by-area presentation of this budget is available to Section and Division Board members at:

<http://extranet.4spe.org/council/index.php?dir=Fall%202007%20Council%20Meeting/>.

Awards and Recognition Programs

Fellow and Honored Service Member Programs – Applications for the Fellow-of-the-Society and Honored Service Member (HSM) programs are due October 20th, 2007. Applications are available on the SPE website. Questions about the Fellows program can be directed to Marie Salzo or Gail Bristol. Questions relating to the HSM program should be addressed to Marie Salzo or Tricia McKnight.

Annual Awards Program – Applications for the SPE Annual Awards Program, recognizing excellence in business management, education, engineering technology, research, benefit to society, and overall industry contributions, are due November 15, 2007. Nominations for the Plastics Product Design Awards are due February 15th, 2008; parts will be shipped to ANTEC 2008 for judging. Gail Bristol can answer questions about these awards.

Essay Contest – The 2008 "Wonders of Plastics" Essay contest is under way; and all SPE Sections are encouraged to work with local middle/junior high schools and senior high schools to obtain entries for the 2008 contest. Information on the contest, an entry form that can be tailored to local Sections, a copy of the timetable for the 2008 contest, and a score sheet to use in judging entries are available on the SPE website. Questions on the essay contest should be addressed to Gail Bristol.

Husky and Chase Education Awards – Applications are available online for the Husky Section Education Award and the Chase Student Chapter Award. Applications are due February 6th, 2008. Questions about these two awards should be addressed to Laurie McDougal.

(continued on next page)

(continued from previous page)

Pinnacle Awards – Section and Division boards should begin working on the 2008 Pinnacle Award application now, as it takes time to compile the required information for this award. Applications are available on the SPE website, and are due December 31st, 2007. Questions should be addressed to Tricia McKnight.

Outstanding Student Chapter Awards – Applications are available online for the Outstanding Student Chapter Award (formerly STRETCH). Applications are due February 6th, 2008. Tricia McKnight is the contact for this award.

Information on all SPE Awards is available on the SPE website at www.4spe.org/awards.

Bylaws & Policies

The Bylaws & Policies Committee submitted four new policies for consideration by Council:

- 003-Conflict of Interest
- 007-Fellow Election Committee
- 011-Unemployed Members

- 017-Election of Councilors

Council voted to approve all four policies.

K-Show

The SPE Seminar program for the K-Show in Dusseldorf, Germany, will be conducted by a new slate of Seminar instructors, recruited exclusively from the European Divisions and SIGs. It is felt that an all-European core of instructors will enhance attendance at the October K-Show and get the European Seminars program off to a faster start in 2008.

The SPE Foundation

The SPE Foundation ended August with a surplus of \$64,818. Expenses are on track with this year's budget. We continue to realize less income from the dues check-off boxes, which we attribute in part to the fact that the response to the dues invoice mailing is about 3.5% less than the same time last year. The Foundation investment balance is approximately \$1,592,000.

Presentations

- The Composites Division presented two checks to The SPE Foundation - \$1,500 for the Harold Giles Scholarship fund and \$1,000 to the general scholarship fund. Thank you, Composites Division!
- Jon Ratzlaff presented a \$6,000 check from Chevron Phillips for sponsorship of SPE India's Autoplast Conference.

Sections Committee Report

The following Sections were moved from Active status to Provisional status:

- Buffalo
- Mexico City
- Wichita

The following Section was moved from Provisional status to Abandoned status:

- Arizona

Divisions Committee Report

Special Interest Groups

The following three Special Interest Groups were approved by Council:

- **Plastics in Building in Construction.** Contact: Mark Barger (markbarger@dow.com).
- **Biopolymers.** Contact: Doug Hirt (hirt@dlemson.edu).
- **Medical Polymers Europe.** Contact: Gerard McNally (g.mcnally@qub.ac.uk).

The following SIG name change was approved by Council:

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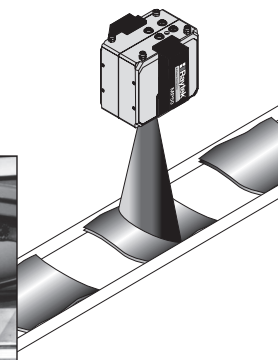
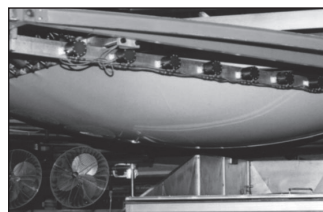
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Council Highlights continued ...

- From North American Radiation Processing to **Radiation Processing of Polymers North America**. Contact: Dave Kerluke (DKerluke@sterigenics.com).

International Committee Report

A discussion was held relative to changing the name and focus of the International Committee to a Strategic Growth Committee. A decision was not required at this time. ◀

The next formal Council meeting is scheduled for Saturday, January 26th, 2008 in Savannah, Georgia.



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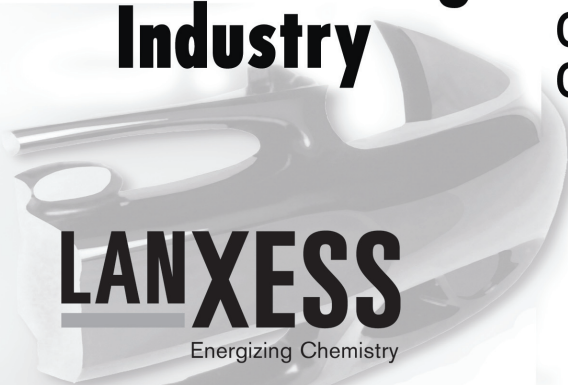
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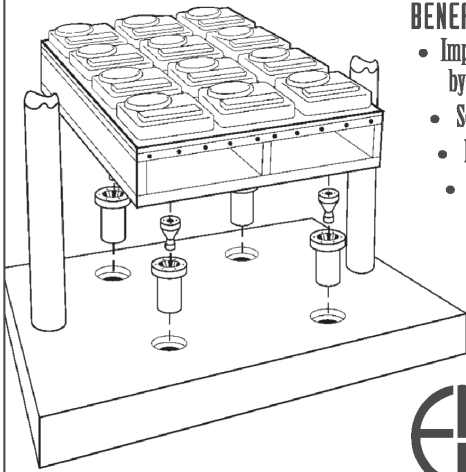


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CURT ZAMEC

2007 THERMOFORMER of the YEAR



Pictured left to right are daughter Katie, Curt Zamec and wife Nancy.

Curt Zamec accepted the award September 1st at the Society of Plastics Engineers' 17th Annual Thermoforming Conference in Cincinnati, Ohio.

A Cleveland native, Zamec began his plastics career about 30 years ago, when he worked at the Goodyear Tire & Rubber Co. in Akron, Ohio, in a division that marketed polyester films. Soon after he joined, Goodyear closed that business and Zamec joined a Cleveland distributor of plastics and rubber products.

His involvement with thermoforming began when he became president of R. B. Plastics, a small heavy-gauge former in Rochester, New York, that was in Chapter 11 protection. He helped turn the company around. Dur-



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ing that same time, he started a company – Zamec Industries – to make single-station thermoforming machines, because R. B. Plastics could not afford to buy a new large machine.

Zamec then moved to Thermoform Plastics Inc. in St. Paul, Minnesota, which was owned by Wilbert. TPI formed the plastic liners for Wilbert's concrete burial vaults.

Zamec is known today as a plastics deal maker and you need a scorecard to keep track of Wilbert's moves. It all started in 1996 when Zamec, then president of TPI, made his first acquisition – Plativac Inc. with plants in Cleveland and Gastonia, North Carolina.

In 1999, Zamec was promoted to the top spot at Wilbert. The company continued to make plastics acquisitions as Thermoform Plastics bought TransPak-USA to expand into thermoformed pallets.

Today, Zamec said, heavy-gauge thermoforming generates about \$10 million of the \$280 million in sales for Wilbert Plastics Services.

Zamec said technology has improved greatly since his first thermoforming assignment at R.B. Plastics. ◀

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Pictured left to right are: Marie and Ken Darby, Walt Walker, Division Chair, and Andy and Lillion Eaves.

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If you have any questions, please do not hesitate to contact Yetty Pauwels at: Society of Plastics Engineers-Europe, European Thermoforming Division, Eric Sasselaan 51 ~ BE-2020 Antwerpen ~ Belgium, who will be only too willing to help.

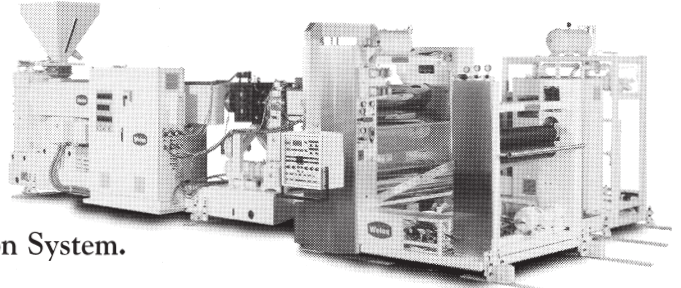
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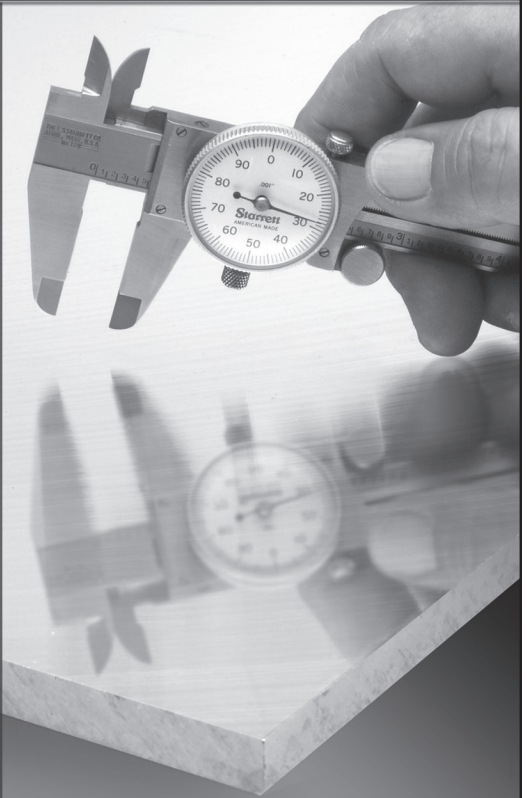
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Process (choose all that apply)

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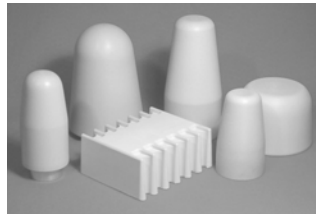
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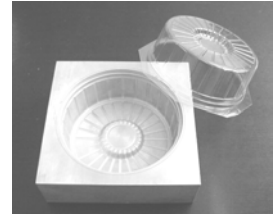
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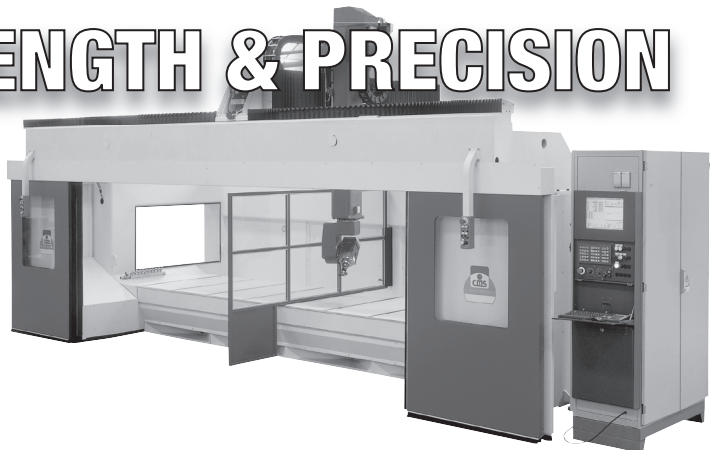
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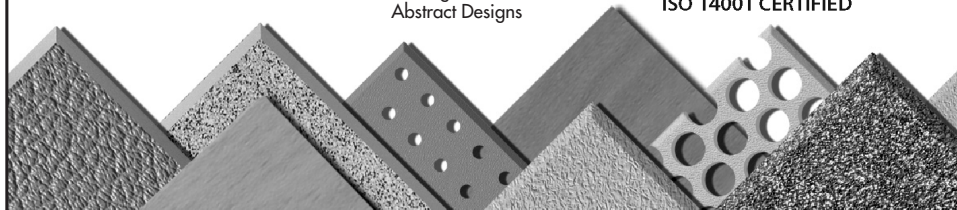
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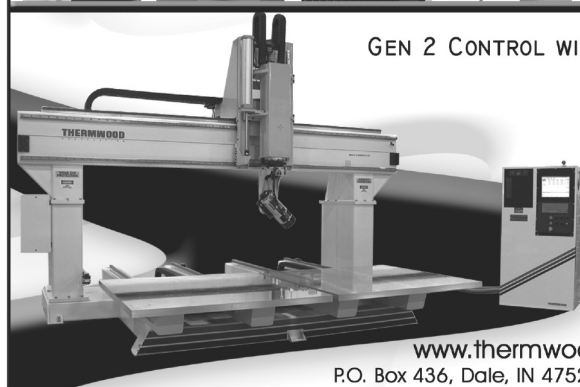
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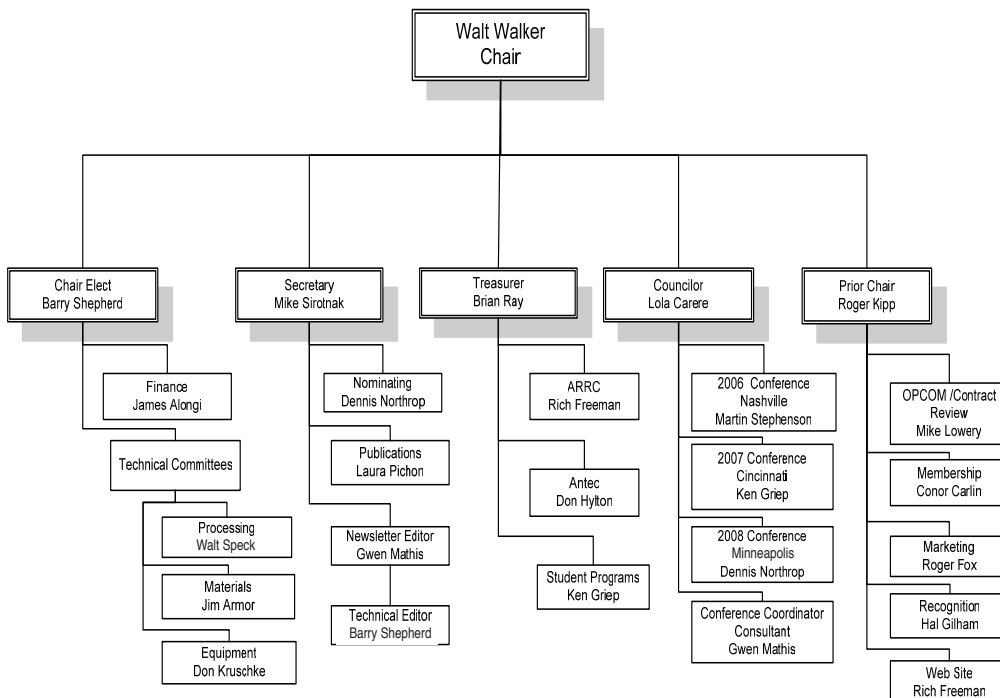
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