

Thermoforming

QUARTERLY™

A JOURNAL OF THE THERMOFORMING DIVISION OF THE SOCIETY OF PLASTICS ENGINEERS

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Thermoforming

QUARTERLY®

A JOURNAL OF THE THERMOFORMING DIVISION OF THE SOCIETY OF PLASTICS ENGINEERS
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Industry Spotlight ...

Universal Plastics: Accepting the Challenge



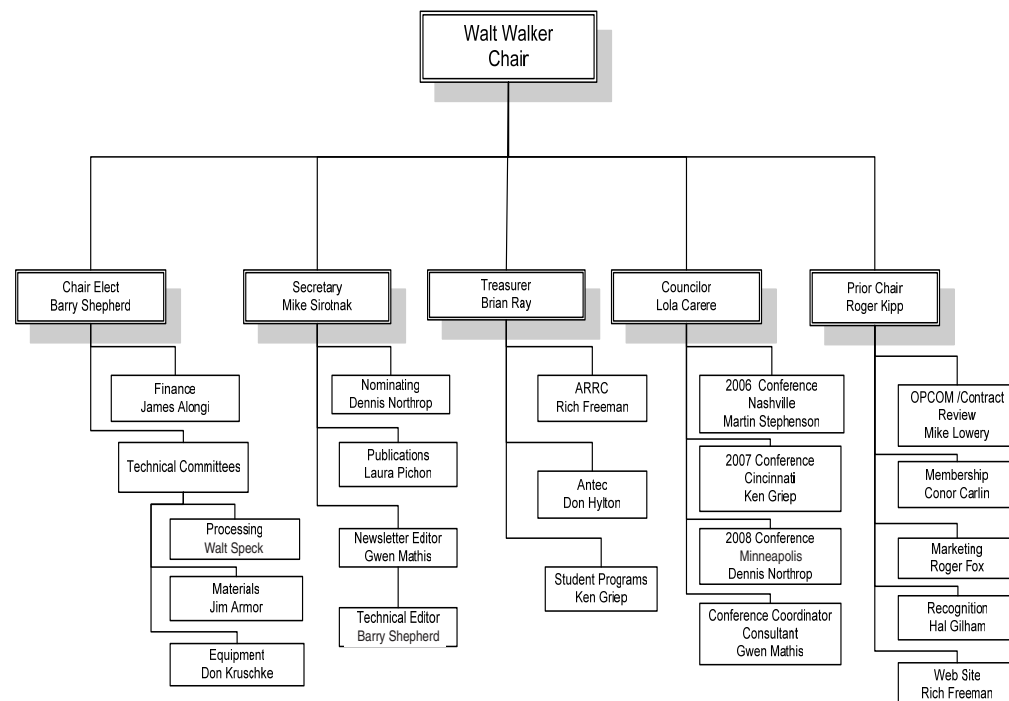
Our mission is to facilitate the advancement of thermoforming technologies through education, application, promotion and research.

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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

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MEMBERSHIP

BY CONOR CARLIN, MEMBERSHIP CHAIRMAN

Out With the Old, In With the New

As we look back on 2006, we have an opportunity to reflect on the past twelve months. In talking to thermoformers around the country, all indicators show that our industry is enjoying robust growth. It appears that the changes made during the lean years at the start of the decade have paid off. Profits are up and reinvestment in the sector is underway.

Plastics industry publications usually feature dire news about plant closings or toolmakers going out of business, mainly in the large and diversified injection molding sector. Our segment, however, continues to grow as companies increase market share and compete more effectively with alternative techniques. Bolstered by new technologies, especially in the heavy-gauge business, thermoformers are making the investments needed to keep pace with today's changing market.



Signs of encouragement and growth are all around us. From new package designs on store shelves to innovative products in diversified markets, thermoforming is clearly an integral part of the consumer culture. In fact, several parts that were highlighted at the Nashville Parts Competition can now be seen on television commercials.

The fact that thermoformed products are so important in today's economy really highlights the need to stay informed. New developments in materials, new machine designs and new tooling techniques all combine to improve the quality of the

goods and services provided by the thermoforming community. Our division plays a crucial role in that it provides an arena in which many of these evolutions can be seen and understood before they hit the market.

2007 is shaping up to be a great year. The SPE board is already building a strong technical program for the Cincinnati Conference. If you have suggestions or comments on something you would like to see, please contact us. Also, please remember to sponsor a new member this coming year. This organization derives strength from its membership and your participation is paramount to our success. ■

Questions?

Comments?

Contact me at

conorc@stopol.com

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MEETING SCHEDULE**

**May 16th - 20th, 2007
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Tuesday, May 15th, 2007

Executive Committee Arrives

Wednesday, May 16th, 2007

- 7:30 – 8:30 am – Breakfast – Executive Committee, Conference Suite A
- 8:30 am – 5:00 pm – Executive Committee Meeting, Conference Suite A
- 12:00 – 1:00 p.m. – Lunch – Executive Committee, Conference Suite A
- 2:00 – 3:00 pm – Finance Committee Chairman, Conference Suite A
- 4:00 – 5:00 pm – Technical Chairs meet with Executive Committee, Conference Suite A

Thursday, May 17th, 2007

- 8:30 – 10:30 am – Materials Committee Breakfast, Conference Suite A
- 8:30 – 10:30 am – Processing Committee Breakfast, Conference Suite B
- 8:30 – 10:30 am – Processing Committee Breakfast, Conference Suite C
- 10:30 – 11:15 am – AARC Committee, Carson City 1
- 11:15 am – 12:00 pm – Web Site Committee, Carson City 1
- 12:00 pm – 1:30 pm – LUNCH ON YOUR OWN**
- 1:30 – 2:30 pm – Student Programs, Carson City 1
- 2:30 – 3:00 pm – Recognition, Carson City 1
- 2:30 – 3:30 pm – 2007 Conference Committee, Carson City 1
- 3:30 – 4:15 pm – Marketing Committee, Carson City 1
- 4:00 – 5:00 pm – Membership Committee, Carson City 1

Friday, May 18th, 2007

- 7:30 – 8:30 am – Breakfast – Board of Directors, Laughlin III
- 8:30 am – 12:00 pm – Board of Directors' Meeting, Laughlin III
- 12:00 – 1:00 pm – Lunch – Board of Directors, Laughlin III
- AFTERNOON ON YOUR OWN**
- 6:00 – 7:00 pm – Hosted Cocktail Party
- DINNER ON YOUR OWN**

Saturday, May 19th, 2007

DAY ON YOUR OWN

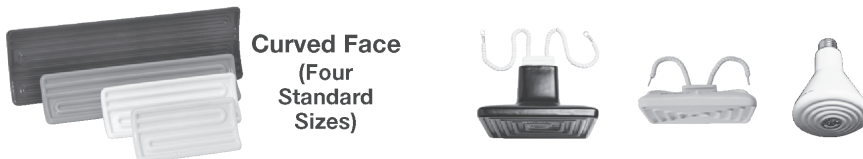
Sunday, May 20th, 2007

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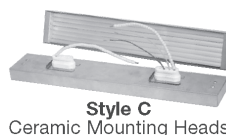


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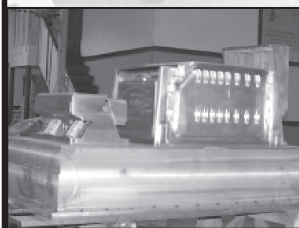
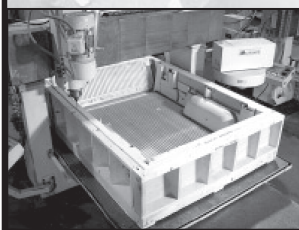
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Our mission is to facilitate the advancement of thermoforming technologies through education, application, promotion, and research. Within this past year alone, our organization has awarded multiple scholarships! Get involved and take advantage of available support from your plastic industry!

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 a individual who has made a outstanding contribution to our industry and awards them the Thermoformer of the Year award.

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 Greip, 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. Osmer, 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

% 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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William K. McConnell, Jr.
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1983

E. Bowman Stratton, Jr.
Auto-Vac Corp.

1984

Gaylord Brown, Brown Machine

1985

Robert L. Butzko
Thermtrol Corp.

1986

George Wiss, Plastofilm Industries

1987

Dr. Herman R. Osmers
Educator & Consultant

1988

Robert Kittridge
Fabri-Kal Corporation

1989

Jack Pregont, Prent Corporation

1990

Ripley W. Gage, Gage Industries

1991

Stanley Rosen
Mold Systems Corp.

1992

Samuel Shapiro
Maryland Cup
Sweetheart Plastics

1993

John Grundy, Profile Plastics

1994

R. Lewis Blanchard
Dow Chemical

1995

James L. Blin, Triangle Plastics

1996

John Griep
Portage Casting & Mold

1997

John S. Hopple, Hopple Plastics

1998

Lyle Shuert, Shuert Industries

1999

Art Buckel, McConnell Company

2000

Dr. James Throne
Sherwood Technologies

2001

Joseph Pregont, Prent Corp.

2002

Stephen Sweig, Profile Plastics

2003

William Benjamin
Benjamin Mfg.

2004

Steve Hasselbach, CMI Plastics

2005

Manfred Jacob
Jacob Kunststofftechnik

2006

Paul Alongi, MAAC Machinery

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 to the Thermoforming Industry in a Technical, Educational, or Management 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
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THERMOFORMING AT UNIVERSAL PLASTICS: ACCEPTING THE CHALLENGE MEANT ADDING THIN-GAUGE PROCESSING

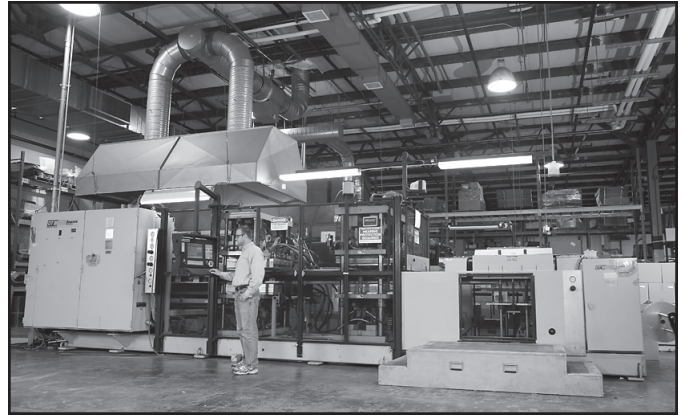
BY JOE PETERS, UNIVERSAL PLASTICS

This article space in the *Thermoforming Quarterly* alternates each year between roll-fed formers and cut-sheet formers. The Thermoforming Division Conference each year divides its program the same way between thin-gauge and heavy-gauge. At Universal Plastics they certainly get their money's worth out of those articles and conferences because they employ both processes in their plant in Holyoke, Massachusetts.

In order to satisfy as many customer needs as possible, Universal added roll-fed thermoforming several years ago.

The company had its beginning in 1966 when James Peters took his 12

years of experience and built his first two heavy-gauge forming machines from the ground up and started forming tote boxes for many of the heavy manufacturers in New England in the sixties. The business evolved through the years and with the advent of the computer age and the development of the Route 128 computer corridor near Boston with its big names from Digital, Raytheon and Data General to Wang, Compugraphics, Polaroid and Prime. In those days CRT housings and bezels, keyboard enclosures and circuit board trays



Universal has adopted the motto "We Accept the Challenge" and living up to that motto has lead them to making the cooling ducts for the guidance system for the space shuttle, kayaks from recycled detergent bottles, the bows for the super secret (not any longer) submarine used by the Navy Seals and the bus stop signs for New York City. The company has a reputation for getting the job done and has some great employees who make it happen.

represented most of their output. These were days before CNC routers and all of the close tolerance cutouts and trimming were done on elaborate routing fixtures using templates and guide bushings in

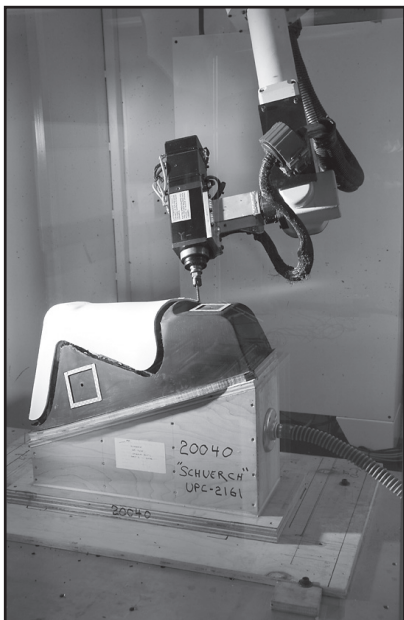
the router plate. They learned enough about repairing router fixtures from those years that when they saw their first Thermwood CNC router in the early 1980's – they bought it on the spot. Looking back now it's amazing how almost none of those big names in the computer industry are even around today. It's not surprising that Universal has had to adapt to its changing market.

Universal has adopted the motto "We Accept the Challenge" and living up to that motto has lead them to making the cooling ducts for the guidance

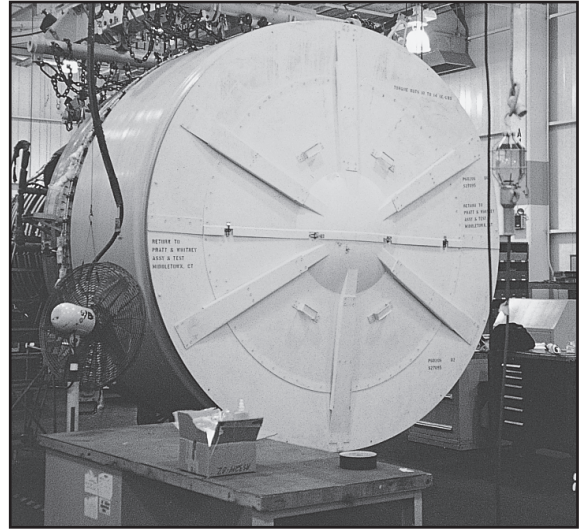


system for the space shuttle, kayaks from recycled detergent bottles, the bows for the super secret (not any longer) submarine used by the Navy Seals and the bus stop signs for New York City. The company has a reputation for getting the job done and has some great employees who make it happen.

As a custom manufacturer, you have to adapt and Universal saw opportunity in the jewelry, cosmetics and POP fields for packages, trays and displays. The journey into thin-gauge thermoforming began with a salesman bringing in a shallow thin-gauge formed cup that was die cut with a small flange. The customer had a number of labor steps to transform the cup into a satin-covered stand for a bracelet in an injection molded box. This customer bought 3 million of



these a year! Universal was accustomed to 250- and 500-piece orders so this number got their attention. After much thought the designers were able to propose an idea that eliminated many of the labor operations. The problem was they would be forming the part on a 64 impression mold on a heavy-gauge machine at rate of about 25 blanks per hour. At this rate it would take 3 people working full time to make 3 million pieces a year.



They decided to buy a small roll-fed machine and after setup and some training, one person could run a year's worth of product in 6 months. Now they had to keep the machine busy the other six months. New business soon appeared and they now have two Sencorp 2500 in-line formers to complement the heavy-gauge business consisting of 12 vacuum and pressure forming machines which include two rotaries and twin-sheet capability. The largest press is a double-ender boasting a 6' x 16' capacity.

Currently thin-gauge work represents about 20% of sales and has been growing steadily. Many similarities exist but there are also some dramatic differences between the two processes. Most dramatic is the competitiveness of the thin-gauge work. With thin-gauge, jobs are won and lost by fractions of pennies per part. If you are \$0.002 too

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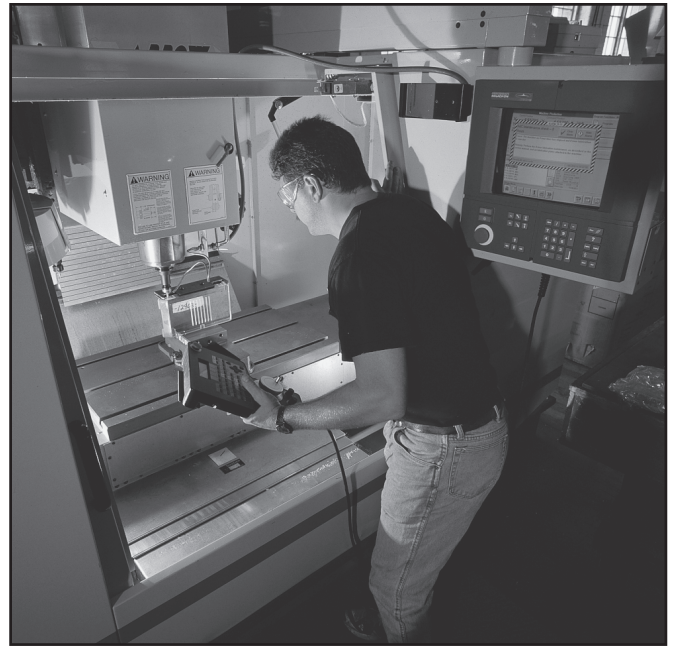


high – sorry!! In thin-gauge, inches add up quick. Estimating a job that ends up with 1/2" longer index than planned can have a dramatic effect on the bottom line – not to mention the rolls of material that you can end up short at the end of a job.

An area of similarity that has become more true in both areas of the business is the need to be in sync with your customer's needs. Universal finds they are working harder and harder to run ahead of their customers. They have to keep more inventory on hand, whether it is raw material or finished goods. They also have worked to reduce set-up times and reduce turnaround time. They use 3D CAD and are able to machine some molds in-house, especially when customers require shorter than normal deliveries (sound familiar?).

While this journey for Universal Plastics was into the world of "Thin," they still find that they are immersed in the world of "Lean." The year 2007 will be an especially taxing one for the 85 employees at Universal Plastics as they will all be more intensely trained in "lean manufacturing." The company was treated to a taste of lean manufacturing through a training grant from the State of Massachusetts in 2002 which gave them exposure to many of the benefits.

In 2003 the factory moved out of a late 19th century mill building where they occupied 100,000 sq. ft. on three floors into a new facility with 75,000



sq. ft. on one floor. It's taken a couple of years to get settled in but now they are ready to take on "lean." The next time we read about Universal Plastics perhaps we will learn how they became "lean" as well as "thin." ■

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COMMENTS FROM THE TECHNICAL EDITOR

BY BARRY SHEPHERD

Newsletter History

The Thermoforming Division has been publishing this newsletter for over 30 years. Bill McConnell, our longest serving Board member, started it in the early 70's and Gwen Mathis, our Division Coordinator, took over as Editor in 1981. Dr. Jim Throne took on the job of Technical Editor in 1998 until this year, a period in which we saw the *Quarterly* develop into the award-winning publication that we know today.

Jim Throne provided technical content for more than 32 volumes including 140 technical articles and 26 book reviews. His "Thermoforming 101" collection of thermoforming basics is a must for every plant library. I am excited about continuing to write these articles from a slightly different perspective. Jim has decided to move on to other things and I have taken on the daunting task of carrying on as the Technical Editor for this *Quarterly*. Gwen Mathis remains as Editor, a job which she has enjoyed for over 25 years and for which I am most thankful.

The *Thermoforming Quarterly* has not won all these awards over all the other SPE newsletters without a great deal of hard work and dedication. Meeting time lines, finding articles, copywriting and proofreading for a publication that sometimes consists of over 40 pages takes effort and the responsibility for bringing it all together 4 times a year falls on Gwen's shoulders.

Content and Format

As for the content of future technical articles, I want to repeat what I told the Board when I accepted this challenge. Thermoforming has been my life and my family's life for 22 years. Our Chairman, Walt Walker, sensed the passion that I have for this industry when he agreed to let me take it on and I hope that this passion will become evident in the technical content of future *Quarterly's*.

I would like to continue providing articles that contain new and useful information for the most knowledgeable readers but I also hope to add my own flavor to these articles that will connect the theory to a real practical application. My experience with building our custom thermoforming business has exposed me to many technical problems so I hope to be able to contribute some personal comment. Having said this I am aware that there is a great deal of innovative work going on in operations and institutions throughout the world by individuals who are dedicated to a specific product or process related to thermoforming. These operations have money, time and highly skilled people that are doing things that will help take our industry to new levels. Therefore I will endeavor to solicit opinions from others on articles that contain information beyond my scope of expertise.

I see no reason to alter the format to any great extent. I do hope to maintain the Lead Articles, Industry Practice articles and Thermoforming 101 articles. Dr. Throne has reviewed a lot of books over the years and I am not sure there are any more that could be considered Thermoforming related. However, I would welcome the opportunity to comment on any new industry related publications.

Some Personal Goals

As a personal project, I want to produce "A Reference Guide to Advanced Thermoforming" using the technical articles that have appeared in this *Quarterly* over the past 10 years. It will take some time to categorize the information to allow quick reference by industry engineers and practitioners to help solve problems or improve quality or maximize efficiency. As new articles are published they will be added to the Guide. It will be available to SPE members in the electronic format via the Division website.

My hope is to expand the "Industry Practice" segments to look at how current trends and issues are affecting the way we run our thermoforming companies. For example, how will Walmart's goal to reduce packaging 5% by 2010 affect designers and producers of thermoformed packaging? Also current trends to global sourcing and the depressed state of North American automotive manufacturing have direct affects on our industry. On the surface these issues would appear to have a negative impact on our industry; however, as thermoformers, we are known for our ability to adapt to change quicker than other processes. If we are aware of the issues and open our minds to our options we can create opportunities for our companies.

Finally, I will be working to find ways to combine our efforts here in North America with those in Europe to benefit our industry on a more global stage. This is a personal goal but I see several indicators that suggest we must do this. The SPE magazine *Plastic Engineering* is combining with its European counterpart starting in January 2007. The North American and European Thermoforming Divisions now take part in each other's conference and of course globalization in general is making it necessary for all of us to be aware of competitive pressures in other countries. The *Quarterly* and the European Thermoforming newsletter must collaborate to become the vehicle for sharing ideas across the Atlantic.

It is with some apprehension that I take on this responsibility after so many years in the hands of such an industry authority; however, I look forward to it with anticipation. I am proud of the *Quarterly* and eager to help Gwen and the Board maintain its award-winning record. ■

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The Thermoforming Board of Directors has taken your advise from completing the surveys and beginning in 2008 we will be going back to our old dates –

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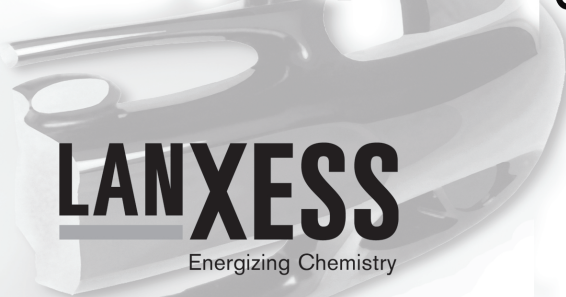
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The Golden Age of Thermoforming

BY STANLEY R. ROSEN, PLASTIMACH CORPORATION, LAS VEGAS, NEVADA

The **First National Plastics Exposition** was held at the Grand Central Palace, New York City, from April 22nd through the 27th, 1946 in conjunction with the S.P.I. Spring Conference with a record assembly of 83,100 attendees. Much vitality and optimism flowed from those attending the show which was evident from their enthusiastic faces in this photo (Fig. 3-1.) World War II was



Fig. 3-1. First NPE Plastics show in New York City, 1946.

over and many in the crowd were discharged veterans anxious to enter and embark on a new career. Visitors to the show were intrigued by seeing operating equipment, displays of new products and processes created from the plastics resins. Critics of the show complained that more than half of the visitors were not from the “trade” but were only “interested spectators.” How shortsighted it was to throw cold water at prospective plastics industry participants!

Many in attendance were the children of the depression era whose parents’ dreams and ambitions were quashed during those harsh economic times. This new generation of prospective businessmen, technicians and

Ed. Note I: The philosopher Santana said, “Those who cannot remember the past are destined to repeat it.” Stan Rosen, our Thermoformer of the Year in 1991, is undertaking this project to document the industry starting with early developments in the 1930’s. His first article (Part I) appeared in Volume 24, Issue #3. This is the fifth in his series entitled “The Golden Age of Thermoforming,” the second half of which will appear in the next Quarterly issue.

engineers with confidence in themselves and the economy visualized a bright future. Assistance came from Congress with the passage of the GI Bill of Rights which covered all of the expenses of any veteran interested in pursuing a career as a technician or attaining a university degree (which included this grateful author). A pool of educated and confident entrepreneurs was created at the same time evolving plastic processes permitted many entry points into the industry.

Injection molding in 1946 was the leading process of choice in which resin was converted into a saleable product. Equipment and molds for injection molding are expensive and the lead time for their procurement is quite lengthy. The high cost was amortized for large quantities of items, but smaller amounts often were priced-out by metallic alternatives. Large injection molded parts require high tonnage presses with huge area platens which limited their adoption for big components. Unfortunately, the cure for this dilemma of producing small quantities of large parts was soon heralded as “**Vacuum Forming – the poor man’s injection molding.**”

The deceptive slogan and attitude was further conveyed to the design of equipment and molds which emphasized cost rather than improving existing technology. A low dollar price was highlighted in the machinery brochures and press releases. Component suppliers of radiant heaters and vacuum pumps offered free machine drawings to “*do it yourself vacuum forming machine builders*” (Fig. 3-2). This mindset also permeated

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Fig. 3-2. Receive a set of free drawings to build a vacuum former when purchasing a heater, 1954.

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early marketing tactics and was used to garner thermoforming orders which often resulted in inconsistent part quality and disappointed customers.

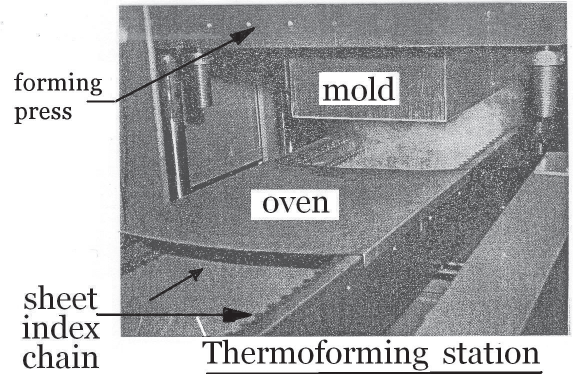
At the Packaging Institute Annual Forum October 1954 in New York City, C. W. Harper of retailer Sears Roebuck blasted the poor quality and reliability of his thermoforming supplier's performance. His kindest remarks included comments concerning peddling of inferior products, charging what the market would bear and that unqualified people were crowding to get into a good thing. This disappointed purchasing agent was the largest thermoforming buyer of his time so these arguments had the power to make the industry sit up and take notice. Eventually the thermoformers modified their sales strategies and sold their strengths- rapid tool scheduling and tightened control of the process. Product designers were then induced to accept the physical limitations of designing a thermoforming part and to circumvent these restraints.

Thermoformed components produced earlier than 1950 were formed on proprietary machinery as no commercial equipment was available for sale. These pioneering thermoforming firms had differing objectives and had to develop equipment that was specific to their own needs.

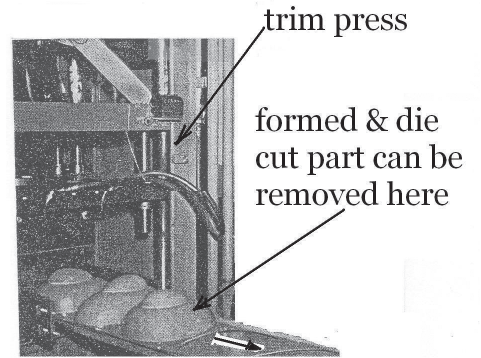
Gustave W. Borkland, an inventor and founder of Borkland Laboratories, Marion, Indiana, filed for his first plastic sheet forming patent in 1941 and was awarded a number of other vacuum forming patents during the 1940s. He produced and formed parts using both mechanical deep drawing methods as well as manufacturing his advertised "*Suction forming machines*" (Fig. 3-3). This equipment was originally available by license only, with none being sold outright until competing com-

mercial vacuum forming machinery caused a change in his policy.

Plaxall Corp. (Div. Design Center), founded by **Louis Pfohl**, utilized the experience gained from the design of his roll fed mechanical deep drawing equipment (1940s) to develop inline pressure thermoforming and trimming machines in 1953 (Fig. 3-4). It is surpris-



Thermoforming station



Inline trim station

Fig. 3-4. Plaxall Corp. inline proprietary thermoformer, 1953.

ing that commercial inline roll fed pressure formers utilizing steel rule die cutting were not available until the Brown Bantam 16 (mold size 16 W. x 8 L. inches, 406 x 203 mm) was marketed in 1965 at a reasonable price of \$10,000 (Fig. 3-5). Plaxall maintained a lead far ahead

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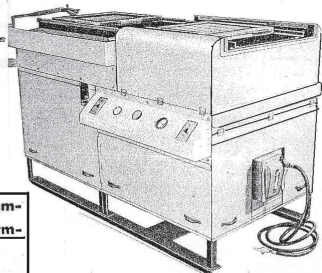
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***Suction Forming . . . commonly called "vacuum forming" erroneously.**

Fig. 3-3. Borkland Lab's "suction forming machine," 1955.

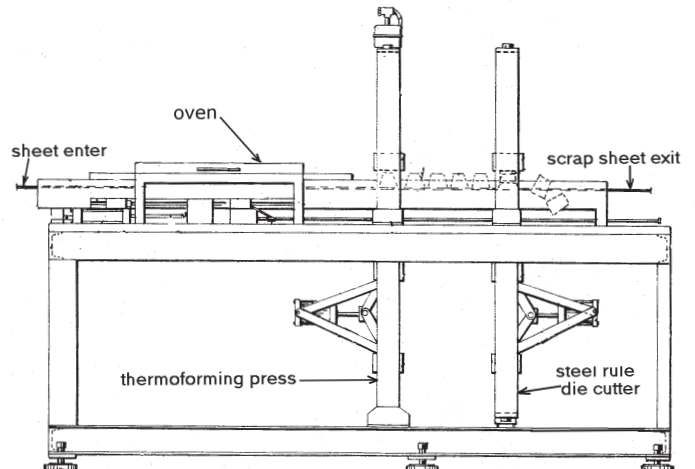


Fig. 3-5. Brown inline thermoformer and steel rule die cutter, 1965.

of their competition because they had been willing to invest in equipment that was quite visionary. This firm was acclaimed by the packaging industry for its creativity and production of high quality formed parts it continued on as a family owned entity into the present time.

Kraft Foods, Chicago, Illinois, in the late 1940s, needed a single service portion blister package for jellies, jams, etc. for its restaurant customers. Before these individual sealed packs were available, most restaurants provided unsanitary common-use containers for the dining public. Portion package designs and equipment described in an article in *Modern Plastics*, May 1952 was acquired by Kraft from the firm, Foodies of Manhattan Ltd. The production rate of 300 units/minute probably was achieved using a rotary drum thermoformer. An earlier Kraft patent (Fig. 3-6) described the pressure

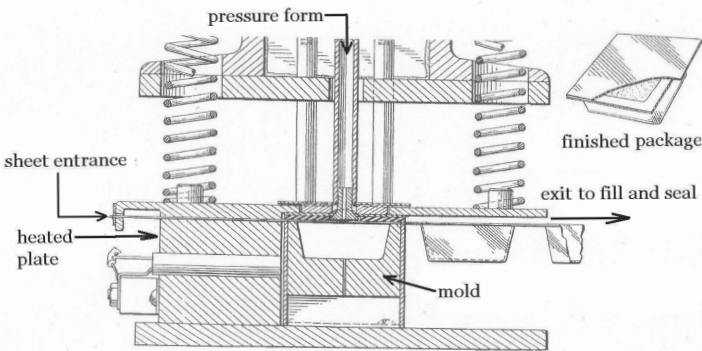


Fig. 3-6. Kraft Foods portion blister packaging, fill and seal machine designed by Theodore Lowe. Filed 1952.

forming of this container as a component of an inline fill and seal machine operating at a much lower production rate.

The specialized thermoforming equipment described here were not low cost universal machines which could be adapted for small part quantities or for large area components.

Bow Stratton of the Army Map Service published a detailed and comprehensive article in *Modern Plastics* magazine, September 1950, of the many years of experimentation to vacuum form contour maps (Fig. 3-7). His description and photos of the mold, radiant heater, vacuum system and clamp frame was sufficient for any competent machine designer to develop commercial versions from this information.

Industrial Radiant Heat Corp., Gladstone, New Jersey, in 1950 negotiated the first sale of a commercial vacuum forming machine (Fig. 3-8). This equipment contained many elements of the Army Map Service vacuum forming designs, including:

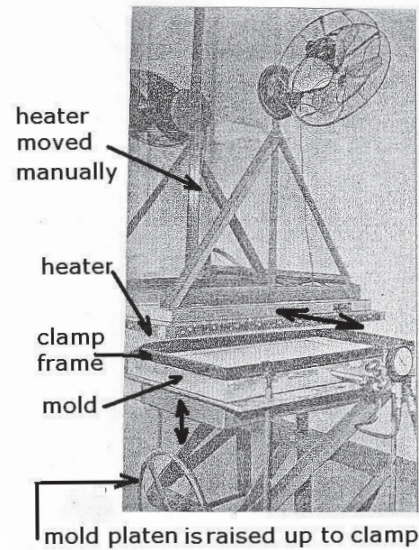


Fig. 3-7. Army Map Service vacuum former served as a prototype for commercial equipment, late 1940s.

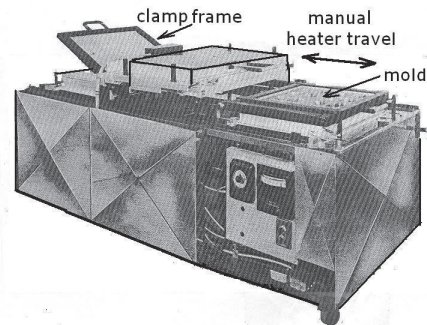


Fig. 3-8. Industrial Radiant Heat Corp. double mold vacuum former, 1953.

Traveling Super Heater consisting of bare nichrome wire sewn into a fiberglass cloth which provided an even heat up to 700°F (371°C). This oven was manually moved to and from the clamped sheet and mold by the operator.

Hinged Top Clamp Frame firmly held the plastic sheet directly against a raised wall built around the periphery of a female mold during the heating cycle.

Duct Tape an Essential. Used to seal the mold to prevent vacuum leaks and to the author's mind, was the main tool employed by many of the early thermoforming operators for multiple purposes. It was applied to cuts and bruises, repairing leaking air and water hoses and also substituted for nuts and bolts and served as a fastener to repair equipment.

Blow off Valve. Supplied compressed air to eject the formed parts from the mold cavities and negated the incorporation of a mechanical stripper within the tool for difficult to release shots.

Industrial Radiant Heat Corp. was the first firm to advertise and demonstrate its vacuum forming machine at a trade show in 1952. Some of its early customers were

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quite varied and comprised a broad range of industry – Auburn Button Works, National Organ Supply, Kelvinator Corp., Dow Chemical, Pratt Institute, Gladwin Plastics, Einson-Freeman, etc. The firm appears to have left the industry by 1955 as no mention was noted in periodicals after that period.

Autovac Corp., Bridgeport, Connecticut, incorporated in February 1953 by Bow Stratton and partner Bob Butzko, marketed a line of vacuum formers with solid engineered features. Their oven contained tubular heating elements, a metallic heat reflector with thermal insulation which was regulated by a temperature controller, a timer and used pneumatic cylinders to drive the oven. Very soon the complete cycle was automated which contributed to consistent forming and high quality finished products (Fig. 3-9).

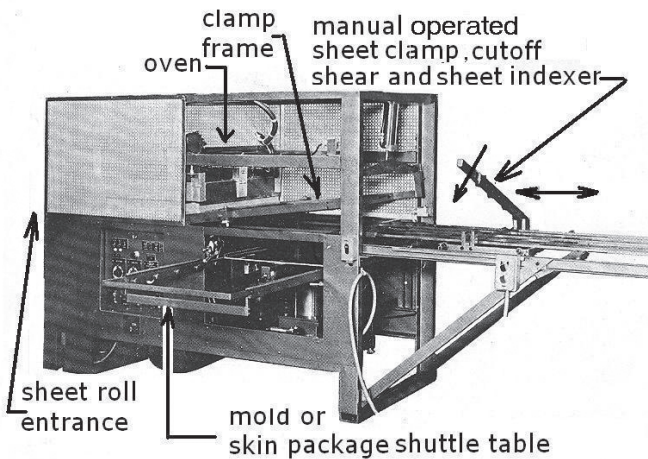


Fig. 3-9. Autovac Corp. The first commercial roll-fed continuous vacuum forming or skin packager, 1954.

In 1953, an important advance in sheet clamp frame design was embodied in a two-piece assembly with an upper member hinged to the lower section and the whole unit was then moved vertically up or down. Previously, the clamp frame was stationary with a hinged section that clamped the sheet directly to the female mold. Hence only female or shallow male cavities could be formed using this early type of clamp frame. Nor is it clear how compensation for hot sheet sag was achieved. The new vertical moving clamp frame was advertised to be used either for **drape** (male cavities) or **vacuum forming** (female cavities) and also to assist ejection of a formed part from the mold (Fig. 3-10). Modern thermoformers are now rarely designed with a stationary mold and a vertically traversing clamp frame instead the mold is secured to a moving platen and the sheet line is fixed.

The drape feature appeared simultaneously in 1953 on both Autovac Corp. and **Vacform Corp.**, Port Wash-

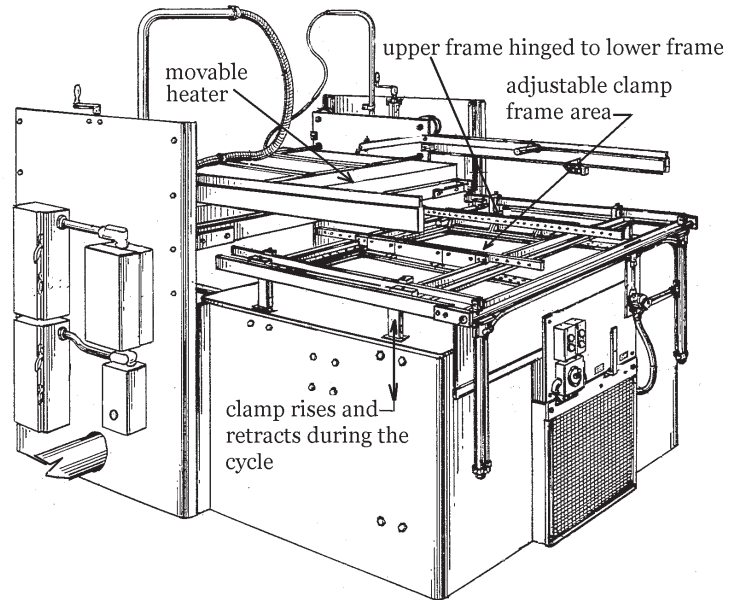


Fig. 3-10. Autovac Corp. cut sheet vacuum former with a fully adjustable clamp frame for the various mold areas. The frame can accommodate male or female cavities, 1954.

ington, N.Y. vacuum forming machines. **Sanford S. Zimmerman**, founder of Vacform Corp., built his machinery in a very robust manner and the designs were very well engineered. This company was eventually sold to **Emhart Corp.** (glass machinery builder) of Hartford, Conn. (Fig. 3-11).

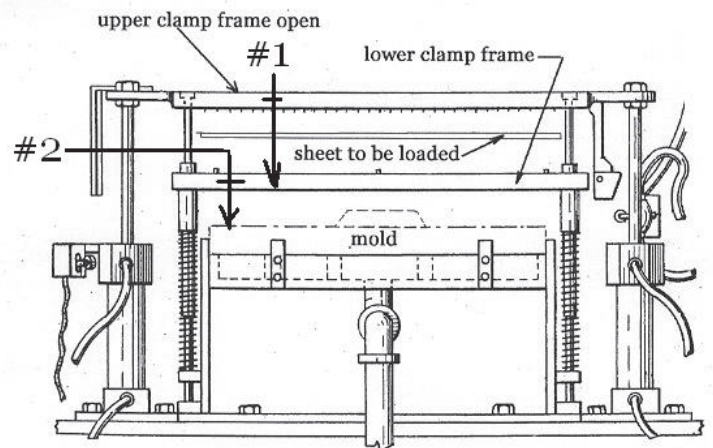


Fig. 3-11. Vacform Corp. Drape vacuum forming clamp frame, 1953.

Skin packaging, a close relative to thermoforming, substitutes a consumer product for a male cavity. The part is encased with hot plastic sheet which is tightly drawn by vacuum and sealed to an underlying porous printed card coated with heat activated cement. This process requires loose products not to shift from their registered spots on the card that had been previously placed on the machine's stationary base. The clamp frame then actuates vertically bringing the heated sheet to the parts for packaging. During this early development period,

vacuum forming equipment advertising promoted its dual ability as a skin packager. Later the two processes separated and each type of machine was specifically designed and sold only for a single purpose.

David Zelnick, President of **Atlas Vac Corp.**, Rochester, N.Y. in 1954, designed and constructed a complete line of vacuum forming machines. Mr. Zelnick in his prior position as a plastic sheet salesman for **U.S. Rubber Corp.** constructed his first vacuum former using an old refrigerator compressor (for vacuum) which his firm demonstrated at the National Plastics Show in 1952. Since this early entry into thermoforming, Mr. Zelnick and his family members continue to operate **Zed Industries** of Vandalia, Ohio whose machines range from sample prototype to high volume thermoformers and many auxiliary machines.

Chicago, Illinois was a heavily industrialized area which quickly encouraged the growth of thermoforming machinery manufacturing. **Comet Industries**, Franklin Park, Illinois in 1955, advertised double forming stations serviced by a single pivoted oven rotating overhead between stations. The founding Kostur family of father and sons built many types of thermoformers but were best known for their advocacy of electric motor driven platens rather than air cylinders for cut sheet formers (Fig. 3-12). This type of platen drive was further per-

vacuum formers which were heavily promoted in 1954 (Fig. 3-13). Eventually the equipment was modified to suit the special needs of the skin packaging industry. ■

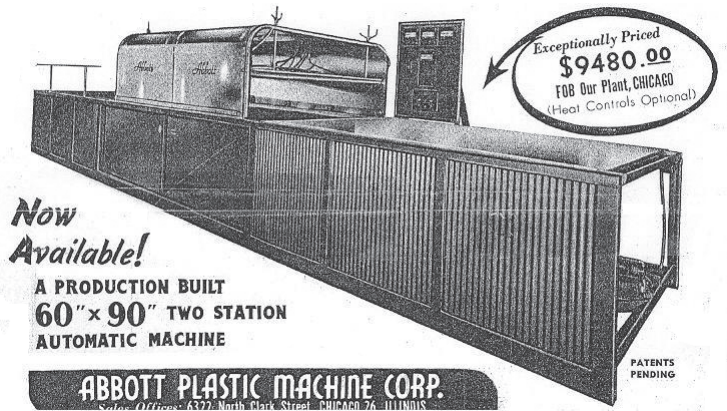


Fig. 3-13. Abbott Machine Corp. large area vacuum former, 1954.

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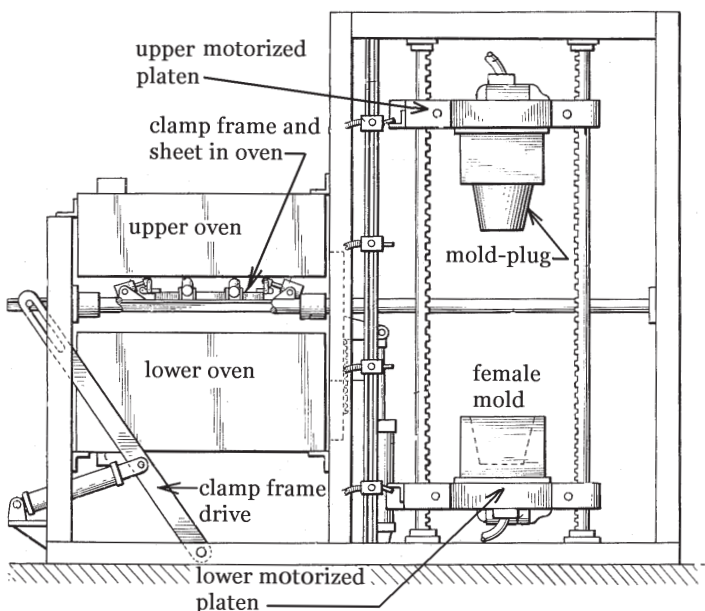


Fig. 3-12. Comet cut sheet vacuum former with electric motor driven dual platens, 1959.

fectured and became a specialty of the **MAAC Machinery Corp.**, Carol Stream, Ill. established by **Paul V. Alongi** in 1982. **ABBOTT Plastic Machine Corp.**, Chicago, Illinois, built very inexpensive large area

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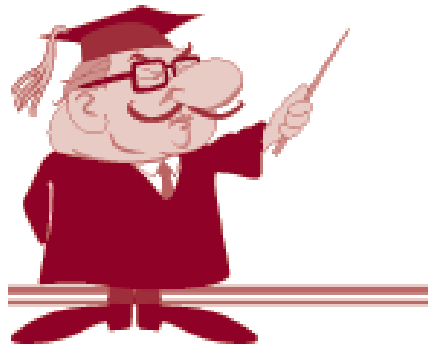
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Process – Cycle Time

BY BARRY SHEPHERD

(Editor's Note: This is the first Thermoforming 101 article written by your new technical editor. Dr. Throne wrote 34 articles that date back to 1998, Volume 17, Number 3. He had originally intended to write a series of 18 general interest articles but the 101 series has become a mainstay of the Quarterly. The year-end booklet that contains every 101 article to date is a great reference source for thermoforming practitioners. This technical editor has every intention of maintaining the series and the booklet which is becoming the perfect reading material for people entering the industry or seasoned personnel who need help on a specific problem. Jim wrote 4 articles last year that dealt with part design. I hope he will forgive me for not continuing with the "Trimmed Edge" topic he suggested for this lesson. I will deal with this topic when we take a closer look at the subject of "Die-Cutting." This Thermoforming 101 article deals with a subject about which we should all be more diligent. Foreign competition has forced us to maximize efficiency and become more competitive. So let us review the basic factors that determine cycle time.)



THERMOFORMING 101

General Assumptions

We all should be aware that if we let the operator determine when a machine cycles, our production rate will suffer. Running thermoforming machines on manual mode is necessary for set up and of course if all you have is a simple shuttle machine with rudimentary controls you have no other choice. So let's just deal with thermoforming in automatic mode. We will only deal with the forming part of the process. Trimming of heavy gauge parts is another topic. Also for this purpose we will assume that when thinking roll-fed, we are using a machine with in-line die-cutting.

The Basic Concept

If we take all the segments of the rotary or in-line thermoforming process: heating, indexing the sheet, closing the press, forming the part, cooling the part, opening the press,

trimming and stacking (if in-line), the cycle time is dictated solely by the slowest segment of the process. Most people looking at our process for the first time will say it has to be the heating segment that is the slowest part of the process. This is not necessarily so.

Roll-Fed

It is especially not so with roll-fed machines that usually are designed to have 4 indexes in the ovens. For example if the maximum mold size in the index direction is 36". The oven length will be roughly 4 times 36" or 12 feet long. So if you are running .020 PVC which would normally be in the oven for 20 seconds to get up to forming temperature, your cycle time, based on a 4 index oven, is 5 seconds (20 divided by 4) or 12 cycles per minute. This is not bad for running smaller and medium size quantities but it can be a lot better. I will explain later.

(continued on next page)

Sheet-Fed

OK, so what about heavy-gauge, sheet-fed forming? The same principle applies. In North America the machinery manufacturers recognized early on that they must do something about the length of time it takes to heat the sheet evenly and thoroughly. So the 4 station rotary machine was designed which cut heating time dramatically by using 2 heater banks through which the sheet travels on its way to the mold. So why not build a 5 station rotary with 3 heater banks and really cut heating time? The answer is, there would be no point unless the part could be formed and cooled in a time less than one third the heating time. In fact the cooling of some materials is so difficult that one heater bank on a 4 station would have to be shut off or set at a lower temperature to allow time for proper cooling. So if we can do things to speed up the heating of the sheet, what can we do to cool the part quicker? This is where it gets tricky.

The Forming Segment of the Cycle

On roll-fed machines, unless you are dealing with super fast lines, you can forget about the trimming and stacking segments of the cycle when looking for what is slowing you down. Concentrate on the forming segment from the time the sheet leaves the heaters to the time the formed part leaves the form

station. Let's break down the actions that take place.

Index speed is the speed that the sheet travels from the heaters to the form station. Roll-fed pin chains can travel up to 95 inches per second. A rotary turntable moves a lot slower. On both roll-fed and sheet-fed lines the stopping and starting actions can become too violent if the index speed is too fast which may cause the hot sheet to move as the mold closes on it. Move the sheet as fast as possible but make sure that the drape is stationary when the mold closes.

Shut height or platen travel is the distance the form platens must travel from the open position to the closed position. All too often set-up people will not take the time to reduce the shut height to optimum levels. I have seen a roll-fed job running very shallow pill blisters with a female tool on the bottom and the plugs on the top showing 3 inches of daylight between the plugs and the sheet line because the operator did not lower the shut height of the top press. This added at least 1 second to the cycle time and over a 30 hour run at 15 cycles per minute added over 2 hours of unnecessary labor and machine time. If you don't have shut height adjustment on your form press the only way to do this is to add build ups behind the tooling. Fortunately the new machines have electric presses which make setting the shut height so much easier.

Press speed affects the length of the cycle time but sometimes it is necessary to slow the press closing speed to accommodate

plug or assist action. If you are having difficulty with de-molding you may need to slow the opening speed. Other than these conditions, you can move the platens as fast as you want. Third motion tooling or independent plug control with individual cavity clamping can greatly improve cycle time but this is getting beyond the scope of a 101 article.

Cooling time is by far the most important factor in achieving a fast cycle time. In my very early days of thermoforming we tried running an epoxy mold on a modern in line machine. Even with a water cooled base under the mold the best we could do is 2 cycles per minute simply because the mold never got a chance to cool down. Using an aluminum mold on a water cooled base allows you to run most jobs at reasonable speeds as long as the height (or depth if it's a female) of the mold is no more than say 2 inches. To achieve maximum efficiency and reduce cooling time the mold must be kept at the target temperature as specified by the material supplier. Hot material at 350 degrees F hitting the metal mold requires a very efficient cooling system to maintain that mold temperature that may have to run at 200 degrees F constantly to run fast cycles. The only way to do this is to run cooling lines in the mold itself usually no more than 2" to 3" apart depending on the size and configuration of the mold. Cast-in lines are the norm for aluminum cast molds and machined in lines are the norm for machined aluminum molds.

Cooling time on sheet-fed rotary machines running thick HDPE can be improved by using external fans, water mist or cold air directed onto the part but care must be taken not to form in stresses. A well built water cooled mold is still necessary for the most significant improvement in cycle time.

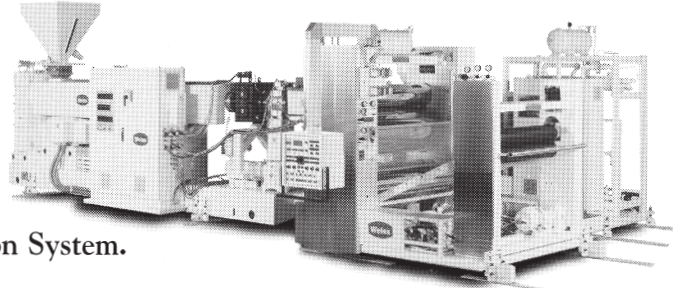
So how do some roll-fed thermoformers get 50,000 parts per hour? This will be the subject of technical articles in the future. It's not a subject for the 101 series but here is a hint: third motion tools, cavity clamping, pre-heaters and great cooling in the molds.

Cycle time is just one way to make our operations lean and more competitive. Other ways will be discussed in future Thermoforming 101 articles. ■

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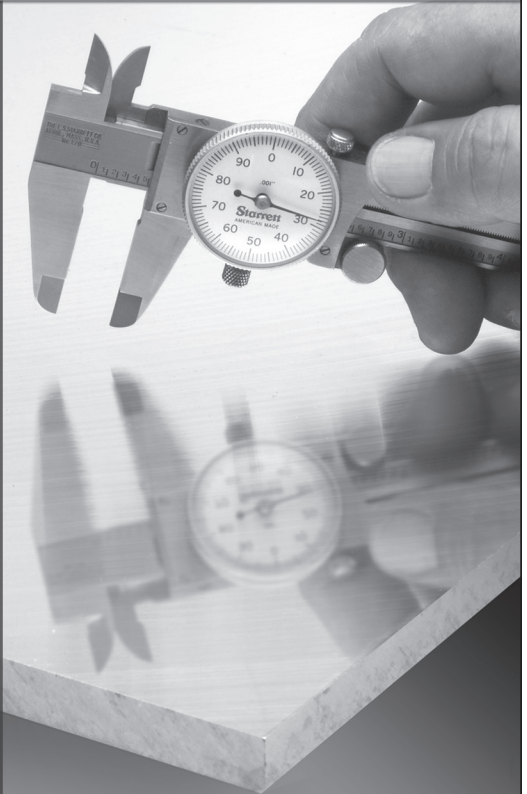
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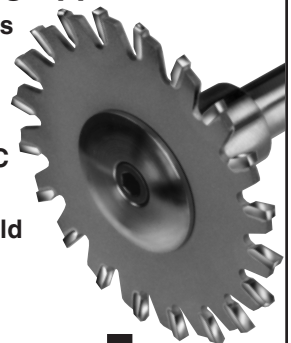
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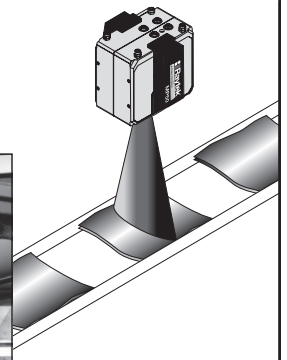
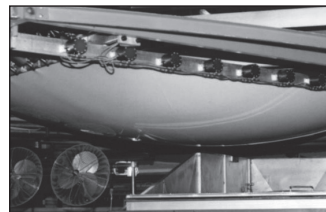
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2007 PARTS COMPETITION ANNOUNCEMENT

BY HAYDN FORWARD, PARTS COMPETITION CHAIRMAN



W elcome to our introduction of the 2007 Parts Competition.

These are exciting times for our industry and the 2007 Parts Competition will again showcase advancements in thermoforming design, innovation and capabilities.

I'm confident all of you have experienced and introduced many changes in your business over the last year and change is in the air for this year's competition format. I'm pleased to say the changes are in response to numerous ideas and recommendations to enhance the viability of the competition.

Media has shown a strong interest in thermoforming and has requested improvements to assist them in publicizing well deserved recognition of the parts and award recipients.

We will be opening the part entrance door wider by inviting a broader range of those involved in part development, which will generate a new category and winner. In respect to our history of close competition, other award categories will be rolled into a larger grouping and multiple winners announced from that grouping. Contrary to the past, part entries that might have been "a close second place" will now have a greater opportunity of industry recognition.

A simple stream-lined entrance process will be introduced for rapid international announcement of the winners.

The conference committee is gearing up to help educate the industry this year and our parts competition will be part of that effort.

Each submitter's representative will have the opportunity to speak with the press, your peer's, designers, tool makers and OEM's, at a dedicated time and gathering for the occasion.

History has shown that every part entered deserves recognition, but unfortunately every part does not receive an award. In light of this, each entered submittal will receive a "Certificate of Acknowledgment" from the SPE.

Details on these exciting changes will soon be found on our website www.thermoformingdivision.com and in the next *Quarterly*.

It'll be easy to start thinking now about how to take advantage of this once a year opportunity to showcase your capabilities, research and introduce your firm to and through the press.

I'm encouraging you to take a few moments and forward your e-mail address to me at hforward@smi-mfg.com. Once sent, you'll be on the list to receive the necessary, short and easy, instructions to enter the 2007 SPE Thermoforming Division Parts Competition. ■

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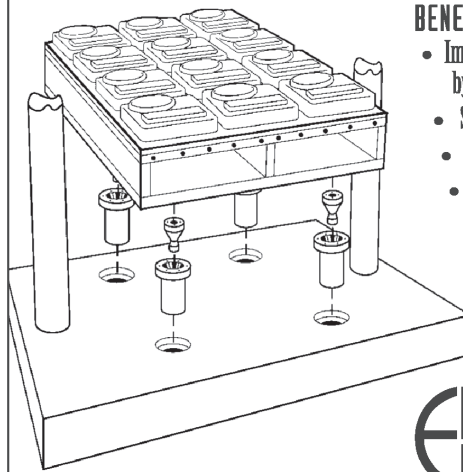
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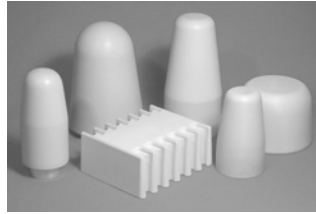
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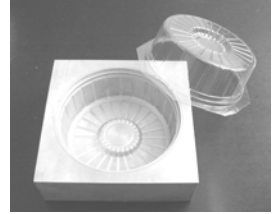
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2007: A Year to Nurture Future Leadership

My Hard-Charging New Year's Resolutions

It's that time of the year again ... for New Year's Resolutions. As usual, mine focus on health and fitness. Unfortunately, I find myself looking back with dismay at my unfinished 2006 personal resolutions. Too little physical activity. Not much movement on the weight loss front! But with a renewed sense of vigor, I'm charging hard into 2007!

But in addition to personal resolutions, I also made three SPE Thermoforming resolutions. As your new Chairman ...

- I resolve to guide your organization with the integrity and energy you expect.
- I resolve to bring continuing relevance to your organization through conferences, seminars, technical information and networking opportunities.
- And – most importantly – I resolve to nurture new people for your organization's leadership.

Currently, we are blessed with an incredibly capable group of professionals who are extremely generous with their time. And, by the time you read this, you will already have voted on an outstanding slate of 2007 candidates to the Board of Directors.

But my "leadership" resolution is really about planting and germinating the seeds of interest in 2007 and harvesting Division leadership for 2008 and beyond. To each of you, I ask: *Have you ever considered joining the Board of Directors to help plan and execute the many initiatives of your organization?*

My Challenge to You

Take it from me – from someone who's been involved in Thermoforming Division leadership for a number of years – it is extremely rewarding and gratifying to give back to my vocation.

Every day we "take, take, take" from the thermoforming industry; after all it's where we derive our livelihood. So, I challenge you – especially the thin- and heavy-gauge thermoformers – to get involved. Consider "giving back" to your industry through Board leadership. Each year one-third of our Board members either rotates off or is up for reelection, so each year there are a number of new openings. We especially need a few more practicing thermoformers interested in Board membership.

Please don't be shy. If you would like to know more about Board activities, I encourage you to contact a current or past Board member ... someone you may know, someone in your industry or someone in your geographic area. They would be

delighted to talk with you about what Board membership means to them and the duties involved.

To All Members: Cultivate and Nourish Potential Leadership

But wait, there's more to my resolution. This leadership appeal wouldn't be complete without also asking ALL members to cultivate and encourage others to consider a leadership position. Nine times out of ten, people don't get involved unless they're asked. So, ask. Ask the best and the brightest you know. Or contact an existing Board member with a name, so we can begin nourishing that leadership relationship.

Thank You, Jim Throne

Long-time technical editor of *Thermoforming Quarterly*, Jim Throne (Sherwood Technologies, Inc.), has put down his pen and retired from his editing duties. Author of several books, Jim generously shared with us his deep knowledge of the thermoforming industry for many, many years. Thank you, Jim, for your true dedicated service. You'll be much missed. Picking up Jim's mighty-mantle is Board Chair-Elect Barry Shepherd of Shepherd Thermoforming & Packaging, Inc. in Ontario. Welcome, Barry!

2007 Conference Planning Underway

At our February Board meeting, we'll be reviewing the agenda for our upcoming conference in Cincinnati from September 16th-19th, 2007. Conference Chairman Ken Griep and Technical Co-Chairs Conor Carlin, Brian Winton, and Haydn Forward will be presenting the upcoming conference agenda. We'll also be talking about our 2008 Minneapolis Conference, plus a possible alternative to our 2009 Conference. There has been some interest in holding several regional one-day technical sessions across the country to provide professional development opportunities to more people.

Is a European Conference in Our Future?

Also at the February Board meeting, we'll be discussing a possible joint conference with the European Thermoforming Division. It's a very small world today. Perhaps there's some value in sharing a conference date, exploring common global issues and industry challenges. There is much to explore and debate. What do you think?

Happy New Year!

Finally, I wish all of you a healthy and prosperous new year. And, if you're interested in taking up my leadership challenge, give me a call!

It's a great day in thermoforming!

Walt Walker

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