Society of Plastics Engineers • Upper Midwest Section

**September 2008** • *Volume 36*

# THE SPECIALIST

**September 2008**

*Volume 36*

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# Section MiniTec

**TUESDAY SEPTEMBER 23, 2008**

HENNEPIN TECHNICAL COLLEGE NORTH CAMPUS • 9000 BROOKLYN BLVD, BROOKLYN PARK, MN

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**12:30 PM REGISTRATION 1:00 – 5:00 PM SEMINAR**

## PROCESS & DESIGN TECHNOLOGIES, LLC.

### EVAPORATIVE COOLING OF MOLDS VERSES TURBULENT FLOW COOLING

**Terry L. Schwenk**

This very informative presentation will begin with a review of the science behind evaporative and turbulent flow technologies. Attendees will walk away with an understanding of how cooling molds works and why evaporative cooling is an efficient and cost effective solution in this process.

Terry Schwenk is a member of Mold-Masters Academy and has over 34 years of experience in the plastics industry, of which more than 22 years has been specializing in hot runner technology. Terry's greatest strengths are in his abilities to identify, brainstorm, conceptualize, and deliver the best solution for the desired outcome. Terry's experience combined with his effective communication style allows him to convey complex ideas in a way that audiences can fully benefit from his experience.

Terry's business "Process & Design Technologies LLC" provides consulting services for companies striving to maximize their productivity. As an associate of SWM-Associates, Terry represents Ritemp Mould Cooling Technology, an innovative product from Australia for cooling molds.

Terry is an active member of Society of Plastics Engineers and currently holds the position of Past Chair for Mold Making & Mold Design Division of SPE. Terry also has an Associates Degree in Business Administration from Lake Forest School of Management, and has several accredited patents.

**Here's what Terry's colleagues have to say:**

*"Terry Schwenk; an exceptional person with a thirst for finding solutions. He embraces opportunities and moves forward with a determination and enthusiasm that impresses me."*

*"Terry's knowledge showed clearly in the presentations; questions were answered to the fullest and clearly for everyone."*

**For reservations or questions,**
**email Sean Mertes (sdmertes@ashland.com) or Jeff Voelker ( jeffrey.voelker@sabic-ip.com).**
**If you don't have access to the internet then call Sean Mertes at 612.801.2417**
**EMAIL IS PREFERRED**

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# President's Remarks

**Paul Rothweiler**

It's hard to believe that summer is beginning to fade, because the time has flown by. I think a reason for that is we had so much fun this summer (under the direction of Shilpa Manjure) preparing for the *2008 S22 Summer Golf Extravaganza*. I want to thank everyone who participated in the golf outing. We had an excellent turnout with people from as far away as Texas, Chicago and Iowa. I get the distinct feeling from talking with them, that they will make the trip again in 2009. In the mix we had first-time golfers and some very good talent that made some of us pause. I naturally blamed my golf clubs. I also want to thank the sponsors for all their support and I'd ask you to thank them when you see one of their representatives. Without the sponsors the event would not have been possible. Stay tuned for more information on upcoming social events that are currently under development.

I am beginning to "sound like a broken record," but we keep adding to our membership. In August alone, Dick Bopp (S22's Membership Chair) copied me on 15 "welcome letters." While 15 is not a record-breaking month, it's still great to see the number of new people that have joined over the last year. In addition to the new professional members, we have been talking with Plastics Engineering Program at the University of Wisconsin-Stout about starting a student chapter. We are eager to welcome the students to our ranks.

This newsletter continues our tradition of providing excellent articles. In this newsletter you will see Dan Mishek's article on *low-volume production.* Dan will expand the on topic in a three-part series that includes *Direct Digital Manufacturing* (DDM). If there is a topic you would like to see, please contact our Newsletter Editor, Rolly Enderes.

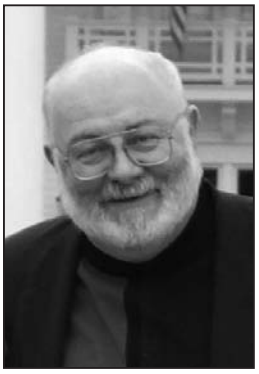
As you can tell by the cover of the Newsletter, the September MiniTech should be another great presentation. I want to thank everyone that stayed after the April MiniTech for a little networking and I look forward to meeting even more of you after the September MiniTech.

***See you at the September 23rd MiniTech!***

MEMBERSHIP MATTERS

# Welcome to our New Members

Richard C. Bopp, Membership Chairman
Email: Richard_C_Bopp@NatureWorksLLC.com • Phone: (952) 742-0454



Richard C. Bopp

**We are very pleased to welcome the following new members who joined our section during the months of May, June and July of this year and ask you all to introduce yourselves to them at your next opportunity, possibly the MiniTech in September.**

| | | |
|---|---|---|
| **Bob Archambault** | **MME** | **Vadnais Heights, MN** |
| **Ryan Baumgarter** | **Fey Industries** | **Edgerton, MN** |
| **Mike Fenske** | **Fey Industries** | **Edgerton, MN** |
| **David Gregerson** | **RTP** | **Winona, MN** |
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| **Craig Kallemeyn** | **Fey Industries** | **Edgerton, MN** |
| **Mark G. Kurtzweg** | **Worldwide Dispensers** | **Lester Prairie, MN** |
| **Stephen F. Lacey** | **Milwaukee Institute of Art & Design** | **Milwaukee, WI** |
| **David W. Magnuson** | **FiSA North America** | **Elk Grove Village, IL** |
| **Brian Rice** | **Boston Scientific** | **Maple Grove, MN** |
| **Tim Runge** | **Film Tech** | **Stanley, WI** |
| **Steve Swain** | **Omnitool** | **Minneapolis, MN** |
| **Jeffery Walczak** | **Alpha Plastics** | **Coon Rapids, MN** |
| **David Wirth** | | **Hartland, WI** |

SPOTLIGHT ON THE BOARD

# Spotlight on the Board

***Dick Bopp, Membership Chairman***

"Spotlight on the Board" is a new feature of our newsletter where we ask a board member to introduce her/himself with a short bio. In so doing, we hope to improve communication, facilitate networking and broaden the overall fellowship within our Section.

This issue's spotlight features **Shilpa Manjure**, a relatively new board member who has already distinguished herself as Special Events Chair and who did an absolutely outstanding job in reprising our golf outing last month at the Theo Wirth Course in Minneapolis. If you missed it, you missed a really good time. Anyway, here's Shilpa's story which she submitted before the golf outing became history. *You can think of part of it as an early invitation for next year.*

## Shilpa Manjure

*I have been a member of the SPE since 1999 and currently serve as Special Events Chair and Program Co-Chair for the Upper Midwest Section.*

*After receiving my Doctorate in Chemical Engineering from Clemson University in 2002, I have worked in a couple of engineering roles of product development and product engineering of polyolefin films and copper-based laminates, respectively. Recently, I accepted a position with Northern Technologies International Corp. (NTIC) in Circle Pines, MN as an Applications Development Engineer for their Natur-Tec business. Natur-Tec provides biobased, fully biodegradable and compostable alternatives to traditional plastic products.*

Shilpa Manjure

*I joined SPE as a graduate student, presenting my research at ANTEC. What instantly got my attention was the pool of technical presentations from both academia and industry. SPE has not only served as a networking ground with professionals from all over the world, it has also provided necessary technical updates and trends in the plastic industry. It has been a part of me wherever my career, work & personal demands have taken me and I would encourage everyone involved in plastics to become a member of SPE. SPE is my family as a young professional where all the individuals speak one language – plastics!!!*

*As a Special Events Chair I have plans on hosting a Christmas Party this year in addition to the Golf Outing already set for July 31st. By no means are you expected to be an Annika Sorenstam or Tiger Woods of golf to participate. In fact, I myself might have picked up a set of golf clubs only once so far (I think that was at the age of 3). My goal is to provide an opportunity for networking and an informal environment for healthy exchange of ideas through these events.*

*For inputs/suggestions on the Christmas Party or other events you would like to see next year please feel free to write to me at Shilpa.Manjure@gmail.com.*

# ESTIMATING PERMEABILITY OF MULTILAYER FILMS

**Shilpa Manjure – Northern Technologies International Corp., Natur-Tec – Circle Pines, MN 55014**

Multilayer films have been widely used in the packaging industry for several decades. The number of layers can vary anywhere from 3 upto 7 layers. Designing of a packaging film can present several challenges. The type of product to be packaged, its chemical composition, size, storage conditions, expected shelf life, moisture content, aroma/flavor and appearance are just a few of the characteristics that must be taken into consideration when selecting the right material. A continuing trend in packaging is the design of packages to extend the product's shelf life while maintaining its quality. In such situations, it is important to be able to predict barrier performance prior to data testing, as it can result in substantial cost savings. The critical property used in making these barrier performance predictions is the Permeability. The following article discusses the fundamental phenomenon of gas permeation through a film and derives the formula for estimating permeability in a multilayered structure.

**Steady State Diffusion Across a Single Sheet**

Let us consider the case of a plane plastic sheet of thickness l that is contacted on both sides with a penetrant at different concentration values. At the surface x=0, the penetrant concentration $c=c_2$, and at x=l, $c=c_1$). Applying these conditions to Fick's First Law of diffusion, the penetrant flow rate F across any section of the sheet is given by:

$F = -D\, dc/dx = D\,(c_2 - c_1)/l$ where D is the Diffusion coefficient of the penetrant molecule

In permeability studies, however, the partial pressure, pi, in the gas phase surrounding the sheet is easier to measure than the penetrant concentration $c_i$ in the polymer. If we are at low concentrations, Henry's Law applies, and we can substitute for c using, $c_i = S\, p_i$, where S is the solubility coefficient of the penetrant in the polymer at a given temperature. Moreover, the flow rate F is given by the quantity q of permeant transferred by a unit of area A in a time t, i.e. F = q/At.

$F = q/At = DS\,(p_2 - p_1)/l$

Rearranging,

$P = DS = q\, l/At\, \Delta p$ where $\Delta p = p_2 - p_1$

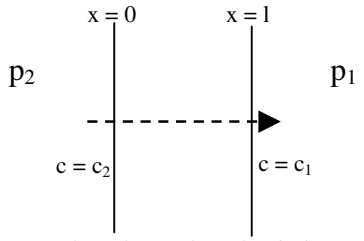


**Figure 1. Permeation through a single layer structure**

We have introduced a new parameter, the permeability coefficient, P. P is defined as the product of the diffusion coefficient and the solubility coefficient. Since P combines the effects of the diffusion coefficient and the solubility coefficient of the permeant/plastic system, it is an indicator of the barrier characteristic of the polymer for the permeant under consideration. A material having a low value of P for a particular permeant is a good barrier, i.e. only a small quantity of permeant will be transferred through it. Conversely, a high permeability value indicates a material with poor barrier properties.

**Multilayer Structures**

The calculation of permeation across such a structure can be done by examining transfer through the individual layers of the structure. Figure 2 and the following analysis show the situation for a three-layer material. We assume the material is at steady state. This means the amount of permeant passing through each layer is identical, and equal to the amount passing through the total structure.

The partial pressure differences across the layers are as follows:

$\Delta p = p_2 - p_1$
$\Delta p_1 = p_i - p_1$
$\Delta p_2 = p_{ii} - p_i$
$\Delta p_3 = p_2 - p_{ii}$
so, $\Delta p = \Delta p_1 + \Delta p_2 + \Delta p_3$
For the overall structure, we know

$P_T = q\, l_T/At\, \Delta p$ ➔ $\Delta p = q\, l_T / At\, P_T$

*Continued on page 10*

# WHO CAN HELP YOU

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# Upper Midwest Section (S22)
# Membership

*August, 2008*

**Total .....488**

# Councilor's Corner

***Tom McNamara***

The last Council meeting took place May 3-4 preceding the 2008 ANTEC in Milwaukee. Again, the ANTEC was combined with Plastics Encounter and the total attendee count reached 2679. Also, 135 registrants attended 14 Society seminars.

The Presidents gavel was turned over to William O'Connell from Vicki Flaris. Vicki was thanked for all of her efforts as President last year and Bill is coming into the office with the mantra of "Make it Happen". Much of his focus will be to increase membership and improve the financial status of the Society.

Some of the key activities going on at this time are: An agreement with Wiley Publishing for Plastics Engineering magazine has been concluded. SPE and SPI are in final negotiations on a written contract for holding ANTEC @ NPE 2009. No major outstanding issues exist. Membership is a primary concern as numbers continue to decline with the slowdown in economic activity in the US. Conferencing continues at a good pace but seminar attendance has slowed. SPE continues with the full re-design of the SPE website and it is nearly complete. The SPE Foundation remains fairly healthy as they were able to award $120,000 in scholarships to 32 students in 2007. Plans continue for the merger of The SPE Foundation and the SPE. A new Student Chapter was established at the University of Michigan – Dearborn.

As mentioned in previous SPEcialists, the ANTEC 2009 will be co-located with the SPI NPE. Dates for the ANTEC will be Monday through Wednesday, June 22-24, at the McCormick Place West. ANTEC abstracts are due September 1, and the submission website is now open. The manuscript deadline is November 14. Contact ANTEC Technical Program Coordinator, Peter Boergermann (203-740-5472).

The inaugural Eurotec will take place September 29-October 3, 2009, at the Hotel New York and Convention Center in Marne la Vallee, France (near Paris). The call for papers is now available on the SPE website. Contact Lesley Kyle for more information.

As mentioned earlier, a primary concern of the SPE is the continued decline in membership. There are many reasons for this – tightened spending due to the economy, global pressures on business, other means of obtaining technical information such as the internet, etc. Total membership of SPE International has declined from 19,427 in June of 2007 to 18,217 in June of 2008. All of us current members can help the Society by recruiting those people that have an interest in furthering their plastics careers. In addition to being the best and most focused resource for knowledge on all aspects of plastics technology, the SPE offers the best avenue for face-to-face networking. The internet cannot offer the huge benefits of meeting and exchanging experience in plastics with other colleagues in our profession. We need to get the word out to those that do not understand the power of personal contact to accelerate knowledge growth and advancement of careers.

Please help your Society by recruiting members.
Have them contact our Membership Chair, Dick Bopp,
Richard_C_Bopp@natureworksllc.com or 952-742-0454.
**THANKS FOR YOU HELP.**

# Golf Outing 2008

Ajay Gupta - Boston Scientific
Paul St. Onge - DiversiPlast
Dennis Paradise - Extrusion Dies Industries, LLC
Ricardo Peters - Bamberger Polymers

← Rob Poupard - Clariant,
Ken McCrocklin - Aspen Research
Shilpa Manjure - NTIC
Marilyn Green - Clariant

← Andy Marine - Aspen Research
Paul Rothweiler - Aspen Research

← Marilyn Green - Clariant
Eric Swensied - Harbor Plastics
Rob Poupard - Clariant,
Sean Mertes - Ashland
Rolly Enderes - Chemstock
Shilpa Manjure - NTIC

# THE FUTURE IN LOW-VOLUME PRODUCTION

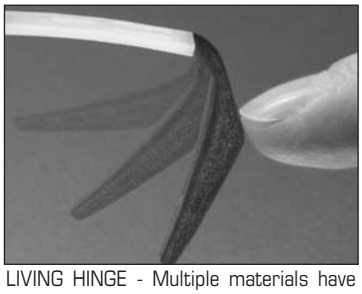
*Dan Mishek of Vista Technologies*

3M METER - This assembly was produced in a 1+1+1+1 family aluminum tool for low-volume production. Ony 1,000 assemblies are needed every 6 months.

**Low-volume production is often overlooked by high-volume projects. Low-volume is rarely catered to or even acknowledged by suppliers or customers. In this three part series, I would like to discuss today's methods of manufacturing for low-volume production plastic parts. Times are changing and engineers and buyers are slow to make the adjustment.**

Part one will talk about and identify today's methods of low-volume production. We will discuss new technologies and show how old technologies are being used in a new way. We will define low-volume production in the plastics world along with explaining why it needs to be dealt with differently than high-volume production. Part two of this series will discuss what you should look for when choosing your low-volume production application. We will break down components that will assist you in your decision making from complexity of the part to functional material options. Myths of Rapid Tooling will be dispelled along with showing real examples of successes. The third and final part of the series will show pricing comparisons between Direct Digital Manufacturing (DDM) and Rapid Tooling. We will show where the breakeven points are in quantity vs. cost and complexity. Real life projects will be shared with my closing thoughts on the future of low-volume production.

The Connex 500™ is the first 3-D printing system that jets multiple model materials simultaneously. Great for soft touch, living hinges and over-molded parts.



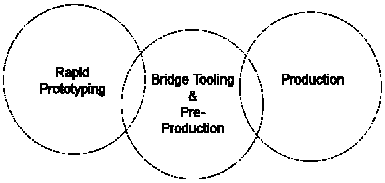
LIVING HINGE - Multiple materials have been laid simultaneously in an additive manufacturing method using the Connex 500™ from Object to mimic a living hinged feature without any form of tooling.

## PART 1:

Before we look at today's manufacturing trends, we must first take a step back and identify today's product trends. The product trends from companies are to have more products and have them released faster than ever before. These products are more customized and are filling more niche markets. The products are quickly updated for the next iterations to keep "new" products in front of consumers. This new trend for products has made them lower in volume, but higher in margin.

Now let's look at the trends of prototyping these products. This is the first time in my 12 year experience in this industry that speed has **not** been the number one demand. There is a need for speed, but not a greed for speed. Function, function and function is where it is at. Engineers need their prototypes to work across the board. These parts need to fulfill the needs for engineering, packaging, focus groups and field tests. It does not matter how fast the prototypes are completed if they do not work for all purposes. These prototypes need to be made from a spec material for real testing and hold production like tolerances.

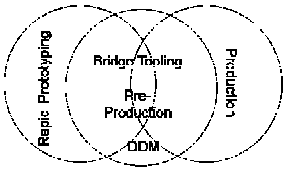
### TRADITION MANUFACTURING FOR LOW-VOLUME PRODUCTION PLASTIC PARTS.




**TRADITIONAL MANUFACTURING**

Notice there have been three rings with very little overlap from one to another. Specific technology was used only for a specific ring of manufacturing. Technologies did not cross from rapid prototyping to production. With the advancement in technology and thought process, the rings have been redefined into Today's Manufacturing. Techniques, methods and technologies in Rapid Prototyping have crossed over into production. Many methods in Bridge Tooling or Rapid Tooling are successful in low-volume production. Along with the advancements comes a new terminology call Direct Digital Manufacturing (DDM).

These parts are made from an aluminum tool and ran over 20,000+ parts. It was used as a bridge tool until production got online.




**TODAY'S MANUFACTURING**

### What is DDM

DDM is defined as a direct production of finished goods from additive manufacturing technologies. Or, DDM is the process of going directly from an electronic digital representation of a part to the final product via additive manufacturing.

DDM has joined the likes of Bridge Tooling and Pre-Production (Rapid Tooling) as a legitimate method of low-volume production. The most common technologies that are used in DDM are FDM (Fused Deposition Modeling) from Stratasys and SLS (Selective Laser Sintering) from 3D Systems and EOS. These parts are built using an additive process then are used as an end product in low-volume production. The materials have become rigid enough for true function. The FDM process is building plastic parts from materials such as ABS, Polycarbonate (PC) and Polyphenylsulfonen (PPSF).

*Continued on back cover*

We can form similar equations for each of the individual layers to obtain $\Delta p_1$, $\Delta p_2$, $\Delta p_3$. Then, adding

$$\Delta p = \frac{q}{A\,t}\frac{\ell_T}{P_T} = \frac{q}{A\,t}\left(\frac{\ell_1}{P_1}+\frac{\ell_2}{P_2}+\frac{\ell_3}{P_3}\right)$$

$$\frac{\ell_T}{P_T} = \frac{\ell_1}{P_1}+\frac{\ell_2}{P_2}+\frac{\ell_3}{P_3}$$

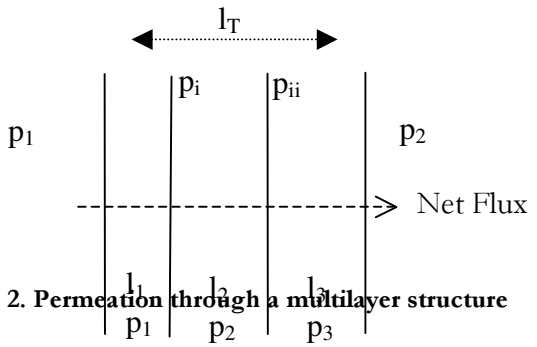



**Figure 2. Permeation through a multilayer structure**

Thus, knowing the thickness of each layer and the permeability coefficient for that material, we can calculate a permeability coefficient for the overall structure. For a n layer structure we can obtain:

$$P_T = l_T / \Sigma(l_i/P_i)$$

**Summary**

The permeability equation is a very powerful equation that relates key attributes of a packaging system: product characteristics q, $p_1$ and t; package parameters P, A, and l and environmental conditions $p_2$ and temperature. As such, it provides an easy way of estimating the quantity of gas or vapor taken up or eliminated by the packaged product. On the other hand, the same equation also allows one to estimate the shelf life of a product when the quantity of permeant transferred through the package is known.

**Table 1. Values of Permeability Coefficients at 25 deg C (P in cc (STP) µm/m² d kPa)**

| Polymer | Permeability | | | | Polymer | Permeability | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $O_2$ | $CO_2$ | $N_2$ | $H_2O$ | | $O_2$ | $CO_2$ | $N_2$ | $H_2O$ |
| LDPE | 1900 | 700 | 630 | 59000 | PTFE (Teflon) | 28000 | 6500 | 860 | |
| HDPE | 260 | 230 | 95 | 7800 | PET, 40% crystallinity | 22 | 80 | 39 | 85000 |
| PP | 620 | 2100 | 80 | 44000 | PET amorphous | 38 | 200 | | |
| PAN | 3.5 | 10 | | 42000 | PC (Lexan) | 910 | 5200 | 190 | 91000 |
| PVA | 8300 | 310 | | | Nylon-6 (100% RH) | 25 | 50 | 3.5 | 120 |
| EVOH AT 65% RH (E 32%) | 0.2 | | | 31000 | PB, biaxially oriented | 1100 | 3500 | 520 | 73000 |
| EVOH (E 44%) | 0.3 | | | 11000 | Cellophane (76% RH) | 5.7 | 47 | 4.8 | $1.6x10^7$ |
| PVDC (Saran) | 3.3 | 19 | 60 | 6000 | | | | | |

(Ref: Plastics Packaging – Properties, Processing, Applications, and Regulations by Ruben J. Hernandez/Susan E. M. Selke/John D. Culter; Hanser Gardner publication, 2000)

# Ask The SPEcialist

***Q: What would be a good way to set a specification and inspect resin pellets for FM (colored, transparent resin)? TAPPI charts may work better for molded items, but not with pellets.***

**Thanks, JH**

***A:*** JH, First of all, one should really make an effort to have the resin inspected before it is shipped specially with a LONG supply chain, or better still work with the supplier to eliminate the problem at the source. The second thing to think about is to define the problem caused by FM. This could be a loss in functional properties, processing difficulties, following GMP, or aesthetics. If a spec. and inspection cannot be avoided, one should have a proper maximum specification instead of something vague like "no FM allowed".

We surveyed our board and other SPEcialists in the area, and came up with the following ideas:

- Dissolve specified quantity of resin in appropriate solvent, filter and do image analysis on particulate for size and count.
- Make blown film using a lab type extruder with no breaker plates and screens. Melt some resin between two clean clear glass plates in a vacuum oven. This will give a thin sheet of the polymer that you can see the contaminations exposed from both sides.
- Request the resin supplier to supply a molded or extruded sheet or chip made with the lot they are supplying to us. That sheet or chip can be examined using TAPPI chart. (preferably by the supplier-Ed.)
- Inspect individual pellets and institute a statistical acceptance sampling plan. (The implied spec. then is maximum FM level in pellets- Ed.)
- We've had good luck using the Satake color sorter system. This can be used as an inspection tool or to actually clean up the mixed product. It's the type of technology that is used to sort grain and lima beans, too. Check out their website at www.satake-usa.com
- Use a digital photograph of known amounts of particulate scattered in a monolayer across a white surface. Then, you can analyze the photograph image using standard image analysis software, like Image Pro Plus from Media Cybernetics. Their website is www.mediacy.com

## Vincent Berger, 64, had 'heart of gold'

**By Bill Bregar**
July 16, 2008
PLASTICS NEWS STAFF

WHITE BEAR LAKE, MINN. (July 16, 5:35 p.m. EDT) — Vincent Berger, a 41-year veteran of plastics machinery sales and co-founder of manufacturers´ representative A/B Associates Inc., died July 3 after a five-year battle with bladder cancer. Berger died just one day before his 65th birthday.

"Vin was just hard driving, hard working and had a heart of gold," said his partner at A/B Associates, Jim Anderson. Berger continued to go into A/B nearly every day as he fought the cancer, until about a week before he died. "He insisted on being honest and always doing the right thing, for both the customers and the principals. He was a stickler for details," Anderson said. Berger and Anderson started A/B Associates in White Bear Lake, Minn., in 1991. Berger's son, Vinnie, who works at the sales firm, said his father was a good role model. "He was great to work for, and his knowledge and his experience in the industry are irreplaceable," his son said.

A native of Bridgeport, Conn., Vincent Berger graduated in 1965 with a history degree from St. Bonaventure University, where he was in ROTC. He served in South Korea. Berger started his plastics career in the late 1960s when he took a sales job with Polymer Machinery Inc. of Berlin, Conn., the original importer of Arburg injection presses from Germany. In 1980, he went to HPM Corp. in Mount Gilead, Ohio, to become vice president of sales of the extrusion division. After five years at HPM, he became vice president of sales at Whitlock Inc. in Dearborn, Mich., then moved to parent company AEC Inc.'s headquarters in Wood Dale, Ill. In 1990, Berger went to Rapid Granulator Inc. in Rockford, Ill. He left Rapid to join Anderson and form A/B Associates. He was inducted into the Plastics Pioneers Association in 2002.

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## Upper Midwest Section Board of Directors 2008 - 2009



*Low Volume Production, Continued from page 9*

### Defining low-volume

Low-volume is no longer black or white. It is a growing grey area with the demand for lower volumes and quicker deliveries being critical. In all reality, low-volume needs to be defined by overall quantities and/or the time of which it is being run. I have customers that have run 40,000 parts as a prototype run for field tests and other customers that run 50 to 150 parts every three months. Parts that are only running 5,000 at a time are deemed low-volume. Consider any quantities that can be run in an injection molding press in a single cavity mold under 48 hours should be low-volume. Also, a onetime run of 20,000 parts is also considered low-volume. It may be on the high side of low-volume production, but it still qualifies. Traditionally, low-volume runs would be parts ranging from 20 parts to 1,000 parts. When these are the quantities, DDM and Rapid Tooling are great methods for low-volume production. But, which method should you use? Why should low-volume production be dealt with differently than high-volume production? The answer lies in the suppliers. High-volume injection molding suppliers are not set up for quick sampling or making multiple tooling changes throughout the day. They want long runs that can run unattended. Low-volume runs need supervision at the press, less time to pay for the set-up and smaller batches of specified material. Everything in low-volume production works against how high-volume suppliers make their money.

**I look forward to expanding on low-volume production and its methods in the next two parts.**

*Dan Mishek is the Sales Manager and part owner of Vista Technologies. Dan has been published in Moldmaking Technology, Injection Molding, Manufacturing Engineering, and Time Compression. He has also presented at the RP&M Show ('07) in Chicago and Mold Making Expo ('07-'08) in Chicago and Detroit. Dan Mishek graduated from Mount Mercy College in 1997 with a double major in Marketing and Public Relations. He started at Vista Technologies in 1998. Vista Technologies was founded in 1996. Vista is a full-service Rapid Prototyping, Rapid Tooling and Injection Molding Service Bureau. Today, this privately held company has in-house capabilities of SLA, Polyjet, FDM, High Speed Milling, Mold Making, and Injection Molding.*

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