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SPE® AUTOMOTIVE PLASTICS News

AUTOMOTIVE

DEC 2013
VOLUME 43, ISSUE 2

SPE® Automotive Division Names Winners of 43rd-Annual Automotive Innovation Awards Competition

SPE® AUTOMOTIVE INNOVATION AWARDS COMPETITION & GALA
HONORING THE BEST IN AUTOMOTIVE PLASTICS

43 Years

For the 43rd year in a row, members of the SPE® Automotive Division's board of directors and guests from the global automotive and plastics industries gathered to honor the year's most innovative use of plastics in ground transportation at the SPE Automotive Innovation Awards Gala. Approximately 600 people attended the annual banquet on November 6, 2013, at Burton Manor in Livonia, Michigan, U.S.A. to learn which applications in this year's Automotive Innovation Awards Competition won awards in eight categories, and which category winner was also named the Grand Award winner, the most prestigious honor of the evening.

Winners survived a prequalification round as well as presentations before a panel of industry experts on September 26 and 27. Finalists from that round presented before a Blue Ribbon panel of judges on October 7, where category and Grand Award winners were selected. Details on all of this year's nominations will be found at http://speautomotive.com/awa.htm. Part and event photography can be found at http://www.flickr.com/photos/speautomotive/collections.

SPE's Automotive Innovation Awards Program is the oldest and largest competition of its kind in the world. Dozens of teams made up of OEMs, tier suppliers, and polymer producers submit nominations describing their part, system, or complete vehicle and why it merits the claim as the Year's Most Innovative Use of Plastics. This annual event typically draws over 600-700 OEM engineers, automotive and plastics industry executives, and media. As is customary, funds raised from this event are used to support SPE educational efforts and technical seminars, which help educate and secure the role of plastics in the advancement of the automobile.

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AUTOMOTIVE DIVISION MEETING SCHEDULE & SPECIAL EVENTS CALENDAR

SPE AUTOMOTIVE

Auto. Div. Board Meeting
American Chemistry Council - Auto. Ctr. — 5:30 - 7:30 pm
Troy, MI USA — Dec 9, 2013

SPE ANTEC Conference
Rio All Suites Resort & Casino — ALL DAY
Las Vegas, NV USA — April 28-30, 2014

9th-Annual SPE AutoEPCON Conference
MSU Management Education Center — ALL DAY
Troy, MI USA — May 6, 2014

14th-Annual SPE Automotive Composites Conference & Exhibition (ACCE)
Diamond Center — ALL DAY
Novi, MI USA — Sept. 9-11, 2014

16th-Annual TPO Automotive Engineered Polyolefins Conference
Troy Marriott — ALL DAY
Troy, MI USA — Oct. 5-8, 2014

Automotive Division Board of Directors meetings are open to all SPE members. All events are listed on our website at http: speautomotive.com/ec
EMail Yvonne Bankowski Merritt at auto-div-chair@speautomotive.com for more information.

TREASURER'S REPORT

Jackie Rehkopf

As we approach the end of 2013, the finances for the SPE Automotive Division remain healthy. As of November 24, 2013 we have $88,300.26 in checking, $27,400 in savings, and $46,259.40 in PayPal (with an additional $25,000 pending), giving a total balance of $186,959.66. As of November 24, 2013, all bills received by the Treasurer have been paid.

CHAIR'S MESSAGE

by Yvonne (Bankowski) Merritt
SPE Automotive Division Chair

The fall months are the busiest time of year for the SPE Automotive Division. I would like to start out by thanking everyone involved in this year's SPE Automotive Innovations Award Competition & Gala. As always, it was a tremendous success andenjoyed by all who attended. This year we had 50 surviving nominations and almost 600 attendees. None of this would have been possible without the hard work from our Awards committee led by Jeff Helms and comprised of many of our board members as well as other volunteers. I would like to individually thank the following people who contributed in making this a successful evening:

- Jeff Helms — Event Chair
- Mark Lapain and Teri Chouinard — Sponsorship
- Peggy Malnati — Communications
- Kevin Pageau — Nomination Wrangler
- Brian Grosser — Vehicle Wrangler
- Monica Prokopyshen— Blue Ribbon Judging, Chassis/Hardware Captain
- Tom Pickett — Body Exterior Captain
- Jake Welland — Powertrain Captain
- Norm Kakarala — Materials Captain
- Suzanne Cole — Safety Captain
- Nippani Rao, Dave Reed, and Conrad Zumhagen — Hall of Fame/Lifetime Achievement Captains
- Vince Holmes — Electrical Systems Captain
- Steve Van Loozen — Process/Assembly/Enabling Technologies Captain

I would also like to thank Elizabeth Johnston and Jim Keeler, who organized our student ushers, and the student volunteers from Ferris State University and Kettering University and their professors who came a great distance to help with the evening. I have to salute these students, who really took their responsibilities very seriously. Even when I told them I was the chair of this organization, they still wouldn't let me bring a guest into the VIP reception without a proper badge!

This past September, the Automotive Division also co-hosted the SPE Automotive Composites Conference and Exhibition (ACCE), which was the largest one to date with over 900 registered guests. Thank you to all who contributed to its success.

Thanks also go to Teri Chouinard for organizing a social event the week after the SPE ACCE at the Buick Gallery in the Sloan Museum in Flint. Our members were joined by students from Kettering University and we toured the *"Corvettes from 0 to 60"* exhibit. This was a wonderful opportunity for the students to network with working professionals in the automotive plastics field. Thanks go to Dave Reed for a presentation on his career in plastics. It gave the students a real-world view of what they might be doing in their future careers.

Next spring brings two conference events that our division is involved with: 1) SPE Annual Technical Conference (ANTEC) in Las Vegas, Nevada, USA, April 28-30, 2014 where we host a technical session on automotive plastics that is organized by Anthony Gasbarro; and 2) SPE Automotive Engineering Plastics Conference (AutoEPCON), a one-day technical conference and exhibition on May 6, 2014 at the MSU Management Education Center in Troy, Michigan, USA that highlights the latest advances in automotive engineering plastics, design, and processing. AutoEPCON is jointly organized with members of the SPE Detroit Section.

I would like to wish everyone happy holidays and a healthy, prosperous New Year. I look forward to 2014 and seeing you at our conferences and events.

Yvonne Bankowski Merritt

Chair, SPE Automotive Division
Ford Motor Company

2013 SPE AUTOMOTIVE DIVISION
GRAND AWARD & CATEGORY WINNER: BODY EXTERIOR

ALL-OLEFINIC LIFTGATE
2014 Nissan Motor Co. Nissan* Rogue* cross-over utility vehicle (CUV)

OEM MAKE & MODEL:	2014 Nissan Motor Co. Nissan* Rogue* cross-over utility vehicle (CUV)
TIER SUPPLIER/PROCESSOR:	Hitachi Chemical / Magna-Decostar
MATERIAL SUPPLIER / TOOLMAKER:	LyondellBasell & Advanced Composites, Inc. / Kyowa Industrial Co., Ltd.
MATERIAL / PROCESS:	Hifax* TYC 1175P thermoplastic polyolefin (TPO, outer panel) & Mostran* L5091-P long-fiber thermoplastic polypropylene (LFT-PP, inner panel) / Injection molding

This liftgate is unique in that all materials are fully olefinic (hence, fully recyclable at end of vehicle life) and it features North America's first TPO outer panel. The full assembly sports unique styling and is 30% lighter than comparable stamped steel systems, improving fuel efficiency by 10%. Lower weight also reduces carbon dioxide (CO2) emissions and facilitates customer opening/closing of the lighter liftgate. Thanks to parts integration, low scrap, and reuse of offal possible with injection-molded thermoplastics, raw-material costs on the outer panel were reduced 35% vs sheet-molding compound (SMC). Use of a high-flow, high-stiffness, high-impact TPO formulation reduced molding cycles vs. SMC and traditional TPO compounds for the painted Class A outer panel. Use of molded-in-color (MIC) LFT-PP met mechanical requirements and eliminated paint on the Class A inner panel, reducing VOC emissions. Both panels were joined via a structural adhesive for which they were formulated to have an affinity.

CATEGORY WINNER: BODY INTERIOR

THINWALL INSTRUMENT PANEL RETAINER

OEM MAKE & MODEL:	2014 Chrysler Group LLC Jeep* Cherokee*sport-utility vehicle (SUV)
TIER SUPPLIER/PROCESSOR:	Intertec Systems
MATERIAL SUPPLIER / TOOLMAKER:	SABIC / Windsor Mold Group
MATERIAL / PROCESS:	Stamax* 30YK270 PP / Thinwall injection molding

This application represents North America's first instrument-panel (IP) retainer molded at 2.0-mm walls in LFT-PP composite. Typical wallstock on conventional injection-molded olefin resin is 2.5-4.0 mm, meaning parts are heavier and have longer molding cycles. The 30% glass-reinforced (GR) LFT-PP resin provides required stiffness, strength, and impact performance to meet interior safety requirements at a great value. Thinwall molding helped reduce cycle times 30%, part weight 27%, and costs $3 USD/vehicle, contributing to better vehicle weight, fuel efficiency, and U.S. Corporate Average Fuel Economy (CAFE) targets. It also helped reduce plastics consumption by 2.5-million lb over the life of the program. Advanced fiber-orientation modeling was used to reduce warpage during mold design.

CATEGORY WINNER: CHASSIS / HARDWARE

BUMPER ENERGY ABSORBER

OEM MAKE & MODEL:	2013 Ford Motor Co. Ford* Fusion* & Mondeo* sedans
TIER SUPPLIER/PROCESSOR:	Magna Exteriors & Interiors.
MATERIAL SUPPLIER / TOOLMAKER:	SABIC / not stated
MATERIAL / PROCESS:	MTM Prepreg 57 Series epoxy/ carbon fiber prepreg / Vacuum-bag/autoclave cure

This single-piece CFRP composite construction with exposed fabric weave provides a lightweight, functional component that increases downforce at high speeds while providing an aesthetically pleasing appearance. The air extractor makes extensive use of adhesive bonding to join additional components in alternative materials (a polyamide vent screen and a thermoplastic polyester deflector). Adhesive bonding also isolates the carbon composite panel from the rest of the aluminum hood, preventing galvanic corrosion.

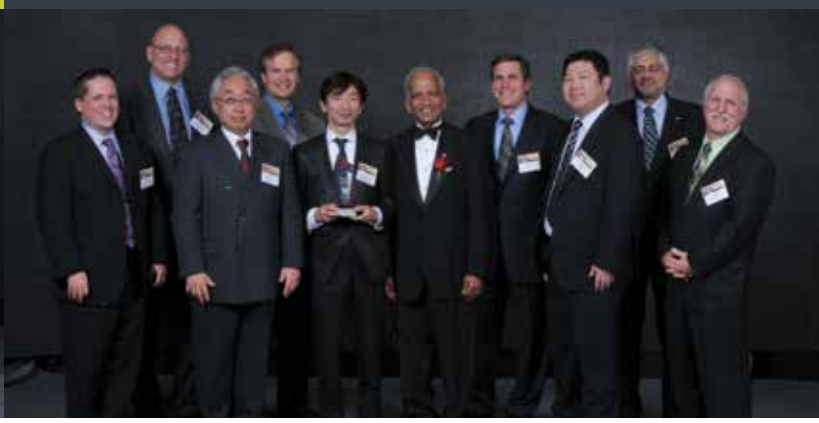
CATEGORY WINNER: **ELECTRICAL SYSTEMS** (NEW CATEGORY FOR 2013)

ELECTRIC VEHICLE-BATTERY ENCLOSURE

OEM MAKE & MODEL:	2014 General Motors Co. Chevrolet* Spark* electric vehicle (EV)
TIER SUPPLIER/PROCESSOR:	A123 Systems, LLC / Continental Structural Plastics
MATERIAL SUPPLIER / TOOLMAKER:	Cytec Industries Inc. / Century Tool & Gage
MATERIAL / PROCESS:	Vinyl ester / Compression molding

This composite EV battery enclosure was required to meet a number of severe performance requirements, including 30o offset-barrier, side-impact, and rear-barrier crash; 50 G impulse shock (X, Y, Z); post-crash package integrity; fire-resistance testing; 3-m drop testing (bottom/end); 1-m water-submersion test; and vibration/shock testing. To satisfy all criteria, new material, production process, post-mold finishing, and non-destructive test methods were needed. The result is industry's first application of a volatile-organic compound (VOC)-free thermoset vinyl ester resin reinforced with a coarse basket-weave glass rove cloth to form a complex-shaped enclosure that protects the EV's battery components in the event of a catastrophic event. The tough compression-molded composite is 40% lighter than metallic solutions, helping the vehicle achieve extended range and enhanced performance. Since it is non-conductive, it protects occupants and first responders to an accident scene. Specially formulated resin is free of styrene emissions, making it safer for workers and the environment. Selective pattern layups allow for localized reinforcement. The application also features a large structural joint of composite to steel.

CATEGORY WINNER: **CHASSIS / HARDWARE**



INSTRUMENT PANEL WITH INJECTION-MOLDED SKIN

OEM MAKE & MODEL:	2013 Nissan Motor Co. Nissan* Sentra* compact car
TIER SUPPLIER/PROCESSOR:	Calsonic Kansei Corp.
MATERIAL SUPPLIER / TOOLMAKER:	Asahi Kasei Chemicals / Calsonic Kansei Corp.
MATERIAL / PROCESS:	Sunvieo* A7171 thermoplastic vulcanizate (TPV) / Injection molding

This is the world's first instrument panel featuring an injection-molded thinwall skin in ultrahigh-flow TPV. With a melt-flow rate of 250 g/10 min and excellent mechanical properties, this specially formulated material made it possible to mold a 1-mm skin that could accommodate the IP's deep draws and uneven undercuts without tearing, thereby providing new levels of design and styling options. The TPV also provides superior visual appeal, distinctive elongation, and softer touch desired by consumers without compromising proper airbag deployment and function. Compared with polyvinyl chloride (PVC) slush molding, it offers good long-term appearance and gloss levels. Molded in a 60-sec cycle, the new skin material is 25% lighter and 10% less costly than PVC slush molding and also reduced tooling costs, plus scrap is reusable. Additionally, there also was a 58% CO_2 savings vs. PVC slush molding since the process is less energy intensive. The skin's good mold-release characteristics help minimize the need for mold-release spray, reducing volatiles further.

CATEGORY WINNER: POWERTRAIN

TURBOCHARGED AIR DUCT

OEM MAKE & MODEL:	2011 Audi AG Audi A4* & A5* sedans with 2.0L TDI & TFSI engines
TIER SUPPLIER/PROCESSOR:	Röchling Automotive
MATERIAL SUPPLIER / TOOLMAKER:	ZEON Corp. / Röchling Automotive
MATERIAL / PROCESS:	Polyamide (PA, also called nylon) 6 + alkyl acrylate copolymer (ACM, also called acrylic rubber) / Suction blow molding

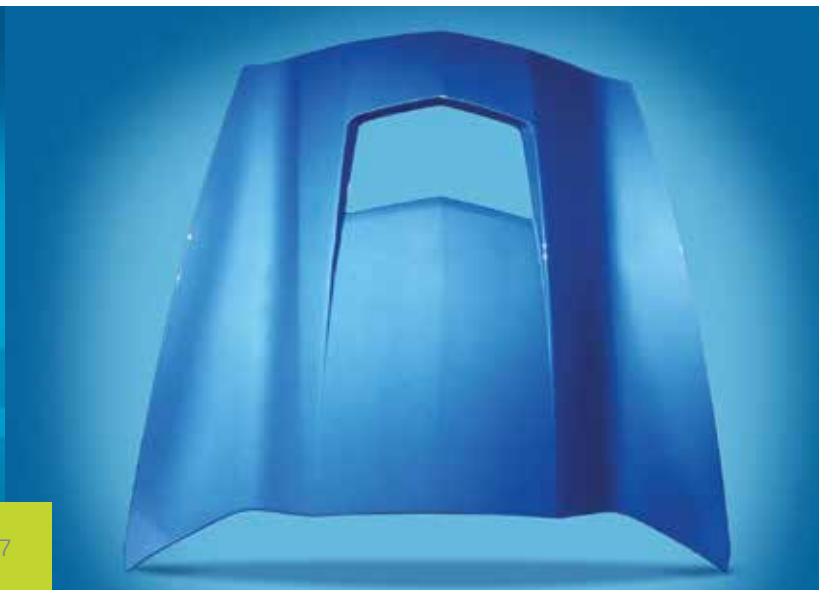
This application combines the air-intake duct with charge air cooler and integrates both into the intake manifold, reducing air-intake loop volume by up to 50% (for better engine response) while also lowering package space 40% and part count, weight, and costs by 20%. The resulting system reduces pressure losses so turbine work is reduced while keeping the same boost pressure at air-intake valves and helping reduce pumping work in the turbocharger 10% at high engine loads. Novel production technology (suction blow molding) and a new high-performance soft TPV (PA 6 + ACM), which can withstand 2.7 bars of overpressure at 125C were used. There was no need to design in bellows on this part, since the material was able to decouple engine movements from the intercooler by itself, and no internal protection layer was needed to shield the material from exposure to acidic blow-by fluids. Unlike conventional rubber, the part is fully recyclable at end of life. This led to 50% direct and 50% indirect cost savings. Thanks to acoustic improvements, interior cabin noise also is reduced for occupants.

CATEGORY WINNER: PROCESS / ASSEMBLY / ENABLING TECHNOLOGIES

PRESSURE PRESS TECHNOLOGY

OEM MAKE & MODEL:	2014 General Motors Co. Corvette* Stingray* sports car
TIER SUPPLIER/PROCESSOR:	Globe Machine Manufacturing Co. / Plasan Carbon Composites
MATERIAL SUPPLIER / TOOLMAKER:	Toray North America / Weber Manufacturing Technologies
MATERIAL / PROCESS:	Epoxy carbon fiber prepreg / New out-of-autoclave molding process

This is the first production use of a new rapid out-of-autoclave production process for carbon fiber-reinforced composites. It produces parts with equivalent mechanical properties and better aesthetics far faster than the traditional autoclave (in 17 vs. 150 min). This significantly reduces costs and makes carbon composites practical and affordable for the first time for medium-volume automotive production. Key to this significant technology breakthrough was R&D characterization of the autoclave cure cycle and resin cure kinetics, which led to several patent filings, a 66% reduction in cycle time, a 30% reduction in direct part costs, and a 75% reduction in the cost of process consumables. Additionally, the specially designed process and equipment prevents the traditional exothermic cure reaction, eliminating the need for nitrogen blanketing and release of volatiles. Nickel-vapor-deposition (NVD) tooling with embedded hot-oil heating/cooling lines moves heat quickly through the Z-axis for rapid curing. A reusable silicone rubber canopy (good for 400-500 parts) reduces the cost and hassle of traditional disposable bagging. Parts exit the tool with more consistent surfaces, reducing finishing operations by 35%.



CATEGORY WINNER: SAFETY

SIDE AIRBAG COVER

OEM MAKE & MODEL:	2013 Ford Motor Co. Ford* Fusion* mid-size sedan
TIER SUPPLIER/PROCESSOR:	Autoliv Inc. / Atlantic Precision Products
MATERIAL SUPPLIER / TOOLMAKER:	Mitsubishi / Great Lakes Mold & Engineering
MATERIAL / PROCESS:	TT914 CNP TPO / Injection molding

Replacing a conventional metal can and plastic cover, this is the first time that an insert-molded bracket/cover assembly has been designed to be both the mounting surface for the seat side airbag (SAB) as well as integral to the performance and cosmetic function of the cover. This unique design answered the challenge of meeting styling studio requests for a thin seat appearance, but providing packaging space for increasingly large side airbags, which now typically protect occupants from chest to pelvis. The insert-molded cantilevered metal bracket allows for efficient assembly at the airbag supplier, reducing part counts typically required for a Class A side airbag module and saving 300 g of weight. Extensive filling and tooling development was used to ensure proper bracket encapsulation by the tough TPO resin, which maintains a Class A appearance during normal usage, but delivers proper airbag deployment in a side impact event. The design also virtually eliminates craftsmanship fit concerns that can be an issue with conventional "can & cover" SAB designs.

CATEGORY WINNER: HALL OF FAME

INTEGRATED FRONT-END MODULE SYSTEM

OEM MAKE & MODEL:	1996 Ford Motor Co. Ford* Taurus* & Lincoln* Sable* sedans
TIER SUPPLIER/PROCESSOR:	Toledo Mold & Die / Budd Plastics Division.
MATERIAL SUPPLIER / TOOLMAKER:	Budd Plastics Division
MATERIAL / PROCESS:	SMC / Compression molding

Compression-molded SMC was used on the first North American implementation of integrated front-end module (FEM) systems for cost, weight, and functional performance. Switching from metals allowed for significant parts consolidation, eliminating 22 major subcomponents and 27 fasteners/vehicle plus related design drawings/CAE models, stamping tools, gauges, fixtures, plus purchasing and logistical tasks. The single-piece 'ready-to-install' structural carrier with self-locating fasteners improved assembly operations, provided an 'open architecture' for powertrain installation, eliminated 9 line locations and 15 work-cell locations, reduced weight 22% and costs 14%, while boosting quality (R/1000) 22% vs. previous designs. Additional benefits included improved serviceability and documented reductions in collision insurance costs while meeting all safety requirements.

9TH-ANNUAL

AUTO EPCON

CALL FOR TECHNICAL PRESENTATIONS

MAY 6, 2014

MSU Management Education Center Troy, MI, USA

DEADLINE FOR 50-WORD ABSTRACT: March 1, 2014

DEADLINE FOR PRESENTATIONS: April 8, 2014 No Paper Required

PROGRAM SCOPE The Automotive Division and Detroit Section of the Society of Plastics Engineers (SPE®) invite you to attend a 1-day technical conference & exhibition showcasing innovative developments in the Design, Materials, Processing, & Use of Engineering Plastics for the Global Automotive Industry.

WHO SHOULD ATTEND This conference is specifically designed to inform, update and educate the OEM & supplier communities about advances in both thermoset & thermoplastic engineering polymers. Learn how these widely used materials can help improve performance & productivity, while reducing cost and mass.

PRESENTATIONS Hear technical presentations on the newest advances in engineering materials related to: Design Engineering; Materials Development; Lighting; Thermal Management; Processing & Enabling Technologies; Predictive Engineering; New Applications & More.

EXHIBITS See Exhibits from Engineering Plastics Suppliers, Molders, Compounders, Additives & Reinforcement Suppliers, Design & Engineering Firms, & Machinery Suppliers. Experts will show you how to apply the latest technologies to your next project or program.

CONFERENCE INCLUDES Full Day of Technical Presentations, Plenary & Keynote Presentations on Automotive Business Trends, Lunch & Coffee Breaks, Exhibits of Advanced Technologies and Evening Reception.

Visit www.speautomotive.com/emc.htm, or contact us at karen@spedetroit.com.

Karen Rhodes-Parker, SPE Detroit Section (Ph: +1.248.244.8993 ext. 3)

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How can We Place Higher in the Innovation Awards?

by Rhoda Miel, Reporter, Plastics News

Rhoda Miel has covered the auto industry for Plastics News since January 2000. She also writes about mold making, industrial design, office furniture and housewares.

"Let me ask you something," a resin company representative said to me during the reception prior to this year's SPE Automotive Innovation Awards Gala. "We've had parts that make it to the finalists' list, but what can we do to move higher?"

The answer, I warned him, is not simple.

Obviously, the best place to start in getting a top award in the annual SPE parts competition begins with having an innovative part. However, every year I see plenty of innovation out there in plants and on cars that are never submitted.

Before this year's K2013, I swung by the automotive awards for SPE Central Europe. I asked an engineer from one company why the part he'd worked on – which was a finalist in its division there – hadn't been nominated for the Automotive Innovation Awards Competition here.

He said that he didn't think their part would qualify, since it had just gone into production in Europe.

But this year's finalists covered global production, from North America, South America, Europe, Asia and – for the first time – even a Turkish truck part. There have been winners for parts never in production in the U.S.

That's one of the interesting things about the Automotive Innovation Awards Competition: the wide range of parts, processes, and regions represented among the finalists each year.

The Blue Ribbon panel doing the judging is another.

Unlike other awards I've seen, finalists for the automotive prize must prove their worth not just to a panel of their peers, but to a wide-ranging panel made up of engineers, educators, and members of the media (like me) who have never run a press or designed a part, but talk to a lot of people who have.

Don't be surprised if one of the veteran industry professionals on the judging panel asks you to compare it to a part that was produced 20 or 25 years ago. There is some vast institutional knowledge represented in that group, as well as those of us trying to wrap our heads around the intricacies of in-line compounding.

No one specific point of view wins out over the course of all the awards. I've never batted a thousand on picking the winners in every category, but I can always see the value in those parts that do win.

I've been part of that Blue Ribbon judging panel for more than 10 years, and have seen winning parts that became standard operating practice in the auto industry. I've also seen promising breakthroughs that never quite fulfilled that promise.

In a grueling 2-day judging event, SPE Automotive Div. board members and invited guests from industry sort through the entries every year to narrow down the list of submitted parts to a group of finalists that will present to the Blue Ribbon judges. That judging takes place over the course of a day, with representatives brought in to present their case for parts in each category (which this year included Body Exterior, Body Interior, Chassis/Hardware, Electrical Systems, Materials, Process/Assembly/Enabling Technologies, Powertrain, and Safety). The Blue Ribbon panel picks one winner for each category, and then chooses the event's Grand Award winner from category winners.

And anyone who has been a part of the judging knows that the judging falls under a very strict time limit. You've got five minutes to present your part, followed by two minutes of Q&A.

Batter's Box CONTINUED FROM PAGE 11

Go over your allotted time and the time keeper will let you know, first with written cards telling you it's time to stop, then announcing that time is up, thank you very much, so please collect your parts and you can answer that one last question on your way out the door.

Which brings up the first tip about the judging process – practice. When you see 25 to 30 presentations over the course of one day, you know which presenters have rehearsed and which haven't.

Know your key points, hit them, and move on. You can always go back with more details during Q&A, or note that there is more information in the packet that is handed out to each judge. More than once, I've seen presentations that hit the first two bullet points out of five, and have to rush over the final three in the closing moments. And unfortunately sometimes the best info in there is one of those final three points, which is then lost in the shuffle.

Tip two: Bring samples, if you can. If you're going to tell us about how much lighter your part is than something else – and it's small enough to carry or pass around – then bring a "before" and "after" sample. It's one thing to read about something being 25% lighter; it's another thing to hold both parts in your hands and know it for certain.

Show us a video if it's about processing. As I mentioned, some of the judges are not engineers. Seeing something like the process of inserting fuel system components into the fuel tank by opening the mold during production is a lot easier to understand when you see it (and probably takes less time too).

Tip three: Make sure your presentation works well and that it's compatible with the system being used during judging. Check which way the event host prefers to get its files (email in advance? Flash drive?) and use that. Have a backup if you can. Make sure you've got enough printed copies of the presentation to hand out to everyone. No one wants to be the company that holds up the judging process because you have to reformat your presentation.

Obviously, technical issues beyond your control happen. This year's judging, for instance, included a power outage that set everyone back for 20 minutes.

Tip four: Remember those comments earlier on the diversity of people on the panel? Please keep that in mind. The automotive and the plastics world may be overwhelming male, but there are women out there as well — both in the industry and on the panel. It's kind of frustrating as one of a half-dozen women in the room to hear the presentation start by thanking the "gentlemen" on the jury — especially when you're hearing it three or four times in a row.

Those may all seem like minor points in a very long process, but decisions on each category are made very quickly. A strong presentation can carry a lot of weight – much as an attorney wants to have a strong closing argument in a court case because it's the last thing a jury will hear.

And if all that sounds like advice you may never need for a competition you may never personally take part in, just remember – it's not that different from a pitch to a potential customer, is it? If you're at a trade show, and a customer comes by your booth, you want to make a quick and lasting impression. If you're invited to a technology day at an OEM, you want to be sure you're prepared for those few moments when a purchasing exec stops by. It never hurts to get some extra practice on the SPE judges.

Besides, think how happy your OEM customer will be to get a nice prize to take home at next year's SPE Automotive Innovation Awards Gala as a result of your work.

An Engineer's Life...

by Elizabeth Johnston Tengler

Elizabeth with sons, Douglas (left) and Michael (right).

It's not easy being green

Like most engineers, I have always been drawn to the STEM (science/technology/engineering/math) topics in more ways than one.

By the time I had reached my senior year of high school, four out of my seven classes were the bookends of the acronym (i.e. science and math). For many years, most of my teachers and counselors had told me that I should be an engineer for my career. Looking back, I don't understand why no one ever said that I should be a doctor, but engineering got lodged in my head and here I am.

I was fortunate to attend The University of Michigan's Society of Women Engineering's (SWE's) Summer Engineering Exploration Camp after my junior year in high school, which really helped me to see all the different fields of engineering that might be open to me. During that week, I realized that I was really interested in the field of ergonomics. What a great way to combine my love of math and science with my love of helping people! Six years later, I emerged from U of M with my undergraduate degree in Industrial and Operations Engineering (IOE) and Master's degrees in both IOE and Industrial Hygiene. The latter degree was my assumption that I'd be working with a plant, but little did I know I'd be working with plants (plural!) — as in the green ones that grow in the ground.

In the Indigo Girls song *Love's Recovery*, the lyric goes "There I am in younger days, star gazing, painting picture-perfect maps of how my life ... would be..." (http://www.azlyrics.com/lyrics/indigogirls/lovesrecovery.html). Sure enough, my destiny had a different path and I never actually had a job in a factory. After graduation, I started work at Ford Motor Co., where my initial jobs were designing and releasing interior plastic parts. My first assignment was working on the instrument panel for the last 18-wheeler long-haul truck that Ford made. As a 5 foot 4 inch tall female engineer, my part was wider than I was tall! I always looked funny when I had to carry this part through the hallways at work. My favorite part of this work rotation was the day I spent driving an 18-wheeler on the Dearborn Test Track. In order to bring it to a stop, I literally had to stand up on the pedals. To this day, this is still one of my favorite memories at Ford.

After a few years of being a design & release (D&R) engineer, I transferred into the Ergonomics Department. I designed vehicles so they would be easy for customers to use. My areas of responsibility covered everything from making sure that the various red shades used in instrumentation were visible to color-blind people to assuring that there was enough room between the door panel and seat cushions for customers to use the seat controls. Anything that the customers could interact with

An Engineer's Life CONTINUED FROM PAGE 14

was part of my job, such as finding the oil dipstick underhood, determining the speed on the speedometer, making sure that the radio display was high enough up on the instrument panel while still being within reach of the driver. This helped me tremendously as an all-around automotive engineer, since I learned so many areas of the vehicle. I really enjoyed this part of my career and had the opportunity to work on many different vehicles — everything from the *Econoline** van to the *Fiesta** supermini. I even participated in a few media launches where engineers, managers, and marketing experts from Ford met with various media personnel to discuss our new vehicles. I either gave quotes to beat reporters or was interviewed by television journalists in New York City, Toronto and Sedona, Arizona as well as Dearborn, Michigan.

After many years as an Ergonomic Engineer, I approached my bosses about a new opportunity. In my personal life, I had become very interested in "being green." I tried to purchase products for my family and my household that were more environmentally friendly — from food to household cleaners. We talked about starting a new position for me dealing with green materials. Since that time, I have worked on getting more "green" materials into our vehicles — both recycled materials and bio-materials. For example, I helped get a number of recycled and bio materials qualified for use in vehicle interiors, including Class A surfaces, and I helped get a coconut fiber-reinforced loadfloor spec'd for the *Focus** battery-electric vehicle, and there's more to come. I now work with Ford colleagues all over the world on determining how best to implement these new materials while still meeting our tough automotive material standards. Now I get to work from the product development point of view: seeing research materials move from their infancy stages and eventually blossom into production implementation. The STEM interest inside of me has grown into a vast world of "green" products.

I also have been able to take part in a great program at Ford: I work part-time, so I get to spend time at work, but also extra time with my children. Ten-and-a-half years ago, my oldest son was born and I have been working part-time ever since. I have still been able to complete all of my work, while getting the bonus of spending extra time with my boys. I even get to run a lunchtime science-enrichment class during the lunch hour at my sons' school, where I hope to influence the engineers of tomorrow.

I definitely seem to be one of those "lifers" at Ford who are becoming more rare these days. Ford has been a great place for me because the company has allowed me to drastically change my career several times plus achieve a super work/life balance.

ABOUT ELIZABETH JOHNSTON TENGLER

Elizabeth Johnston Tengler has spent her entire career with Ford Motor Company. She did a few internships at the automaker while still in school and started working at the company full-time after graduating with her Master's degrees in 1996. She began as a design and release engineer on instrument panels and consoles, then moved into Ford's Ergonomic Department. After her children were born, she became more interested in eco-friendly products and was able to change her career again to accommodate her growing interest in all things "green." Elizabeth holds three degrees — all of them from the University of Michigan. Her bachelor's degree is in Industrial and Operations Engineering with a focus on Ergonomics. Her Master's degrees are in Industrial and Operations Engineering (Ergonomics) and Industrial Hygiene.

ANTEC® 2014

2014 SPE ANTEC's Automotive Program

Anthony Gasbarro, ANTEC 2014 Committee Chair

SPE's Annual Technical Conference (ANTEC) 2014 will be held in Las Vegas, Nevada, U.S.A. from April 28-30 at the RIO All Suites Hotel and Casino.

While we are still in the early stages of organizing for the event, we have found some very exciting and relevant projects that will be presented in the Automotive Program at ANTEC.

We have been growing our Automotive Session over the past few years, and we are continuing that trend this year. In 2013, we had 8 papers presented, and we had hoped to have more than 12 for 2014. To date, we have 13, so thanks to all who've helped make this happen.

We still have 2 positions open for possible keynote presentations. These keynotes give the presenter up to 1 hour to talk about a topic. Last year, long-time plastics author, Don Rosato and myself joined together for a talk on recent advances in the ways plastics are helping to make automobiles lighter. Our collaboration worked well and I believe it played to each speaker's strong points.

ANTEC is a wonderful way to see the work that others are doing in all sorts of areas of plastics, and we would really appreciate it if you could take the time to show the work you are doing. Typically, over 900 presentations are given at ANTEC each year, and each one is important because it advances our industry. I personally feel that the work we do in automotive is worthy of showing to the rest of the plastics world. Whether it be advances in material technology, fasteners, processing, painting, strengthening, or *lightweighting,* we want to hear about it.

Please contact me if you are interested in presenting at ANTEC 2014 or if you have any questions about ANTEC in general. I would be happy to answer any questions you have.

Thank You.

Anthony Gasbarro

Anthony Gasbarro
SPE Automotive Division ANTEC Automotive Program Chair
Marubeni Specialty Chemicals Inc.

Hall of Fame Award

First Integrated Front-End Module Named SPE® Automotive Division Hall of Fame Award Winner

The first North American implementation of integrated front-end module (FEM) system used on 1996 model year (MY) Ford® Taurus® and Mercury® Sable® sedans produced by Ford Motor Co. was selected as the 2013 ***Hall of Fame*** winner by the ***Automotive Division of the Society of Plastics Engineers*** (***SPE®***) for the group's 43rd-annual ***Automotive Innovation Awards Competition***. To be considered for a ***Hall of Fame*** award, an automotive-plastic component must have been in continuous service in some form for at least 15 years and preferably have been widely adopted within the automotive or ground-transportation industries. This application certainly meets those criteria: in continuous use on Ford vehicles for 17 years, as of 2012 it is estimated to have been featured on 5-million Ford Taurus derivative vehicles worldwide and was adapted by other automakers including Volkswagen AG, Audi AG, Daimler AG, PSA Peugeot Citroën, and Chrysler Group LLC.

According to SPE Hall of Fame committee co-chair, Nippani Rao, president, Rao & Associates, "The integrated FEM has proliferated widely because polymer composites allow engineers to mold in features and locators, and to integrate a number of previously separate subsystems and functions into a single component that saves money, reduces weight, and provides for faster, more accurate, and less costly assembly."

FEMs were originally multi-piece stamped steel or aluminum assemblies that gradually evolved into non-integrated (radiator-support frameworks) on low-volume Ford commercial trucks (supplied by General Tire Co.) as well as to similar sub-assemblies on vehicles by Volkswagen in bulk-molding compound (BMC) polypropylene composites — an application deemed by Ford engineers to provide insufficient strength and thermal performance for the Taurus / Sable platform.

The Ford team evaluated numerous materials and process options and settled on compression-molded sheet-molding compound (SMC) for optimized cost, weight, and functional performance on the original program. Over the years, thermoplastic composites have come to dominate the application, changing initially to glass-mat thermoplastic (GMT) composites, and later to injection or compression-molded long-fiber thermoplastic (LFT) composites with steel inserts or to inline compounded (ILC) direct-LFT composites

AUTOMOTIVE

with or without additional continuous strand fiberglass reinforcements. With each generation and technology iteration, more weight and cost have been removed from the module.

"Switching to SMC on the original program allowed us to eliminate significant numbers of parts and their specific design drawings/computer-aided engineering models, stamping tools, gauges, fixtures, plus purchasing and logistical tasks," notes John A. Young, engineer-Product Development at Ford. "Thanks to composites-enabled part integration, we were able to eliminate 22 major sub-components and 27 fasteners per vehicle. We ended up with a single 'ready-to-install' structural carrier with self-locating fasteners that in turn improved assembly operations since it provided an 'open architecture' for powertrain installation, eliminating 9 line locations and 15 work-cell locations. We also reduced weight 22% and costs 14% while boosting quality (R/1000) 22% vs. conventional design and assembly practices at the time. Additional benefits included improved serviceability and documented reductions in collision insurance costs while meeting all safety requirements, making this a win-win all the way around."

Moving away from metallic systems to molded-in-color composites also eliminated volatile-organic compound (VOC) emissions and energy usage associated with priming and painting plus welding metal parts. And thanks to component weight reduction, this application also helped reduce fuel usage and greenhouse gas emissions over the use life of millions of vehicles. This Ford innovation won SPE Automotive Division's 1996 Chassis and Grand Award prizes, and also received recognition from the American Plastics Council and the SMC Automotive Alliance.

The 2013 SPE Automotive Division Hall Of Fame committee was co-chaired by Nippani Rao, Rao & Associates and Dave Reed, retired, General Motors Corp. Committee members include Bonnie Bennyhoff, ExxonMobil Chemical; Terrence Cressy, DuPont Automotive; Fred Deans, Allied Composite Technologies, LLC; John Fialka, Styrolution Group GmbH; Ed Garnham, retired, General Motors Corp.; Anthony Gasbarro, Marubeni America Corp.; Jeffrey Helms, Celanese Corp.; Norm Kakarala, retired, Inteva Products, LLC; James Kolb, retired, American Chemistry Council; Mark Lapain, Magna International Inc.; Gary Lownsdale, Plasan Carbon Composites; Allan Murray, Allied Composite Technologies, LLC; Kevin Pageau, Sonoco; Tom Pickett, General Motors Co.; Irv Poston, retired, General Motors Corp.; Ron Price, Global Composite Solutions; Suresh Shah, SPE; Venkatakrishnan Umamaheswaran, SABIC; Bill Windscheif, Advanced Innovative Solutions, Ltd.; and Conrad Zumhagen, The Zumhagen Co. LLC.

Service through Science

by Adrian Merrington

You can't get there from here may be the punch line to many a logistics joke, but it also accurately describes the career path I have spent my life meandering through.

From as far back as I can remember, I always wanted to be a scientist — well, with the exception of a brief period when I considered a career in law enforcement, but more on that later. I remember reading *Professor Branestawm* books as a very-young child. The Professor was an absent-minded scientist who invented all kinds of strange and wonderful things that even worked on occasion. I remember thinking that that was what I wanted to be, but of course, at that age, I had no concept of what becoming a scientist actually involved.

I received all of my education in England. I grew up in the City of Leeds, a large, northern industrial town filled with friendly people who all have an opinion on everything that they're willing to share (even if you don't ask them). I went to the Leeds Grammar School where I was blessed to be taught chemistry by a wonderfully colorful Irish teacher called Mr. Brown. We made boats out of sodium. We experimented with chlorine gas (a special treat given that Mr. Brown was allergic to chlorine). We would disappear to the range to test projectile fuelants. And we were always free to ask whatever questions we wanted, even if getting answers meant throwing Mr. Brown's work plan for the day out of the window. I think more than anyone else, his influence steered me towards the decision to study chemistry at university.

For some reason that is entirely lost to me now, I had convinced myself that I wanted to be an analytical chemist. There were only five such programs in all of the UK at the time I was looking at colleges. I applied and was accepted to all of them. I ended up studying Applied Chemistry, which had that strong analytical chemistry backbone I thought I wanted, at the University of Greenwich (formerly Thames Polytechnic). The fact that the University of Greenwich was in London played high on my desire to study there as I chose the city rather than the school.

I discovered pretty quickly that I really, *really* disliked analytical chemistry and that there was no way that I wanted to be an analytical chemist when I graduated. When one is accepted to study a course of chemistry at an English university, you study that course at the university selected. The British system at that time was far less flexible than the American system. Because I had been accepted into the Chemistry program, that's where my grant (scholarship) was sent and that was where I was expected to be. What I did have though was the option to take a course that was heavier in the biological sciences or in the materials sciences. I strongly disliked biology (even more than analytical chemistry) so I opted for materials science by default. This choice turned out to be fortuitous. Looking back at it now, if I had known that materials science courses even existed I think that that would have been the subject I would have studied. Still, there was enough materials science in my chemistry course that I stayed interested. Materials science classes consisted of a few classes in metals, but most were in polymers. This was my first introduction to plastics.

Service through Science

CONTINUED FROM PAGE 20

Not feeling like *Forrest Gump* at all, after four years in London playing football, they gave me an honors degree in Applied Chemistry. Some might think sports a distraction from getting an education, but I found the discipline required to compete and still maintain good grades really helped me to focus. Of course, the university sports system in the U.K. is not as *professional* as it is in the U.S. so maybe my experience wouldn't translate to students over here. In addition to spending a lot of time playing (American) football for the college team, I earned money working weekend evenings as a bouncer at a punk night club (and yes, it was as much fun as it sounds). Both of these activities somehow prompted me towards the decision to follow a career into law enforcement. My grandfather had been, and my cousins were in the police and I was quickly accepted into the accelerated program with the prestigious City of London Police Force. I had been measured for my officer's suit, was a week from going back to London to start my career and had every intention of making that my life.

And then I didn't.

I was sitting in my parents' kitchen very late one night reading a section I never read (the *Want Ads*) in a paper I rarely read (my dad's *Yorkshire Evening Post*) and I saw an advertisement from the University of Bradford indicating the school was looking for graduate students with a background in plastics. This, as they say, was a life-changing moment. I had not even considered the possibility of going to graduate school, but thought I'd look into the opportunity. I met with Professor Les Woodcock (who would eventually be my advisor) and Professor Barry Harness (my mentor) and they offered me a full-ride scholarship on the spot.

The thing that differentiated an undergraduate degree in Applied Chemistry from one in Chemistry at the University of Greenwich was the requirement that you spend a year in industry. I'd spent my third year as an undergraduate working for a contact lens manufacturer (CLM) in Redhill. If you've ever flown into Gatwick Airport, Redhill is the next stop north on the way into London's Victoria train station. I got a great deal out of my time at CLM and left with two important pieces of knowledge: 1. I liked working with plastics and 2. if I ever wanted to perform my own research, I needed more than a Bachelor's degree. It was armed with this background information that I accepted the professors' offer.

I entered the Department of Chemical Engineering at the University of Bradford to perform research on the synthesis and rheology of polymer colloids. I was also part of the Chemistry department under Professor Tony Johnson (a second mentor) and part of the Interdisciplinary Research Center (IRC) for Polymers (now Polymer Engineering). This was a phenomenal opportunity for me and I really grasped at everything that was on offer. Professor Woodcock also arranged for me to receive a Unilever Student stipend, so I had some industrial interactions through collaboration with the ever-enthusiastic Dr. Alex Lipps. All three professors and Dr. Lipps were outstanding people whose focus was entirely upon the success of their students and I was truly blessed to work with each of them.

Amongst the many, many benefits in the graduate school program was the availability of travel bursaries (stipends) and I seemed to be the only student interested in taking advantage of them. These bursaries paid for me to attend a conference on *surface forces* in Moscow (imagine trying to explain that to British customs as this was before *glasnost* and *perestroika* after all) and a conference on *multiphase systems* in Portland, Oregon in the U.S. I realized what great opportunities these were. I had already represented Great Britain playing American football against Australia and had been invited to trials for the upcoming European Championship squad. I made the conscious decision to not pursue the sports opportunity and instead took the Oregon trail (pun definitely intended).

It was the enjoyment of this visit to Oregon that later led me to seek an opportunity to perform post-doctoral research in the U.S. after my second graduation. I had a number of offers but chose to move to Midland, Michigan and the Michigan Molecular Institute (MMI) to work with Professor Dale Meier. I chose MMI because the project seemed to be the most interesting amongst those that I was offered. I was a little hesitant over moving to mid-Michigan at first as I had only

Service through Science

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lived in big cities and Midland is a small town. I convinced myself that it wouldn't be *too bad* after looking at a map and, mistaking kilometers for miles, thought Chicago was only a couple of hours away. This turned out to be a happy mistake seeing as I've lived in Midland for 21 years now.

I spent a couple of years continuing to work in the area of colloid rheology when the opportunity arose to work as part of a team funded by a U.S. National Institute of Standards & Technology (NIST) Advanced Technology Program (ATP) on Plastics Recycling. The ATP looked at recycling mixed, post-consumer plastics and my focus was to be on the interfaces and compatibility of multiphase systems. There was a connection to the work I'd been doing before but as much as anything, I decided to move into plastics recycling because I was fed up with seeing the glazed look that appeared on the faces of family and friends when I mentioned the words *colloid rheology* (see, you're doing it too!). As part of the recycling team, I had the opportunity to work with the late Connie Balazs and Lowell Thomas, both of whom had strong industrial backgrounds — something I still felt I needed to develop.

That initial work in recycling helped me gain knowledge in plastics (as opposed to polymers), composites, additives, compounding, processing and, more recently, sustainable materials. I've led or been part of many industry- and government-sponsored programs with these foci (a number of which are highlighted at www.adrianmerrington.com). I've used the knowledge I've garnered as source for chapters for books and encyclopedias, numerous papers, and proprietary reports I've written, and presentations I've given all over the world. I've also had the opportunity to garner industrial experience with spells as research director at American Commodities, Inc. and Resource Recycling of Western Michigan, and now as chief technology officer for Eco Bio Plastics Midland. I've furthered my academic accomplishments as an adjunct professor with Central Michigan University.

Another thing for which I owe the late Connie Balazs thanks is that he insisted I join and be active in the Society of Plastics Engineers. He was on the mid-Michigan board, which I also joined. Since joining, I think I've been active taking every board role except those of treasurer and organizing the golf outing, having neither a taste nor a talent for either. I'm also active, due to my recycling background, in the Plastics Environmental Division acting as technical chair for half a decade now. Working with the SPE has opened many doors for me and has led to developing some life-long friendships. Now that the Mid-Michigan Section has merged with the Detroit Section of SPE, I'm continuing my service as first vice-president of the Detroit Section.

So, if I was to share the most useful things I've learnt along the way, they would be to: take opportunities as they appear; learn from those willing to share; don't be afraid of change; don't be too tied to your own decisions; have lots of fun; and remember to read the want ads every now and again as you never know what opportunity lies there-in.

ABOUT ADRIAN MERRINGTON

Dr. Adrian Merrington is a senior associate scientist and assistant professor at Michigan Molecular Institute (MMI) and chief technical officer for Eco Bio Plastics Midland (EBPM), an MMI partnership with Eco Research Institute (ERI). He is a Chartered Chemist and a Chartered Scientist. He has been with MMI since 1992 when he joined as a visiting scientist and postdoctoral fellow after completion of his Ph.D. in Chemical Engineering at the University of Bradford (England, U.K.). He is heavily involved in the plastics industry and has been a collaborator and principal investigator on a number of programs in the areas of composites, additives, blends, plastics, inorganic fillers, rheology, colloids, and particulates, plastics recycling, and fuel cells. His achievements in these projects have led to publishing 2 book chapters, 39 publications or presentations, numerous proprietary reports, and a listing in *Who's Who in Plastics*.

Scholarship Awards

Winners of SPE® ACCE Scholarships Sponsored by Michigan Economic Development Corp.

Three students have won ***SPE ACCE Scholarship Awards*** sponsored by **Michigan Economic Development Corp.** for the 2013-2014 academic year. Winning students whose composites-intensive projects were judged to have the greatest potential impact on ground transportation were **Thomas Keith (Keith) Honaker-Schroeder** of ***Michigan State University***, **Nicholas (Nick) Smith** of ***Purdue University,*** and **Sarah Stair** of ***Baylor University***. Each student will receive a total scholarship of $2,000 USD — and will return to present the results of his or her research at next year's SPE ACCE show, September 9-11, 2014.

Keith Honaker-Schroeder won the scholarship for a student enrolled in a Michigan institute of higher learning with the topic: *Exfoliated Graphene Nanoplatelet-High Density Polyethylene Nanocomposites and their Use in the Automotive Industry*. Explaining how his work is applicable to ground transportation, Honaker-Schroeder says, "I'll be modifying a high-density polyethylene (HDPE) polymer matrix with a platelet-structured nanoparticle — specifically, exfoliated graphene nanoplatelets (GnP). The resulting HDPE-GnP composites provide enhanced mechanical, electrical, and barrier properties, allowing for use in the manufacture of automotive fuel tank and fuel line systems to reduce vehicle weight."

Currently a second-year doctoral candidate studying Chemical Engineering and working as a research assistant at Michigan State University (East Lansing, Mich.), Honaker-Schroeder's focus is on enhancing the properties of a polymer matrix using graphene nanoplatelets. Originally from Battle Creek, Mich., he graduated *summa cum laude* with a Bachelor's degree in Chemical Engineering last year from Kettering Univertsity (Flint, Mich.), which is known for its innovative co-operative education program. While a Kettering student, Honaker-Schroeder did an internship at Argonne National Laboratory (Lemont, Ill.) where he tested polymer composites for use in bipolar plates for fuel cells, as well as tested materials for use as cathodes for lithium-ion batteries. After graduation, he plans to go into industrial research.

Sponsored by PURE MICHIGAN® Michigan Economic Development Corporation

Nick Smith of Purdue University (West Lafayette, Ind.) won a traditional SPE ACCE Graduate Scholarship for his topic, *Simulation of Compression Molded Composites using a High Volume Fraction of Long Fibers & Prepreg Precursor Material.* About his project, Smith says, "One of the great challenges for short-fiber polymer composites is their large variability in strength. My research is specifically focused on predicting the orientation of fibers within composite components produced by compression molding with pre-impregnated short-fiber prepreg as a precursor. Success in this work will provide tools for design of high-performance parts with fiber aspect ratios over 2000 and fiber weight fractions over 50%. No currently-available simulation tool accurately predicts the final orientation state or the strength variability found in parts made with this process, which is capable of producing parts at a cost and speed appropriate for the automotive industry."

Originally from Moscow, Idaho, Smith is currently an Andrew's Fellow at Purdue and about to obtain his Master's degree in Aerospace & Aeronautical Engineering. He also is a Ph.D. candidate in Aerospace & Aeronautical Engineering at the school. Previously he was a Heritage Scholar at Brigham Young University (Provo, Utah) where he earned a Bachelor's degree in Mechanical Engineering in 2011. Upon graduation, Smith says he hopes to continue researching higher performance, lower cost composites for use in both the automotive and aerospace industries.

Sarah Stair of Baylor University also won a traditional SPE ACCE Graduate Scholarship for her topic, *Non-Destructive Characterization of Ply Orientation and Ply Type of Carbon Fiber Reinforced Laminates.* About her work, Stair says, "Manufacturing laminate-based advanced composites can be difficult, and final parts don't always meet as-designed specs. For example, during molding, a ply might slip and rotate 5 degrees from its designated orientation, which could affect final molded-part properties. My research will determine the "as manufactured" ply orientation of each lamina in a fiber-reinforced part and the failure envelope associated with the final part. My long-term goal is to fully automate this process so any technician who is making a repair on a car or performing quality-control tests at a manufacturing facility can scan a part with the system I'm developing. All of the ply orientation and failure envelope calculations will be performed by the device and results will be displayed for the user."

Stair graduated *magna cum laude* with a Bachelor's degree in Mechanical Engineering and a minor in Mathematics from Baylor last year. She continued working on her Master's degree in Mechanical Engineering at Baylor and currently is in her second year of the program. Her research focuses on non-destructive testing techniques for fiber reinforced laminated composites. Originally from Arlington, Texas, after graduation, she hopes to continue performing materials-related research in the aerospace industry.

Composites Person of the Year

Dr. Michael Connolly

The SPE® Composites Division has named Dr. Michael Connolly, principal scientist and program manager-Urethane Composites Huntsman Polyurethanes as the 2012-2013 recipient of the group's prestigious ***Composites Person of the Year*** award. Connolly is being recognized for his contributions to the SPE Composites Division and the broader composites industry at this year's SPE Automotive Composites Conference & Exhibition during opening ceremonies.

First given in 2004, the ***Composites Person of the Year*** award publicly acknowledges a contributor who has provided significant aid to the SPE Composites Division, particularly during the prior year, as well as made broader contributions to the composites industry as a whole. Nominations are reviewed by the board and one recipient is selected by the current division chair in consultation with the current awards chair. Previous winners of the award include:

- Dan Buckley of American GFM,
- John Muzzy of the Georgia Institute of Technology,
- James Griffing of The Boeing Co.,
- Fred Deans of Allied Composite Technologies LLC,
- Peggy Malnati of Malnati & Associates LLC,
- Dale Grove of US Silica,
- Dale Brosius of Quickstep Composites LLC, and
- Creig Bowland of PPG Industries.

Explaining how Connolly was selected as this year's award recipient, SPE Composites Division immediate past-chair, Dale Brosius – who is president of his own consulting company as well as president of Quickstep Composites LLC – explained, "Michael was selected for the ***Composites Person of the Year*** award for a number of reasons. First, he led the creation of a totally new website for the Composites Division, with significant rebranding and enhanced functionality to tie into social media, including a blog and Twitter® applications. He also led the successful application for the SPE Communications Excellence Award, which our division achieved for 2012-2013. He took on a greatly expanded role as technical program chair of the 2013 SPE ACCE, and was very active in scanning various news outlets across the globe for potential innovations and developments that were worth pursuing for program content, then engaging the program committee to solicit papers. As a result, we have the largest and strongest technical program content of any ACCE conference to date. These efforts required a lot of investment of time on Michael's part. Furthermore, he has achieved Honored Service Member status within SPE — the result of many years of dedicated service to both the Composites and Automotive Divisions of our society. And last, but not least, Michael was selected for the position of chair-elect for the Composites Division, and will become division chair in 2015."

In his current job at Huntsman, Connolly specializes in composite-resin development, materials structure / property / process characterization, test-method development, and customer programs. He has worked for Huntsman for 17 years supporting polyurethane product development in the automotive, consumer, and industrial market segments. He has spent a total of 29 years in materials development including basic research, polymer composites, thermoplastic polyurethanes and engineering thermoplastics, plus acoustic, energy absorbing, and structural foams. Connolly has authored or co-authored 12 papers on polyurethane composites at international conferences since 2005 and holds 2 patents. He holds a Ph.D. degree in Polymer Science & Engineering from the University of Massachusetts in Amherst and a B.S. degree in Polymer Chemistry from the SUNY College of Environmental Science and Forestry. Connolly is a long-time member of the American Chemical Society (since 1982) and SPE (since 1992). He has long been involved in SPE and currently is both chair-elect and communications chair for SPE's Composites Division where he also manages the division website (**http://www.specomposites.org/**). Previously he also served as chair-elect and then chair of the SPE Automotive Division and is a former director of that board. He was one of the original organizers of the SPE Automotive Composites Conference and Exhibition (ACCE), serving as sponsorship chair (2001), event chair (2002), and technical program chair (2003, 2004, and 2013). In addition, Connolly is currently a member of the advisory board for the Fraunhofer Project Centre for Composites Research at Western University and he formerly chaired the American Plastic Council's Automotive Roadmap Technical Committee. He was named an SPE Honored Service Member in 2013.

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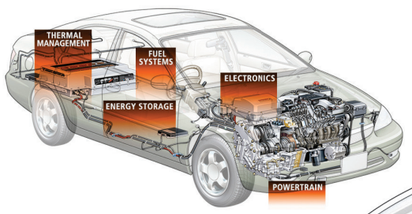

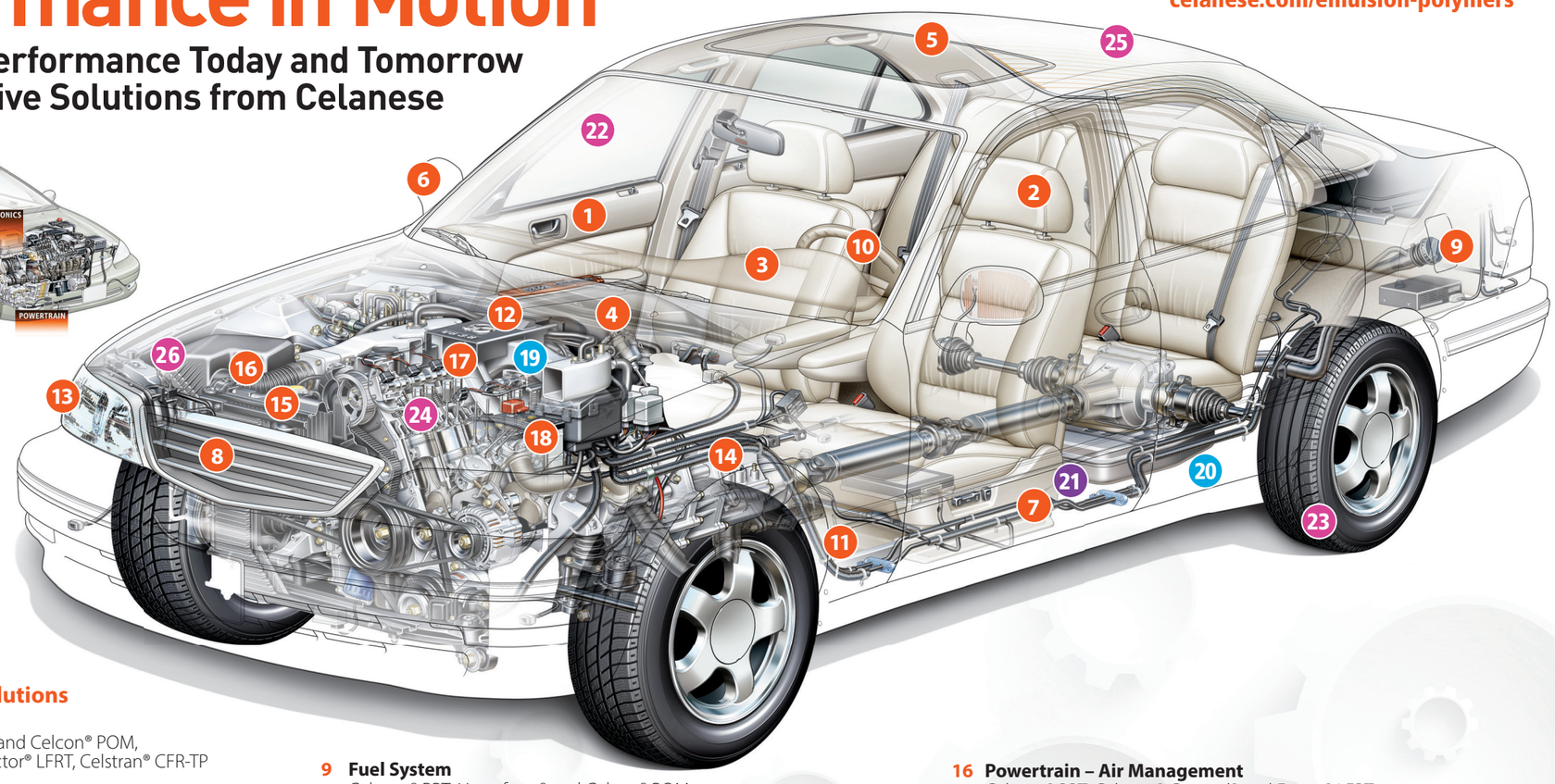

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The 13th-annual SPE Automotive Composites Conference & Exhibition (ACCE), held September 11-13, 2013, broke all kinds of records: most registered attendees, most sponsors and exhibitors, largest technical program, and biggest group of student poster competition participants. This year also heralded a move to a new (to the show) and much larger facility, The Diamond Banquet & Conference Center at the Suburban Collection Showplace. The decision to change venues proved fortuitous as early registration indicated attendance would likely exceed 700. In actual fact, over 900 exhibitors, sponsors, speakers, panel members, students, and attendees registered to attend the 3-day event in Novi, Michigan, U.S.A. — a whopping 42% increase over 2012 registrations of 636. Furthermore, 68 exhibitors and sponsors helped underwrite the increased costs of holding the conference (up from 55 in 2012), and 24 media and association sponsors swapped print ads, and web banners and buttons to promote the conference around the world (up from 22 the year before).

A record-breaking audience attended this year's SPE ACCE, the 13th co-organized by SPE's Automotive and Composites Divisions. Attendance was up 42% from 2012, the previous record holder. The conference also benefited from the support and presence of 68 exhibitors and sponsors. A new venue proved critical to accommodate this year's larger and very engaged crowds.

 CONTINUED FROM PAGE 28

The conference was moved to a much larger facility in Novi, Michigan this year, The Diamond Banquet & Conference Center at the Suburban Collection Showplace.

The 2013 technical program also broke records for the most tracks and most presentations. Last year's conference had 77 30-minute talks scheduled (71 regular presentations plus the event's first tutorial, a 2-½ hour seminar on Thermoset & Thermoplastic Materials), plus two panel discussions, and three keynote speakers. This year, the technical program swelled to 92 30-minute presentation slots (77 regular talks plus 7-½ hours of tutorials on a wide range of composites-related topics), one panel discussion, and six keynotes. To fit the larger program into the conference's 2-½ day schedule, conference organizers needed to add a fourth parallel technical track (for the first time ever) during the first day-and-a-half to accommodate the much larger tutorials offering.

Keynote and panel discussion topics this year were quite interesting and diverse. Greg Rucks, senior consultant for the Rocky Mountain Institute (RMI) gave a talk after lunch on the first day on the topic of *The Autocomposites Commercialization Launchpad: Kickstarting Mainstream Adoption of Automotive CF Composites.* Later that afternoon, Mario Greco, director-Ground Transportation Market Sector Team, Growth & Market Strategy at Alcoa, Inc. gave a talk on *The Multimaterial Reality*, then participated in a lively panel discussion on *Aluminum & Composites — Compete or Collaborate?* SPE ACCE co-chair, Antony Dodworth, managing director-Dodworth Design moderated the panel, which included Doug Richman, vice-president-Engineering & Technology, Kaiser Aluminum; Jim deVries, global manager of Materials & Manufacturing, Ford Motor Co.; Jai Venkatesan, director-Materials Science & Engineering, The Dow Chemical Co.; Jay Baron, president & CEO, Center for Automotive Research (CAR); and Jan-Anders Månson, professor and director-Polymer and Composite Laboratory, École Polytechnique Fédérale de Lausanne. The day ended with a networking reception sponsored by Momentive Specialty Chemicals Inc. After lunch on day 2, Dow's Venkatesan returned with a keynote on *Industrialization of Carbon Fiber Composites – Lessons Learned, Investment Priorities for the Future.* Later in the day, two back-to-back keynotes were given by Elias Shakour, research scientist-Manufacturing, Engineering & Technology, at the Center for Automotive Research on *Creating Value through Collaboration.* His talk was followed by Ray Boeman, program director-Energy Partnership at Oak Ridge National Laboratory, who spoke on *The National Advanced Composites Manufacturing Institute – A Consortium Approach to Automotive Composites.* Day 2 ended with a networking reception sponsored by Autodesk Inc. Day 3 of the conference ended with a keynote by Howard Coopmans, senior manager-Body Engineering, SRT Viper, at Chrysler Group LLC on *Composite Technology Developments on the SRT Viper.*

Keynote speaker #1, Greg Rucks senior consultant for the Rocky Mountain Institute (RMI) spoke on the topic of The Autocomposites Commercialization Launchpad: Kickstarting Mainstream Adoption of Automotive CF Composites.

Keynote speaker #2, Mario Greco (left), director-Ground Transportation Market Sector Team, Growth & Market Strategy at Alcoa, Inc. gave a keynote on The Multimaterial Reality. Antony Dodworth (right), SPE ACCE co-chair and managing director, Dodworth Design is thanking Greco after his talk.

Keynote speaker #5, Ray Boeman, program director-Energy Partnership at Oak Ridge National Laboratory, gave a keynote on The National Advanced Composites Manufacturing Institute – A Consortium Approach to Automotive Composites.

Keynote speaker #3, Jai Venkatesan (left), director-Materials Science & Engineering, The Dow Chemical Co. gave a keynote on Industrialization of Carbon Fiber Composites – Lessons Learned, Investment Priorities for the Future. He is being thanked by Dale Brosius of the SPE ACCE organizing committee and Quickstep Technologies.

Keynote speaker #6, Howard Coopmans, senior manager-Body Engineering, SRT Viper, at Chrysler Group LLC gave a keynote on Composite Technology Developments on the SRT Viper.

Keynote speaker #4, Elias Shakour, research scientist-Manufacturing, Engineering & Technology, at the Center for Automotive Research spoke on Creating Value through Collaboration.

A lively panel discussion on Aluminum & Composites — Compete or Collaborate? drew a large audience at the show. From left to right, participants included Mario Greco, Alcoa, Inc.; Doug Richman, Kaiser Aluminum; Jim deVries, Ford Motor Co.; moderator, Antony Dodworth; Jay Baron, Center for Automotive Research; Jai Venkatesan, The Dow Chemical Co.; and Jan-Anders Månson, École Polytechnique Fédérale de Lausanne.

ACCE CONTINUED FROM PAGE 30

The event's second composites parts competition got underway with roughly twice the nominations as last year's contest. Since judges had said it was too hard to choose a single part for recognition in 2012 owing to the diversity of entries and technologies involved, this year's competition was expanded to include both *Body Interior* and *Body Exterior* awards, plus a new *People's Choice* award for the most popular part in the competition voted on by conference attendees. Interestingly, tier one, Plasan Carbon Composites made a complete sweep of the contest this year, winning both *Body Interior* and *People's Choice* prizes for the new carbon composite X-brace for the *SRT* Viper** supercar produced by Chrysler Group LLC, and winning the *Body Exterior* for the hood assembly for the *Chevrolet* Stingray** sports car produced by General Motors Co.

From left to right, 2013 SPE ACCE co-chair, Creig Bowland, PPG Industries, Leland Decker, Chrysler Group LLC, and Anastasia Satterthwaite and Gary Lownsdale, Plasan Carbon Composites holding prizes for both Body Interior and People's Choice awards in the event's Best Parts Competition. Plasan swept the competition by picking up a third prize for Body Exterior as well.

Another aspect of the conference that was greatly expanded this year is the annual student poster competition, which drew 31 posters from students enrolled at schools in the U.S., Canada, and the Republic of Korea. Winning students received plaques from SPE and monetary prizes from competition sponsor, INVISTA Engineering Polymers. Among graduate students, the first-place winner was Meng Zhang, Clemson University, whose topic was *Carbon Fibers Derived from Sustainable Precursors.* The second-place graduate award went to Sarah Stair, Baylor University, for the topic, *Non-Destructive Testing of Carbon Fiber Laminates — Manufacturing Induced Curvature Predictions.* Stair also was one of three SPE ACCE scholarship award winners for the 2013-2014 academic year. And the third-place graduate award went to Mohammedmahdi Salvatian of Washington State University for work on *1D Microvascular Network for Damage Detection in Carbon Fiber*. An undergraduate student, Alexis Wagner of University of Guelph, received a special mention for work on *Novel Porous Electrospun Fibers from Blends of Poly(L-lactic acid)/poly(3-hydroxybutyrate-co-3-hydroxyvalerate) for Advanced Air Filters in Automotive Applications.*

Kurt Burmeister, executive vice-president, INVISTA Engineering Polymers presents first-place graduate poster award to Meng Zhang of Clemson University.

Burmeister presents award to second-place graduate poster winner, Sarah Stair of Baylor University.

ACCE CONTINUED FROM PAGE 31

Burmeister presents award to third-place graduate poster competition winner, Mohammedmahdi Salvatian of Washington State University.

This year's conference began and ended with a plant tour. On Tuesday afternoon, September 10, BASF Corp. hosted a tour at its Wyandotte, Michigan facility of a new natural fiber composite prepregging line and compression-molding station. Key to the technology is BASF's unique, formaldehyde-free, water-based Acrodur* acrylic latex binder resin, which permits production of composite parts with extremely high fiber volume fractions using natural fibers, glass fibers, carbon fibers, and other reinforcements. The newly installed line is being used by BASF and its customers to develop prototype parts using this environmentally friendly technology for use in the furniture, building & construction, filter media, and European automotive industries. And after the conference ended, a second tour hosted by Chrysler Group LLC' Street & Racing Technology SRT group of its Conner Avenue *Viper** supercar assembly plant in Detroit. Participants listened to a short overview on *Viper* production, then walked through five major assembly stations/zones, including receiving; chassis; drive cell; body cell; and end-of-line (testing). After the formal tour, participants viewed a small museum collection of classic *Viper* vehicles in the major body styles that have been offered since the vehicle first went on sale in 1992.

Next year's SPE ACCE will be held September 9-11, 2014 at The Diamond Banquet & Conference Center at the Suburban Collection Showplace. Dr. Michael Connolly will take over as event chair with support from returning Antony Dodworth as co-chair.

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Integrated Anisotropic Simulation for Components made from Glass Fiber Reinforced Thermoplastics

David Sheridan, Ticona*, Auburn Hills, Michigan
Ulrich Mohr-Matuschek & Anton Grzeschik, Ticona*, Sulzbach, Germany
Roland Peter, Inteva Roof Systems, Germany

ABSTRACT

Designing components made from glass fiber reinforced thermoplastics is not trivial since the fibers are inclusions in the matrix material. Fibers are specifically oriented in the mold filling phase during manufacturing through injection molding technology. This leads to, first, non-uniform and anisotropic shrinkage during and after the manufacturing process and, secondly, to a complex mechanical part behavior which cannot easily be predicted.

Simulation techniques such as finite element analyses are well established and can effectively support the part design process. But still in the majority of cases the mechanical behavior of a component under external load is calculated by means of isotropic material models. The quality of the simulation results can be significantly improved if the local fiber orientations are taken into account. This is possible when a mold filling simulation is done upfront and the resulting local fiber orientation tensors are mapped to the structural analysis mesh and non-linear and anisotropic material models are generated locally in this FEA model. This analysis process and a practical application of the integrated approach are presented.

INTRODUCTION

Components from short and long-glass reinforced thermoplastic materials such as PA66 GF30, PBT GF30, PET GF45, POM GF20, PP LGF30, PP LGF40 are broadly used in many industry segments for applications with high mechanical and thermal requirements. The parts are typically manufactured through injection molding, a processing technology which is mature and very cost effective for large series.

The part development engineer is faced with challenging goals. He has to deliver innovative solutions and must ensure high quality and reliability of the part such as precision, surface appearance, light weight and structural integrity i.e. no failure under operating conditions or in some abuse situations. Moreover he has to fully utilize the material`s mechanical performance potential since companies are always under cost pressure. Solutions with lower wall thickness will give lighter parts and reduced injection molding cycle times which both contribute to cost efficiency. And light weight design itself becomes increasingly important for fuel efficiency in the car industry. The part and system development teams are also requested to reduce the number of physical tests with prototype parts since this is another lever to control cost.

* On October 1, 2013, Ticona Engineering Polymers changed to Celanese Corp.

David Sheridan, senior design engineer at Ticona Engineering Polymers (which became Celanese Corp. on October 1, 2013) was named a Best Paper Award winner by the peer-review committee for the SPE® Automotive Composites Conference & Exhibition (ACCE). He was lead author (along with Ulrich Mohr-Matuschek and Anton Grzeschik of Celanese GmbH and Roland Peter of Inteva Roof Systems) on a paper entitled *Integrated Anisotropic Simulation for Components Made from Glass Fiber Reinforced Thermoplastics*, which he presented on September 12 from 11:30 a.m. - 12:00 p.m. along with a tutorial earlier that day on *Design & Development of Precision Plastic Gear Transmissions.* Sheridan received a special plaque for excellence in technical writing during opening ceremonies at the thirteenth-annual SPE ACCE on September 11.

Sheridan has worked for Celanese and been involved with the design and analysis of plastic parts for over 25 years. He also has been involved with plastic gear design and analysis for the past 15 years and is an active member of the American Gear Manufacturers Association's Plastics Gearing Committee. He has authored many articles on plastic part and gear-related topics. He holds a Bachelor's of Science degree in Mechanical Engineering from the former GMI Engineering & Management Institute (now called Kettering University).

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In addition to all of this injection molded components have become more complex over the years because there is a need to consolidate several parts into one component so that simulation techniques for mold and part design are essential to get the needed insight into part manufacturing details as well as into the particular part performance under (thermo-) mechanical load conditions.

State of the art in predicting the behavior of injection molded components is applying a mold filling analysis software and a structural analysis software independently. The mold filling analysis (using Autodesk Moldflow) gives detailed information about cavity filling problems, flow hesitation, weld lines, air inclusions, shear rates, temperature and pressure levels, velocity fields, frozen layer information, core deflection, glass fiber orientation, shrinkage and warpage [9]. The structural FE analysis (using Ansys) can predict part behavior, most important stress and strain distributions, deflection under load and failure indicators [11].

Recent developments deal with a coupling of the processing simulation with the mechanical load analysis. This is a major step forward since material properties in the part are strongly influenced by the flow pattern when the thermoplastic melt is injected into the cavity of the mold. For the studies presented here Digimat has been applied for the integrated analyses [10].

This paper will focus on three aspects of the so called integrated analysis of short fiber reinforced thermoplastics:

1. Fiber orientation as a critical result of the mold filling analysis. Realistic quantitative fiber orientation tensors are the basis for an improved prediction of the part behavior. The analysis engineer must set up an appropriate FE model and then specify the numbers of layers over the cross section. He also must select one of the available simulation methods and determine the optimum parameter settings.
2. Localized and processing-dependent material modeling is important in the structural analysis and can be done with new interface tools [10] and FEA subroutines. But the user has to prepare the settings of the anisotropic material modeling procedure through an iterative process which gives a best fit of the predictive material model to experimental results from test bars. And again the analysis engineer has to make decisions on the structural FE mesh details e.g. number of layers over the cross section.
3. The typical non-linearity of the stress-strain behavior of thermoplastic materials cannot be neglected in most cases, since even glass fiber reinforced thermoplastics normally show this non-linear characteristics

MATERIAL CHARACTERISTICS

The reinforcing fibers can easily double or triple the level of mechanical performance of the thermoplastic polymer compound (Table 1).

Table 1. Effect of adding glass to the properties of a POM (measured with ISO test standard specimen) [1]

% Glass	Density g/cm3	Stress at break / yield MPa	Flexural modulus MPa
0	1.41	64	2850
10	1.48	90	4500
20	1.57	120	5400
26	1.6	135	7800

These high values for stiffness and strength are typically reached when almost all fibers are aligned in one direction, e.g. in melt flow direction in an ISO 527 tensile test bar where the flow is very directed and uniform.

However, perpendicular to this main fiber orientation the mechanical behavior is on a much lower level. In addition, depending on part design and injection location (gate) in real components the fiber alignment (orientation) very often does not reach the high levels as observed in the ISO tensile test bars. Therefore the design engineer must be very careful when selecting material data for the analysis of the part behavior. It is not appropriate to use the stress-strain curves which were measured from injection molded tensile test bars. These data reflect only one direction (in flow) and the stiffness and strength levels are much too high compared to what would be measured in a real component with areas dominated by extensional flow of the melt.

More realistic mechanical data have to be measured from tensile bars which are cut from plaques which them-selves are large enough for the development of the typical layered structure over the cross section and a good portion of extensional flow during injection molding which generates a less aligned and more realistic fiber orientation pattern.

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Figure 1 shows stress-strain curves for a POM GF20 in flow direction of the melt (0 degree), in 45 degrees to flow direction and perpendicular to flow direction (90 degree). The data were determined from tensile bars which were cut from injection molded plaques with DIN A4 format (297mm x 210 mm) and 2 different wall thicknesses 2,5 mm and 4,0 mm (Figure 2 and 5). The flow path was long enough to get a realistic representation of the anisotropic material behavior.

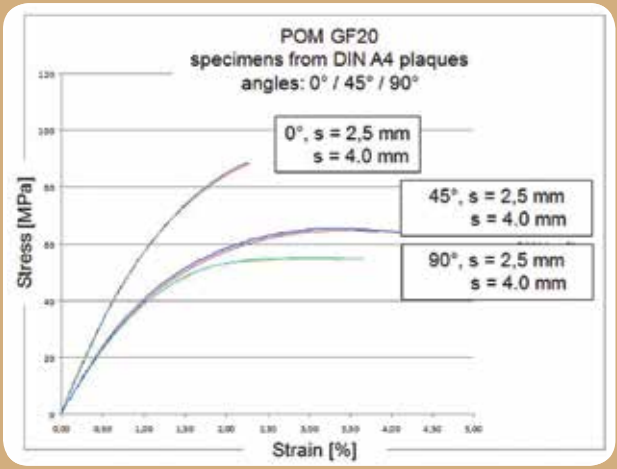

Figure 1. Stress strain diagram for POM GF20 in three angles to flow direction (0, 45, 90 degree) based on 297 mm x 210 mm plaques [2]

Figure 2. Injection molded test plaque from POM GF20, size: DIN A4 = 297 mm x 210 mm [2]

Figure 3. Injection molded test plaque from POM GF20, size: 80 mm x 80 mm [2]

Small plaques like the 80 mm x 80 mm in Figure 3 may be more comfortable to be produced and handled but there is a high probability that fibers will not be oriented enough to generate a clear anisotropic material behavior (Figure 4). This will be a disadvantage in the material model calibration step.

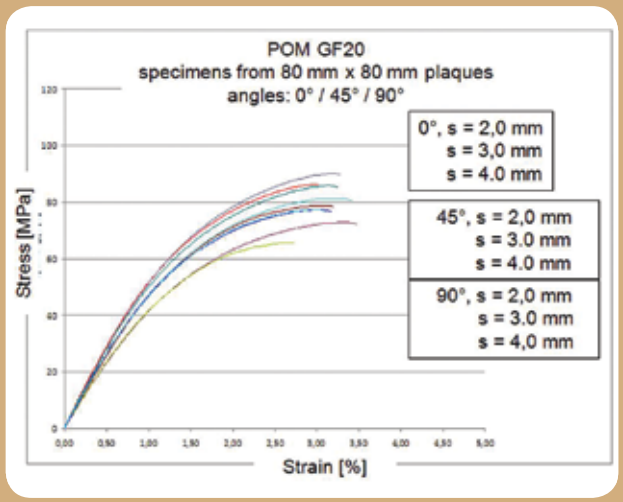

Figure 4. Stress strain diagram for POM GF20 in three angles to flow direction (0, 45, 90 degree) based on 80 x 80 mm plaques [2]

For the material modeling step the elements of the orientation tensor in the center of the tensile bar are needed. They can be measured by means of optical microscopy and image processing (Figure 5) and can also be determined through mold filling simulation (Figure 6) for the exact same test plaques which were used for characterization. This gives an opportunity to compare experimental and simulated data which represent fiber orientation. This allows for validation of the simulation parameter settings. Normally a layered structure can be observed consisting of a core layer between two skin layers with shear dominated fiber orientation [12].

MATERIAL MODELING

Experimental data from tensile test bars cut from injection molded plaques in 2 or 3 different directions (0, 90, 45 degrees, Figure 7) are used for the parameter calibration of the numerical material model. Goal of this step is that the numerical material model at least fits with these experimental curves. (re-engineering approach). It is assumed that the resulting parameters of the model are then also good enough for the "online" material modeling during the iterative non-linear anisotropic FE analysis in all

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locations of the component under investigation. Figure 8 shows that it is not always possible to fit each of the experimental curves simultanously. Our preference in such cases is that the in-flow direction curve (0 degree) is well represented.

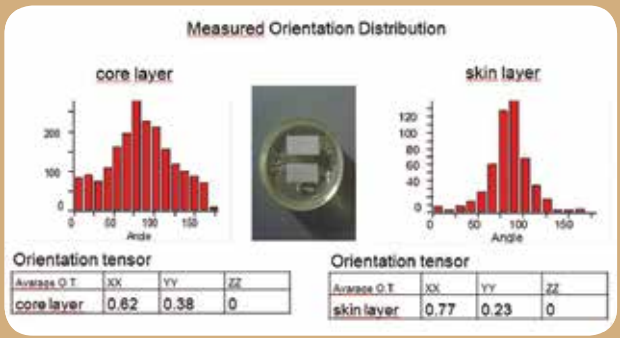


Figure 5. Measured fiber orientation for POM GF20 in skin and core layer [2]

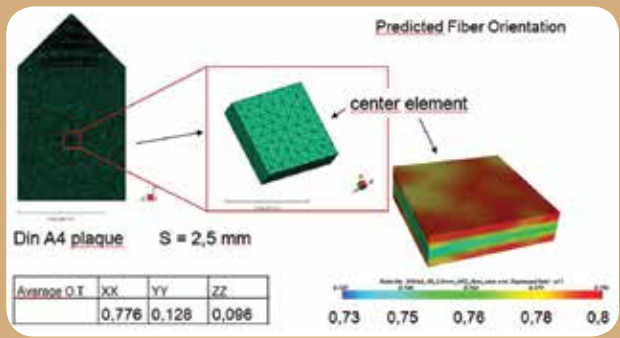


Figure 6. Simulated fiber orientation, POM GF20 [2]

Figure 7. Layout for cutting out ISO 527 tensile bars from test plaques

Figure 9 indicates how fiber orientation tensors affect the material response. The upper curve represents a material where all fibers are fully oriented in load direction, the second curve represents a fiber orientation with 65 % in load direction, 34 % perpendicular to load (in plane) and 1 % perpendicular to load (out of plane). The third curve shows the mechanical response when all fibers are oriented perpendicular to the load direction.

In addition the two lower curves show the measured matrix material response and the reengineered matrix material model. The latter is needed to fit the composite model behavior to experimental results. It needs experience in performing a good fit for anisotropic material models as well as solid experimental data from test plaques and reference parts for data comparison and method evaluation.

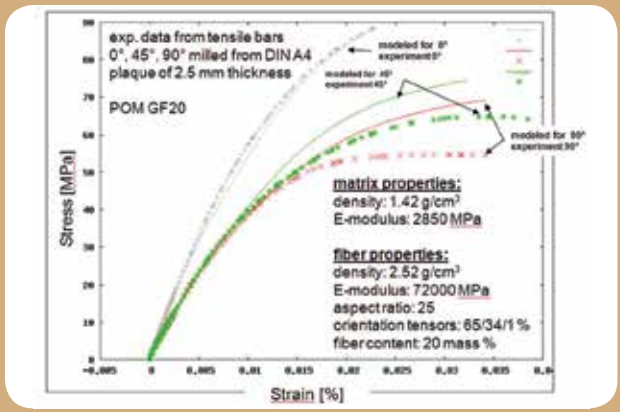


Figure 8. Comparison between experimental stress-strain curves and curves which were computed by a reengineered mathematical material model for POM GF20 [2]

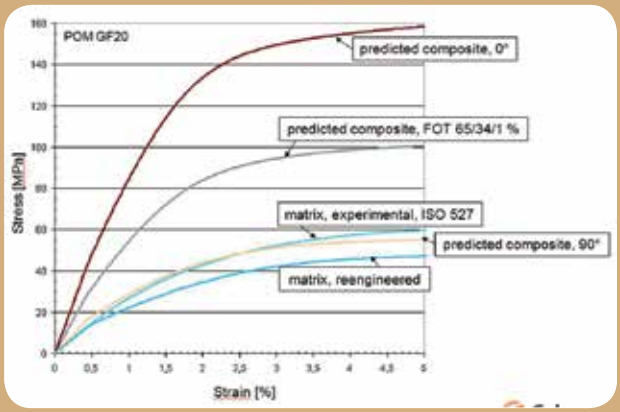


Figure 9. Predicted material responses of a numerical material model applying different orientation tensors for POM GF20 [2]

INTEGRATED ANALYSIS APPROACH

Localized, non-linear and anisotropic material models must be generated for each finite element in the FEA model based on micro-mechanical theories [5, 7] and adequate input data for the thermoplastic matrix and the short glass fibers. Today software modules (like Digimat in our case) are on the market or under development at universities which do most of the needed steps and support the Design/CAE engineer in identifying a sufficient non-linear anisotropic material model [10].

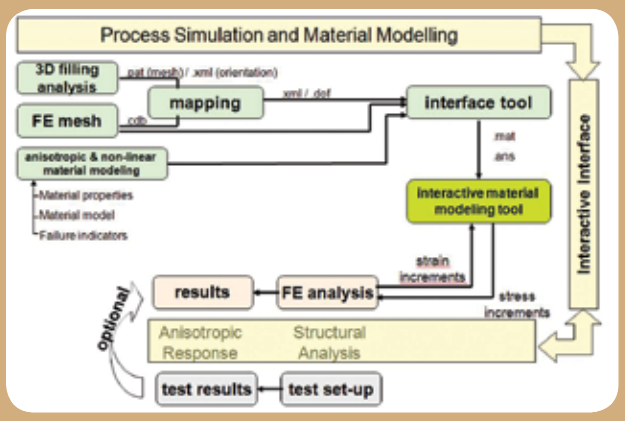


Figure 10. Integrated analysis approach

Figure 10 gives an overview on the complete flow of the integrated analysis approach. There are two major tasks which have to be done before the mechanical load analysis can be performed. First, the calibration of the material modeling parameters as described above and, secondly, the determination of all local fiber orientation tensors through a mold filling analysis with Autodesk Moldflow. The fiber orientation tensors are then mapped through Digimat onto the FEA model. After this step a Digimat interface module will prepare all needed data for the FE analysis. Once the FE analysis with Ansys is started another interactive Digimat software module works with the FE code in each iteration step and determines the local and anisotropic tangential stiffness matrix. Since this is a time consuming operation in each increment of the FE analysis the computational effort is relatively high compared to a standard isotropic non-linear analysis.

FIBER ORIENTATION SIMULATION

The final result of the structural analysis is very much dependent on the local material models which themselves depend on the local fiber orientations. Therefore high attention should be brought to the fiber orientation simulation quality during the mold filling analysis.

A good start to analyze and optimize the quality of the fiber orientation prediction is to simulate the melt flow into the test plaques during injection molding.

It is important to know that the calculated fiber orientation over the cross section depends on meshing details. Figure 11 shows that a simulation with 20 layers will give a more detailed representation of the fiber orientation over the wall thickness. A 20 layer setup is not always practical for the analysis of real components. To limit the calculation time it is recommended to use a lower number, but at least 8 layers.

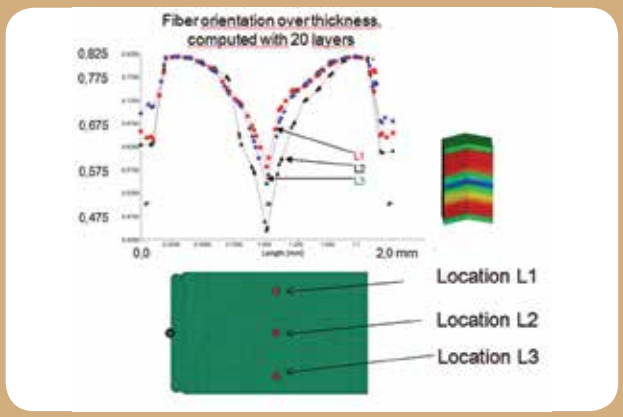


Figure 11. Calculated fiber orientations with 8 layers and 20 layers over the cross section

It is also important to select an appropriate algorithm for the fiber orientation calculation (within Autodesk Moldflow). Internal studies showed that good results can be reached with the "RSC model with specified Ci" [9]. The parameters Ci ad Kapa have to be specified. Parameter studies are necessary to identify values for these parameters which give simulation results with the best correlation to experimental orientation data.

Figure 12 shows how the simulated orientation over the cross section can be influenced by different simulation parameter settings.

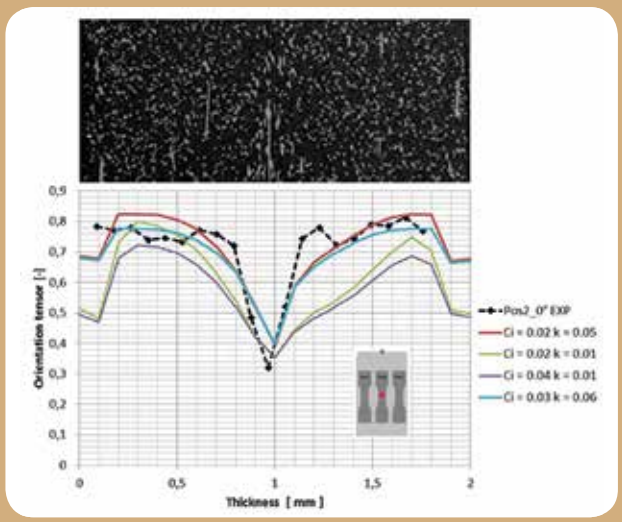


Figure 12. Calculated fiber orientations in comparison with experimental results over the cross section

Since a good fiber orientation prediction is an important pre-requisite for the integrated analysis of mechanically loaded parts the design engineer seeks for more ways to get confidence in the mold filling simulation results. Apart from experimentally analyzing fiber orientations for components of real applications a second approach to check the quality of the fiber orientation prediction is the detailed measurement of the part warpage and the comparison with simulation results.

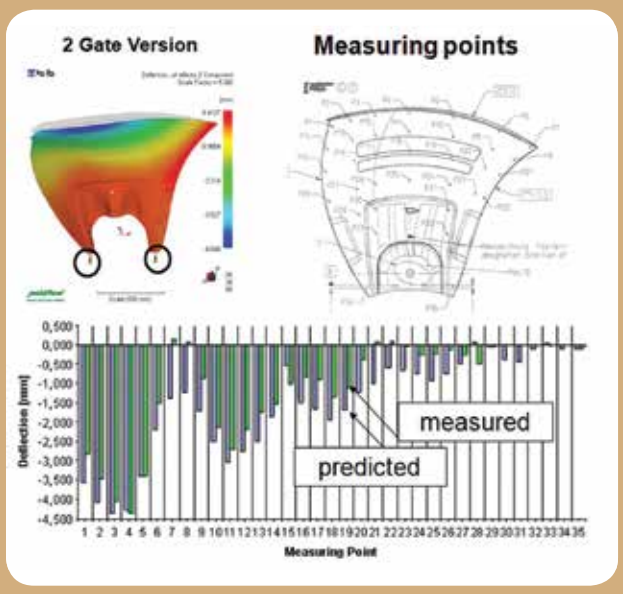
Figure 13 shows such a comparison for a fan component which was manufactured in two different ways. One version with two injection gates, another one with only a single injection gate.

The measured deflection pattern could not be predicted through simulation with absolute accuracy but both displacement patterns are well reflected.

Prediction of Load-Deflection Behavior Case Study: Clip from POM GF20

After having set-up the non-linear anisotropic material model according to figure 8 and 9 the procedure according to Figure 10 can be started to analyze the mechanical load behavior of a particular component.

As an example we look at a simple quasi-static bending load case of a clip component which is part of a sunroof system (Figure 14). This part was made from POM GF20.



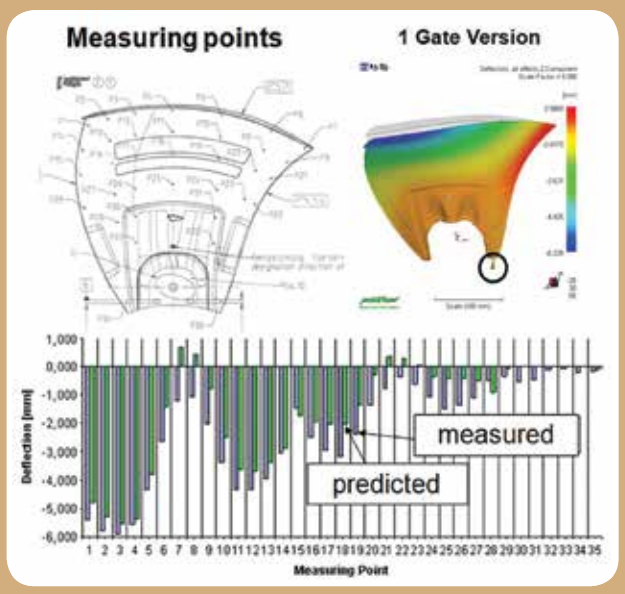


Figure 13. Predicted and measured warpage induced displacements of an injection molded part for two gating variants

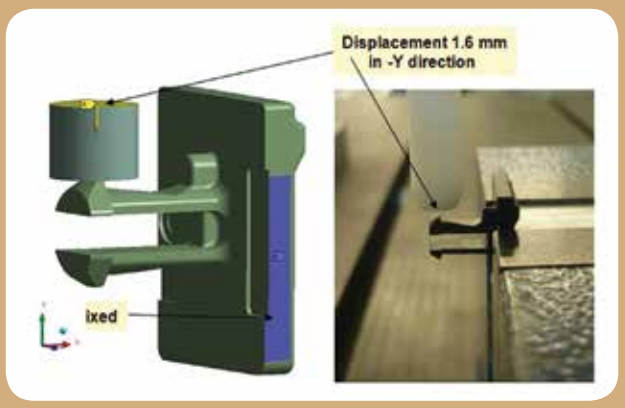


Figure 14. Clip from POM GF20 under a bending load

In a first step the mold filling simulation was performed. This gave the fiber orientation tensors for the whole part (Figure 15).

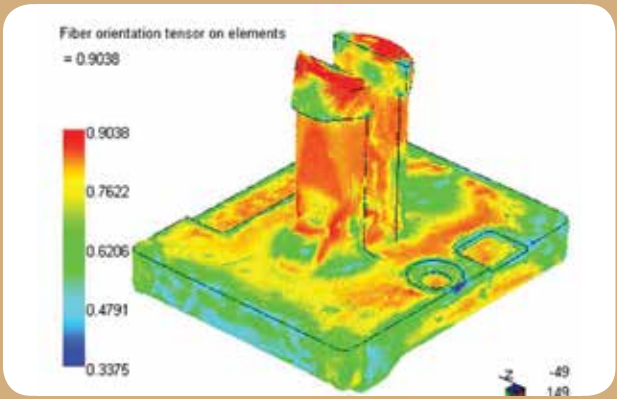


Figure 15. Fiber orientation tensors on elements in flow-direction for a clip made from POM GF20

In a second step these fiber orientations were mapped to the structural analysis FE mesh and the local non-linear anisotropic material models were automatically prepared through a software module. This module uses the settings which were previously prepared through the curve fitting approach. Finally the quasi-static, non-linear FE analysis was performed with Ansys. The result can be seen in Figure 16.

It can be stated that the correlation between the test result and the predicted force-displacement curve which used the localized, non-linear anisotropic material modeling is very good and much better than all other modeling techniques shown in this picture for comparison.

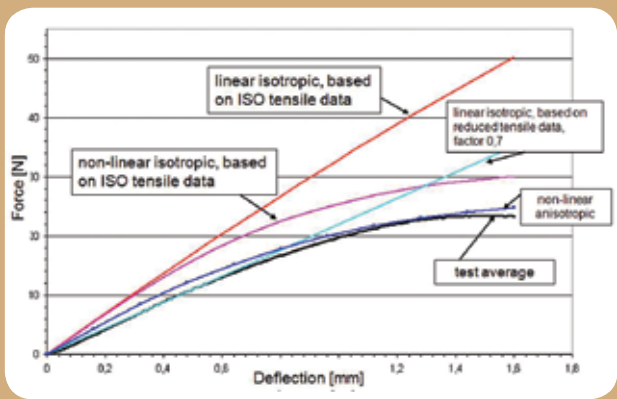


Figure 16. Force over displacement for a clip made from POM GF20 / Comparison of experimental curve with simulation results based on different material models

The location of failure could also be predicted with good accuracy. However, more basic research has yet to be done to become better in calibrating and applying an appropriate failure criteria to predict the exact load level under which failure will occur.

Figure 17. Failure mode of a clip under bending load

DISCUSSION

This paper gives an overview on the elements which are needed for an integrated analysis approach which is not based on uniform material properties but builds on a material modeling concept where the material behavior is dependent on the influence of the manufacturing process.

A practical example is given which demonstrates for a quasi-static load case how the prediction quality can be improved with this method. Comparisons between practical results from experiments and simulation show that the now existing techniques and tools can be successfully applied with higher but acceptable efforts.

Sufficient quality for computed local fiber orientations is important for a good prediction of the mechanical behavior of a component. The coefficients for the fiber orientation algorithm must be optimized through parameter studies to match experimental results. Apart from covering the anisotropic material behavior another important factor is the non-linearity which often must be taken into account for higher load levels. Furthermore it is important that the material data are well measured with tensile bars from plaques which are large enough to reflect a typical anisotropic fiber orientation field.

The integrated approach for long fiber reinforced materials can be performed in the same way but still suffers from less accuracy for the fiber orientation prediction.

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CONCLUSIONS

The integrated analysis of components made from short-fiber reinforced thermoplastics in static load cases is possible with methods and tools available in the industry and can increase the accuracy of the prediction of the load deflection behavior.

To limit the effort when optimizing first a molding condition and its consequence (gating, warpage) and secondly the structural behavior (stiffness, stress distribution) of a specific part the analysis engineer should start with the conventional i.e. sequential approach.

That means in a first step a practical gate location for injection molding has to be determined, then the local fiber orientation in the component and the resulting shrinkage and warpage are analyzed. In a second step the mechanical analyses of all geometry variants under consideration are performed with linear or non-linear isotropic material models to identify a promising geometry option. In a third step a fully integrated analysis should be performed for the selected geometry and mold gating situation. This finite element analysis with process-dependent, localized non-linear and anisotropic material modeling based on imported local fiber orientation tensors will then give a more precise view onto the components behavior under mechanical load.

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Membership REPORT

Steve Van Loozen
SPE Automotive Div. Membership Chair

I wanted to say hello as your new SPE Automotive Division Membership Chair.

I'd be remiss if I didn't take a minute to thank my predecessor, Anthony Gasbarro, for his work toward increasing our memberships by nearly 28% as reflected in the numbers below:

- On August 5, 2012, SPE's Automotive Division had 819 active members.
- As of November 1, 2013 the Automotive Division has 1,048 members.

This will certainly be a tough act to follow, but I promise to work hard and hope to make 2014 even better for the Automotive Division.

I also would like to thank all of our new members and express our ongoing gratitude to those that have renewed their membership in 2013. We will be planning and distributing a survey to current and lapsed members to better understand the benefits of membership and try to determine where we might add additional value.

As the push for lightweight solutions intensifies within the global automotive industry, I will look to focus our membership efforts on automotive tier suppliers and OEMs. It will also be important to continue exposing young professionals, either just entering or very new to our industry. We will look to energize some of our events in 2014 in the hope that they will attract this group to membership in SPE.

However, the best tool we have to maintain and increase our membership has always been and will continue to be our current members. We'd ask any member with a coworker or colleague that you feel could benefit from the relationships and resources of the SPE Automotive Division, to ask him or her to join! And don't forget that our board meetings (held at the American Chemistry Council's Automotive Learning Center in Troy, Michigan) are open to any of our members. Just call ahead or eMail to let us know you're coming. You can check on upcoming meeting schedules by looking at our Events Calendar on our website at http://speautomotive.com/ec.htm.

Thank you for taking a few minutes from your busy schedule and happy holidays to you and yours.

Kind regards,

Steven Van Loozen

Steven Van Loozen
SPE Automotive Division Membership Chair
BASF

SOCIAL REPORT

Teri Chouinard,
SPE Automotive Div. Social Chair

Corvettes from Zero to 60 – Cool Cars Drive Cool Careers

Our most recent SPE Automotive Div. social event took place at the exhibit, *"Corvettes from Zero to 60"* at the Buick Gallery/Sloan Museum in Flint, Michigan, U.S.A. on September 19, 2013. The outing attracted 35 registered attendees, including 17 members, 16 students, and 2 faculty members from Kettering University. The event kicked off with a tour of 16 classic *Corvette*® sports cars representing each design class of this iconic American automobile. After the tour, everyone enjoyed hors d'oeuvres and beverages plus great conversations with *Corvette* lovers, students, and SPE veterans.

Dave Reed, SPE Automotive Div.'s 2011 *Lifetime Achievement Award* recipient, spoke to the group about the *Corvette* and key innovations with plastics on vehicles at GM over the course of his career. After the presentation, Kettering student and SPE Student Chapter President (B Section), Paul Woodson commented on one of the innovations made possible with plastics. "In the car industry nowadays," Woodson noted, "so much time and effort is put into validating things, and here you were able to experiment with unproven technology and try new things – the newest untested adhesive and crossing your fingers that it would work. I can't believe the risks they allowed you to take and I admire your courage in doing so." And of course the crowd laughed and then laughed again when Reed replied "That is sometimes how innovation starts. We had nothing else and we had to try something." Afterwards, Reed noted that he wished he had said *"Engineering is the art of making good decisions with insufficient data."*

Fred Deans, member, SPE Automotive Div. board spoke to students about the benefits of membership in SPE, including how it has strengthened his knowledge of plastics and composite materials. He referenced the close associations and friendships gained through his membership in and service to SPE and encouraged students to include SPE membership and volunteer work in their college plans. He said that it would enrich their professional development and careers.

Bob Shalla, a seasoned auto-industry retiree and SPE veteran attended the event with his wife and surprised us with a very heartwarming talk about how SPE had benefitted his career selling plastic injection-molding equipment. He encouraged students to get involved in SPE because it would help their career and enhance their life with friendships.

Mark Richardson, director of the Plastics Lab in Kettering's Department of Industrial and Manufacturing Engineering addressed the group next. He encouraged his students to participate and thanked SPE for all it has done to support Kettering's programs and students over the years. As the purpose of this event was also to encourage SPE student chapter membership, the presentations portion of the evening ended with Kettering student, Sharna-Kay Dobney speaking to the group about efforts at Kettering to get their student chapter up and running and asking if SPE could assist with funding to accelerate the process. Of course, since plastics education and nurturing students is a big part of what the SPE Automotive Div. does, efforts are underway to oblige.

Future SPE social events will be planned to include participation from student chapter members and others interested in SPE to help grow membership and encourage participation from the next generation of automotive plastics engineers.

The next SPE social event will be held in late January or early February and will include a plant tour of Asahi Kasei Plastics North America in Fowlerville, Michigan, near Michigan State University. Stay tuned to SPE Automotive Div. eBlast updates for more information.

The purpose of SPE Automotive Div.'s social events is to learn new things, offer networking opportunities for new and old members, have fun, and build membership. If you have an idea for an upcoming social event, which may include a tour of your facility, reaching out to a specific college or university, or other educational and fun ideas that will interest our membership and draw new members, please email teri@intuitgroup.com or call 810.797.7242.

EDUCATION REPORT

by Monica Prokopyshen, Education Chair

The motion to approve 30 days of *Plastivan*® funding for the 2013-2014 academic year was passed at the August SPE Automotive Div. board meeting. This represents an increase of three days over the previous fiscal year for a total investment of at $40,500 USD. Teri Chouinard proposed scheduling future social events in venues near students to facilitate student participation. For example, the September SPE Automotive Div. social event was held at the Sloan Museum in Flint, Michigan, U.S.A., near Kettering University, giving students there the opportunity not only to see the museum's iconic 60th-anniversary *Corvette*® exhibit, but also to meet current SPE members and learn how society resources can help with their academic and business careers. At the September social event, Fred Deans provided an overview of Jim Keeler's Detroit Section program to develop new student chapters, which require a minimum of 10 students plus an advisor. The Detroit Section would like to have two liaisons for each school, one from the Detroit Section and one from the Automotive Division. Dave Reed is the Automotive Division representative for Kettering University.

The division would like to thank the Polymer Science and Engineering students from Ferris State University, Kettering University, and Michigan State University plus faculty who assisted at the November 6th SPE Automotive Innovation Awards Gala. It is our pleasure to recognize these inspiring students and faculty who combined a long day of study, travel, and volunteering before, during, and after the event.

Ferris State University

Professor Robert Speirs
Claire Davey
Charlie Bradley
Michael Scott
Heath Harding
Ethan Stiefel
Dylan Clark
Chris Laverty
Andrea Mitrink

Kettering University

Associate Professor Mark Richardson
Director of Philanthropy and Corporate Foundation Relations Eve Vitale
Adit Agrawal
Sharna-Kay Dobney
Lizra Fabien
Joel George
Julia Hershey, and
Paul Woodson

Michigan State University

Aubrey Ray Flint
Jordan Martin
Ben Nabor

Please join me in conveying a special thanks to this year's Lifetime Achievement Award winner, Roy Sjöberg who discussed "7 Keys to Innovation Success — The Heptagon Tower" and presented a 3-D heptagon to each student volunteer at November's 43rd-annual SPE Automotive Innovation Awards Gala.

Students holding their heptagon towers created via 3D printing and designed by SPE Automotive's 2013 Lifetime Achievement Award winner, Roy Sjöberg

Education Report CONTINUED FROM PAGE 46

Students from Ferris State University holding signed posters for Chrysler Group LLC's iconic Viper® supercar

Students volunteers from Kettering University along with SPE Automotive Div. board member, Mike Whitens (center) of Ford Motor Co.

Students from Michigan State University who also worked as ushers and helpers during the evening of the 43rd-annual SPE Automotive Innovation Awards Gala

SECRETARY'S REPORT

SPE Automotive Division Board
Aug 12, 2013 Minutes

Next BOD Meeting: December 9, 2013

ATTENDEES

Yvonne Bankowski	Brian Grosser	Peggy Malnati	Dave Reed
Peter Bejin	Jeff Helms	Kevin Pageau	Elias Shakour
Teri Chouinard	Vince Holmes	Tom Pickett	Suresh Shah
Parashar Davé	Elizabeth Johnston	Monica Prokopyshen	Dawn Stephens
Fred Deans	Ed Luibrand	Nippani Rao	Steve Van Loozen

The meeting was held at the ACC and via conference call, 5:30 p.m. – 8:00 p.m. June minutes were approved.

EDUCATION – Monica Prokopyshen

The motion to approve 30 days of *Plastivan*® funding for the 2013-2014 academic year was passed. The BOD discussed methods of attracting student members, such as including students in more SPE social events and attracting students into the plastics industry. Refer also to the Education Report. The board also discussed internships, resume review programs, funding 4-year memberships for ACCE student participants, and participating in university open-house days at the start of the 2014 fall term.

BOD MEETING – Yvonne Bankowski

Neil Fuenmayor and Parashar Davé expressed interest in joining the board. Elias Shakour of the Center for Automotive Research (CAR) was elected as Division Vice-Chair. Peter Bejin joined the board of directors.

SOCIAL – Teri Chouinard

Teri proposed holding the September SPE Automotive Div. social event at the Sloan Museum in Flint, Michigan, U.S.A., near Kettering University, giving students there the opportunity to see the museum's iconic 60th-anniversary *Corvette*® exhibit, and to meet current SPE members and learn how society resources can help with their academic and business careers. The motion to approve $1,000 USD for exclusive Sloan gallery rental on Sept. 19 or 20 for 3 hours, finger food, plus non-alcoholic beverages was approved. Kettering students and faculty are invited. Teri also proposed developing a college-student targeted SPE AD display.

ANTEC – Anthony Gasbarro

The preferred times and day for the SPE AD sessions are Tuesday am and pm. The 2014 event location is Las Vegas from April 28-30.

MARCOM – Peggy Malnati

2013 ACCE (Sept. 11-13, 2013) – The event is breaking records across the board: 62 paid sponsorships, a sold out exhibit area, 90 plus papers, an 80-page program guide and 4 parallel tracks for the first time on days 1 and 2. The Michigan Economic Development Corp. is sponsoring three scholarships and INVISTA Engineering Polymers is sponsoring the student poster competition, which also has record participation this year, including a student coming from South Korea. The ACCE is the first SPE event to use the new Event App. Over 7 hours of the new tutorial track will be filmed.

AWARDS GALA (Nov. 6, 2013) – All SPE AD ads are booked with publications that are swapping with us on this event. Some have already been sent to publication. This year all plaque/trophy orders will be made online.

SPE AD Website – July set another all-time monthly traffic record for the SPEAutomotive.com website of 47,932 unique hits/month.

SPE AD Newsletter – The 43-page September issue features the ACCE Student Poster Competition, designs along with the popular technical and celebrity columns. Jeff Sloan (Batter's Box) discusses the dramatic differences he's witnessed between injection molding and composites in, "When Worlds Collide" and Dave Reed is in the spotlight in: "An Engineer's Life."

Misc. Marcom – The *Engineer's Life* columns are now available on the SPE AD blog, with feeds to Twitter and LinkedIn.

NEW BUSINESS

The Hall of Fame award this year will be renamed in tribute to Josh Madden.

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