



July 2011 - Volume 40, Issue 4

## Innovation Awards Program 2011

The Automotive Division of the Society of Plastics Engineers announced the date, location, and theme for its 41st-annual Automotive Innovation Awards Gala, the oldest and largest recognition event in the automotive and plastics industries. This year's event will be held Wednesday, November 9, 2011 at Burton Manor ([www.burtonmanor.net](http://www.burtonmanor.net)) in Livonia, Mich.



Jeffrey Helms, global automotive director, Ticona Engineering Polymers, who returns as the 2011 SPE Automotive Innovation Awards chair said, "This year's competition and gala theme is **Passion to Innovate**, which really captures the excitement that's in the air as the global automotive industry continues to recover from the 2008-2009 downturn. The level of innovation we've seen among nominations at the past few years' competition – parts that would have been designed during the worst part of the recession – underscores how hard automakers and their suppliers are working to add function and value, improve aesthetics and durability, and reduce weight and cost on virtually every component throughout the vehicle.

It's an exciting time to be in the automotive plastics industry and we're eagerly anticipating our review of

### Call for Nominations

**Nominate your Innovative Application for the 41<sup>st</sup> Annual Innovation Awards Program. See Page 5.**

Visit [www.speautomotive.com/inno](http://www.speautomotive.com/inno) for the nomination form.

this year's nominations for our 41st Automotive Innovation Awards Competition."

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

*Continued Page 4*

• ANTEC 2011	Page 2	• Councilor's Report	Page 12
• Automotive Composites (ACCE)	Page 6	• Lifetime Achievement Award	Page 8
• Automotive Division Calendar	Page 2	• SPE Golf Outing	Page 16
• Board of Directors Meeting Minutes	Page 18	• Technical Article	Page 20
• Call for Nominations—Awards	Page 5	• TPO Global Conference	Page 10
• Chair's Message	Page 3	• Treasurer's Report	Page 2

# Treasurers Report

Yvonne Bankowski

The SPE Automotive Division bank account balance is in good standing with \$147,601 in checking and \$27,383 in savings for a total of \$174,984. In April and May, five middle and high schools were visited by the National Plastivan Outreach Program and SPE Automotive provided \$8,850 in funding to the National Plastics Center and Museum. The Ferris State Chapter of SPE received \$1,000 in funding towards their 2011 ANTEC expenses.

[www.speautomotive.com](http://www.speautomotive.com)



The 2011 Society of Plastics Engineering Annual Technical Conference (ANTEC) took place in Boston, Massachusetts at the Hynes Convention Center and Boston Marriott Copley Center Hotel May 1 – 5, 2011. The SPE Automotive Session had 2 technical sessions on Tuesday, May 3, 2011. The morning session had 5 presentations on Development of Automotive Materials. **Jeff Helms** was the moderator for the session.

The afternoon session had 6 presentations on Processing and Testing Development. **Anthony Gasbarro** was the moderator. The Chair of the 2011 ANTEC Automotive Division Session was **Tom Pickett**. Helping Tom review the papers were **Norm Kakarala, Jay Raisoni, Suresh Shah** and **Mike Tolinski**.

The SPE Automotive Division Business Meeting took place at ANTEC on Tuesday, May 3, 2011 at 5:00PM. The Automotive Divisions events for the year were discussed. The 2012 ANTEC will join with NPE to be held on April 2-4, 2012 in Orlando, Florida.

## Automotive Division Meeting Schedule and Special-Events Calendar

<b>Automotive Division BOD Meeting—All invited !</b> American Chemistry Council, Troy, MI	August 15, 2011 5:30 pm
<b>11th-annual SPE Automotive Composites Conference &amp; Exhibition</b> Troy, MI	September 13-15, 2011
<b>IAG BOD Judging</b> Ticona Auburn Hills, MI	September 29th & 30th
<b>13th-annual SPE Automotive TPO Global Conference</b> Troy, MI	October 2-5, 2011
<b>41st-Annual SPE Automotive Innovation Awards Program</b> Burton Manor, Livonia, MI	November 9, 2011 5:30 pm
<b>Automotive Division BOD Meetings—All invited !</b> American Chemistry Council, Troy, MI	January 30th, 2012 April 2, 2012 June 18, 2012

Automotive Division Board of Directors meetings are open to all SPE members. All our events are listed on our website at <http://speautomotive.com/ec>  
Call Anthony Gasbarro at (248) 721.0276 for more information.

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# Chair's Message

## Anthony Gasbarro

Believe it or not, we have just begun our new fiscal year for the Automotive Division of the SPE. I am proud to be your Chair for the Automotive Division for the next year. However, we start this year a little different than most. Let me explain.

The new President of SPE – Russell Broome made some comments in a speech he made at the SPE Annual Business meeting during ANTEC in Boston. He paraphrased his journey through the SPE: noting that his father took him to SPE meetings in North Carolina as a boy; he then joined the student chapter of SPE while in college; and after graduation he became active in the society as a young professional, eventually coming to be elected president. Russell is only 40 years old – however he realized while a bit younger the value that SPE offers. He (as I did) realized the value in getting together on a regular basis with fellow “plastics geeks” (these are my words) and talking about problems, solutions, issues, and successes. He realized there is real value in regular meetings with fellow SPE members – fellow people who all have something in common with each other.

If you have ever met someone new and, when asked what you do for work said “Oh, you wouldn’t get it, I work in Plastics”? What is the feeling you get when they say “Oh, really? Me too!” It has happened to us all – and it really feels great. We start throwing around acronyms like they are going out of style – and everyone around us starts to think we are really weird... If this has happened to you, keep reading.

We live in a world where it is easier to email or text someone than call them, we get news from “tweets” and “posts;” we find things by “googling” and searching. I, more than anyone, embrace this change – it really does help and it is easier than picking up an encyclopedia. However there is a problem with this. There are some obscure things that you just can’t Google and get good results with – we have all had this problem. You search and search and just can’t find what you are looking for. We -- as a generation are the “lynchpin” between the old way and the new way of doing things. There is a generation of people who have a wealth of knowledge that we could tap into, however they don’t text, tweet, Facebook, email, Skype, Google...you get my point. We need to talk to them – preferably face to face. My friends, these are the people that have the information we need, they have been there and done that...they are the pioneers in the plastics world that blazed the trails for us.

What I am asking is that you -- the generation of change, the lynchpins bridging the new and the old

become involved. The generation after us will lose a great deal if we don’t bridge that gap. We have a duty as engineers, as members of a unique society of plastics engineers and professionals to continue this knowledge and to help transition from the old way to the new way.

How can you do this? It’s really quite easy – come to events – come to meetings – subscribe to our twitter feed – bookmark our website ([www.speautomotive.com](http://www.speautomotive.com)) and visit it frequently– subscribe to our blog - be a part of our Board of Directors – we are always looking for people who are active, people who are passionate, and people who want to keep this field alive and well.

I challenge you to go to our website and pick an event or two to attend this year – make it a commitment – and become active. The SPE is more than just an organization that sends out newsletters – we have a lot to offer and we want you to be a part of it.

I look forward to seeing you around. Make it a great day!

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## Innovation Awards Program

Continued from Page 1

why it merits the claim as the Year's Most Innovative Use of Plastics. This annual event typically draws 600 to 800 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.

For more information about the SPE Automotive Innovation Awards Competition and Gala or to download nomination forms and rules for this year's competition, please visit the SPE Automotive Division website at <http://speautomotive.com/inno>.

## 2010 SPE Automotive Division Grand Award Winner "Most Innovative Use of Plastics" Diesel Exhaust Fluid (DEF) System on the 2011MY Ford® SuperDuty® Pickup



**OEM:** Ford Motor Co.  
**Make & Model:** 2011MY Ford® SuperDuty® Pickup  
**Tier Supplier:** Robert Bosch LLC  
**Processor:** Kautex Textron GmbH & Co. KG  
**Material:** Multiple  
**Process:** Injection Molding

*Also named Powertrain Category Winner*

**Description:** This is the first high-volume pickup truck application to use an all-plastic system to fill, store, and deliver diesel-exhaust fluid (DEF) to the exhaust system to meet stringent diesel-emissions requirements. Multiple materials and molding processes are featured on this system, 90% of whose components are polymeric, including the plastic filler-pipe assembly (which requires no clamps), plastic supply module with integrated pump, reverting valve, pressure sensor, heater, and filtration unit. Additional plastic components in the system include heated intake reservoir, level sensor, filter, and temperature sensor. The only other type of material that could have withstood the DEF fluid would be stainless steel, which would have been 7x heavier and have cost 40% more than this design.



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# Call for Nominations - SPE Innovation Awards Competition

The Automotive Division of the **Society of Plastics Engineers** has issued its annual call for parts and vehicle-engineering team nominations for the group's 41<sup>st</sup>-annual **Automotive Innovation Awards Competition**, the oldest and largest recognition event in the automotive and plastics industries.

Nomination forms for this year's competition are available at <http://speautomotive.com/inno> and are due **September 1, 2011** for applications and vehicles that are available for commercial sale on or before November 1 of this year. Winners will be announced at this year's **Automotive Innovation Awards Gala** on November 9, 2011 at Burton Manor in Livonia, Mich.

## Vehicle Engineering Team Award (VETA)

**SPE's Vehicle Engineering Team Award** recognizes the technical achievements of teams comprised of automotive designers and engineers, tier integrators, materials suppliers, toolmakers, and others whose work – in research, design, engineering, and/or manufacturing – has led to significant integration of polymeric materials on a notable vehicle. This is the fifth time in eight years that the award has been presented. Previous winners include Porsche AG for the 2004 Model Year (2004MY) Porsche<sup>®</sup> Carrera GT supercar, and Ford Motor Co. for three straight years with the 2008MY Ford<sup>®</sup> Flex cross-over utility vehicle, the 2009MY Ford Taurus sedan, and the 2011MY Ford<sup>®</sup> Explorer mid-size sport-utility vehicle (SUV). Any automaker may nominate its eligible vehicles (and their innovative plastics content).

## Automotive Innovation Awards Parts Competition

Since 1970, the **SPE Automotive Innovation Awards Competition** has highlighted the positive changes that polymeric materials have brought to the automotive and ground-transportation industries, such as weight reduction, parts consolidation, and enhanced aesthetics and design freedom.

Over the years, the competition drew attention to plastics as an underutilized design tool and made industry aware of more progressive ways of designing, engineering, and manufacturing automotive components. From its humble beginnings, the competition has grown to be one of the most fiercely contested recognition events in the plastics and automotive industries. Today, polymeric materials are no longer substitutes for more expensive materials, but rather are the materials of choice in hundreds of different applications throughout the vehicle.



Without plastics, many of the auto industry's most common comfort, control, and safety applications would not be possible. Current competition categories include:

**Body Exterior,  
Body Interior,  
Chassis / Hardware,  
Environmental,  
Hall of Fame,  
Materials,  
Performance & Customization,  
Process / Assembly / Enabling Technologies,  
Powertrain, and  
Safety**

During the competition phase of the event, dozens of teams made up of OEMs, tier suppliers, consultants, and polymer producers work for months to hone submission forms and presentations describing their part, system, or complete vehicle module and why it merits the claim as the year's "**Most Innovative Use of Plastics.**" To win, teams must survive a pre-competition review and two rounds of presentations before industry and media judges.

There is no cost to nominate parts or vehicles. However, nominations that are accepted into the 2011 competition will need to be presented (in person or by webinar) by their nominating teams during the first round of **Automotive Innovation Awards Competition** judging, September 29-30. In the case of part nominations, finalists selected during the first round of judging will need to be presented again before the Blue Ribbon judging panel on October 10. Winners of each part category and the VETA winner will be honored during the **Automotive Innovation Awards Gala** on November 9 .

**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 600 to 800 OEM engineers, automotive and plastics industry executives, and media.

SPE's Automotive Division is active in educating, promoting, recognizing, and communicating technical accomplishments for all phases of plastics and plastic based-composite developments in the global transportation industry. Topic areas include applications, materials, processing, equipment, tooling, design, and development.

For more information about the **SPE Automotive Innovation Awards Competition and Gala** or to download nomination forms and rules for this year's competition, please visit the **SPE Automotive Division** website at <http://speautomotive.com/inno> , or contact the group at +1.248.244.8993.

## Motive Industries President, Nathan Armstrong to Give Keynote at SPE<sup>®</sup> Automotive Composites Conference.

The first confirmed keynote speaker for the 2011 SPE Automotive Composites Conference & Exhibition (ACCE) – held September 13-15, 2011 at the MSU Management Education Center in Troy, Mich., U.S.A. – will be Nathan Armstrong, president and director of Motive Industries Inc. speaking on a topic near and dear to the heart of his company: *Return of the Small Automaker*. Motive, which has significant experience providing vehicle design, engineering, and prototyping for composite-bodied electric vehicles (EVs), announced last fall that it would be producing prototypes of an all-Canadian content, bio-composites-intensive EV named the **Kestrel**, targeted for commercial introduction in 2012.

According to Armstrong, over the last decade, the pace of technology has advanced in all fields of design and manufacturing at an unparalleled pace thanks to a number of useful tools that have come into common usage. These include highly advanced computer-aided design (CAD), rapid prototyping machines capable of printing useable parts; computer numeric controlled (CNC) mills with up to six axis that allow nearly any shape imaginable to be cut; plastics that can be molded at room temperature using silicone molds; composite materials that have unimaginable strength properties; and the knowledge and experience needed to combine all these elements into what he calls *'the second industrial revolution.'*

“The impact this has had on industry is unquestionably enabling the largest shift in influence ever seen,” explains Armstrong. “The small guys now have the same tools as the big guys, but often with more freedom and flexibility to demonstrate applications in technology that the large companies cannot. This means that fresh innovation and ideas are coming from the bottom up, not from the top down. If we combine this freedom of design with the access to advanced materials, such as fibre-reinforced plastics, the possibility of the small automaker re-emerges. By using composites and plastics, tooling costs to produce such vehicles drop drastically and the performance can be accurately determined before any production begins. Also, with the dramatic increase in strength and durability that composites bring vs. metals, the safety level of these vehicles can be increased, eliminating any fears over liability.”

Nathan James Armstrong has over 16 years of transportation design engineering experience in both the aerospace and automotive sectors. Prior to founding Motive in 2004, Armstrong worked for Boeing and Arrowhead Products on the International Space Station, Delta Rockets, and Joint Strike Fighter programs. In 1996, Nathan moved from aerospace to automotive engineering working for Metalcrafters and Aria Group in Southern California as vice-president-Engineering where he managed the design and construction of a vast array of vehicle projects including over 30 production vehicles,



over 200 concept vehicles, and close to 1,000 clay models, interior models, and scale models. Moving himself and the company to Calgary in 2006, Armstrong has become a mainstay of local tech talks and advisory presentations to large companies. These include presentations at the ENMAX Leadership Forum where he gave a one-hour lecture on Electric Vehicles and Smart Grid Technology, the Alberta Clean Tech Forum, the Haskayne School of Business, the Edmonton Division of the American Society of Material Engineers (ASME), and the Canadian Prairies Group of Chartered Engineers, where he gathered the largest audience in the group's history.

The date and time of Armstrong's SPE ACCE keynote address have not yet been set.

Held annually in suburban Detroit, the SPE ACCE typically draws 400+ speakers, exhibitors, sponsors, and attendees from 14 countries on five continents and provides an environment dedicated solely to discussion and networking about advances in transportation composites. Its global appeal is evident in the diversity of exhibitors, speakers, and attendees who come to the conference from Europe, the Middle East, Africa, and Asia / Pacific as well as North America and who represent transportation OEMs -- traditional automotive and light truck, as well as agriculture, truck & bus, heavy truck, and aviation – and tier suppliers; composite materials, processing equipment, additives, and reinforcement suppliers; trade associations, consultants, university and government labs; media; and investment bankers. The show is sponsored jointly by the SPE Automotive and Composites Divisions.

For more information about the SPE Automotive Composites Conference, visit the Automotive Division's website at <http://speautomotive.com/comp.htm>, or the Composites' Division website at <http://compositeshelp.com>.



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The **SPE ACCE** typically draws over 400 attendees from 14 countries on 4 continents who are interested in learning about the latest composites technologies. Fully a third of attendees work for an automotive, heavy truck, agricultural / off-road equipment, or aerospace OEM, and roughly a fifth work for a tier integrator. Few conferences of any size offers such an engaged, global audience vitally interested in hearing the latest composites advances.

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### FOR MORE INFORMATION

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# GM Retiree Named 2011 SPE Lifetime Achievement Winner

David (Dave) B. Reed P.E., who worked for then General Motors Corp. (GM) for 45 years in Product Engineering and helped develop many innovative automotive-plastics applications, has been named the eleventh recipient of the group's prestigious Lifetime Achievement award from the Automotive Division of the Society of Plastics Engineers (SPE®). Reed will be honored at the 41st-annual SPE Automotive Innovations Awards Gala on November 9 at Burton Manor in Livonia, Mich.

The award recognizes the technical achievements of automotive executives whose work – in research, design, and engineering, etc. – has led to significant integration of polymeric materials on vehicles.

Dave Reed was selected as this year's Lifetime Achievement award winner for his leading role on many of GM's composite-bodied vehicles as well as numerous plastics innovations. He began his career at GM in 1963 while a co-op student at then General Motors Institute (GMI, renamed Kettering University) and joined the Chevrolet Materials Group in 1967. He received his Bachelors Degree in Mechanical Engineering / Materials Science and completed his thesis on Development of Nylon Fuel Lines, in which he developed and recommended use of a more durable grade of nylon Type 11 fuel lines, which eventually led to industry-wide use of nylon in fuel lines.

In 1969 he was promoted to the position of senior engineer with responsibility for all Chevrolet plastics, elastomers, gaskets, and adhesives. During this time he introduced ethylene-propylene-diene monomer (EPDM) rubber for heater and radiator hoses on all Chevrolet vehicles, which doubled hose life. Reed also led the development of painted thermoplastic polyolefin (TPO) bumper-filler panels, painted polyurethane (PUR) reaction-injection-molded (RIM) bumper fascias, as well as polycarbonate (PC) lenses for all Chevrolet and GMC® truck rear tail lamps. In 1977 he was promoted to staff engineer at Pontiac Engineering where he was responsible for all Pontiac plastics and elastomers. Reed helped develop the composite body constructions for the Fiero, Camaro®, and Firebird® sports cars, as well as the Saturn coupe and sedan, and the EV1 electric vehicle.

In fact, five of the programs he worked on were named Grand Award winners in SPE's annual Automotive Innovation Awards Competition, including 1974's win for the front and rear bumper covers (fascias) on the Chevrolet® Monza® subcompact – an application that in 1993 also received' SPE's Hall of Fame award; 1983's win for exterior body panels on the Pontiac® Fiero® sports car; a second Fiero sports car award in 1986 for rear quarter windows; the 1990 award for exterior door panels on Saturn® sedans; and the 1996 award for the structural

battery tray on GM's iconic EV1® electric vehicle.

Before retiring from GM in 2008, Reed led the development of enhanced interior materials introduced on the Cadillac® SRX®, STS®, and CTS® luxury vehicles. Not only were these vehicles highly acclaimed for the luxury, functionality, and good looks of their interiors, but they led to a new generation of interior technology integration for aesthetics, comfort,

and safety at GM. He also proposed GM's partnership role in order to start an industry-wide plastics recycling program with government assistance, which eventually became the USCAR Vehicle Recycling Partnership. He also led GM's recycling team to share and optimize use of in-house plastics molding scrap across all of GM's molding operations, saving the automaker millions of dollars annually.

Reed has a long history of service to engineering societies. He is a recipient of SAE® International's Forest R. McFarland Award for organizing and running innovative technical sessions on such topics as Advances in Automotive Composite Body Panels, New Composite Cars, New Developments in Asian Plastics Applications, Automotive Plastics Recycling. He also organized and led a technical session on Challenges in SMC Finishing at SPE's own inaugural Automotive Composites Conference & Exhibition (ACCE), and has been a long-time director on the board of the SPE Automotive Division. He holds a patent in nanocomposites and two defensive publications. Since retiring, he has continued his dedication to plastics innovations as a consultant.

On November 9, Dave Reed will be honored for his significant automotive plastics contributions at this year's SPE Automotive Innovation Awards Gala.

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For more information about the SPE Automotive Innovation Awards Competition and Gala or to download nomination forms and rules for this year's competition, please visit the SPE Automotive Division website at <http://speautomotive.com/inno>



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# Four Keynotes Highlight Current Industry Trends at 2011 Automotive TPO Global Conference

This year's **SPE® Automotive TPO Global Conference**, the world's leading automotive polyolefins conference, will feature four keynote speakers who will highlight current trends that are reshaping the global automotive-plastics market. The polyolefin supply chain has experienced major changes in recent years that are providing both challenges and opportunities for automakers and the entire supply community. Interspersed throughout the annual two-and-a-half-day event, which this year will be held **October 2-5, 2011**, organizers from the **Detroit Section** of the **Society of Plastics Engineers** (SPE®) will use keynote addresses to help attendees better understand the impact of changing conditions.

The conference will open on Monday morning, October 3<sup>rd</sup> with a keynote address by **Jeff Schuster**, executive director -Global Forecasting & Product Analysis at **J.D. Power and Associates**, who will talk about "**Global Automotive Light-Vehicle Market, Where Do We Go From Here?**" with specific emphasis on trends in North America. Schuster will discuss the pace of the automotive recovery in mature markets and growth opportunities in emerging markets. He will then focus his attention on the outlook for the dynamic North American automotive market and will discuss trends in segmentation as well as the OEM competitive landscape.

Later that day, **Ralph A. Mosca**, global automotive marketing manager, **ExxonMobil Chemical Co.** will deliver the noon keynote entitled "**Polyolefins are a Sustainable Solution.**" Led by high growth rates in emerging economies, automotive production continues to expand globally. While not the largest energy-consuming segment, transportation – thanks to increased vehicle penetration in developing economies – contributes significantly to increased energy demand.

On Day 2 of the conference, Tuesday, October 4<sup>th</sup>, **Leon Jacobs**, Polypropylene (PP) global business director, **SABIC Innovative Plastics**, will open the event with a keynote address entitled "**The Opportunities & Challenges of a Globalizing Automotive Industry.**" According to Jacobs, his talk will discuss how the globalization of the automotive industry is impacting plastics raw-material supply, in particular the supply of PP-based materials, taking into account the differing markets, their requirements, OEM specifications, and available raw materials in the context of environmental, economic, and political considerations.

"The last day of the show, Wednesday October 5<sup>th</sup> will open with a keynote address by **Dagmar van Heur**, vice-president-Automotive at **Styron LLC** who will speak about "**CAFE Requirements: Lightweighting for Improved Energy Efficiency.**" Automakers selling into Europe are aggressively pursuing weight-reduction opportunities to help them achieve European Union (EU) carbon dioxide

(CO<sub>2</sub>)-emissions legislation. Van Heur says he will discuss this trend and will detail lightweighting solutions now being sought in Europe as well as to discuss the likelihood that U.S. carmakers will move in similar directions to meet current CAFE requirements and even tougher targets being discussed by the U.S. government.

Since 1998, the **SPE Automotive TPO Global Conference** has highlighted the importance of rigid and flexible polyolefins throughout the automobile – in applications ranging from semi-structural composite underbody shields and front-end modules to soft-touch interior skins and bumper fascia. The show typically draws over 400 attendees from 20 countries on four continents who are interested in learning about the latest in rigid and elastomeric thermoplastic polyolefin (TPO) as well as thermoplastic elastomer (TPE) and thermoplastic vulcanizate (TPV) technologies.

Traditional technical sessions on **Materials Development, Polypropylene Compounds, Applications Development, and Surface Enhancements** are planned for this year's program, as well as new sessions on **TPO / TPE Interfaces** and **Polyolefin Foams & Advances in Olefin Processes**.

For more information about the **SPE Automotive TPO Global Conference**, to view the conference's evolving technical program, or to register to attend the event, please visit <http://auto-tpo.com> or <http://speautomotive.com/tpo.htm>

The advertisement features a photograph of an industrial electric valve gate system. The system consists of a control panel with a digital display and several buttons, connected to a complex assembly of pipes, valves, and actuators. The background is dark, making the metallic components stand out. Text overlays provide key information: 'Eco-Friendly Manufacturing' at the top right, 'Reduce costs with advanced technology and reduced carbon footprint' below it, and 'Electric Valve Gate System' at the bottom left. At the bottom center, there is a logo for 'Plastic Engineering & Technical Services, Inc.' with the website 'www.PETSinc.net' and the phone number '800.811-4403'.



2011 SPE AUTOMOTIVE TPO GLOBAL CONFERENCE SPONSORS:



## Please Attend Exhibit & Sponsorship Opportunities

### Attend the World's Leading Automotive Olefins Forum

Since 1998, the Detroit Section of the Society of Plastics Engineers (SPE®) International has organized the SPE Automotive TPO Global Conference to update attendees on the latest developments in thermoplastic polyolefins (TPOs). Now in its 13th year, the show is the world's leading automotive polyolefins forum featuring 40+ technical presentations, panel discussions, keynote speakers, networking receptions, & exhibits that highlight advances in polyolefin materials, processes, and applications technologies as well as a growing range of thermoplastic elastomers (TPEs) and thermoplastic vulcanizates (TPVs). This year's show will be held October 2-5, 2011 at the Troy-Marriott and will feature sessions on Materials Development, Engineered Polyolefin Compounds, Applications Development, Surface Enhancements, TPO/TPE Interfaces, and a new session on Polyolefin Foams & Advances in Olefin Processes.

### Interact With an Engaged, Global Audience

The SPE Automotive TPO Global Conference typically draws over 400 attendees from 20 countries on 4 continents who are vitally interested in learning about the latest in rigid and elastomeric TPO as well as TPE and TPV technologies. Fully a third of conference attendees work for a transportation OEM, and roughly 20% work for a tier integrator. Few conferences of any size can provide this type of networking opportunity with such an engaged, global audience vitally interested in hearing the latest olefin advances.

### Showcase Your Products & Services with Exhibit & Sponsorship Opportunities

A variety of sponsorship packages are available. Companies interested in showcasing their products and/or services at the SPE Auto-TPO should contact Nippari Rao at [nrao@auto-tpo.com](mailto:nrao@auto-tpo.com).

#### For More Information

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Ph: +1.248.244.8993 or email: [dawn@auto-tpo.com](mailto:dawn@auto-tpo.com)

SPE Detroit Section, 1800 Crooks Road, Suite A, Troy, MI 48064, USA

# Councilor's Report

## Tom Pickett

SPE Automotive Division Councilor

April 30 – May 1, 2011

Council Meetings at ANTEC 2011

The following summarizes the highlights of the Council meetings on April 30 to May 1, 2011 in Boston, Massachusetts. Details of the reports and presentations are available on the SPE website via the following link:

[http://extranet.4spe.org/council/index.php?dir=2011-12 Term/2011.05 \(Boston\)](http://extranet.4spe.org/council/index.php?dir=2011-12 Term/2011.05 (Boston))

### Division Meeting

- Roll call by Mark Barger. Approved meeting minutes from previous meeting.
- OLD BUSINESS Reviewed Division goals.
  1. Grow Division Membership. SPE membership increased 4.2% over last year. Certain divisions grew more. Need to have a Best Practice on ways to increase membership.
  2. Increase Conference Activity. 2010 / 2011 had an increase in TOPCON activity.
  3. Corporate Outreach. Minimal activity to date. Suggest that the division committee appoint a liaison to corporate outreach activity.
  4. Standing Operating Procedure.
- Motion to have a new Flame Retardant Division. Motion approved.
- Division Membership updates and Best Practices. The Automotive Division added 39 new members. The Thermoforming Division added 53 new members. Injection Molding Division added 105 members. Composite Division added 156 new members. The Composite Division added the most new members of any Division or Section this year. How did the Composite Division accomplish this? Dale Grove, Councilor for Composite Division, reported that the Composite Division had a membership drive in which they would buy a year membership for good prospects that would continue to join SPE even after the first year. 35 prospects were signed in as new members. Also the Composites Division has a linked in site. Other than that, Dale explained that the Composite Division was not sure what actually accounted for the large increase in membership.
- TOPCON are more reactive than proactive. Blow Molding hired a coordinator to recruit sponsors like the Thermoforming Conference does.
- Barbara Farit is the incoming Division Chair. The Division vice Chair position needs to be filled.
- Compliance for the rebate. Make sure each division meets SPE National requirements to be in compliance for the rebate. Each Division Leadership can go the SPE website under leadership to review the requirements.

### COUNCIL I Meeting as a Whole

(chairs: Dick Cameron, Dale Grove, Minica Vereij)

- Rich Bradley and Sandra Davis reiterated the importance of following the HSM Application Procedures. The Process Champion for the HSM nomination needs to be more engaged in highlighting the candidate's credentials to facilitate the review by the judging committee. Try to quantify the accomplishments. The judges want to see results. The deadline for submitting application is September 20, 2011.

### Council 1 Meeting

(Ken Braney, SPE President Presiding)

- Ken Braney emphasized that the SPE needs to organize more activities and meetings overseas to recruit more new members. The Eurotech in fall is shaping nicely and the SPE approved the ANTEC – Mumbai in November 2012.
- Bylaws & Policies. Council approved a motion to amend Policy 002 – Rebates to include rebate calculations for additional Sections. Council also approved two new policies: Policy 026 - SPE Europe Territory and Policy 027 - Student Chapter Deactivation.
- Executive Director Report: Financial Review & Staff Update Executive Director Susan Oderwald provided a Financial Review and Staff update. Susan stated that a full financial update is available online, which includes Gross Operating Incomes & Expenses from 2010. A detailed brief on the 2010 audit and a revised staff organizational chart is available on the extranet. Sarah Sullinger has joined SPE as Governance Coordinator.
- Membership Update. Tom Conklin stated that SPE's membership is now over 15,000. 40% of new members came from acquisition campaigns. He also reported on the new approaches being taken in the acquisition of members, including the New Member program and the Student Member program. Tom reported that there is a 50% renewal rate for SPE first time members.
- ANTEC Update. Lesley Kyle reported on ANTEC performance (approximately \$300K over budget on income, including booth sales, sponsorship, and registration revenues). Next year ANTEC will join with NPE on April 2-4, 2012 in Orlando, Florida.
- ANTEC Student Activities. Stephen McCarthy reported that \$32,000 was raised for student activities at ANTEC. There was a tour of Gillette factory for students. More poster sessions this year for students.
- Section Committee Report. (Rich Bradley, Chair and Steve McCarthy, Vice-Chair) Status changes were approved for the following sections because of lack of activity and participation: Scandinavia Section received Abandonment Status and three sections received Provisional Status Baltimore – (Washington Section, Binghamton – Scranton Section and Mid-Hudson Section) and the Abandonment will be considered if no improvement in participation. New Student Chapter was approved for the U of Wisconsin

– Stout. SPE has about 100 student chapters and most of them are affiliated to Sections and very few with the Divisions. The student chapters are currently being reviewed for meeting the minimum requirements: Active faculty adviser, minimum 10 active student members, and affiliation with a Section or a Division. Clark Broome of Piedmont –Coastal Section reviewed the Best Practices in increasing the Section Membership: Offering first meeting free to potential new members, more plant tours, keeping dinner cost below \$20, making personal contacts, showing connectivity. Detroit Section was recognized for providing the Platinum (\$2000) sponsorship for the ANTEC Student Program. Total \$32,000 was raised for travel awards, Student Poster Awards, and the ANTEC Student Luncheon. Four CEOs of Medical Plastics Companies provided inspirational messages on running a business at the student luncheon. Over 100 students and sponsors attended the luncheon.

- Division Committee Report. Mark Barger reported out to the Committee. Mark provided highlights on the Division Councilor Meeting. See above for details of the report.
- Gail Bristol reported that \$6900 scholarship was given to Yale University.
- Strategic Planning Committee (SPC) presented Proposed Alternative Operating Model of SPE (PAOM). Alternative operating procedures for SPE is a community of SPE Member groups (Sections, Divisions, SIG) to recommend alternative operating strategies to support members by pushing authorities down to the lower levels of the group.
- Stimulus package to help sections & divisions that are struggling. Further discussions at next Councilor meeting.
- New Business. A motion was made, seconded and approved to hold the 2014 Annual Business Meeting on April 25, 2014, in Las Vegas, Nevada. In essence, this motion approved Las Vegas as the site of ANTEC 2014.
- Presentations & Acknowledgements. President Ken Braney recognized the Detroit Section for their donations of \$10,000 for the Tom Powers Scholarship, \$2,500 for the SPE Education Award, \$2,000 for student activities at ANTEC, and \$2,000 for the Wonders of Plastics Essay Contest. They also donated back their rebate. Their support of SPE activities is greatly appreciated. The Color and Appearance Division presented a check for \$24,263 as SPE's share of the CAD RETEC. The Palisades-New Jersey Section donated \$1,000 to Student Activities. Outgoing Officers and Councilors were recognized for their service. President Braney expressed his appreciation to retiring Past President Paul Anderson for his many years of service to the Society, particularly for his Presidential year of 2009-2010. President-elect Broome moved that the Society of Plastics Engineers express its gratitude to Ken Braney for his dedicated service as 2010-2011 President of the Society.

## Leadership Awards Luncheon

- The Automotive Division received the 2011 Pinnacle Award and the 2011 Communications Excellence Award. Congratulations to Jeff Helms for his leadership and the Automotive Board of Directors and the Committee Chairs and volunteers for their great work in allowing the SPE Automotive Division to be successful in 2010 - 2011.

## COUNCIL II

(Russell Broome, the in-coming SPE President Presiding)

- Introduced the incoming 2011- 2012 Executive Committee: Ken Braney, Past President; Jim Griffing, Senior Vice President; Scott Owens, Senior Vice President; Brian Grady, Vice President/ Treasurer; Oliver Crave, Vice President/Secretary; Jon Tatzlaff, Vice President; Bill Arendt, Vice President; Brent Strong, Vice President; Raed AL-Zubi, Vice President; Lance Neward, Ad Hoc member; Vijay Boolani, Ad Hoc member; and Susan Oderwald, Executive Director.
- Russell Broome (will be 40 next month) wants to reinvigorate the student chapters and engage younger professionals to join and participate in the SPE growth. Russel said we must embrace change. He emphasized membership, revenue and member groups.
- Past presidents in attendance were recognized. New Councilors were welcomed.
- 2011-2012 Operating Plan and Committee Chair Approvals. Motions were made, seconded and approved to approve the 2011-2012 Operating Plan and 2011-2012 Committee Chairs.
- Guest speaker Howard Rappaport gave a presentation on "Global Overview—Polymers." He talked about the Middle East, Asia, US for polymers. The full presentation is available on the extranet.
- Financial Report. Incoming Treasurer Vijay Boolani gave a brief presentation on the financial year, specifically pointing out that 2012 budget approval will take place at the November Council meeting.
- Moment of Silence. President Broome requested a moment of silence for Alex Mora, a past member of the Executive Committee and former SPE seminar instructor, who recently passed away.

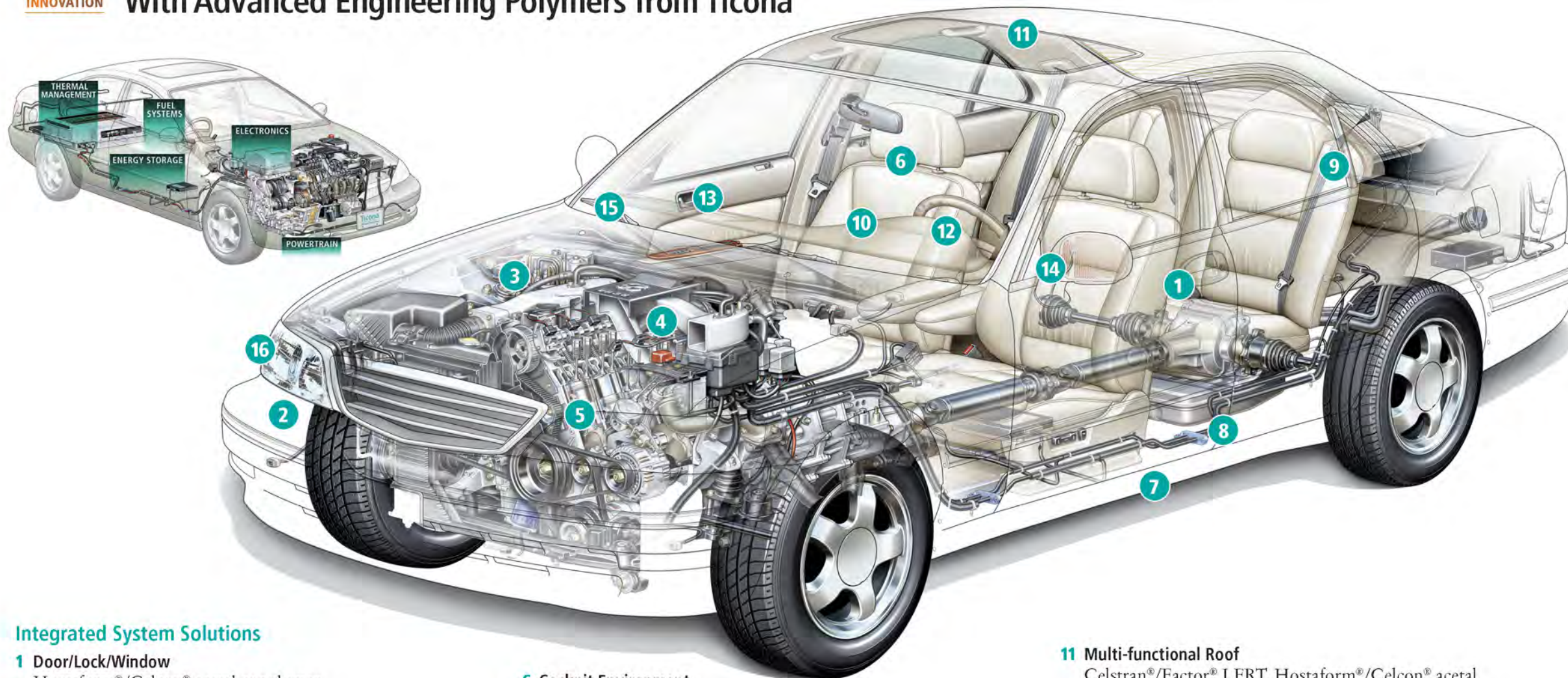
## ANTEC

- Attendance in Boston reached approximately 2,023.
- Incoming President Russell Broome's SPE mantra is: "Embracing Change." The full text of his speech is available on the SPE Council extranet site.



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### 3 Electrical/Ignition

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### 4 Power Distribution

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### 11 Multi-functional Roof

Celstran®/Factor® LFRT, Hostaform®/Celcon® acetal copolymer, Celanex® PBT, Fortron® PPS

### 12 Instrument Panels

Celstran®/Factor® LFRT

### 13 Speaker Grilles, Knobs, Handles and Levers

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### 14 Mirror Housings

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### 15 Wiper Plenums

Hostaform®/Celcon® acetal copolymer, Celanex® PBT, Celstran®/Factor® LFRT

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# **SPE Automotive Division Golf Outing**

**Monday, September 12, 2011**

**Fieldstone Golf Club  
Auburn Hills, MI**

Once again, the SPE Automotive Division and the Automotive Composites Alliance have joined forces to sponsor the SPE/ACA Golf Outing. The outing will again be held at Fieldstone Golf Club, Auburn Hills, MI. The event will take place on **Monday, September 12, 2011, the day before the Automotive Composite Conference & Exhibition.** It ends at 4:30 pm, leaving time for ACCE exhibitors to set up their booths at MSU in Troy.



“This year’s outing will again be held at Fieldstone GC. The course has been upgraded to true championship conditions,” states Brian Czuchra of Plasticolors, Co-Chairman – Golf Outing.

“The SPE golf outing has always been a perfect “feel good” event. This year, we are going to make an even better event,” states Fred Deans, Golf Outing Co-Chairman.

Teri Chouinard, Intuit Group, Golf Outing Sponsorship Chairman has lined up a very effective sponsor program for this year’s event. A list of sponsorship opportunities follows:

- Contest Hole Sponsorships \$1,000.00 includes a foursome, signage, prize awarded on your behalf resulting in additional recognition – we will reward this on your behalf with many thanks to you and your company or you may have the honor of presenting the award to the winner.

- Hole Sponsorships \$750.00 includes a foursome and signage, and 50 flyers printed and distributed at the event to promote your company and/ or products.
- Lunch Sponsorship \$2,000.00 includes two foursomes, signage, and 50 flyers printed and distributed at the event to promote your company and/or products.
- Dinner Sponsorship \$3,000.00 includes three foursomes, signage and 100 flyers printed and distributed at the event to promote your company and/or products. Also includes your company advertisement and/or message as a centerpiece on the dinner tables.

Details on registration are:

Registration Fee - \$500.00/foursome (\$125.00 each)  
Includes Golf, Continental Breakfast, Lunch & Dinner!  
All Participants are asked to bring a prize to give away, such as golf balls, umbrellas, shirts, hats, coolers, towels, etc.

Registration & Sponsorship Contact:

Teri Chouinard 810.797.7242  
email: [teri@intuitgroup.com](mailto:teri@intuitgroup.com)  
Fred Deans 248.760.7717  
email: [fdeans@alliedcomptech.com](mailto:fdeans@alliedcomptech.com)  
Brian Czuchra 440-997-5130 x 211;  
email: [bczuchra@plasticolors.com](mailto:bczuchra@plasticolors.com)

Contact us and we will send you a registration and payment form. Register soon!

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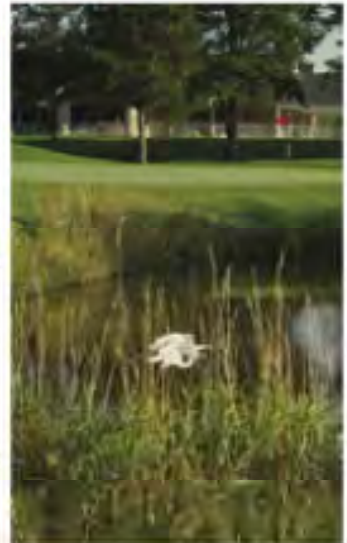
- Acoustic damping
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# 4th Annual SPE Golf Outing



## 2011 Sponsorship Opportunities

There are a number of promotional opportunities available for this year's SPE Golf Outing:

Type of Sponsorship:	Cost:	Benefits Include:
Contest Hole	\$1,000 USD	1-Foursome, Signage, Prize, and more.
Hole	\$750 USD	1-Foursome & Signage
Lunch	\$2,000 USD	2-Foursomes, Signage, & 100 Fliers Printed & Distributed at the Event Promoting Sponsoring Company or its Products
Dinner	\$3,000 USD	3-Foursomes, Signage, Company Message/Logo on Dinner Table Centerpieces, & 100 Fliers Printed & Distributed at the Event Promoting Sponsoring Company or its Products

Hole-in-One and Shootout Sponsorships are also available.  
Contact Teri Chouinard for more details.

### Intuit Group

Phone: 810.797.7242

FAX: 810.797.7243

teri@intuitgroup.com

### Date:

**Monday,  
September 12,  
2011**

### Location:

**Fieldstone Golf Club,  
1984 Taylor Road,  
Auburn Hills,  
Michigan 48326  
U.S.A.**

### Cost:

**\$500 USD / Foursome**

**\$125 USD / Player**

### Program:

**10:00 am - Shotgun Start**

**Box Lunch at Turn**

**3:30 pm - Buffet Dinner**

**4:00 pm - Awards & Prizes**

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# Automotive Division Board Meeting Minutes

April 28, 2011

Monica Prokopyshen—Secretary

## ATTENDEES (italics)

Yvonne Bankowski ,Teri Chouinard, Anthony Gasbarro, Ed Garnham, Jeff Helms. Peggy Malnati , Al Murray, Bill Pippine, Monica Prokopyshen, Nippani Rao, Sheldon Brown, Suzanne Cole, Gary Kogowski

Meeting held at ACC in Troy, 5:30 p.m. – 8:00 p.m., February 07 minutes approved.

**Education** (Monica Prokopyshen) The BOD approved \$1000 in ANTEC travel support for the Society of Plastics Engineers Ferris Chapter. An education subcommittee comprising P. Malnati, B. Pippine and M. Prokopyshen will develop a process for managing education funding requests. A community credit basis, including automotive division activities, was suggested.

**Membership** (Bill Pippine) Membership increased by 15 to 668. Kevin Pageau's 5 slide presentation will be used as the basis for a marketing program explaining the benefits of SPE membership to key industry leaders. One point of discussion was the benefit of educating new engineers. A proposal will be prepared for the next BOD meeting.

**SPE Social Programs** Suzanne Cole has volunteered to co-chair the social programs together with Brian Grosser. Suzanne proposed a joint SPE AD / Society of Automotive Analysts social event.

**Treasurer's Report** (Yvonne Bankowski)  
Since last meeting, \$65,200 (net gain)  
Read the treasurer's report for full details. The account balance is as follows: checking \$140 K, savings \$27.4 K and total \$167.4 K.

Income summary 2/7/2011 – 4/28/2011:

Income	\$85.4 K
Expenses	\$20.2 K
Net Income	\$65.2 K

**AutoEPCON** – (Nippani Rao) 186 people attended AutoEPCON held at the MSU extension in Troy, Michigan on April 26, 2011. Sponsorship increased and the conference had record attendance.

## **MARCOM** (Peggy Malnati)

Website content is 2.3 GB including latest 2011 ACCE conference and IAG information along with new content and fresh look: new banner and buttons, media center with all 2009 & 2010 press releases, as well as survey, online subscribe, and twitter and blog links.

A new record number of hits 27,409 (March 2011) was reached and steady upward trend in readership continues.

Technical issues with 4spe.org's online registration software.

Negotiated exchange deals with recruiters. In exchange for assistance in filling a job opening, several recruiters will make a tax deductible contribution to SPE for a scholarship.

Twitter followers have risen to 152 (from 98).

Launched new WordPress blog:

<http://speautomotive.wordpress.com/> .

## **IAG** (2011 Dates Finalized)

**First Round Judging:** Sept. 29 & 30, Ticona Engineering Polymers, Auburn Hills, Mi

**Blue Ribbon Judging:** October 10, 2011, Ticona Engineering Polymers, Auburn Hills, Mi

Four new Blue Ribbon Judge candidates were proposed.

**Awards Gala:** Wednesday, November 9, 2011, Burton Manor, Livonia, Michigan

The board reviewed the 2011 Lifetime Achievement award candidate nominations. Voting for this year's recipient from the 3 finalists was coordinated by P. Malnati, using the Survey Monkey online tool.

RFQ for photography in process.

## **Newsletter / Sponsorship**

Teri Chouinard provided the newsletter sponsorship summary.

Opening Balance	\$32,000
New Sponsorship	2,400
Closing Balance	<u>\$36,400</u>

Prospects Pending \$2,400

## **New Business/Other**

Dawn Stephens has been selected to replace Pat Levine as SPE office manager upon her retirement. The board approved a motion to co-host a retirement dinner, together with the Detroit section, to honor Pat's many years of excellent service to the Detroit Section and Automotive Division.

The SPE AD received top honors at this year's ANTEC -- **both the Pinnacle and highest Communications Excellence awards.**

## **Next BOD Meeting**

Monday June 13, 2011

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# The Road to Innovation Starts at Asahi Kasei

## 3 Game-Changing SPE Award Nominations

**Process Enabling Category:** Using an innovative short-glass PP resin, Inalfa Roof Systems consolidated a four-part metal/plastic sunroof assembly into a single, molded frame, resulting in significant weight, piece price, capital investment and lead time savings.



**Material Category:** Utilizing an innovative, patented PP+mPPE resin for a liquid cooled battery application, Asahi Kasei was able to create a material for Cobasys, LLC that provides superior chemical resistance and exceeds critical environmental conditions while allowing for thin-wall molding, high-temp creep resistance and weldability.



**Environmental Category:** The development of a low-emission acetal copolymer resin for Brose Group's advanced lumbar support mat has exceeded even the most stringent of global OEM standards for volatile organic compound emissions.



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# Enabling Faster Resin Infusion Processing of Automotive Composites: A “Nano-Nectar” Technology Leading Epoxy to High Performance and Low Viscosity

W.H. Zhong  
 School of Mechanical and Materials Engineering  
 Washington State University, Pullman, WA  
 katie\_zhong@wsu.edu

## Abstract

Graphitic carbon nanofibers (GNFs) were first made into a “nano-nectar”, which is “liquid nano-reinforcement” (LNR) with reactive nanofibers (r-GNFs). Due to the uniform dispersion of r-GNFs in the LNR, simply mixing the LNR with an epoxy led to a nano-modified epoxy with uniform dispersion of nanofibers, a so-called nano-epoxy. More importantly, the nanofibers were involved in the cross-linking structures of the epoxy through covalent bonding between the epoxy matrix and the nanofibers. Results showed that the nano-epoxy possesses dramatically reduced viscosity and enhanced multiple mechanical and thermal performances by simply mixing two kinds of liquids: a very small amount of LNR, functioning as a “nectar” and a base epoxy matrix. The simplicity of the “nano-nectar” approach leading to reduced viscosity (e.g. 50% lower than the pure epoxy) can lead to faster Resin Infusion processing for automotive composite manufacturing due to reduced power requirements for flow and part consolidation.

## Introduction

A resin matrix with good processability (e.g. low viscosity) and advanced comprehensive performance including high mechanical properties, thermal stabilities, good wetting and adhesion capability are highly desired for fiber reinforced polymer (FRP) composites. Through nanotechnology, properties of FRPs could be enhanced through developing high performance reinforcements and resin matrix materials, as well as increasing interfacial adhesion properties between the fiber and matrix (Figure 1) [1].

Though the absolute properties of carbon nanofibers (CNFs) in the length direction, such as mechanical properties and electrical conductivity, are not as high as CNTs, there are several advantages available for CNFs. Firstly, because of the high purity components of graphitic structures (extremely low

contents of free carbon and non-carbon ingredients), there is little or no need to do any purification for commercial CNF products, which have much lower price and stable quality. Secondly, the stacked geometry of CNFs provide an abundance of reactive edges at the ends of the graphene sheets along the fiber direction, which can be used to enhance nanofiber chemical modification – edge sites are far more reactive than surface sites. Thus, CNFs can be surface-functionalized with reduced processing time. This can lead to great potential for applications in structural FRP composites with bulk volume needs.

## Preparation of Liquid Nano-reinforcement (LNR)

Detailed procedures for preparing surface-functionalized herringbone CNFs with (3, 4'-oxydianilino)amidyl (ODA) linker molecules, 4', formed into CNF-ODA suitable for covalent incorporation into epoxy resins were provided in [2-4]. The subsequent treatment procedures that resulted in the “liquid nano-reinforcement”, LNR, include cutting the as-received GNF-ODA nanofibers into shorter ones using appropriate ultra-sonication methods with controlled sonication conditions [5], and then these CNFs were further reacted with a “small epoxy”, butyl glycidyl ether (BGE, a reactive diluent of epoxy) (Figure 2) under special conditions [7]. This is because BGE has the epoxide group similar to the epoxy but being smaller molecules than typical epoxy molecules, thus it functioned as a reactant that can react with CNF-ODA.

On the other hand, BGE was used as a dispersant for cutting GNF-ODA nanofibers through ultra sonication methods. After the reaction with the GNF-ODA to obtain the reactive nanofibers, r-GNFs, as shown in Figure 2 [7], a controlled amount of BGE with uniform dispersion of r-GNFs will be kept. Because BGE is a reactive diluent the main function for conventional epoxy processing is to

*Continued page 27*

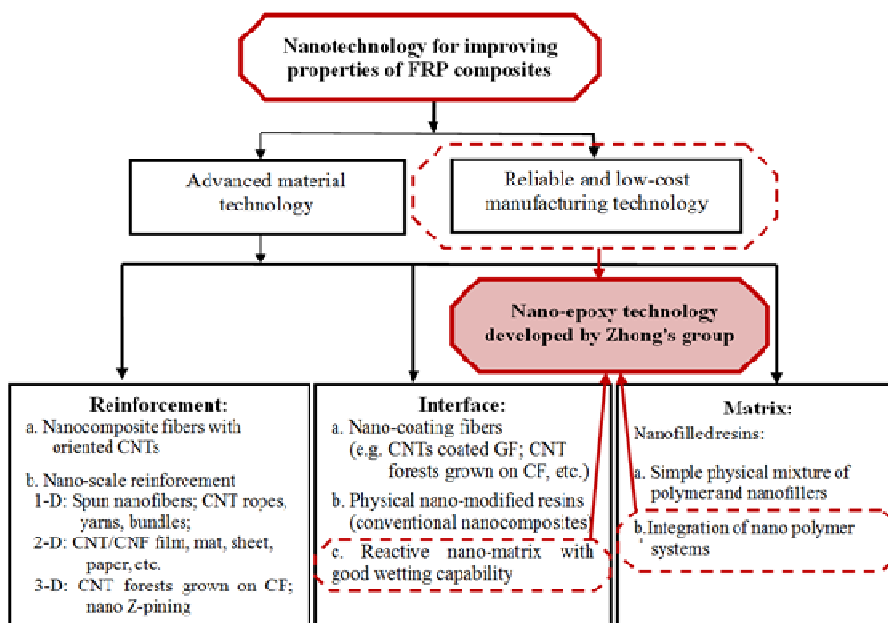


Figure 1: Nanotechnology for FRP composite property enhancement [1]

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# Technical Paper

Continued from Page 24

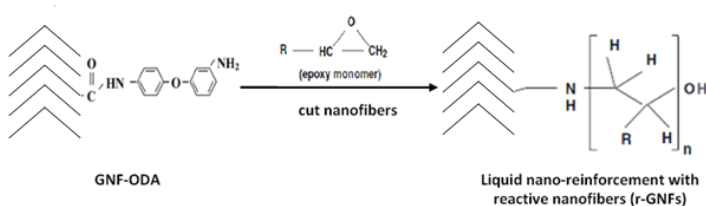


Figure 2: Structure of GNF-ODA and formation of an r-GNF [7]

lower the viscosity of the epoxy. Through the series studies, an optimum ratio of r-GNFs to BGE in the solution was obtained. Through addition of a very small amount of this solution into the epoxy showed a dramatically improved multiple performances; in particular, the viscosity is decreased dramatically. Thus, the nanofibers were converted into a liquid form, the so-called “liquid nano-reinforcement”, with a controlled ratio of the reactive nanofibers to BGE. This stable and uniform solution was then simply added to the epoxy resin. Because the nanofibers were evenly dispersed in the LNR, simply mixing two kinds of liquid: LNR and pure epoxy resulted in the nano-modified epoxy with good dispersion of the nanofibers. Thus, a nano-epoxy matrix with low concentration of nanofibers, such as 0.3 wt% r-GNFs, was obtained.

By developing a nano-epoxy based on the conversion from the dry nanofibers into the LNR, we have solved several key problems including: (1) strong interaction between graphitic nanofibers and epoxy resin through further treatment to achieve covalent bonding level; (2) uniform dispersion of the graphitic nanofibers in a polymer; (3) curing mechanisms for optimization of cure cycles [7-8]. Theoretically, strong interactions from covalent bonding between the nanofibers and polymer resins and good dispersibility have the capacity of enhanced properties for composite applications. Subsequent further work is underway to fully characterize the various properties and advantages of this nano-epoxy.

## Viscosity and Wetting of Nano-epoxy with (LNR)

Durability and reliability of a composite structure highly depends on the fiber/matrix interface, which can be a weak area of structural integrity and overall performance. Utilization of treatment methods can increase the surface energy of the reinforcements, which leads to improved wetting along the fiber/matrix interface. Our proposed approach (Figure 3) is to fabricate a reactive matrix with low surface energy [8], which is a cost-effective way for manufacturing more durable composites. Thus far, there have been no reported studies on the improvement of fiber/matrix interface adhesion through fabricating reactive nano-matrix materials, besides the author’s group’s research.

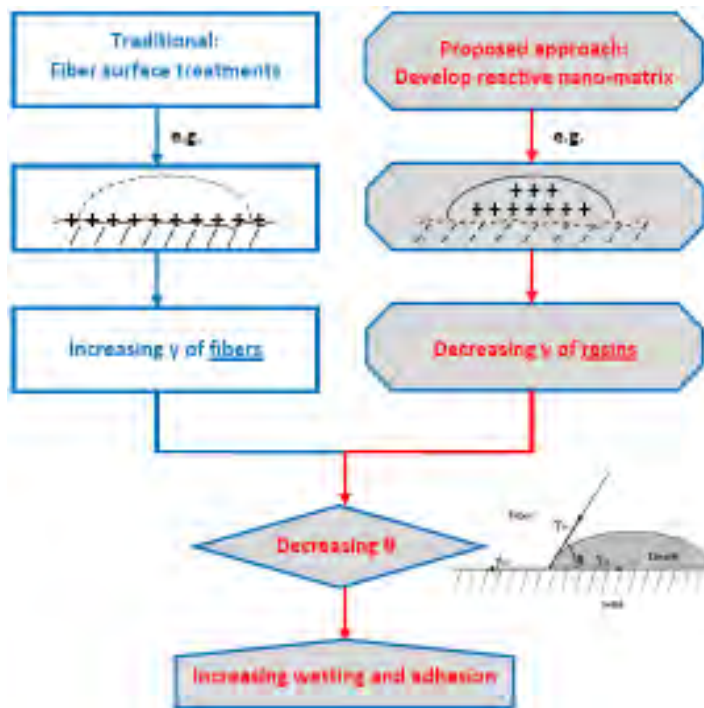


Figure 3: Approaches for increasing wetting and adhesion

Viscosity is one of the important factors that influence wetting of a liquid on a fiber surface. The more viscous or the higher the viscosity of a matrix, the longer the time it takes for the matrix to spread on the fiber surface. Since viscosity is temperature-dependent, even in the environmental temperature range of 23–27 °C, the viscosity fluctuates. However, in this case we found that compared to that of pure epoxy, the variation rates (decrease rates) of viscosity for various samples are fairly stable. The decrease rates of viscosity of five types of samples in comparison with pure epoxy were calculated and shown in Table 1 [8].

Samples	Concentration of Nanofibers, (wt%)		
	0.2	0.3	0.5
Nano-epoxy:	42	52	68
Epoxy + GNFs	30	12	-2
Epoxy + GNFs (non-cut)	20	8	N/A

\*Note: Error is less than 2 %

Table 1: Viscosity decreases: nano-epoxy vs. pure epoxy [8]

Wetting the surface of reinforcing fibers with polymeric matrices is one of the critical aspects for obtaining good interfacial adhesion during the processing stage of fiber/polymeric composites. The term, wettability, is used to describe the extent to which a liquid spreads on a solid surface. The state of wetting between a resin matrix and a fiber can considerably affect the interfacial adhesion. It is evident that insufficient wetting generates interfacial defects and reduces the bonding strength. The wettability of a polymeric matrix on the surface of a fiber is characterized by the contact angle between the fiber and the polymer.

Continued page 28

# Technical Paper

Continued from Page 27

As comparison, wetting behavior of the nano-epoxy and pure epoxy samples on smooth surfaces were characterized using contact angle analysis method and are shown in Figure 4 [9]. It can be seen that although variations in geometric shapes and contact angles between two matrix systems were observed on the smooth surfaces, it cannot fully reflect the differences in the practical application because in reality fewer solid surfaces are truly smooth.

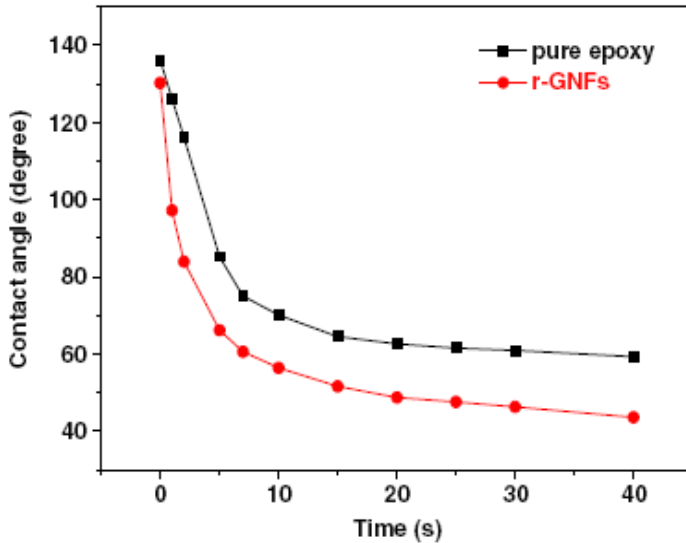
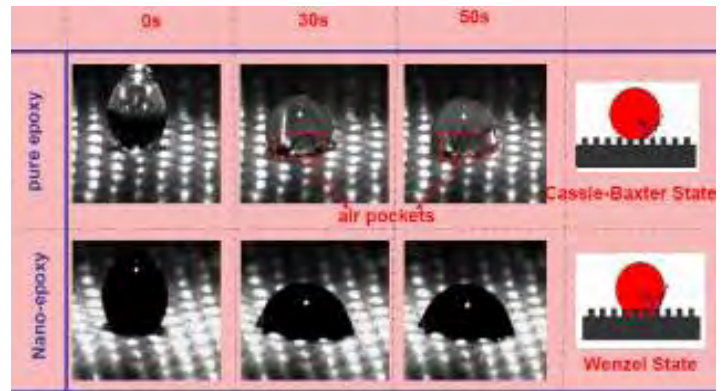


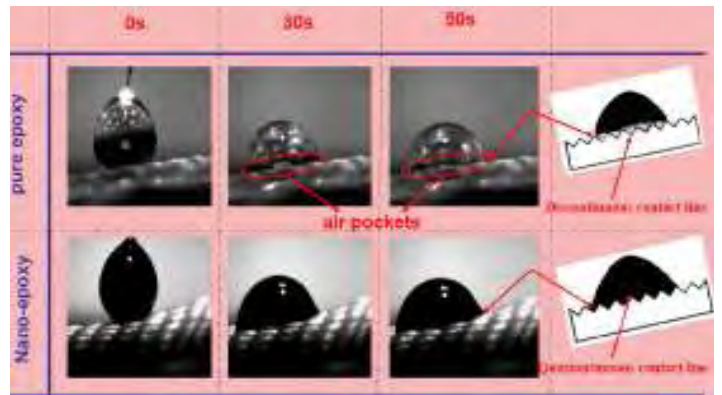
Figure 4: Wetting behavior of pure epoxy and nano-epoxy[9]

Figure 5 shows the wetting behaviors of nano-epoxy and pure epoxy on glass fabric surface [10]. It can be seen that the nano-epoxy matrix had significantly different wetting characteristics on the glass fabric surface from the pure epoxy. The nano-epoxy quickly spread and easily filled up the grooves on these rough fabric surfaces and hence showed a zigzag-like contact line on the rough fabric surfaces. However, the droplets of pure epoxy sat on the top of these rough fabric surfaces without filling up the grooves of the woven fibers so that air was enclosed between the droplet and the fabric substrate.

This difference in wetting state of the two epoxy systems on the rough fabric surfaces reflected the influences of addition of the r-GNFs into epoxy resin. However, from this study it is seen that the conventional contact angle analysis approach and equipment cannot realize quantitative characterizations of wetting behavior of the nano-epoxy on rough or fabric surfaces as shown in Figure 5. To investigate in-depth how the r-GNFs in the format of LNR affect the wetting behavior of the resulting epoxy system is our future research task, which is believed to be significant for the application of nanotechnology in manufacturing FRP composites.



(a)



(b)

Figure 5: Dynamic wetting phenomena of pure epoxy and nano-epoxy on the glass fiber fabric surfaces [9]: (a) horizontal surface; (b) on tilted surface

## Property Summary of the Nano-epoxy with LNR

The previous research indicated that such nano-matrices, in which the covalent bond in nanofiber/epoxy resin and nanofibers are in the form of LNR, possessed greatly enhanced comprehensive performance with broad ranges of improvement [10-20]. The results showed that the nano-epoxy has very low nanofiber concentration (0.3 wt %) and interestingly, it showed lower viscosity compared with the pure epoxy [17]. Property enhancements for the developed nano-epoxy with 0.3 wt% r-GNFs vs. pure epoxy are summarized as follow [11-20]:

- Enhanced mechanical properties (three-point bending):
  - Strength (30%);
  - Modulus (>35%);
  - Toughness (45%)
- Increased thermal properties (DMA and TMA):
  - Higher Tg (14°C higher);
  - Stable Coefficient of Thermal Expansion (CTE)
- Improved processability for manufacturing FRPs (contact angle, viscometer and rheometer):
  - Faster wetting rate on UHMWPE fiber surface (45%);
  - Lower viscosity (50%) and better resin infusion

Continued page 30



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Continued from Page 28

performance;

- Improved overall rheological properties for commercial processing

- Improved interfacial adhesion property with UHMWPE fibers (by pullout tests):
  - Initial debonding force (35%);
  - Maximum pullout force (25%);
  - Energy to debonding (65%)
- Improved mechanical (tensile) properties of UHMWPE fiber composites:
  - Higher at RT: longitudinal stiffness and ultimate tensile strength
  - Hygrothermal effects: Lower diffusivity (60%) (60°C, water, 30 days)
  - Hygrothermal + UV effects: Less effect (UV, 60°C, water, 4 hours)

## Conclusion Remarks

This paper summarized the application of carbon nanofibers in modifying polymer resins used as matrices of structural fiber composites, and introduced the new nano-matrix technology that resulted in a nanofiber-reinforced epoxy matrix with greatly enhanced comprehensive properties. The developed nano-epoxy matrix has successfully tackled several daunting barriers for carbon nanofiber use. Through making carbon nanofibers into liquid nano-reinforcement (LNR), and then compounding with epoxy, the functionalized carbon nanofibers effectively translated their extraordinary performance to end products through covalent bonding between matrix and nanofibers. The liquid nano-reinforcement can easily be dispersed in the base epoxy matrix and proves highly effective for reinforcing and toughening the epoxy resin as well as contributing to dramatically reduced viscosity, which is significant to FRP composites manufacturing energy efficiency (reduced power requirements for flow and part consolidation).

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