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FIRST BLOW-MOLDED TPE CVJ HALF-SHAFT DRIVE-AXLE BOOT SEAL IS 2014 SPE[®] AUTOMOTIVE HALL OF FAME WINNER

TROY, (DETROIT) MICH. – The first global implementation of a blow-molded, thermoplastic elastomer (TPE) constant velocity joint (CVJ) half-shaft drive-axle boot seal used on 1984 model year (MY) *Buick* Riviera**, *Cadillac* Eldorado**, and *Oldsmobile* Toronado** sedans (E/K platform) produced by then General Motors Corp. (GM) was selected as the 2014 *Hall of Fame* winner by the **Automotive Division of the Society of Plastics Engineers (SPE[®])** for the group's 44th-annual **Automotive Innovation Awards Competition**. To be considered for a *Hall of Fame* award, an automotive plastic or composite 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 the criteria: it has been in continuous use on GM cars and trucks for 30 years, and 85% of front-axle CVJ boot seals on light-duty vehicles worldwide now use TPE in this application to replace polychloroprene rubber. Many recreational and commercial vehicles also use the technology.

According to SPE *Hall of Fame* committee co-chair, Nippani Rao, president, RAO Associates, "The success of the first TPE CVJ boot is truly the result of a co-operative development effort that drew on the strengths of tier 1 Nexteer Automotive, formerly GM Saginaw Steering Gear Division (plastics, steering/driveline expertise), tier 2 ABC Group (process innovator and part manufacturer), and materials supplier E.I. DuPont de Nemours and Co. (Hytrel* thermoplastic copolyester elastomer (TPC-ET, a type of TPE) supplier). The team's hard work — which began in 1977 with joint development of the first blow-molded TPE rack & pinion steering boot — was led by Nexteer with boot design, testing, validation, and correlation to vehicle performance. The result was a very-successful introduction of a far more robust CVJ sealing solution that also was lighter, more durable, and less costly than the injection-molded rubber boots it replaced. This is just the kind of application we seek to honor in our annual *Hall of Fame* award."

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David Reed, General Motors Corp.-retired and also SPE *Hall of Fame* committee co-chair, who was involved with the original application's approval process when he worked at GM's Chevrolet and Pontiac divisions as well as CPC Engineering, explained the significance, "It was a truly bold and revolutionary change to switch from thermoset rubber to thermoplastic elastomer. Saginaw (Nexteer) ran every performance test we could come up with on the new material, and with each iteration, the TPE passed with flying colors. It offered us both low-temperature flex to -40 degrees Fahrenheit (-40 degrees Celsius) *and* high-temperature durability to 250 degrees Fahrenheit (121 degrees Celsius)."

The basic function of CVJ boots is twofold. First, it protects bearings in the constant-velocity joint by keeping out dirt, water, salt, ice, snow, mud, stones, and other road debris. Second, it keeps lubricating grease inside the CVJ as the drive axle rotates and propels the vehicle. At the time the application was developed, rubber boot failures accounted for the majority of drive-axle repairs. The team set out to develop a new boot that would solve performance problems inherent to the incumbent material. The new part had to meet a challenging set of performance standards, including providing:

- Excellent resistance to flexural fatigue to allow for high steering angles and dynamic suspension travel;
- Broad temperature performance ranging from -40 to 121 degrees Celsius (-40 to 250 degrees Fahrenheit);
- Resistance to attack from chemicals (underhood fluids and greases) and ozone;
- Resistance to punctures, impacts, and abrasion;
- Dimensional stability at higher speeds; and
- Smaller, more compact designs with thinner wall sections to reduce part weight and material costs.

Following successful launch of the rack & pinion boots in TPE, the three suppliers worked for several years to develop the CVJ boot application. Process innovations as well as specialized equipment were developed by ABC Group to blow mold what at the time was a new material. Challenges that had to be solved included parison control, material distribution to achieve thinner-walled parts, shot-to-shot consistency, and ramp-up work to launch this sizable program. Efforts paid off with DuPont developing a new grade of the TPE and ABC Group patenting process developments that permitted tighter tolerances on the sealing surface to prevent leaks, which had been a big issue with the era's incumbent technology.

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That first year, 250,000 of the parts were produced for the initial limited launch. The following year, in 1985, ABC Group produced 11-million of the TPE boots for GM cars and trucks. The application proved a resounding success. It offered initial tooling savings of \$380,000 USD (versus the cost to injection mold either rubber or hard plastic). It was 65 grams / 2.3 ounces lighter than the rubber part it replaced (85 versus 150 grams / 3.0 versus 5.3 ounces). Technical innovations in the application have continued, with current TPE CVJ boots weighing as little as 40 grams / 1.4 ounces.

The TPE boots also proved to be less expensive than the typical cost for thermoset rubber boots of the same size. More importantly for automakers and their customers, the TPE boots extended product life and durability by 3-4 times and are now considered "service for life" parts, eliminating the need for replacement under normal conditions. The parts also met all the application requirements for flexural fatigue, chemical and ozone resistance, puncture / impact / abrasion resistance, and did indeed make it possible to mold the part in thinner walled, more compact designs. Furthermore, the TPE material is better for the environment, since the process does not generate scrap, the much longer service life means fewer parts are produced and replaced, and the parts are fully recyclable at the end of their use life. Now – 30 years after the first TPE CVJ boots hit the highway – the application still uses Hytrel resin, but weighs half (or less) what the original CVJ boots did, in part due to axle size reduction and the need for less grease. ABC Group continues to supply automakers and global drive-axle suppliers from locations in Canada, Mexico, Brazil, Spain, and China. And whereas the initial application focused solely on front drive axles, today rear axles also sport the TPE boots.

According to Danny Cacciaccaro, ABC Group senior vice-president, "This product was ABC Group's first innovation, and it allowed the company to significantly increase its sales and expand beyond the North American market. Its development was driven by three company partners from the technical process and tooling side. Its success allowed us to establish a global reputation as a pioneer in automotive blow molding, a technology that was in its infancy at the time. The unique process we developed allowed us to create features on the inside of the part and achieve new levels of dimensional control for sealing surfaces."

On **November 12** at SPE's annual ***Automotive Innovation Awards Gala*** held at Burton Manor (www.Burtonmanor.net) in Livonia, Mich., a representative from GM will accept the award on behalf of the original team that worked on the program. Members from ABC Group, Nexteer Automotive, and DuPont Automotive also will be recognized on stage.

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At 4:30 p.m., the event starts with the VIP Cocktail Reception sponsored by Celanese Corp. At 5:00 p.m. the main exhibit area opens for general admissions so guests can review this year's **Automotive Innovation Awards** part nominations, as well as enjoy the specialty and antique vehicles that are always a highlight of the show. Dinner will begin at 6:30 p.m. and the awards program itself will last from 7:00-9:00 p.m. For those who wish to extend merrymaking and networking activities, the ever-popular *Afterglow* – also sponsored by Celanese – will run from 9:00-11:00 p.m.

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 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.

The mission of SPE is to promote scientific and engineering knowledge relating to plastics worldwide and to educate industry, academia, and the public about these advances. 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**, please see <http://speautomotive.com/inno> and <http://speautomotive.com/awa>. For more information on the **Society of Plastics Engineers** or other society events, visit the **SPE** website at www.4spe.org.

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Attn. Editors: High-resolution digital photography available upon request. Numerous other formal and informal shots from prior years' **Automotive Innovation Awards Gala** are available for free download at <http://www.flickr.com/photos/speautomotive/collections/>. Image courtesy of General Motors Co.