

The Dynamic Drive Toward Vehicle Electrification

The Future of E-Mobility is a Mystery—One That Will Lead to the Same Innovation, Disruption and Ingenuity Found in the Early Days of the Automotive Industry

Matthew Jaster, Senior Editor

I will miss the presentations, the debates, and the conversations that were supposed to take place during the annual CTI Transmission Symposium in Novi, Michigan. My favorite ritual as a journalist covering the show was to walk around the tables and watch engineers, managers and manufacturers jot down their ideas on the notepads in front of them during the event. How many of these scribbled doodles and handwritten notes returned to the office and became the starting point for a concrete, sustainable transportation technology?

It's an exciting time to pioneer new technologies and drive systems for the future of the automotive, commercial vehicle, off-highway and transportation industries. There are so many different approaches, guidelines and needs in these markets across the globe that it feels like trying to put together a giant, 5,000-piece puzzle that should probably be divided into 25 smaller—more manageable—box sets.

Though the industry has been unable to come together face-to-face in recent months, it's safe to say that in lieu of trade show discussions debates on batteries, transmission technologies, charging stations, controls, connectivity, digitalization, and drive configurations continue. Companies like Dana, Schaeffler and Eaton recently shared some of their thoughts and ideas on E-mobility in 2020.

Dana Accelerates Electrification Strategy

Dana supplies power-conveyance and energy-management solutions for light vehicles, commercial vehicles, and off-highway equipment, and the company is advancing E-Mobility solutions across all these markets.

"The number one benefit our OEM customers and vehicle buyers are looking for in electric vehicles is performance," said Christophe Dominiak, senior vice president and chief technology officer at Dana Incorporated. "They want EVs that offer not only the same performance characteristics as gas- or diesel-powered vehicles, including speed, maneuverability, comfort, torque response, light weight, and range/operating hours, but they also seek low NVH and minimal weight."

While the company has varying degrees of influence over many of these characteristics, Dana improves performance primarily by optimizing the efficiency and power density of their products. They also develop electronic controls and data analysis solutions, which are critical for optimizing



The Spicer Electrified e-Gearbox from Dana features a compact design that manages high input speeds, provides superior power density, improves mechanical efficiency, and offers a precision-engineered interface for connecting high-performance motors.

performance.

"Since electric and hybrid applications are still evolving, we've found a receptiveness to completely new approaches to propulsion. While we've always supported tremendous variability in drive systems across off-highway applications, manufacturers in the light-vehicle and commercial-vehicle markets are increasingly receptive to unique drive configurations," Dominiak said.

It's important to note that Dana offers a wide portfolio of thermal-management products that improve the durability, reliability, and efficiency of EVs by better managing the operating temperatures of batteries, power electronics, and other key components used in electric and hybrid vehicles.

"We've offered these types of thermal-management products for more than 20 years and won numerous awards for our technologies, which gives us a unique insight into the broader engineering challenges facing electric and hybrid vehicle manufacturers," Dominiak said.

Since Dana is heavily involved in the light-vehicle, commercial-vehicle, and off-highway markets, they see that the EV market is evolving at different rates across these markets and even within markets, especially off-highway.

For example, Dominiak said that the EV market in the light- and commercial-vehicle markets is progressing quickly, driven by increasingly stringent vehicle emissions regulations, the introduction of zero-emissions zones, government incentives, total cost of ownership, and buyer demand.

In off-highway, underground mining equipment, aerial work platforms, and construction equipment used in city centers are moving rapidly toward electrified drivelines.

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The EV market is evolving at different rates across regions as well. The Chinese government has heavily incentivized the purchase of electric-drive automobiles, making it the world leader, while adoption in Western Europe was surging before the current economic downturn.

EV manufacturers and suppliers will face numerous challenges as the market moves toward higher output. The greatest challenges are continuing to extend vehicle range/working hours, bringing the costs of ownership in line with expectations, and establishing a charging infrastructure for plug-in electric vehicles.

"The movement toward electrified vehicles is truly an evolution, so our engineers involved in developing drivelines for traditional gas- and diesel-fueled vehicles are taking advantage of the opportunity to expand their skillsets to manage

the integration of these capabilities is key in delivering effective solutions to market in a timely way," Dominiak said.

To demonstrate how Dana is continuously elevating their capabilities to the highest industry standards, the technical centers are going through rigorous engineering appraisal processes, including CMMI certification for product development as well as the Automotive SPICE certification for software development.

Given the current economic conditions, it's impossible to predict how quickly the EV market will progress in the very near term, but Dominiak firmly believes that the market share of EVs will continue to grow in the long term across all the vehicle markets.

"Over the past year, we have accelerated our capabilities in vehicle electrification, delivering all the elements of a complete, fully integrated electrified system across all mobility markets in any region of the world," Dominiak said. "In addition to our targeted investment in mechatronics research and development, we've made 7 acquisitions since 2017 to position us for success amidst the shift toward electrification."

Schaeffler Touts Innovation in E-Mobility

Schaeffler is a global company with over 11,000 customers worldwide. Now, more than ever, it is apparent that different customers in different countries want different things from an E-mobility perspective, according to Chris Shamie, vice president, hybrid, eAxles and PMO at Schaeffler Group USA.

"For that reason, Schaeffler is 'backing all horses' by offering engineered components, engineered systems and anything in between," Shamie said.

A common denominator of Schaeffler's E-Mobility technology is power density. They are continuously working hard to deliver innovative engineered solutions that do more in a smaller footprint.

"In the US, our customers really look at the overall value equation. Batteries cost somewhere between \$150 and \$200 per kWh capacity. Most modern BEVs will have at least 75 kWh battery which will cost perhaps \$15,000, so each percentage point of overall vehicle efficiency is worth \$150. With that in mind, our customers are looking for ways to reduce mechanical and electrical losses to reduce battery costs. As battery costs continue to come down, that loss reduction could be used to increase vehicle range," Shamie said.

Modularity is also important in the hybrid space. If an OE customer can use the same vehicle structure for both a conventional powertrain and a hybrid powertrain, the savings are immense.

The greatest challenge in meeting the needs of the EV market is that everyone wants something different.

"If you consider the traditional powertrain market in the



Dana electric motor production.

new engineering competencies, such as EV gear geometries and driveline tuning," Dominiak said. "We're also actively expanding our skillset throughout the company by training and hiring engineers with specializations in numerous areas, including mechatronics, electrical, software, and controls.

For example, the Dana Mechatronics Technical Center in Rovereto, Italy, identifies and leverages mechatronics system development opportunities with OEMs, facilitates co-development and networking opportunities with high-tech collaborators, and attracts engineering talent.

The engineers in Rovereto perform systems and components design and validation; technology evaluations and comparisons; proof-of-performance vehicle prototype development; feasibility and performance evaluations; and other advanced engineering functions. They're also deployed to support Dana engineering teams developing specific products for customers around the globe.

"We've also added valuable expertise through our acquisitions of TM4, Nordresa, and the SME Group, which have added critical motor and inverter competencies, as well as integration and application engineering expertise. Obviously,

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old days, an OE customer would have a limited number of engines that would be mated to a limited number of transmissions. Components and systems would often be used across multiple powerpack combinations to boost economies of scale. Often suppliers could market a component or system to multiple OE customers because the powertrain paradigm was very similar across the globe," Shamie said.

Mobility-as-a-service customers might like million-mile durability and low total cost of ownership, but power isn't so important. Pickup truck customers want to be able to tow the world, while energy costs are less important. In Europe, CO₂ reduction is king. These different attributes lead to different ideal propulsion systems, and this hurts the ability for the industry to take advantage of economies of scale.

"While Schaeffler is known for its mechanical products, we've been producing automotive mechatronic products for over 25 years. This background has given us a huge head start for a wider implementation of a mechatronics curriculum," Shamie said.

To prepare the company for a broader life in mechatronics, Schaeffler takes a multifaceted approach.

"First off, we invest in our current team. Schaeffler is fortunate to have an army of good engineers that are passionate about cars. If you have a good engineering skill set and a passion to grow that skill set, with a training investment we can easily pivot to learn new engineering disciplines," Shamie said.

Next, the company works closely with universities to bring in the best talent early on through co-ops and internships. While this is nothing new for Schaeffler, they have put more emphasis on finding electrical engineers and software engineers from these programs.

Finally, as powertrains rely less on drivers and more on software (as delivered in supplied mechatronic systems) the need for functional safety and software quality systems cannot be overstated.

"When Schaeffler was supplying purely mechanical products, the OE customer would give a requirements list with maybe 100 characteristics that must be met. With

mechatronic systems, that list of requirements will have tens of thousands of characteristics that we must deliver. While the fundamentals of our engineering activities did not change, we needed to automate our product development processes to track these thousands of requirements and ensure that we deliver a safe and robust product to our customers," Shamie added.

Shamie said looking back at the early days of the automotive industry, the first few decades were wild.

"We had hundreds of car companies competing for market. We had many different powertrain concepts with different body shapes, different passenger configurations, different levels of safety, and different price points. (Some of the first cars were BEVs!) The free market reigned, and those hundreds of companies dwindled down to around 20. And all those different powertrain architectures funneled down to one main one: an internal combustion engine spinning a multi-speed transmission," he said.

Shamie believes we are going back to those early days where we will see many new companies using different powertrains: ICEs with improved efficiency, parallel hybrids with improved performance and reduced emissions, dedicated hybrids with even better emissions, pure battery electric vehicles with eAxles, and people movers with in-wheel drives.

"Schaeffler is already in all these markets, and we will continue our long history of innovation to make each of these technologies better to improve the value equation," Shamie said. "Eventually the people will pick a new powertrain paradigm, and we will be there to give the market what it wants."

Eaton Looks to Expansion in EV Market

Eaton's eMobility business continues to regularly launch new technologies for the growing electric vehicle industry. They currently focus on three areas of the EV system: power electronics; power distribution and protection; and power systems.

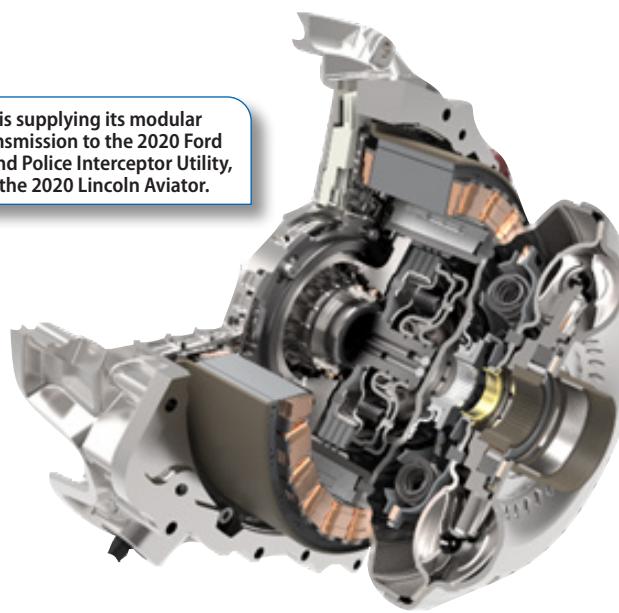
Breaktor, for example, is designed to handle higher voltages than that of competing circuit protection devices. Electrified vehicle manufacturers have increasingly begun to raise the voltage levels on their products to boost range and performance. Breaktor is ideally suited to enable this voltage growth trend.

Eaton has produced industrial circuit breakers and relays for more than 70 years, so even the highest vehicle system voltage is still considered low- or medium-voltage in industrial applications.

"Conventional protection has contradicting design requirements that creates coordination challenges, which can lead to nuisance tripping and significantly reduced reaction time in short circuits or overloads, especially in higher powered battery-electric applications. With less than 5-millisecond actuation up to 1,000 volts and 30,000 amps, Breaktor improves vehicle safety and protects components from any level of overcurrent condition more effectively than traditional circuit protection methods," said Brian McKay, Ph.D., global head of engineering, E-Mobility at Eaton.

Eaton has seen increased demand for intelligent power

Schaeffler is supplying its modular hybrid transmission to the 2020 Ford Explorer and Police Interceptor Utility, as well as the 2020 Lincoln Aviator.





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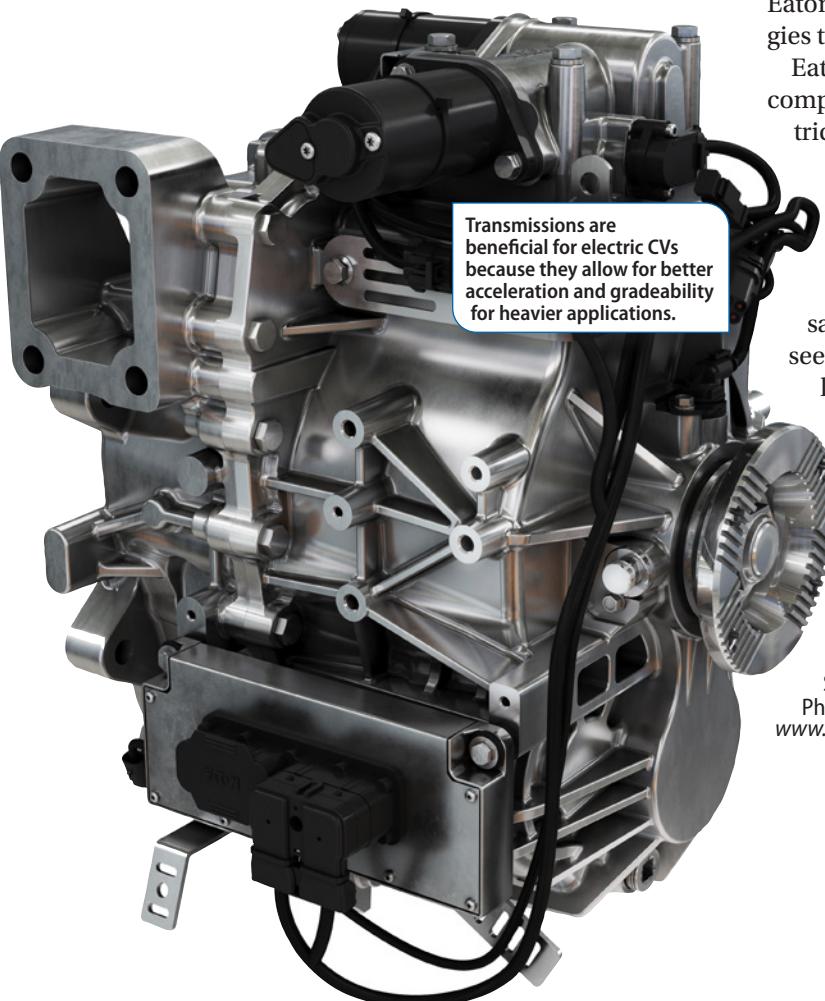
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electronics, power systems, and advanced power distribution and circuit protection, according to McKay. The power distribution and protection category which includes fuses, supercapacitors and power distribution units (PDUs), while converters and on-board chargers fall under the power electronics umbrella. Power systems include electric vehicle transmissions for a variety of medium- and heavy-duty applications, as well as a 48-volt regenerative accessory drive system for heavy-duty trucks.

"Eaton has been in the electric business for years. We formed E-Mobility to combine elements of our Electrical Sector with our Vehicle Group. Eaton has extensive knowledge of vehicle dynamics, management of electrical power and vehicle safety standards," McKay said.

Eaton sells a great number of electrified parts/components, including high-voltage fuses, on-board chargers, inverters, DC/DC converters, and electrified vehicle transmissions. Eaton is a market leader in high-voltage fuses for electrified vehicles.

The electric vehicle passenger car market has grown steadily in recent years, in terms of both the number of vehicles available in the market and in sales. Regulations also are driving electrification. There is a demand for improved fuel economy and efficiency in the passenger and commercial vehicle markets, and it's always a value proposition. Is the cost to add that technology worth the investment?



McKay said that Eaton has solutions that are very cost effective, and they also know that in certain markets, such as China, it doesn't matter what the U.S. is doing with regulations, they're going to battery electric vehicles. And it's the same in Europe.

"Automakers have aggressive growth strategies for EVs for two reasons: consumer demand and to meet increasingly stringent governmental regulations to reduce emissions and improve fuel economy," McKay said.

The expected growth in the EV market for passenger vehicles, as well as for buses and medium- and heavy-duty trucks, will create increased demand for the components needed to electric vehicles: batteries, EV transmissions, circuit protection, on-board chargers, power distribution units, and more.

Eaton's E-Mobility division provides an array of power conversion, management and distribution solutions, making it well-positioned to support automakers and truck and bus manufacturers to meet demand for EVs.

"Our advancements in the components in power electronics, power systems, and power distribution can help our OEMs with a variety of challenges like increasing range, enhancing safety and improving serviceability," McKay added.

While alternative powertrains are expected to increase market share, Eaton does not see the internal combustion engine going away. Because demand for gasoline and diesel engines will remain for passenger and commercial vehicles, Eaton is also focused on developing and refining technologies to reduce CO₂ and NOX.

Eaton's eMobility business combines elements of the company's electrical and vehicle businesses to deliver electric vehicle solutions to passenger car, commercial vehicle and off-highway OEMs.

"While we rely on automotive sales and production forecasting experts for specifics on the future of the EV market, there is no doubt the number of EV models entering the market, as well as production and sales, will continue to increase dramatically for the foreseeable future. The largest expected growth is in China, followed by Europe. EV growth in the U.S. is smaller, but slow and steady increases are expected," McKay said.

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