German Five Push Three New EE Standards

The top electrical engineers from Audi, BMW, Daimler, Porsche and Volkswagen took the stage during the Advances in Automotive Electronics conference earlier this month in Ludwigsburg, Germany, to announce their united effort to develop three new standards. We wrote about two of those standards last month, one for a 48-volt sub-bus architecture, and the other to jointly press for new CAN transceiver chips capable of selectively powering up only the ECUs currently in use so the rest of the vehicle can sleep, the so-called CAN partial-network architecture.

The third major standard announced during their presentation was a cooperative development of electric vehicle charging interfaces designed to handle either AC or DC charging with a single plug. Capable of charging the vehicle in minutes rather than hours, DC charging, also called fast charging, bypasses the onboard AC to DC converter and connects to the high-voltage battery bus.

A sixth German electrical engineer, Burkhard Milke, director of electrical systems, hybrids and electric vehicles at GM Opel, joined the others on stage to show his support for two of the standards: partial networks and the electric vehicle charge interfaces.

Electric Vehicle Charge Interface Standards

About a year ago at a meeting of the Technical Committee of the IEC (International Electrotechnical Commission) in Beijing, engineers from the Society of Automotive Engineers in the United States sat down with some of the German engineers who also were working on combination AC and DC charging interfaces for electric vehicles. “We said, let’s try to harmonize this and move forward. In the past year we have done a lot of work,” said SAE task force leader, Gery Kissel, an engineering specialist from General Motors.

At the Ludwigsburg meeting, the German Five EEs announced the results of those cooperative efforts: Combo 1 is a combination single-phase AC and DC connector developed by the Americans and designed for the U.S. market, and Combo 2 is the three-phase AC/DC connector developed by the Germans for the European market.

Volkmar Tanneberger, Volkswagen’s top electrical engineer, spoke to us by phone after the conference: “We based our standard on the reality that we have the infrastructure for single-phase in North America and Japan, and three-phase in Europe. We are in agreement with the SAE. To each of the type 1 and type 2 connectors we have to add two pins for the DC part, which is necessary for rapid charging.”

Thus far, the SAE and the German Five have agreed to use PLC (power line communications) to communicate over the DC bus. Communications are needed so the vehicle can tell the offboard charger how much voltage and current is appropriate. The SAE and the Germans are presently working to decide which PLC protocol is best and what the messaging formats should be. Work on the interface standard is expected to be completed in the first quarter of 2012.

Volkswagen plans to introduce the Combo plug in its Up electric vehicle in the first quarter of 2013 and later in the electric version of the Golf. Volkswagen markets its electric powertrain vehicles as Blue-e-motion models.

According to Christof Kellerwessel, Ford Europe’s top electrical engineer, the Combo 1 connector will not be ready in time for next year’s launch of the Focus Electric vehicle. “It is in the next genera-
unconstrained. You could have different basic software in every module in the vehicle. So there was a tendency to add a new ECU with every new feature.”

**Autosar Versions**
With most of the world’s carmakers gravitating to Autosar, the existing 150 or so unique ECU software platforms will quickly decline in favor of Autosar. That will greatly simplify the development of software and lead to a much more productive industry. But because some carmakers already have Autosar ECUs in cars on the road, and because of each manufacturer’s new platform rollout timeline and their varying requirements, suppliers will have to support at least three versions of Autosar for many years to come.

The Volkswagen Group plans to use version 3.1 of Autosar in 2012 production starts. BMW and Daimler have also planned releases of version 3.1. But in 2014, Daimler, Volkswagen, Audi and Porsche will transition to version 3.2, while GM, Volvo, BMW, PSA and possibly Ford are going with Autosar release 4.0. Although 3.2 is backward compatible with 3.1, version 4.0 isn’t generally backward compatible with prior versions. Versions 2.1 and 3.0 are already in use.

“The real potential of Autosar is not utilized to the fullest extent,” said Helmut Matschi, member of the executive board at Continental. “We currently must support three versions, 3.1, 3.2 and 4.0.” Version 3.1 will not be used in new vehicles for much longer, according to Autosar spokesman Alain Gilberg. “We foresee that 3.2 and 4.0 will be the main versions used by OEMs and suppliers,” he said.

While having to support two or three versions poses challenges for suppliers, it doesn’t come as a surprise. “It is part of our business to maintain different versions, because the customers are usually at different steps in development,” noted Vector co-founder Helmut Schelling. Still, Dr. Schelling is hoping that there will be no more than two versions under development at any time. Vector provides Autosar software and tools.

Volkswagen, Audi and Mercedes all intend to begin a comprehensive transition to Autosar version 3.2 starting in 2014. “At some point you have to stop the standardization process and define the product,” pointed out Volkswagen’s top electrical engineer, Volkmar Tanneberger. “You need a standard to be stable for a specific time in order to handle your cycle plans and ensure compatibility between different car lines and products.” At this point VW has no plans to move to 4.0.

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**Roland Berger Assesses Li-Ion Battery Makers**

At the Advances in Automotive Electronics conference held in Ludwigsburg earlier this month, Wolfgang Bernhart, of Roland Berger Strategy Consultants, offered his views on current market trends in automotive lithium-ion batteries. Dr. Bernhart sees the large Japanese and Korean battery makers dominating in the mid-term, given their five-year head start over most Western companies in manufacturing lithium-ion cells. Some of the smaller players, some who rely on one major customer and some joint ventures could risk when the market consolidates. Last month Johnson Controls began legal proceedings to dissolve its battery joint venture with Saft.

The table below is from Dr. Bernhart’s presentation, Powertrain 2020, the Li-Ion Battery Value Chain—Trends and Implications. The list is not exhaustive and the companies are not ranked in a particular order.

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### Strong Position

<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG Chem</td>
<td>Leading HEV supplier today, in-house electrolyte material</td>
</tr>
<tr>
<td>SB LiMotive</td>
<td>Bosch and Samsung joint venture with very good cost position, aggressive pricing, key contracts closed and in negotiation</td>
</tr>
<tr>
<td>AESC</td>
<td>Nissan and NEC joint venture has strong partnerships with French OEMs and has large volumes already in production</td>
</tr>
<tr>
<td>Sanyo/Panasonic</td>
<td>Good access to large OEMs (e.g. Volkswagen, Ford); improved position after merger; could become significant player for large-format Li-ion batteries in the mid-term</td>
</tr>
</tbody>
</table>

### Follower

<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lishen</td>
<td>Supplies Chinese OEMs mainly, focus is on China</td>
</tr>
<tr>
<td>BYD</td>
<td>Growing in-house EV demand, low cost structure</td>
</tr>
<tr>
<td>GS Yuasa</td>
<td>No consumer Li-Ion but large volumes through Mitsubishi</td>
</tr>
<tr>
<td>A123</td>
<td>Seeking more automotive partners; mainly in trucks and SAIC JV in China</td>
</tr>
<tr>
<td>SK Energy</td>
<td>Lack of customers, so far</td>
</tr>
<tr>
<td>Hitachi</td>
<td>Electronics competence in house and has supply agreement with GM</td>
</tr>
<tr>
<td>China BAK</td>
<td>Access to Chinese OEMs</td>
</tr>
</tbody>
</table>

### New Business Model May Be Necessary

<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson Controls-Saft</td>
<td>JV is suspended; SAFT has very strong position in military applications</td>
</tr>
<tr>
<td>Ener1</td>
<td>Less cost competitive than Korean/Japanese battery makers</td>
</tr>
<tr>
<td>Dow Kokam</td>
<td>Dow joint venture with TK Advanced Battery and Dassault lacks strong partnerships with OEMs; high investment</td>
</tr>
<tr>
<td>I-Tec</td>
<td>Limited scale, only supplies Daimler today</td>
</tr>
<tr>
<td>Electrovaya</td>
<td>Canadian company, limited success so far with Li-Ion for automotive use</td>
</tr>
</tbody>
</table>

Source: Roland Berger at Advances in Automotive Electronics, Ludwigsburg, Germany
tion of electric vehicles where we would like to commonize ... We have been working with GM and Germany’s National Platform for Electromobility, but we still have a lot of work to do to get complete global alignment.”

Next, carmakers in Germany and the United States will try to convince the Chinese and Japanese OEMs to buy into the standard. “It will be a great success just to have North America and Europe in agreement,” said Dr. Tanneberger. “That will give us momentum toward our goal of having one worldwide standard. ... We have been in discussions with the Japanese and Chinese OEMs and plan many more.”

Partial Networks
To implement partial networks, German carmakers will need redesigned CAN transceivers. “The CAN transceiver needs to handle the sleep mode in a partial network solution, but it also needs to be backward compatible so it can be used in cars that don’t have a partial network mode,” said Dr. Tanneberger.

According to an email from Dr. Tanneberger, “All changes to the CAN transceiver will be done in the public domain. They will be standardized in ISO and Autosar. The functionality will be available and transparent for everyone; proprietary chip designs will be handled by the semiconductor manufacturers.”

Because partial networks will allow carmakers to turn on only those ECUs that are needed, they will contribute to CO2 reduction. For example, there is no benefit to having the seat-control ECU running all the time if you only adjust the seat position once. Likewise, when an electric vehicle is being charged, only the ECUs required for charging need to be on. Without partial networking the vehicle’s ECUs would exceed their specified operating life.

Dr. Tanneberger anticipates that the new CAN transceivers will cost no more than the ones they will replace. “We had the same expectation when we changed from low-speed CAN to high-speed CAN,” he said. “High-speed CAN actually turned out to be less expensive; we like that kind of outcome very well.” The Volkswagen Group, which includes Audi, plans to first use the new transceivers in a partial network solution in a new platform slated for introduction in 2014.

48-Volt Bus
The main benefit of complementing the 12-volt bus with a 48-volt bus is CO2 reduction, through higher performance regenerative braking, optimization of HVAC systems, and shrinking the size and weight of high-power actuators.

According to Dr. Tanneberger, Volkswagen is considering using the 48-volt bus in heavy vehicles with stop-start systems. “We would also use it for driver assistance systems because the demand for electrical energy in critical situations will increase dramatically in the future. ... At least two actuators would be connected to the 48-volt bus, the steering system and the starter,” he said.

All five German carmakers, but not Opel, are planning to employ the 48-volt bus in production vehicles in the short to medium term.

Autosar...

GM (in 2015), BMW (in 2015), Toyota (in 2014), PSA (in 2016), Volvo and possibly Ford are planning implementations of Autosar 4.0. Asked why GM chose the 4.0 platform, Robert Rimkus said, “Since we didn’t have any legacy implementations of versions 2.x or 3.x, it seemed a much better fit for us to start with the latest version. There were also some features we wanted that at the time would only be available in 4.0, for example dual-channel FlexRay. We also wanted support for partial networks, multicore [MCUs] and functional safety [ISO 26262] implementations as well as conformance testing.”

Tool Difficulties
In a presentation made at the Advances in Automotive Electronics conference in Ludwigsburg earlier this month, Audi’s Jens Kötz outlined his experience developing a system based on Autosar 2.1 that is now in production. The development of the system, which involved nine CAN modules and 16 Flexray modules, was not easy. Among the 957 issues that had to be addressed, two-thirds of them had to do with tooling and interchange format problems, which led Mr. Kötz to suggest the need for increasing cooperation among tool suppliers.

“This is exactly the reason the ARTOP [Autosar Tool Platform] user group was formed,” said Mr. Gilberg. ARTOP is developing a common open-source platform for Autosar tools based on Eclipse. ARTOP source code is available free of charge to Autosar members. ARTOP members include BMW, PSA, Continental and Mentor Graphics.
The Company Profile... Valeo

Background

From its founding in 1923, first as a distributor and later a manufacturer of brake linings and clutch facings, Valeo has evolved into one of the leading global suppliers to the automotive industry. Intent on being one of the top three worldwide suppliers in each of its product lines, Valeo has already achieved that position in driving assistance systems, interior controls, transmission systems, electrical systems, thermal systems, lighting systems and wiper systems.

In its 88 years in business, Valeo’s strategic acquisitions, product diversification and international partnerships have enabled its expansion into all the major regional automotive markets.

Valeo set a record for order intake in 2010: €12.5 billion compared with €10.0 billion in 2007, €10.1 billion in 2008, and €9.2 billion in 2009. It expects to match its €12.5 billion order intake record in 2011.

Valeo’s net debt stood at €278 million at year end 2010. On May 3, 2011, Moody’s upgraded Valeo’s credit rating from Baa1 to Baa3 (Moody’s lowest investment grade rating, subject to moderate credit risk) outlook stable.

The company aims to outperform the annual growth in world vehicle production by 3%; its goal is €14 billion in sales by 2015 with operating margin greater than 7%.

Strategy

Since we last profiled Valeo, in the July/August 2007 Hansen Report, the company sold off several businesses including its wiring harness business, which went to Leoni, its truck engine cooling division, its headlamp leveling business and its Telma speed controller group.

Among the biggest changes is the company-wide reorganization in 2009, which consolidated eleven product families into four core businesses: Powertrain Systems, Thermal Systems, Comfort and Driving Assistance Systems and Visibility Systems.

Also in 2009, Valeo elevated the role of its national directorates (regional managers) whose job it is to understand local markets and customers, and devise and implement investments on behalf of those customers and markets. There are thirteen national directorates covering Germany, North America, South America, China, South Korea, Spain, India, Italy, Japan, Poland, Turkey, ASEAN (Association of Southeast Asian Nations) and Russia.

Since our last profile, Valeo has also sharply focused its research and development expenditures toward innovations that help reduce CO2 emissions. The company already produces several products that serve that purpose including stop-start starters and starter-alternator systems, LED headlamps and battery cooling systems. Additionally, the company has received orders for its innovative double clutch transmission system and its combined charge air cooler-air intake system. Valeo is also working on development contracts for a range extender as well as a complete electric drivetrain. Valeo is also investing in new electrically driven compressors, energy recovery systems, electric motors and an eco-driving assistance system.
Distinctions Claimed by Valeo
- World’s number-one supplier of stop-start systems
- World’s number-two supplier of transmission systems
- World’s number-two supplier of global thermal systems (cabin and engine)
- World’s number-one supplier of driving assistance systems
- World’s number-one supplier of interior controls switches
- World’s number-one supplier of wiper systems
- World’s number-two supplier of lighting systems
- World’s only supplier to mass produce three obstacle detection sensors: ultrasonic, camera and radar
- The world’s first supplier to link safety features with a central body electronics module by means of FlexRay

The second major component of Valeo’s new strategy is a strong focus on emerging markets. Noting a significant shift since 2007 in vehicle production to Asia at the expense of North American and European production, the company has sharply focused its market development investments on Asia, especially China and India. By 2020, Valeo expects that Asia will account for 60% of global vehicle production compared with 50% of production in 2010. China was the world’s largest automotive market in 2010 with 17 million vehicles produced. Valeo intends to more than double its sales to China by 2015. Valeo’s goal for sales to China and India is €1 billion by 2013, and €3 billion by 2015.

In 2009, Valeo’s investments in emerging countries such as China and Brazil equaled 5% of sales. In 2010, Valeo’s investments in emerging countries, mainly in Asia, Eastern Europe and Mexico, represented approximately 50% of total investments, or 1.7% of sales.

Valeo employs nearly 8,000 people in China in 15 production sites, three R&D centers, eight engineering centers and an aftermarket distribution center. There are two Valeo technical service centers in China: one in Wuhan for mechanical design and simulation dedicated to lighting, and one in Shenzhen for electronic circuit design.

Valeo also has a technical service center in Cairo, Egypt, for software development and one in Chennai, India, for mechanical design and simulation.

Acquisitions remain a key part of Valeo’s strategy. Of interest especially are companies that have a strong presence in Asia and/or compatible CO2-reducing products and technologies.

In February 2011 Valeo announced its purchase of the Japanese switch maker Niles, for €320 million. More than 90% of Niles’ sales are to Japanese carmakers, including Nissan, its largest customer.

Stop-Start
One of Valeo’s most promising product lines is starters and starter-alternators for stop-start systems. Valeo invested €39 million in micro-hybrid (stop-start) system development in 2010. “With Europe aiming to bring CO2 down to 120 grams per kilometer by 2015, and 95 grams per kilometer by 2020, as well as a strong push in China to mandate CO2 limits, you can imagine the worldwide market tipping in the direction of making stop-start systems standard. We are convinced that by 2020 and beyond stop-start will be standard, heading toward 100% use in non-electric vehicles,” said Martin Haub, group senior vice president for R&D and product marketing.

Valeo offers two belt-driven stop-start systems. One is based on its StARS (Starter Alternator Reversible System) technology; the other is based on a reinforced starter motor capable of making up to 300,000 starts. Conventional starters are usually rated for 50,000 starts. Less expensive than the starter-alternator, the reinforced starter can be installed on small to mid-range vehicles.

Valeo began producing its second-generation starter-alternator, called i-StARS, in the third quarter of 2010, for Peugeot and Citroën diesel vehicles. A mechatronic solution, i-StARS integrates a 1,000-amp inverter within the starter-alternator, which reduces the system’s volume by two-thirds compared with the first generation solution, which had a 600-amp inverter in a separate housing. The i-StARS’ integrated inverter is assembled on a circular aluminum heat sink that is part of the motor.

continued on following page
The i-StARS system can cut off the engine even before the vehicle comes to a complete stop, as soon as the vehicle's speed falls below 8 km/h with an automatic transmission and 20 km/h with a manual transmission. Engine restart takes just 400 milliseconds; it is noiseless and produces no vibrations. On average, stop-start systems can reduce CO2 emissions by 5 grams per kilometer; in congested urban traffic CO2 can be reduced by up to 15%.

Since 2004, when Valeo began selling starter-alternators, the company has booked orders to equip 50 vehicle models from 10 different carmakers by 2015.

Stop-start machines are also produced by Bosch and by Denso, the two other market leaders.

Expertise in Electrification

Mr. Haub expects that by 2020, hybrids, plug-in hybrids and electric vehicles will make up nearly 10% of new vehicles. Valeo gained valuable experience in power electronics for EVs through its work in a French government-funded consortium formed to develop an electric drivetrain. The consortium members, including Johnson Controls-Saft, Leoni, Michelin and others, demonstrated an electric vehicle at the Paris Motor Show last fall. Valeo’s focus is on power electronics (inverter, charger and DC/DC converter) and heat management, as well as reducing overall system costs.

According to Valeo, cost savings could be achieved with its new architecture that allows the traction motor’s coils to be used as part of the charging circuit, which also saves space and weight.

Even though the market for pure electric vehicles will remain small for years to come, Mr. Haub sees a larger payoff for the investment Valeo is making in EV technologies: “The technology you have to develop—power electronics, traction motors, special batteries—for electric vehicles is equally necessary for full hybrids and mild hybrids as well.”

Valeo is developing heat management solutions for both passenger comfort and battery cooling in electric vehicles. “At low temperatures you need as much electric energy to heat the vehicle as you need to drive it,” Mr. Haub noted. One obvious improvement, he noted, can be gained by using a heat pump for both heating and cooling. Valeo will be ready to go into production with energy-saving heat pump systems by 2015 or 2016.

Driving Assistance

Valeo claims the number-one position among the world’s suppliers of driver assistance systems. (Bosch is second, followed by Panasonic.) Most of Valeo’s sales in this product category come from systems that help with low-speed maneuvering and parking. ParkVue uses a camera to provide rearview visibility. Valeo’s 360Vue system uses four cameras to provide the driver with a bird’s-eye view of the vehicle’s position with respect to its surroundings. By the end of 2011, 17 vehicle models will be equipped with multi-camera viewing systems from Valeo. Park4U does semiautomatic parking using a combination of cameras and ultrasonic sensors.

Martin Haub explained: “In its first generation, Park4U handled parallel parking. Now in the second generation it does perpendicular parking as well. It not only helps you get into the parking space, steering for you, it also helps you get out of it. And if you forget to brake, the system gives you a reminder.”

Valeo produces radar blind-spot detection systems, which also serve to alert the driver to obstacles when backing out of a parking space with limited visibility. Valeo also produces a lane departure warning system called LaneGuide, which uses a forward looking camera.

### Interior Controls/Switch Competitors by Global Market Share

<table>
<thead>
<tr>
<th>Supplier Rank</th>
<th>Driving Assistance</th>
<th>Interior Controls</th>
<th>Transmission Systems</th>
<th>Electrical</th>
<th>Thermal</th>
<th>Lighting</th>
<th>Wiper Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Valeo</td>
<td>Kostal</td>
<td>LuK</td>
<td>Valeo</td>
<td>Denso</td>
<td>Valeo</td>
<td>Valeo</td>
</tr>
<tr>
<td>#2</td>
<td>Bosch</td>
<td>Tokai Rika</td>
<td>Valeo</td>
<td>Denso</td>
<td>Kito</td>
<td>Valeo</td>
<td>Bosch</td>
</tr>
<tr>
<td>#3</td>
<td>Panasonic</td>
<td>Valeo</td>
<td>ZF Sachs</td>
<td>Bosch</td>
<td>Magneti</td>
<td>Valeo</td>
<td>Denso</td>
</tr>
</tbody>
</table>

| Market Share of Top Three | 57% | 34% | 44% | 65% | >50% | 59% | 72% |

Source: Valeo

### Valeo’s Competitive Position by Product

<table>
<thead>
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<td>Valeo</td>
<td>Denso</td>
</tr>
</tbody>
</table>

| Source: Valeo |

### Energy Savings from Valeo Technologies*

<table>
<thead>
<tr>
<th>High performance A/C systems</th>
<th>Projected Energy Savings: 3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED headlamp</td>
<td>1%</td>
</tr>
<tr>
<td>UltimateCooling thermal management</td>
<td>3% to 5%</td>
</tr>
<tr>
<td>THEMIS valve</td>
<td>2% to 4%</td>
</tr>
<tr>
<td>Dual-clutch transmission we/electromechanical actuators</td>
<td>4% to 6%</td>
</tr>
<tr>
<td>Exhaust gas recirculation cooler</td>
<td>5% to 7%</td>
</tr>
<tr>
<td>SIARS micro-hybrid system</td>
<td>6% to 15%</td>
</tr>
<tr>
<td>High output alternators</td>
<td>1% to 2%</td>
</tr>
<tr>
<td>Reinforced starter</td>
<td>4% to 5%</td>
</tr>
<tr>
<td>e-Valve system</td>
<td>Up to 20%</td>
</tr>
</tbody>
</table>

*Reductions not necessarily cumulative

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**Interior Controls/Switch Competitors by Global Market Share**

With its acquisition of Niles, Valeo claims the number-one position in the interior controls market. (Bosch is second, followed by Panasonic.) Most of Valeo’s sales in this product category come from systems that help with low-speed maneuvering and parking. ParkVue uses a camera to provide rearview visibility. Valeo’s 360Vue system uses four cameras to provide the driver with a bird’s-eye view of the vehicle’s position with respect to its surroundings. By the end of 2011, 17 vehicle models will be equipped with multi-camera viewing systems from Valeo. Park4U does semiautomatic parking using a combination of cameras and ultrasonic sensors.

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Valeo produces radar blind-spot detection systems, which also serve to alert the driver to obstacles when backing out of a parking space with limited visibility. Valeo also produces a lane departure warning system called LaneGuide, which uses a forward looking camera.
At Auto Shanghai 2011, Valeo demonstrated a system that uses ultrasonic sensors and cameras to detect pedestrians in the vehicle’s path. Once detected, the system emits an audible alert aimed in the direction of the pedestrian. In 2010, Valeo invested €12 million in ultrasonic sensor and camera system production lines.

Valeo claims to be the world’s only company that mass produces these three sensors: ultrasonic, camera and radar. Since it began using ultrasonic sensors in park assist systems in the late 1990s, Valeo has produced well over 100 million ultrasonic sensors. As many as 12 ultrasonic sensors are used in each vehicle.

Anticipating the growing market for driving assistance systems, especially systems with autonomous features, Valeo is in the process of commercializing a fourth sensor: laser scanners. In December 2010, the company announced an agreement with laser-scanner specialist Ibeo Automotive Systems GmbH to bring laser scanner technology to the high-volume automotive market.

Mr. Haub noted: “Nearly all the cars in the DARPA Urban Challenge test of driverless cars used laser scanners, which provide a nearly three-dimensional view of the environment around the vehicle. Having that technology will give us a chance to fuse data from cameras, ultrasonic sensors, laser scanners and radar sensors to master very complex situations in the city such as pedestrian detection, automatic braking for pedestrians, intersection control and more.”

### Products

#### POWERTRAIN SYSTEMS
- Transmission Systems
  - Dual dry clutches*
  - Clutches with or without self-adjusting technology
  - Clutch discs
  - Clutch facings
  - Release bearings
  - Hydraulic clutch actuators
  - Flexible flywheels
  - Dual mass flywheels
  - Torque converters

#### Electrical Systems and Hybrid and Electric Vehicle Systems
- Stop-start machines
- Starter alternators
- Reinforced starters
- Electric drivetrains including
  - Power electronics for hybrids and EVs*
  - Electric motor drives

#### Engine Management Systems and Air Management Systems
- Engine control systems for gas and vehicle natural gas (VNG) engines
- Engine control units for direct and indirect injection*
- Engine control units for VNG and flex fuel alternative fuels
- Engine components
  - Ignition coils
  - Injectors
  - Sensors
  - Canister valves
- EGR and air intake modules

#### THERMAL SYSTEMS
- Climate Control
  - Air conditioning systems and modules
  - Evaporators
  - Heater cores
  - Multi-zone HVAC units
  - Battery thermal management

#### Rear air conditioning
- Electric radiators for instant cabin heating*
- Air-conditioning systems with storage evaporators for stop-start vehicles*
- Electric air-conditioning for hybrid vehicles*
- Air quality products
  - Particle, gas and odor filters
  - Fragrance diffusers
  - Ionizers

#### Powertrain Thermal Systems
- Heating and cooling products
  - Radiators
  - Condensers
  - Oil coolers
  - Fan/motor systems
  - Cooling modules
  - Air intake cooling modules
  - Charge air coolers
  - THEMIS smart temperature controls*
  - EGR coolers
  - Low-energy heating systems for electric vehicles*

#### Air-Conditioning Compressors
- Pallet
- Fixed-cylinder
- Variable-cylinder
- Electric compressors

#### Front-End Modules
- A complete range including Safe4U active pedestrian protection system

#### DRIVING AND ASSISTANCE SYSTEMS
- Driving Assistance
  - Park4U semiautomatic parking system
  - Rain/light/humidity detection system
  - ParkVue rearview visibility system
  - Blind spot and reversing detection systems
  - 360Vue multi-camera system
  - LaneGuide lane departure system
  - Ultrasonic sensors
  - Radar sensors

#### Camera sensors
- Interior Controls and Electronics
  - Top column body control modules
  - Body control modules
  - Battery management modules
  - Switching and driver interface panels for HVAC and multimedia control
  - Steering angle sensors
  - Angle
  - Torque

#### Access Mechanisms
- Keyless entry and ignition systems
- Smart (two-way) car keys*
- RF remote access controls and receivers
- Door latches
- Automatic tailgate closure/movement detection*
- Assisted side-door closing systems
- Transponder-based immobilizer systems
- Mechanical and electrical steering column locks
- Mechanical keys and locks

#### VISIBILITY SYSTEMS
- Lighting Systems
  - Main headlamps with LED, xenon or halogen technology
  - Camera assisted adaptive headlamps
  - Daytime running lights, LED or incandescent
  - Rear and high-mounted stop lamps, LED or incandescent
  - Fog and auxiliary lights
  - Lighting and signaling controllers
  - Cigar lighters
  - Multifunction sockets
  - USB ports

#### Wiper Systems
- Arm and flat/traditional blade sets
- Wiping systems with mechanisms or electronics
- Windshield de-icing and washing systems
- Rear wiping systems
- Wiper motors

*Not yet in high-volume production
Bosch Automotive Technology

2010 Sales: €28.1 billion, 59% of Bosch Group sales
Change from 2009: up 29%
2010 EBIT: €2.3 billion or 8.2% of sales, following its first ever loss, €498 million, in 2009

Outlook for 2011: Sales are expected to exceed €30 billion. Bosch sees continued growth in the automotive sector with increased demand for diesel common rail systems in Europe, and for gasoline direct injection and electronic stability control systems globally. Bosch plans to increase its headcount by approximately 10,000 positions in 2011, most of them in Asia.

While Bosch’s facilities in Japan suffered only minor physical damage from the March earthquake and tsunami, the company says it has been affected by the ensuing global supply chain disruptions, which “put a temporary brake on the world economy.”

While Bosch’s own forecasts predict that electric vehicles, plug-in hybrids and hybrids will make up just 9% of all vehicles produced in 2020, the company firmly believes the electrification of the vehicle is inevitable in the long term.

Beginning in 2004, Bosch has developed a full range of hybrid and electric powertrain products including motors, power electronics and lithium-ion batteries, which it produces through SB LiMotive, a joint venture with Samsung. SB LiMotive began producing battery cells in Korea in November 2010.

Bosch’s full hybrid systems were launched in the Porsche Cayenne S and Volkswagen Toureg in 2010. It is working with Peugeot on a diesel hybrid due in 2011. Bosch spends €400 million annually on powertrain electrification, roughly 13% of its total automotive R&D spending.

In the shorter term, Bosch sees continued growth in products that contribute to fuel efficiency improvement and reduced emissions in conventional vehicles, for example, 10% annual growth in diesel common rail systems through 2015, and a doubling in unit sales of stop-start systems in 2011 compared with 2010.

Aisin Seiki

Fiscal year ending March 31, 2011

FY 2011 Consolidated Net Sales: ¥2,257.4 billion ($27.9 billion)

Change from FY 2010: up 9.9%
FY 2011 Operating Margin: 6.1%

Outlook for FY 2012: None given yet
Aisin depends on Toyota for 65% of sales; Volkswagen/Audi is Aisin’s second largest customer, accounting for 7.5% of sales.
Sales in Japan accounted for more than 70% of total sales; North America and Asia each accounted for about 11%.

Aisin AW, the Aisin Group business that produces automatic transmissions and navigation systems, showed a healthy 15.8% increase in sales, to ¥854.5 billion, and an operating margin of 7.2%.

Automatic transmission production increased 18%. Anticipating increased demand from local OEMs, Aisin AW recently announced the creation of a second subsidiary in China to produce automatic transmissions.

Aisin AW makes a broad line of navigation products including Internet-connected voice navigation systems specifically targeted for Japan, North America or Europe, and iPhone navigation apps for the Japanese market.

Denso

Fiscal year ending March 31, 2011

FY 2011 Consolidated Net Sales: ¥3,131.5 billion ($38.7 billion)

Change from FY 2010: up 5.2%
FY 2011 Operating Margin: 6.0%

Outlook for FY 2012: Denso has not yet released its forecast for the year ending March 31, 2012; it is still assessing what effects the Japan earthquake will have on future sales. A new Denso plant under construction was damaged in the earthquake. Toyota, its major customer, forecast its unit production for the fiscal year ending March 31, 2012, would increase by only a fraction of a percent.

Denso attributes its 2010 sales growth to the recovery in the automotive market in North America and the growth of the automotive market in emerging countries.

Japan accounted for 67.5% of Denso’s sales and 33.7% of its total operating income.

Denso invested 9.3% of sales in R&D in FY 2011 and much of the focus is, not surprisingly, on fuel and energy saving products such as stop-start systems, heat-pump based climate systems and integrated navigation.

Electric Vehicle Cost Reduction a Major Challenge

The biggest challenge in bringing an electric vehicle to market is the high cost of EV components, especially the lithium-ion battery, which costs significantly more than all of the other electrification components combined. Today’s electric vehicles are due in 2013—first the Up Blue-e-motion city car, followed by the Golf Blue-e-motion.

Denso’s forecasts predict that electric vehicles, plug-in hybrids and hybrids will make up just 9% of all vehicles produced in 2020, the company firmly believes the electrification of the vehicle is inevitable in the long term.

Batteries also have insufficient energy density which severely limits their range. Despite the high costs, Volkswagen’s first electric vehicles are due in 2013—first the Up Blue-e-motion city car, followed by the Golf Blue-e-motion.

Change from FY 2010: up 5.2%

Outlook for FY 2012: Denso has not yet released its forecast for the year ending March 31, 2012; it is still assessing what effects the Japan earthquake will have on future sales. A new Denso plant under construction was damaged in the earthquake. Toyota, its major customer, forecast its unit production for the fiscal year ending March 31, 2012, would increase by only a fraction of a percent.

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Source: Volkswagen, at Advances in Automotive Electronics meeting, Ludwigsburg, Germany, June 2011