Passat for Model Year 2016

Active Info Display

Of all the new electronics aboard the 2016 Passat, Dr. Tanneberger is most proud of the 12.3-inch reconfigurable cluster/display, available as an option. You would expect to find a high-resolution (1,440 x 540 pixels), multifunction cluster in the Audi TT, but not in a high-volume B-segment vehicle. The Passat’s MSRP extends from just $21,340 to $35,995.

“We were able to integrate multiple functionalities into the display: driver assistance systems, 3D maps, navigation, comfort systems, entertainment, online services, CarPlay and Android Auto, everything,” said Dr. Tanneberger. The cluster features two eye-catching gauges, an analog appearing speedometer and tachometer. The gauges move from the middle of the display, one to each side, and change size to make room for other functions. One HMI challenge that had to be overcome was that the cluster/display is controlled only by the steering-wheel mounted switches. It is not a touch panel display.

The display advances the state of the art of automotive displays, noted Dr. Tanneberger. “We are approaching Retina resolution.” A name used in Apple marketing, Retina means that your eye is unable to detect the dots even at half a meter away.

Multiple Efforts Underway

It is clear to everyone that the data that will soon be available from connected cars will be worth plenty: tens of billions of dollars per year, at least. One of the many potential uses for that data will be to make driving safer. With permission from the vehicle owners and with control of the dashboard, carmakers are in the best position to harvest that data to accelerate vehicle development and to profit. If all the data conformed to a common standard it could be more easily collected, processed and divvied up among the many public and private entities that want it, thus increasing its value.

Six of the world’s major carmakers have begun working together to develop standard formats for the data that would support fully automated driving. Separately, the U.S. Department of Transportation (USDOT) has already put a small pilot system in place that showcases the data structure it is developing so that data used for safety or to benefit transportation could be shared by all. Separately, Thomas Müller, the top electrical engineer at Volvo, has begun exploring the prospects for carmakers to create a nonprofit association to share collected data. In addition, we have a related development: the acquisition by the German carmakers of the digital map-maker HERE.

USDOT

A component of its Connected Vehicle Pilot Deployment program, USDOT is developing and testing what it hopes will become a widely used standard for moving data to and from vehicles. USDOT’s ITS Joint Program Office has been operating a very small (seven-vehicle) installation in Michigan that appears to confirm its assertion that the data structure it is developing can work.

“We have defined the data units including performance and accuracy require-

ments,” said Walt Fehr, manager of systems engineering for the ITS JPO. “We have the data units moving, we have people investigating how you create them in vehicles, how you deliver them to the back offices, and how you take the derivative data units that are created and send them back to the vehicles.”

The data specs being tested are derived from the DSRC Message Set standard, SAE J2735, which was intended for V2V safety applications but can be used in other applications and wireless spectra. The JPO is encouraging adoption of the new standard by the project teams that will participate in its five-year, $165-million connected vehicle pilot program.

Mr. Fehr: “One of the central points we are trying to emphasize is the development of uniform data from all contributors, information such as the location of moving vehicles on the roadway, the location of stopped traffic, black ice, fog, parking spaces, the fundamental data that everyone should have the benefit of. All can contribute, all can benefit in a commodity-style market.”

“With V2V and V2I it is obvious you have to have a single language. You can’t have each brand of car talking a different language,” noted Danny Shapiro, director of automotive marketing for Nvidia.

To learn more about the data standard or the connected vehicle pilot program, please contact walton.fehr@dot.gov.

Six Major Carmakers Cooperating

Regulators will almost certainly require that cars that can drive autonomously cannot rely on drivers to intervene when there is a problem. Even with a ten-second warning, drivers will find it challenging to take over the wheel in dangerous situations—and do so safely. Drivers will either need more advanced warning, or the car on its own will have to safely negotiate construc-

Turn to Tanneberger, page 8

Turn to Data Standards, page 3
New Car Features

Safety, Fuel Economy and Infotainment Make Inroads

Safety

Despite the steady penetration of active safety features in new vehicles, traffic fatalities in the U.S. are up 14% in the first six months of 2015 compared with the same period in 2014. According to the National Safety Council, lower gas prices, lower unemployment and a rebounding economy are translating to more miles being driven—1.54 trillion vehicle miles, compared with 1.47 trillion for the same period last year. That 4.8% increase doesn’t nearly account for the increase in fatalities.

The role played by driver distraction has not been credibly assessed as part of the increase, but the CDC (Centers for Disease Control and Prevention) says that each day in the U.S. more than nine people are killed and 1,153 are injured in crashes that involve a distracted driver. For example, blind-spot warning, rear cross-traffic alert, lane-keeping assist and forward collision warning are available on the 2016 Chevrolet Cruze, which comes fitted with 10 airbags. Low-speed collision avoidance with automatic braking is a standard feature on the Mazda2/Scion iA subcompact. Volkswagen offers forward collision warning in a $695 option package. Volkswagen will roll out ACC, blind-spot monitoring and automated parking across its U.S. lineup of 2016 VW models. The 2016 Honda Accord has lane-keeping assistance and adaptive cruise control.

Last spring, Toyota announced its Safety Sense C system for compact cars. The package, priced at just $300, includes lane departure warning, automatic high beam control, and collision avoidance and mitigation at speeds up to 50 mph. Continental supplies the multifunction camera and Lidar module for the system. Safety Sense P, priced at $500 for midsize and premium models, adds pedestrian detection and autonomous cruise control. The feature debuts on the 2016 RAV4 and Avalon. The 2016 Lexus GS is also equipped with Safety Sense P.

Fuel Economy

The J.D. Power 2015 U.S. Avoider Study found that fuel economy remains a highly influential factor among new car buyers in selecting which model to purchase. A 2015 survey by the Consumer Federation of America showed similar results. CFA found that gas mileage was very important to 57% of responders and somewhat important to 29%. Many consumers do not believe low gas prices will continue throughout the time they own their vehicles.

Carmakers continue to implement fuel saving technologies such as start-stop (see the table on this page), cylinder deactivation, turbocharging and advanced transmissions—six, seven- and eight-speed are becoming common in new cars. They are also making lighter weight vehicles with better aerodynamics. Several combustion engine small cars achieve more than 40 highway miles per gallon.

Highly automated driving systems can improve fuel economy with more precise control of accelerating and braking, and connecting cars to the infrastructure and to each other improves traffic flow, further saving fuel and reducing emissions. Predictive or intelligent adaptive cruise control can improve fuel economy by an additional 5% over standard ACC, according to Green Car Reports. Honda claims its Intelligent Adaptive Cruise Control, which debuted on the 2015 European CR-V, was the first on a production vehicle. It uses radar and a camera to predict if a car in an adjacent lane is about to cut in front of you and compensates. Continental has demonstrated its Connected Enhanced Cruise Control, which combines adaptive cruise control with its electronic horizon. The system uses map data, the topography of the road, speed limits, traffic information

Continued on page 3
Data Standards...

Continued from page 1

The standards and the central repository must be in place in time for the 2021 model year when carmakers plan to introduce models capable of highly automated driving on expressways.

Sharing Common Data Pools

Apart from the effort already underway by some of the world’s highest-volume carmakers, Thomas Müller, vice president of E/E and E-Propulsion at Volvo, is promoting the idea that carmakers should put their raw data into a single pot that could be used by all OEMs. By sharing data, carmakers would benefit much sooner than if they waited for sufficient coverage in each of the markets where their vehicles are sold.

“Premium OEMs typically have a higher rate of connected vehicles but they have less volume. In the mass market it is the other way around, a lower percentage of those vehicles will be connected,” said Dr. Müller. “By collaborating, the auto industry has a big, big chance of outperforming the consumer electronics and Internet companies. When it comes to data, Google and Apple are way ahead of us. They are working on autonomous cars; they need the data for that.”

Data is needed to make digital maps more dynamic and precise. Apple and Google are already collecting massive amounts from smartphones, but location data from cars is superior because, unlike smartphones, when cars are moving they are almost always sending probe data about roads.

Dr. Müller was the founding chairman of the engineering collaboration that led to the NDS (Navigation Data Standard), a largely successful endeavor. He said he would be happy to talk to others about the prospects for sharing data, possibly through cross-licensing agreements and by creating a nonprofit entity or some other means. He can be reached at thomas.muller@volvocars.com.

HERE Acquisition: German Carmakers Bring Maps in House

Much of the data developed from cars, especially the data required for advanced

Continued on page 8

New Car Features...

Continued from page 2

and sensor information from the vehicle to take full longitudinal control of the vehicle. With an online connection the system could be continuously updated with current road information.

Hybrid and EV sales, with the exception of Tesla’s, have slowed this year with the drop in gasoline prices. Two of the top sellers, the Nissan Leaf and Chevrolet Volt, are in the process of rolling out all new models for 2016. All the major carmakers are developing fuel cell vehicles. Toyota’s hydrogen powered Mirai is already in production.

Infotainment

Large center displays and displays with touchscreen controls are widely used by the OEMs including Audi, Volkswagen, BMW, Mercedes, Porsche, Ford, Honda and others. Larger screens can better support smartphone mirroring features such as CarPlay, Android Auto and MirrorLink.

Hyundai was the first carmaker to offer Android Auto, followed by CarPlay. GM announced that both will be available in 14 of its MY 2016 models.

Ford revamped and simplified the user interface of its MyFord Touch system, now called Sync 3, which launches as an option on the 2016 Escape and Fiesta models. The capacitive touchscreen accommodates pinch and swipe gestures familiar to users of smartphones. According to Ford, natural language voice recognition is improved, as is the system’s response time. Sync 3 can automatically download software updates via Wi-Fi.

According to the Consumer Electronics Association, in-vehicle Wi-Fi installations are taking off. CEA quotes ABI Research’s forecast of 87 million worldwide in 2019, up from about 2.2 million in 2014. Research from Parks Associates predicts that 52% of new cars sold in the U.S. this year will have connectivity built in.

Brought-in tablets and smartphones streaming audio and video to passengers are the rear seat entertainment systems for the non-luxury market. At the higher end of the market, Audi and BMW offer automotive-grade tablets integrated with the vehicle to deliver high quality entertainment to rear seat passengers.

J.D. Power’s 2015 Driver Interactive Vehicle Experience (DrIVE) report revealed perplexing consumer reactions to some of the new high tech features in their cars. At least 20% of the new vehicle buyers never used 16 of the 33 technology features covered in the survey. The most commonly unused features were in-vehicle concierge services, mobile routers, automatic parking systems, head-up displays and built-in apps. More than 20% of respondents indicated they would not want CarPlay and Android Auto in their next vehicle, nor would they want concierge service or voice texting.◆
The Company Profile...  

**Autoliv**

**Thumbprint Sketch**

**Headquarters:** Stockholm, Sweden; www.autoliv.com  
**2014 Sales:** $9,240.5 million  
**R&D:** 5.8% of sales  
**Interest Expense:** 0.7%  
**Capital Expenditures:** 4.9%  
**Net Margin:** 5.1%  
**Headcount:** 60,016 permanent employees and temporary personnel at year-end  
**2014:** 5,500 employees worked in RD&E  
**2014 Sales Total:** $9,241 million  
**Company Target:** 1,000

**Background**

The 1997 merger of the Swedish company Autoliv AB with Morton International’s automotive safety products business created Autoliv Inc. While Autoliv’s headquarters are in Stockholm, Sweden, it is incorporated in the United States and reports its financial results in dollars. Morton International, in Ogden, Utah, was a pioneer in airbag technology and produced the inflators for Mercedes’ introduction of airbags in 1980. Autoliv AB had been producing seatbelts since the 1950s. Autoliv shares (ALV) are traded on the New York Stock Exchange.

The company has approximately 80 production facilities, including joint venture operations, in 28 countries. Component manufacturing plants are concentrated in a few locations while assembly plants are located close to customers’ manufacturing facilities. Approximately 65% of Autoliv employees are in low labor-cost countries. According to Autoliv, its customer base includes virtually every vehicle manufacturer in the world. Autoliv expects its addressable market to grow by 5% per year from 2014 to 2017, from $25 billion to $29 billion.

**Autoliv Sales and Net Margin by Year**

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales (in $ millions)</th>
<th>Net Margin (%)</th>
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<tr>
<td>2010</td>
<td>7,170.6</td>
<td>12.1</td>
</tr>
<tr>
<td>2011</td>
<td>8,232.4</td>
<td>11.6</td>
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<tr>
<td>2012</td>
<td>8,266.7</td>
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<td>2013</td>
<td>8,803.4</td>
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<tr>
<td>2014</td>
<td>9,240.5</td>
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<tr>
<td>2015</td>
<td>9,056</td>
<td>5.1</td>
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**Autoliv Sales by Region**

<table>
<thead>
<tr>
<th>Region</th>
<th>2014 Sales (in $ millions)</th>
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<tr>
<td>Japan</td>
<td>83</td>
</tr>
<tr>
<td>China</td>
<td>160</td>
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<tr>
<td>Europe</td>
<td>218</td>
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<td>345</td>
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<tr>
<td>Rest of Asia</td>
<td>490</td>
</tr>
<tr>
<td>Company Target: 1,000</td>
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</tr>
</tbody>
</table>

**Autoliv Active Safety Sales**

- **2010:** $7,170.6  
- **2011:** $8,232.4  
- **2012:** $8,266.7  
- **2013:** $8,803.4  
- **2014:** $9,240.5  
- **2015:** $9,056

With 37% of the global market, Autoliv claims the number-one share position among suppliers of passive safety products. The company was a pioneer in the field and was first to market with side-impact airbags. Autoliv’s active safety products generated $490 million in sales, roughly 5% of total sales, in 2014.

Autoliv reorganized its operating structure effective January 1, 2015, into two reporting business segments: Passive Safety and Electronics. The Electronics segment now includes all active safety products as well as passive safety electronics, which formerly were counted in Passive Safety. Passive Safety products include airbags, seatbelts, steering wheels, whiplash protection systems and child safety seats. If the new segmentation were applied to 2014, Electronics would have accounted for 16% of Autoliv’s total sales, and Passive Safety would have accounted for 84% to total sales.

In its 2014 Q4 report, Autoliv forecast sales in its Electronics segment will reach $2 billion by 2019, with active safety accounting for $1 billion, or half of that. Today the split is two-thirds passive safety electronics, a low-growth product, and one-third active safety.

**Passive Safety**

According to Autoliv, the passive safety market, excluding passive safety electronics, is expected to grow at just 3% per year over the next three years, with the highest growth coming in seatbelts. The company sold 130 million airbags in 2014, which
gave it a commanding 39% share of that market. But the airbag market is growing even more slowly, at 2% annually, according to Autoliv, due to lagging airbag installation rates in low-end vehicles popular in emerging markets. The passive safety electronics market, where Autoliv has a 22% market share, is expected to increase at approximately 4% per year from 2014 to 2017.

Autoliv’s primary competitors in passive safety have been TRW, now owned by ZF, and Takata, now embroiled in a huge recall effort to replace its faulty airbag igniters in millions of vehicles. Autoliv, TRW and Daicel are producing the bulk of the replacement inflators needed to complete the recall repairs. Toyota will buy its replacement inflators from Nippon Kayaku.

Autoliv increased its capacity to be able to produce 25 million replacements. “We now estimate that we will supply up to 20 million replacement inflators mainly during 2015 and 2016, based upon committed orders and customer inquiries. In addition to this, we have seen an increase in new business awards for frontal airbags over the last 12 months,” said Jan Carlsson, Autoliv chairman, president and CEO, in a second quarter earnings call with analysts. Earlier this year Autoliv began supplying some replacement inflators to Honda, a big Takata customer affected by the recall. Autoliv does not use ammonium nitrate, the propellant identified as unstable in Takata airbags.

Autoliv expects its passive safety electronics sales to grow by just 0.2% per year from 2014 to 2019, likely due to declining prices together with increased application of safety domain controllers that integrate active and passive safety control in one ECU.

While passive safety systems unquestionably save lives and prevent injury, it is possible in the coming years that their usage will decrease as highly autonomous driving features and eventually autonomous vehicles do a much better job than humans at avoiding accidents. Eventually, when drivers of fully automated vehicles are no longer required to monitor the driving, new seating configurations will lead to new occupant protection mechanisms. According to Autoliv, 93% of traffic deaths are caused by human error.

Active Safety

More than seven years ago with its principal market for seatbelts, steering wheels and airbags maturing, Autoliv began implementing its decision to move into active safety.

Carmakers have been implementing active safety systems, including automotive emergency braking, adaptive cruise control, blind spot warning and cross traffic alert, based on cameras, radar sensors or both. Lane departure warning is based on cameras. Cameras are best at seeing lane markings, pedestrians, road signs and traffic lights, whereas radar sensors can see obstacles through fog and snow and perform equally well day or night.

Through acquisitions, Autoliv now has a strong market position in radar. It also has a strong position in the relatively small night-vision market. Autoliv has been developing mono-vision and stereo-vision camera systems including the image processing software.

Autoliv expects its active safety market—radar, front-view cameras and night-driving assist—to grow at a CAGR of 25% from $2 billion in 2014 to $3.9 billion by 2017. Autoliv’s active safety sales have grown from $85 million in 2010 to $490 million in 2014, a 54.9% annual growth rate. By 2019, Autoliv is targeting $1 billion in active safety sales.

The active safety market has received a big boost from New Car Assessment Programs around the world, which have given or will soon give higher ratings to vehicles with certain active safety features, for example lane departure warning and autonomous emergency braking (AEB). An extra boost to camera-based systems will come in 2016 when Euro NCAP adds points for cars that brake autonomously for

Continued on following page
pedestrians. In 2018 Euro NCAP will also require nighttime pedestrian detection.

According to a study initiated by NCAP and ANCAP, the independent safety bodies for Europe and Australasia, vehicles fitted with low-speed AEB showed a 38% reduction in real-world, rear-end crashes compared to vehicles with no AEB.

Autoliv has been producing radar sensors for AEB since 2013. In 2014 Autoliv delivered nearly 5 million active safety sensors on behalf of more than 80 car models. In 2015 it will launch its first mono- and stereo-vision cameras utilizing internally developed algorithms.

A relative newcomer to active safety, Autoliv will have to win share from many formidable incumbents, namely Continental, Bosch, Delphi, Valeo, Magna Electronics, Hella, ZF (TRW), Denso, Kostal, Mando, Mobis, LG Electronics and Panasonic.

Autoliv must also now contend with GPU pioneer Nvidia, which introduced Drive PX in January 2015. Drive PX is a domain computer designed for ADAS and piloted driving applications. Nvidia says that it already has 50 engagements with automakers and tier ones who are exploring applications for the computer. Autoliv’s safety domain computer is scheduled to be introduced in 2015.

**Hard-Nosed Camera Competition from Mobileye**

Then there is Mobileye with its dominant position in monocular camera processing. After years of developing its cameras, Mobileye has learned to make chips itself. Then Mobileye’s products include Mobileye’s proprietary image processing software, but Mobileye says it is no longer cooperating with Autoliv on new business.

“About five years ago Autoliv decided that they were going to pursue vision-based ADAS,” said Mobileye spokesman Yonah Lloyd in an email. “Because our engineers work very closely with the tier ones that we supply, we cannot work with those that decide to directly compete in vision.”

Apart from Mobileye, Autoliv has developed its own image processing software.

We asked Ian Riches, director of Strategy Analytics’ automotive service if Autoliv is up to competing against Mobileye. “Can anyone? It’s a challenge for all automotive suppliers to compete in vision-based safety. Tier-ones such as Autoliv need to get a lot better at recruiting, retaining and rewarding their software engineering talent,” he said.

According to Mobileye, in the five years since Autoliv made the decision to develop its own image processing software, Mobileye has not lost a single RFQ to Autoliv.

**Radar Leads the Way**

In 2008 Autoliv acquired the radar sensor business of Tyco Electronics for $42 million, a business that produced sales of $30 million in 2009. In 2010 it purchased Visteon’s radar system business.

In August 2015 Autoliv completed the acquisition of MACOM’s Automotive Solutions business for $100 million plus incentives. MACOM will provide consulting services to Autoliv for two years for up to $15 million in fees. Based in Lowell, Massachusetts, MACOM’s automotive products include high accuracy GPS modules, map and electronic horizon processing algorithms, RF products and antennas. The business produced sales of about $90 million per year. The acquisition included 25 employees.

In 2014 Autoliv cut 93 jobs from its radar plant in Lowell, Massachusetts (acquired from Tyco Electronics - MACOM) and moved those jobs to its airbag electronics manufacturing facility in Markham, Ontario, Canada.

Autoliv manufactures the radar sensors and offers algorithms that interpret what the sensors “see.” Today Autoliv’s radar sensor portfolio includes 25GHz ultra-wideband radar and 24GHz narrow-band radar. The company plans to launch its 77GHz multimode radar sensors before the end of 2015. Its short- and medium-range sensors cover distances up to 30 meters and are used for blind-spot monitoring and for detecting vehicles at close range, so-called stop-and-go adaptive cruise control. Autoliv is among the world’s leading producers of blind-spot radar sensors.

Longrange radar is also used for ACC, to track vehicles in the lane ahead when traveling at higher speeds.

**CMOS Radar Will Alter Autoliv’s Radar Market**

As radar sensors find higher automotive volumes, their unit prices have been declining, from approximately $120 in 2010 to
roughly $70 or less today. Today’s radar sensor assemblies are made using multiple gallium arsenide or more recently, silicon germanium, semiconductor chips, exotic technologies that are expensive and can’t easily be up-integrated. But two companies have recently produced prototype sensors made from CMOS technology: the number-one automotive semiconductor maker, NXP, and the Belgian research firm, Imec, in partnership with Panasonic.

NXP’s prototype is said to be the world’s first RF CMOS device that can be fully integrated with the baseband. It operates in the range of 77GHz to 81GHz. The transceiver, signal generator and analog-to-digital conversion are all integrated within the CMOS device. Announced in February 2015, Imec’s 79GHz radar is based on advanced (28nm) CMOS technology.

Not only will fully integrated CMOS devices bring the cost of radar down significantly, it will also make the sensors much smaller and more easily integrated into the vehicle. NXP has said that its device will be fit into a postage-stamp-sized module.

Distinctions Claimed by Autoliv

* #1 in passive safety with a 37% share of the market
* #1 in seatbelts, 40% share
* #1 in frontal airbags, 25% share
* #1 in side airbags, 44% share
* #1 in steering wheels, 25% share
* #1 in safety ECUs, 21% share
* #1 in active safety sensors, 22% share*

*A claim we were unable to verify. Autoliv says it produced nearly 5 million active safety sensors in 2014, mostly radar sensors.

Recent Active Safety Alliances

This month Autoliv announced plans to form a joint venture with Japanese brake supplier Nissin Kogyo that will combine Autoliv’s brake control business with a “carve out” of Nissin Kogyo’s automotive brake business. Autoliv will own 51% of the new company.

In the fourth quarter of 2014, Autoliv and Volvo Car agreed to a license agreement that provides Autoliv access to Volvo’s advanced driver assistance algorithms and active safety features such as ACCPlus and intersection assist, along with sensor fusion algorithms and other system capabilities.

New Products

◆ Safety Domain Controller

Autoliv’s ESDC (electronic safety domain controller) will launch at the end of 2015. ESDC links all safety sensors, including radar and cameras, and all actuators that control vehicle motion (brakes, steering and engine/transmission) as well as the passive safety system.

The safety domain controller is an outgrowth from the Autoliv ECU introduced in 2014 that controls both the restraint system (the so-called diagnostic module) and the brakes (traction control, ABS and stability control). That system’s inertial sensors are shared by the electronics stability control system and the airbags.

◆ zForce Drive

Autoliv is cooperating with the optical touch and proximity technology company, Neonode, to bring Neonode’s zForce Drive gesture- and touch-enabled steering wheel to the automotive market. Light sensors integrated into the steering wheel tell the car where the hands are and act as switches to turn on ACC or an autonomous driving function or to make a call. Lights in multiple colors attached to the steering wheel indicate where to put the hands. zForce Drive was introduced at the 2015 CES show.

◆ Torricelli Vacuum Brake

Autoliv has developed a prototype emergency brake that hydraulically deploys a metal vacuum plate from beneath the chassis of the vehicle. It contacts with the road surface and exerts 15,000 newtons of force on the road surface, literally sucking the vehicle to the road. Intended as a last ditch braking effort at speeds up to 70 km/h, the brake reduces stopping distances by 40%. If it were to deploy at higher speeds, belted passengers could be injured by the stopping forces. While potentially effective at cutting accidents, the system is large, complex and expensive.

Antitrust Fallout

In 2011, Autoliv, along with TRW, Takata and Tokai Rika, were investigated by the U.S. Justice Department and the European Commission for conspiring to fix prices of seatbelts, airbags and steering wheels. Toyoda Gosei was later added to the group. Autoliv agreed to plead guilty to the charges in 2012 and to pay a fine to the U.S. Justice Department of $14.5 million. The plea involved a Japanese Autoliv subsidiary.

Following the settlement with the DOJ, a class action suit was filed against Autoliv in the U.S. by direct purchasers, dealers and consumers. The company settled two years later, agreeing to pay $65 million, without admitting liability. Another class action suit was settled in 2014 for $22.5 million, and another in 2015 for $77 million. Other class action suits are still pending.

Products

Passive Safety Systems

Modules and components for:
- Driver-side airbags
- Passenger-side airbags
- Side-impact (curtain) airbags
- Knee airbags
- Seatbelts
- Steering wheels
- Passive safety electronics
- Whiplash protection systems
- Child seats
- Pedestrian protection

Active Safety Systems

- Automotive radar
- Night driving assist
- Active seatbelts
- Dynamic Spot Light
- Camera-based vision systems
- Brake controls
- Other active safety systems

which is how close the cluster is to the driver.

Volkswagen talked with more than ten display suppliers worldwide before choosing Sharp, JDI (Japan Display Inc.) and Samsung for the Passat.

◆ Brought-In Device Connectivity

"Volkswagen is the only carmaker in the world that now offers all three standards for device connectivity, MirrorLink, CarPlay and Android Auto," said Dr. Tanneberger. "MirrorLink is the only [device] supplier independent standard. Samsung, HTC and Sony support it as does Huawei. MirrorLink was developed by Nokia. Its most prominent advocate, Volkswagen, first made MirrorLink available in 2013 on the Polo.

◆ Trailer Assist

The new Passat can be purchased with multiple driver assistance systems including stop-and-go ACC, automatic park assist, 360-degree aerial view, rear traffic alert, and front assist with city emergency braking and pedestrian monitoring. Dr. Tanneberger is especially proud of the newest trailer assist function now available with the Passat—trailer assist, a world's first.

Trailer assist automatically steers the car when backing up with a trailer. The driver directs the trailer right or left with the side mirror adjuster, which functions as a joy stick.

Every New Volkswagen Will Be Online-Capable by 2020

Among all of the challenges that Dr. Tanneberger faces, he says his toughest one is implementing the Volkswagen strategy to provide online connectivity for every new vehicle produced by 2020. "That means we will have to launch back-end structures in all the countries where we operate worldwide, even in places such as South America, Russia, India and China. We will create a scalable concept, where every vehicle will come with basic connectivity, on top of which premium and optional services will be offered."

The plan calls for fundamental changes to the vehicle architecture, not only to provide for more bandwidth in vehicle networks, but to implement robust defenses against hacking. "Our security will be state of the art, the best benchmarked security for our cars," said Dr. Tanneberger.

Another challenge is accommodating the requirement to have drivers input their PINs and interact with online services. That is not a problem for vehicles sold in Europe, which are fitted with displays. But it is a problem in emerging markets where many cars do not have displays, alphanumeric input devices or speech interfaces.

OTA Updates, Hardware Headroom, and Security Standards

Volkswagen has not yet reached a decision as to whether or how completely it will make its connected vehicles updatable over the air. "I want to update my cars over the air. That is my goal but first we have to solve the security threat," he noted.

In order to provide security and accommodate over-the-air updates, carmakers will have to specify semiconductors that have additional capability. "When we download software as a block we would then verify its integrity and in the next step overwrite the RAM with the new software. That will require headroom in the processors and headroom in memory as well as firmware security mechanisms." Adding new features via software updates will also require additional processing capability.

Dr. Tanneberger is keenly interested in developing global cybersecurity standards. "Cybersecurity will be a very, very important discussion over the next decade. Everyone is talking about the additional features that online connectivity brings to the car. But every online car is at risk of being hacked. Today, no one can deliver a 100% secure car. We have to make our cars as secure as possible so they are unattractive for criminal elements to hack."

Private discussions among the German Five about security have already begun. There have also been discussions in Germany that have included Opel and Ford. "But this will not be a German Five or a German standard," declared Dr. Tanneberger. "We have to talk with the Japanese, the Koreans and the U.S. companies. That is a personal statement from me. Security should not be a differentiator."

Data Standards...

driving assistance systems and for automated driving, gets layered into a digital map. Even the map itself will be crowd sourced. Highly automated driving will not be possible without precise, highly reliable maps. Google, Apple and recently Uber are investing to make maps that are suitable for highly automated driving. And now with their planned $2.71 billion acquisition of the HERE map division of Nokia, Audi, BMW and Daimler will also be investing in map technology. Not only do the Germans see maps as core technology; the HERE acquisition will keep them independent from the consumer electronics giants Google and Apple.

HERE has been promoting its own interface standard for car data which for now goes by the unwieldy name of “sensor ingestion interface specification.” According to an August 24 press release, HERE hosted a meeting in Berlin, attended by 16 carmakers and suppliers, to discuss creating a universal format for how information from vehicles is transmitted to the cloud and shared with other vehicles.

HERE has partnered with Continental to develop precision maps for Continental’s eHorizon project where data from different carmakers will be merged in a back-end system. eHorizon integrates digital map data with sensor data for predictive control of vehicle systems. Bosch with its Connected Horizon and TomTom have a similar partnership, as do Denso and Zenrin.