Google and Autonomous Driving: All or Nothing

Over the next five years, carmakers are planning to introduce driver assist functions that are increasingly autonomous. The earliest systems take over steering, acceleration and braking on expressways when traffic is congested and moving slowly. Next, systems will be introduced that operate on expressways at full speed. In both early steps, the driver will have to continue to pay attention to the road. Mercedes Distronic Plus with Stop&Go Pilot, for example, requires a hand on the wheel at all times. If the driver becomes too disengaged from the driving process, the autonomous feature will shut down.

The next step a number of carmakers are working on, and one that commuters will surely be drawn to, is fully autonomous expressway driving that allows the driver to fully disengage from the driving task, allowing him to pay attention to things unrelated to driving, email or texts, for example. But if the driving situation deteriorates, or if the driver falls asleep, the system must either find a way to quickly bring him back in control of the vehicle, or autonomously bring the car to a safe stop.

Google is taking a decidedly different approach to fully autonomous driving. Google is not interested in making another driver assist system; its goal is a fully autonomous vehicle that can go from A to B without a steering wheel. According to sources inside the company, you either have to have light-touch driver assist features without any illusion the car is driving for you, or the car must be fully autonomous. Expecting the driver to engage and disengage as needed is not realistic. And further, as we move closer and closer to fully autonomous but don’t quite get there, we may be making driving more dangerous.

Google did a small pilot test of its autonomous cars on the highway about two years ago. Drivers signed up and went

TTTech Ethernet for ADAS

Background

TTTech was founded in 1998 to commercialize safety-related communications based on the TTP (Time Triggered Protocol) for x-by-wire applications. TTP was adopted by the aerospace industry. The automotive industry opted to develop FlexRay for safety-critical applications, but FlexRay applications remain limited.

By 2009, TTTech’s sales had risen to just €17 million, but since then have grown at 24.8% per year, reaching €52.8 million in 2014. TTTech is targeting 30% annual growth from 2014 to 2018. The company will hire 70 to 80 new employees in 2015.

The Future Is Ethernet

In 2002, TTTech made a smart decision, one that would secure its future. The company began actively looking into Ethernet to see if it could employ TTTech’s estimable safe networking expertise to make Ethernet deterministic. “Seeing the way Ethernet and Internet Protocol swept through the telecom industry, we believed that Ethernet had a lot of momentum and would move to also be a standard in automotive, industrial control, aerospace and many other markets,” said Stefan Poledna, co-founder of TTTech and member of the executive board. “We thought we would be able to use Ethernet in real-time systems and safety-critical systems. ... After about three years we came up with a solution that is fully interoperable. That means you can hook up a laptop computer and some standard equipment on the same Ethernet network and still keep the real-time properties. The problem with the TTP and FlexRay solutions is that every participant in the network needs to have a specific technology to take part.”

By 2014, Ethernet technology was a factor in two-thirds of TTTech’s sales. Automative accounted for roughly half of sales. In the forefront of automotive Ethernet applications, TTTech designed the switching engine that is part of an Ethernet chip being developed by NXP. The device will be the first of its kind in the automotive market.

An appealing feature of the IC will be its ability to handle three different classes of Ethernet traffic. “You can define several sub-networks within the overall Ethernet network, for example, standard Ethernet for diagnostics and flashing, AVB streaming, and time-sensitive networking [synchronous time-triggered] traffic. You can assign data rates for each,” said Dr. Poledna.

While working with Cisco on the IEEE’s AVB (Audio Video Bridging) working group, TTTech saw the emerging interest in taking the standard beyond audio and video to address more critical control traffic. Starting in early 2012, TTTech actively participated in work on the standards 802.1Qbv, 802.1AS-rev. and 802.1CB, among others. In late 2012, the AVB working group was renamed TSN (Time Sensitive Networking) working group.

An extension of AVB, the TSN standard is focused on applications that require safety and hard real-time control to enable backbone architectures and failsafe operational systems such as ADAS and autonomous piloted driving. A first set of standards developed by the TSN working group is close to being finalized.

“We are the first company to offer this pre-standard TSN Ethernet implementa-

Headquarters: Vienna, Austria
Website: www.tttech.com
2014 Revenue: €52.8 million
Products: Robust networking and control; Ethernet solutions account for two-thirds of sales.
Minority Shareholders: Audi, Infineon, GE Ventures and others
Major Automotive Customers: (alphabetically) Audi, Delphi, Volkswagen, Volvo
Staff: 451 (including contractors) as of year-end 2014; staff will increase by approximately 80 new hires in 2015.
Google...

through a training course. They were told to pay full attention to the road, and that they might have to take over driving. Google put a camera in the car to monitor the drivers and despite clear instructions to pay attention there were still people who checked their phones, sent texts or dug around in their bags, clearly not focused on the task of driving. There weren’t any accidents during the pilot, but it showed that even with explicit directions to pay attention to driving, some people didn’t.

Google’s all or nothing approach to self-driving is evident in the fleet of up to 100 prototype vehicles it is building. Except for manual controls for testing, the vehicles are designed to operate without benefit of a steering wheel, brake pedal or accelerator.

Safely managing the transitions between manual and automated driving will be a major challenge for carmakers. Aviation has for decades relied on a combination of automated and manual systems and still there is work to do. According to an article in the Wall Street Journal, air transportation safety experts are concerned about pilots’ ability to master the intricacies of switching between manual control and various levels of automation: “A 2013 U.S. government commissioned study concluded that excessive pilot dependence on automation, combined with failures to master the latest cockpit technology, posed the greatest hazards to passengers.”

The Google self-driving car project is part of Google[x], what Google refers to as its “moonshot factory.” Founded in 2010, Google[x], according to a company statement, “is a team of inventors, engineers and makers that applies audacious thinking and technology to big problems in order to change the world in a positive way… Our primary goal is solving big problems, not making money. At the same time, we’re optimistic that these projects will not only be transformative but will also be good for business.”

Google says it has no intentions of actually manufacturing vehicles. Rather, it intends to work with partners, as it is doing for the prototype fleet of self-driving cars. Google lists three U.S. companies, one Korean and four German suppliers as partners. The self-driving car project at Google involves more than 50 but fewer than 500 employees.

© 2015 Paul Hansen Associates, 150 Pinehurst Road, Portsmouth, NH 03801 USA. Telephone: 603-431-5859; fax: 603-431-5791; email: info@hansenreport.com. All rights reserved.

Materials may not be reproduced in any form without written permission.


Publisher/Editor Paul Hansen
Managing Editor Brianne Wolfe
Director of Marketing Michelle Long
ISSN 1046-1105
TTTech... Continued from page 2

Platform Solutions
◆ Audi’s zFAS Program

In the last decade, TTTech has grown from a networking company to one that can also provide platform solutions for safety controls. Nearly four years ago TTTech began working with Audi on its groundbreaking zFAS concept, which integrates all driver assistance ECUs into a single central control unit. “We did the initial design of the printed circuit board. Within the ECU we have a number of multicore SoCs that are linked via our deterministic Ethernet network. There is a lot of processing power and a lot of data exchange that must be synchronized,” explained Dr. Poledna.

TTTech’s involvement in zFAS goes beyond the networking within the ECU. “We are doing all of the platform software, working on the safety concept according to ASIL D and the software integration. We are managing the interactions of some 30 different functionalities within the single ECU. A number of companies including Audi and Volkswagen are providing the application software,” according to Dr. Poledna. On zFAS, TTTech sees itself as the tier 1.5 supplier; Delphi is the tier-one.

TTTech provided this quote from Mathias Halliger, chief architect at Audi, who said about zFAS: “Deterministic Ethernet enables the building of a safety-critical system by connecting its functional system subcomponents. Furthermore, high-speed Ethernet networks will allow us to design a future-proof system that lets us update its embedded databases over the air.”

◆ ADAS Platform

TTTech is talking to other carmakers about integrating ADAS applications into a central ECU similar to zFAS. Integration yields cost savings with fewer connectors, fewer wiring harnesses and fewer housings.

“We clearly think that the future will bring more integration,” said Dr. Poledna. “We feel like we have a very clever solution because we are using Ethernet within the ECU and we can connect outside the ECU. That gives us flexibility, scalability and the opportunity to provide redundancy. We integrate the ADAS functions, but we don’t own the functions. We are not the experts in how the highway driving or parking functions operate. For us the functions are black boxes. We concentrate on having a strong, highly efficient, safe platform that enables fast function integration and clear separation of the functions, so problems can easily be isolated. Our platform is based on Autosar interfaces and can make use of different operating systems such as Linux, VxWorks or an Autosar OS at the same time.”

With Ethernet as the basic communications infrastructure, the platform can link to an Nvidia Tegra processor or an Infineon Auric, for example.

The ADAS platform can also be expanded to employ PC hardware with its Ethernet interface, which can be used to run C code to rapidly prototype functions and to test and debug applications that are not quite ready to run alongside proven applications already on the platform.

Capital Investment

In March, TTTech raised €50 million from two new strategic partners: GE Ventures and Infineon Technologies. TTTech will deploy the proceeds of the investment in three ways. First, it will continue to expand internationally, setting up more offices close to customers around the world. Operations in Silicon Valley will also be expanded. Second, it will look for some modest acquisitions to complement the product portfolio. Earlier this month, TTTech acquired RT-RK, a Serbian embedded systems engineering firm with 500 engineers. Third, it will set aside some of the funds to maintain financial stability as the company grows. Within the next three years, depending on the business climate, TTTech may initiate an IPO.
The Company Profile...

Mentor Automotive

**Headquarters:** 8005 SW Boeckman Road, Wilsonville, OR 97070-7777 USA; www.mentor.com

**FY 2015 Revenue:** $1,244.1 million  
**R&D:** 30.6% of revenue  
**Interest Expense:** 1.5%  
**Net Margin:** 11.8%  
**Cash Provided by Operating Activities:** $138.2 million  
**Working Capital:** * $424.7 million  
**Stockholders’ Equity:** * $1,272.8 million  
**Market Capitalization:** $2.85 billion as of April 13, 2015  
**Employees:** * 5,447  
**Revenue per Employee:** $228,401  
**FY 2015 Automotive Revenue:** ** $108 million  

*As of January 31, 2015  
**Does not include revenue from top automotive semiconductor makers or sales to large multi-market companies such as Hitachi and Panasonic.

**IC Design to Silicon, 38%**  
**Scalable Verification, 25%**  
**New & Emerging Markets, 7%**  
**Integrated Systems Design, 21%**

**Net Margin**

<table>
<thead>
<tr>
<th>Year</th>
<th>Margins (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2.7%</td>
</tr>
<tr>
<td>2011</td>
<td>3.1%</td>
</tr>
<tr>
<td>2012</td>
<td>8.3%</td>
</tr>
<tr>
<td>2013</td>
<td>12.7%</td>
</tr>
<tr>
<td>2014</td>
<td>13.4%</td>
</tr>
<tr>
<td>2015</td>
<td>11.8%</td>
</tr>
</tbody>
</table>

**Total FY 2015: $108 million**

**Subsystems & Technology, 55%**  
**Connectivity & Networking, 34%**  
**In-Car Experience, 11%**

*Mostly printed circuit board design tools

**Mentor Automotive by Product Category**

**Mentor Graphics Revenue and Net Margin by Fiscal Year**

- **FY 2010 to 2015 CAGR of Revenue:** 9.2%
- **Total Revenue FY 2015:** $1,244.1 million

**Mentor Automotive by Fiscal Year**

- **2010 to 2015 CAGR:** 15.3%

**Mentor Automotive by Business Segment**

**Background**

In 1981, a group of entrepreneurs from Oregon-based Tektronix, a maker of test and measurement devices, founded Mentor Graphics. The new company’s first product, a CAE workstation, came to market the following year. Mentor Graphics (MENT) shares have been traded on the Nasdaq since 1984, and the company has grown to include 85 offices around the world. Automotive revenue accounts for approximately 9% of Mentor’s total revenue.

**Mentor Automotive**

Nearly a year ago, Mentor reorganized its automotive marketing efforts to better present its broad range of products and solutions to automotive OEM and tier-one customers. While not an official reporting segment within Mentor Graphics, the Mentor Automotive grouping unifies three major product and service domains—systems engineering, embedded software and tools—and also helps to establish Mentor’s automotive strategy. The three categories that comprise Mentor Automotive are: In-Car Experience, Subsystems and Technology, and Connectivity and Networking, each detailed below.

**In-Car Experience**

**FY 2015 Revenue:** $12 million  
**FY 2010 to FY 2015 CAGR:** 67%  
**Products**

- **XSe**  
- IVI/Cluster ECU convergence

Mentor Automotive participates in the Genivi Alliance, the Car Connectivity Consortium and the Autosar development partnership.

Active noise control  
Linux-based IVI and smartphone integration  
ADAS/Image recognition  
Nucleus  
SafetyCert cluster design

The In-Car Experience category of Mentor Automotive encompasses all the products from Mentor Graphics’ Embedded Systems division that are part of what the driver or passenger experiences in the cabin. Included are software, tools, services and hardware reference designs associated with the infotainment system, cluster, head-up display and advanced driver assistance systems. Together with hardware reference designs, software provides approximately 60% of the category’s revenues, with tools and engineering services each accounting for roughly 20%.
Embedded Systems revenues were up 20% in FY 2015 and are expected to grow another 50% in FY 2016, a result of three new large programs, plus as many as 10 other programs.

**Multiple Operating Systems and a Hypervisor**

Mentor Automotive is the world’s number-one supplier of commercial Linux operating system-based infotainment solutions. By 2018 more than 50 million vehicles in the fleet will employ Linux operating systems and middleware from Mentor Automotive, almost all of which will be Genivi compliant.

Mentor Automotive had its own Linux software, but the acquisitions of XS Embedded (XSe) and MontaVista Software significantly expanded its Linux portfolio. Mentor Graphics acquired the Linux-based automotive technology platform and quality assurance framework, along with associated employees, from MontaVista in February 2013. XSe was acquired in July 2014. (See below.)

“The vast majority of Linux IVI platforms either planned or already in production are Genivi compliant, meaning they have the Genivi libraries and the Genivi layer and fulfill the Genivi requirement for compatibility,” said Glenn Perry, vice president and general manager of the Embedded Systems division.

The number of operating systems running simultaneously within infotainment systems is growing. “In systems being developed for the near future we are seeing as many as three operating systems: a general purpose Linux operating system, a real-time operating system and an Autosar operating system. In the future there will be even more,” said Mr. Perry. “The ability to run multiple operating systems is enabled by hypervisors or advanced partitioning technologies, which let you dedicate operating systems for specific tasks—maybe one for navigation, another for control within the vehicle, and others partitioned for security and communications off the vehicle. Hypervisors let you maintain separation between the domains that require safety and security from the other domains, all while running on the same multicore SoC.” Mentor Automotive offers an embedded hypervisor as well as a real-time operating system, its Nucleus product.

**XS Embedded**

According to Mr. Perry, In-Car Experience customers are drawn to Mentor Automotive because of its Linux expertise and its automotive experience. “Our team of industry experts came largely from our acquisitions of MontaVista and XS Embedded,” said Mr. Perry. XS Embedded GmbH, Villingen-Schwenningen, Germany, had been an advanced research unit of Harman Becker prior to a management buyout in 2010.

“We have hardware and software engineers from XSe who have spent their careers in automotive doing advanced design of head units, clusters and ADAS-related functions. The XSe team has a great deal of expertise in the areas of audio, graphics and overall system performance. Because we have that expertise, we are often asked to get involved with customers at the earliest phases of their designs,” Mr. Perry added.

**AXSB Hardware Reference Platform**

A noteworthy product from XSe is its near-A sample AXSB hardware reference platform. Used to accelerate infotainment system development, AXSB is much closer to what would actually go into a vehicle than are the typical, more generic B-sample reference designs. AXSB is built from automotive-grade components; it provides automotive interfaces and conforms to EMI and EMC guidelines. The heart of the platform is the Jacinto 6 family of infotainment processors from Texas Instruments. The platform can be purchased as bare boards or with Mentor’s optimized Linux software, including Autosar interfaces. Priced at $2,900 each, the boards have so far been sold to “tens” of tier-one and OEM customers.

**Active Noise Control**

XSe engineers have also developed active noise cancellation technology to minimize road and engine noise in the cabin. By effectively controlling cabin noise with electronics, carmakers can reduce the weight of their vehicles by using less insulation. Integrated into the infotainment system’s audio framework, XSe’s active noise control employs microphones and accelerometers to sense and then cancel both periodic and non-periodic noise using a proprietary broadband noise cancellation algorithm. The system employs Automotive Audio Bus technology from Analog Devices, which distributes audio, control...
Mentor Automotive

and power to each speaker via twisted-pair wire.

- **ADAS**

  Increasingly, Mentor Automotive engineers have been drawn into development assignments involving advanced driver assistance systems, not only those involving the driver interface, but also assignments that comprehend the overall system. “For example, a North American customer has us doing a significant portion of the ADAS hardware design as well as the base software layers,” said Mr. Perry. “And we’ve had several European customers for whom we have done the base system design and the software platform to support sensor fusion.”

  Core to the Mentor Automotive strategy is providing multiple operating systems that are able to operate in a heterogeneous environment. According to Mentor, it is the only vendor that has automotive Linux and a complete Autosar stack, as well as a certified ISO 26262 RTOS and hypervisor multicore framework.

- **Subsystems and Technology**

  The acquisition of Flomerics in 2008 and Flowmaster in 2012 helped to make Mentor Graphics the world’s third-largest computational fluid dynamics vendor.

  While the bulk of Subsystems and Technology’s automotive revenue comes from printed circuit board design and manufacturing tools and from ECU modeling tools, we focus here on two of the hottest automotive applications of thermal analysis tools from Mentor Automotive: automotive lighting and power electronics for hybrid electric and electric vehicles.

  - **FloEFD Thermal Analysis Tools for LED Headlight Design**

    Over the last few years, developers from Mentor Graphics’ Mechanical Analysis division have been working with carmakers and automotive headlight suppliers to apply Mentor’s thermal analysis software to the design of LED headlights and to integrate those tools into the CAD design flow.

    “LED headlights have gotten incredibly complex. If they fail, the warranty costs can be substantial,” said Keith Hanna, director of marketing and product strategy for Mechanical Analysis. “They are closed units that can overheat; you want to design out any thermal issues well before they are manufactured and installed.” Mentor Automotive thermal and radiometric characterization and simulation software helps engineers calculate the properties of LEDs and understand their behavior at different temperatures and currents.

    “A particularly hot topic around the design of LED headlamps has been condensation. Last November we introduced a solution within our computational fluid dynamics tool that lets customers quickly and efficiently predict any vapor condensation or icing on the headlamp surfaces,” noted Mr. Hanna.

    Some of the companies using FloEFD in the design of automotive lighting include: Automotive Lighting, Koito, Stanley, Ford, Audi, Hella, Mercedes Benz and Valeo.

  - **Power Electronics Testing**

    Last year Mentor Graphics adapted its Industrial Power Tester, capable of handling 1,500 amps, to thermally test IGBT (insulated gate bipolar transistor) modules. IGBTs are power semiconductors used in inverters in electric and hybrid vehicles.

    The tester is able to power modules through tens of thousands—potentially millions—of cycles while providing real-time failure-in-progress data for diagnostics, thereby significantly reducing test and lab diagnosis time and eliminating the need for post-mortem or destructive failure analysis. The newest version of the Industrial Power Tester, just released in May 2015, is capable of testing 12 devices simultaneously, compared with three devices on the earlier generation.

  - **Full Car Simulation**

    Mentor Graphics is uniquely able to do both 1D and 3D thermal modeling. “We can model all the vehicle systems individually or concurrently to look at, for example, heat transfer between the cabin and the power electronics, the battery system, the transmission and the IC engine cooling—over extremes of climate,” said Mr. Hanna.

<table>
<thead>
<tr>
<th>Date</th>
<th>Company Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Harness Software</td>
<td>Wire harness design and engineering tools</td>
</tr>
<tr>
<td>2003</td>
<td>First Earth</td>
<td>Electrical systems simulation and analysis tools</td>
</tr>
<tr>
<td>2004</td>
<td>VeSys Ltd.</td>
<td>Wire harness design and engineering tools</td>
</tr>
<tr>
<td>2005</td>
<td>Volcano Communications Technologies AB</td>
<td>Automotive network design tools</td>
</tr>
<tr>
<td>2008</td>
<td>Flomerics Group PLC</td>
<td>Thermal and flow analysis tools</td>
</tr>
<tr>
<td>2010</td>
<td>Virtual Garage product line (from Freescale)</td>
<td>Architectural and service solutions</td>
</tr>
<tr>
<td>2011</td>
<td>Flowmaster Group</td>
<td>Fluid system simulation software</td>
</tr>
<tr>
<td>2013</td>
<td>MontaVista Automotive Business Unit</td>
<td>Embedded software</td>
</tr>
<tr>
<td>2014</td>
<td>MeCel AB asset purchase (from Delphi)</td>
<td>Autosar embedded IP</td>
</tr>
<tr>
<td>2014</td>
<td>XS Embedded GmbH</td>
<td>Automotive system architecture</td>
</tr>
</tbody>
</table>

**Electrical systems design tools account for about 60% of revenue from Capital tools, with the remaining 40% split evenly**
between architecture, wiring harness engineering and service documentation tools.

Autosar software accounts for roughly half of Volcano revenue. Automotive Ethernet is now part of the software stack and comprehended by the tool.

**Capital**

**Electrical Complexity Exploding**

Mentor Automotive’s Capital suite of electrical and wire-harness design tools accounts for 90% of Mentor Graphics’ Integrated and Electrical System division sales. Over the last few years, revenue from Capital has grown at twice its usual rate. While electronics content including the number of ECUs and wiring circuits continues to rise, the biggest impetus to the acceleration of Capital revenues is vehicle complexity.

As the number of options that can be selected for each vehicle increases, the number of unique versions of the electrical wiring system increases geometrically. “We are getting to the point where almost every car that drives off the assembly line can come with a uniquely distinct harness,” said Martin O’Brien, general manager of the Integrated Electrical System division. “In 2009 we would typically see vehicles with about 10,000 possible electrical variants. By 2012 that had increased to about 100,000 variants. By 2014 the number had risen to one billion, so we had to modify our software to cope with that. At a conference a few weeks ago, a spokesperson from Volkswagen said it will go up to one trillion electrical variants.”

The Capital tools suite now covers the entire flow from system and vehicle level design to manufacturing to service. Mentor Automotive is seeing an explosion in the number of subassemblies that must be manufactured. “Manufacturing lines that used to make high-volume harnesses are now making uniquely distinct harnesses, which changes the way factories are configured,” said Mr. O’Brien. “Using our tool, service technicians can enter the vehicle identification number and pull up the exact electrical configuration for the car sitting in front of him. ... A major European OEM recently released Capital to 2,800 service centers.”

Among all of the modules that are part of the Capital suite, increasing complexity has led to the biggest increase in the demand for Capital ModularXC, a tool that creates a bill of materials and cost for each of the harness subassemblies that together make the whole-vehicle harness. ModularXC now accounts for approximately 25% of division revenue, compared with just 3% a few years ago.

Next month, Mentor Graphics will announce the availability of a brand new systems engineering tool to complement its Capital tool suite. The new tool is an architectural trade-off study tool for allocating functions into the vehicle, from which the proposed electrical architecture is then synthesized. It simulates that architecture and makes suggestions about which functions should be implemented in software and which signals should be sent via networks or over a dedicated wire. The data from the new tool can then be fed into Capital harness tools and Mentor Graphics’ Volcano family of system and network design tools. Some years from now, this new tool is expected to account for as much as 15% of division revenue. A bigger payoff will come as users of this tool opt for more of Mentor Graphics’ downstream tools so they can take full advantage of its output. Five carmakers are already using beta versions of the new tool.

**Volcano**

The Mentor Automotive line of Volcano products consists of VSTAR Autosar-compliant run time software, which accounts for nearly half the business, plus two Autosar-compliant tools: Vehicle System Architect (VSA), a functional design and analysis tool, and VSA Com, a communications analysis module within VSA. “VSA Com is a critical tool that lets users analyze the throughput tradeoffs between in-vehicle networks—CAN, Ethernet, FlexRay or LIN—and try different configurations,” said Scot Morrison, general manager of the Platform Solutions business unit. Used by the OEMs, VSA supports the allocation of software components to the ECUs. “Moving software components around can dramatically change the information flow on the networks,” he said.

VSTAR is a complete stack, encompassing all the components that are defined within Autosar 4.x. It includes operating system, basic software and the runtime environment.

The remaining 10% to 20% of Volcano revenue comes from services. “We opened up an Autosar services practice less than two years ago. It is really a critical piece at this point—integration services plus training, and also working with people to optimize the entire run time stack for their application, as well as debugging services for people who are trying to get their ECUs finalized and into production,” explained Mr. Morrison.

**Autosar**

While some European carmakers began their Autosar implementations using version 3.x, Mentor Automotive has focused exclusively on version 4.x in the belief that ultimately the industry will move to the more recent version. 4.02 was the company’s first release followed by 4.03. Version 4.2.1 is next.

“Several of the larger OEMs that were focusing on 3.x will be moving to 4.2.1 over the next couple of years,” said Mr. Morrison. “It is a very compelling release with automotive Ethernet well integrated and specified. Because of Ethernet it will be broadly adopted.” In late 2014, Mentor Automotive enabled Ethernet in its tools and this year it has added an Ethernet component to its Autosar version 4.2.1 software stack.

In the next several years, as carmakers worldwide develop more and more systems based on Autosar 4.x, demand for Mentor Automotive Autosar software, tools and services is expected to quickly grow. **◆**
Roundup 2014: Lear, Mobis, Valeo, TRW

Lear Corporation
2014 Sales: $17,727 million
Change from 2013: up 9.2%
Net Margin: 3.8%
Outlook for 2015: Sales are expected to be in the range of $18.5 to $19.0 billion, an increase of at least 4.5%. Net margin could increase slightly, to approximately 4%.

Sales in the Seating business segment increased 11%, to $13.3 billion, with the help of higher production volumes on some platforms as well as new business. Adjusted segment earnings were 5.7% of sales.

New business also increased sales in the Electrical segment, to $4.4 billion, up 5% from 2013. Adjusted segment earnings in Electrical were 12.8% of sales. Lear is confident the segment’s sales will continue to benefit from increasing electrical content in vehicles related to fuel efficiency, safety, connectivity, comfort and convenience features.

According to Lear’s 10-K: “This content growth, as well as our customers’ continued emphasis on vehicle weight reduction, will require far more complex vehicle electrical architectures. Our significant experience designing and manufacturing highly integrated and standardized architectures that optimize size, performance and quality leaves us well positioned to take advantage of the growth in electrical content and the increasingly complex architectures.”

The report also notes that hybrid and electric vehicles, because they incorporate both high power and low power components, “offer a significant content opportunity with the potential to more than double the electrical content per vehicle.” Lear supplies or will supply high voltage wire harnesses and components for new models from Daimler, Renault-Nissan, General Motors, BMW, Jaguar Land Rover and Fiat Chrysler.

Lear's total seating and electrical content per vehicle in 2014 was $399 in North America and $341 in Europe and Africa. Lear's largest customers are Ford, which accounted for 22% of sales, and General Motors, 21% of sales.

Hyundai Mobis
2014 Sales: KRW 36,185 billion ($33 billion)

Change from 2013: up 5.8%
2014 Net Margin: 9.4%, compared with 9.9% in 2013

Outlook for 2015: None given by the company, but Mobis' growth is tied to that of its primary OEM customer, Hyundai Kia. The carmaker expects a combined increase in sales for the two brands of just 2.5% in 2015, the smallest increase since 2003, according to the Wall Street Journal. Hyundai Kia sales grew 5.8% in 2014, the same rate as Mobis’.

Mobis saw the strongest regional sales growth in China, where sales increased by 10.5%, based on some new model introductions.

The Module business division, which accounted for 80% of Mobis' sales, grew by 6.8% over the prior year and produced a 6.3% operating margin, consistent with the 2013 operating margin. Aftermarket parts sales were basically flat.

Valeo
2014 Sales: €12,725 million
Change from 2013: up 9%
2014 Net Margin: 4.4%, compared with 3.8% in 2013

Outlook for 2015: Valeo expects to outperform the automotive market, assuming a 3% growth in global automotive production and 2% growth in Europe. The company believes operating margin will improve slightly from this year’s 7.2%.

OEM sales, which accounted for 85% of total sales, grew 9% over the prior year, including 28% growth in China, where Valeo added production capacity. China accounted for 15% of Valeo’s sales in 2014. Growth in the OEM segment was also driven by the roll-out of its latest technologies for reducing emissions and by increasing demand for its vision, radar and parking assist systems. The Comfort and Driving Assistance business group, in which those vision, radar and parking assistance systems are produced, increased OEM sales by 15%.

Of Valeo’s €17.5 billion order intake in 2014, 35% was for products and technologies that have been on the market for less than three years.

In 2014 Valeo acquired Osram’s 50% of the joint venture Valeo Sylvania, which is now a fully consolidated subsidiary.

Combined OEM and aftermarket sales for Valeo’s Visibility Systems business group increased 22% as a result.

In March 2015, Valeo announced it had entered into a cooperation agreement with Mobis to develop and produce front facing camera systems for ADAS applications based on Mobis’ image processing algorithms and EyeQ family of microprocessors and Valeo’s radar and infrared LED sensors.

In addition, the two companies intend to develop a new product incorporating Mobis’ vision technology and Valeo’s laser scanners for automated driving applications.

TRW Automotive
2014 Sales: $17,539 million
Change from 2013: up 0.5%
2014 Net Margin: 1.7%, down significantly from 2013 net margin of 5.6% due to special pension abatement, restructuring and transaction costs

Outlook for 2015: The company expects sales in the range of $16.6 billion and $16.9 billion, roughly 4% lower than 2014. The acquisition of TRW by ZF is expected to be complete in the first half of 2015.

TRW’s sales growth was helped by higher vehicle production volumes but tempered by its divestment of parts of its brake business. Its engine valve business was sold to Federal Mogul earlier this year, and in April the company announced the sale of its linkage and suspension business. The divestment of the engine valve business will have the greater effect on 2015 revenue.

While TRW has been divesting product lines that overlap with ZF’s, it has been expanding its electronics business to focus on products to enable automated driving. The company hired more than 650 engineers over the last three years; the majority are working on advanced radar and camera technologies. Last fall, TRW announced a new scalable family of short-range radar sensors that can enable 360-degree sensing around a vehicle. It will launch its next generation video camera in early 2016 with a North American carmaker in China. With increased processing power the camera can enable automatic emergency braking for vehicles and pedestrians.