LEDs Will Dominate All Automotive Lighting—Eventually

Ten Years Until LED Headlamps Match HID Price

A lready widely used throughout the vehicle for interior and rear exterior lighting, LEDs (light emitting diodes) are slowly beginning to make their way into headlamps. The last and most difficult application. Automotive LEDs make a lot of sense. They are bright, exceptionally robust, very small and very energy efficient, making them perfectly suited to electric and hybrid vehicles.

Thus far only a handful of vehicles come equipped with LED headlamps. Brought to market in 2008, A udi's R 8 is the world's first car with an all-LED headlamp. The headlamps are from A utomotive Lighting, a Magneti Marelli company, and the LEDs are from Philips Lumileds. The 2009 Platinum Edition C adillac Escalade has full-LED headlamps from H ella, with LEDs made by O sram O ptic Semiconductors. Introduced two years ago, the L exus LS600h hybrid was the world's first car to have LED headlamps, but only for low beams. T oyota's headlamp supplier is K oito, and the LEDs are from N ichia. K oito and N ichia also provide LED headlamps for a number of vehicles, where penetration could reach 25% or 30% of other vehicles like the A 4. They have to invest a lot of money to bring out a platform. In the future we want to work together with suppliers so they can reuse this software, modify it, add some features and continue growing the IP in this platform," he explained.

Microsoft A udo is based on Windows C E; Genivi's platform will be based on a Linux operating system; A udi's infotainment system will be based on the Q N X operating system. Q N X is a division of H armian International, A udi's current infotainment system supplier. Eventually EB expects to market versions of the framework that can run not just on Q N X but also on M icrosoft A udo and Linux operating systems.

D aimler's head of infotainment systems development, Peter H äussermann, was involved in the initial G enivi discussions, but Daimler is presently working with M icrosoft to develop an open infotainment system that will find production by 2015 at the latest.

A Third Path to Infotainment Software Reuse

First there was M icrosoft A udo, then came the G enivi alliance, and on July 1, 2009, A udi began a joint venture with software developer E B ( E lektrobit) to create its own infotainment software framework. Once complete, that framework will be made available through EB to other carmakers. While different in many ways, all of the approaches have a common objective—reducing the cost of infotainment systems through open hardware and software interfaces and the reuse of proven software. A ll three approaches separate software from software, which will increase competition among software and chip suppliers and help to further reduce cost.

"O ur goal is to be able to reuse software that costs tens of millions of euros to develop," said Peter Steiner, head of infotainment at A udi. "That is a cost not only for us, but for the tier one suppliers as well. They have to invest a lot of money to bring out a platform. In the future we want to work together with suppliers so they can reuse this software, modify it, add some features and continue growing the IP in this platform," he explained.

Of the two other approaches, M r. H äussermann believes A udi's is more promising than G enivi. "I don't think G enivi has enough relevant participants to realize its goals," he said. "And their approach increases complexity, since the O EM has to buy a lot of software pieces, and the tier one has to integrate the pieces into the platform. For a long time I have been a fan of Microsoft, since the integration is already done, and you can concentrate only on the modules that aren't already integrated, like navigation."

M r. H äussermann has concerns about the pace of the G enivi alliance's standardization efforts. "The G enivi alliance has a lot of partners and opinions and directions that need to be accommodated, and that usually takes a long time," he said. "A udi and V W together have enough volume that they can afford to go their own way."

In order to deliver a new, high-end open infotainment platform in time for the 2013 model year, A udi needs to be finished with it by the end of 2011. "W e took a separate path because G enivi doesn't have a time commitment that's binding," noted M r. Steiner. "W e have a very tough time schedule so we must make progress with a committed group of people."

T he A udi-EB joint venture began its work on July 1, 2009 with 60 engineers. M ore to come! A udi needs to develop a framework, which is essentially nonproprietary software used for interfacing and extending other software, but it will also serve as an infotainment system integrator for A udi's high-end infotainment system.

T hat high-end system will be used throughout the Volkswagen G roup, probably on 100% of A 8 vehicles and perhaps 25% or 30% of other vehicles like the A 4. It will also be optionally available on V W vehicles, where penetration could reach approximately 10%. Volkswagen G roup.

Automotive Headlamp Efficiencies by Light Source

<table>
<thead>
<tr>
<th>Light Source</th>
<th>Lumens/Watt</th>
<th>Watt/Hour</th>
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<tbody>
<tr>
<td>Halogen</td>
<td>23</td>
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<tr>
<td>Xenon (HID)</td>
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<td>0.15-0.23</td>
</tr>
<tr>
<td>Theoretical maximum</td>
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U.S. Energy Policy No Boon to Diesels

The U.S. government’s proposal to increase by 40% the average fuel efficiency standard for new light vehicles, to 35.5 mpg by 2016, won’t greatly influence the demand for diesel engines in the States, despite the fact that diesels are 30% more efficient than gasoline engines and produce 25% less CO2.

Fifty percent of the vehicles produced for sale in Europe are powered by diesel engines, but in the States diesels accounted for only 2.2% of passenger vehicle sales in 2008 according to R.L. Polk numbers cited by the Diesel Technology Forum. That percentage could go up by several percent, but diesels’ share of the market won’t dramatically change without a decision by the U.S. government to change incentives that favor gasoline over diesel fuel.

I have seen nothing to suggest that diesel incentives are forthcoming in the United States. “Washington isn’t picking technologies. They are setting the bar at a certain level and whether you get there with an EcoBoost-type engine, or hybrids, or diesel is up to the market,” observed Bob Holycross, regulatory affairs manager at Ford. EcoBoost is Ford’s twin turbocharged, direct injected gasoline engine.

Diesels have it tough in the United States, where especially stringent emission limits on diesel particulate matter and nitrogen oxides make diesel engines expensive to manufacture. California has further regulations under development.

Diesels are also expensive to operate. At 24.4 cents per gallon, the federal excise tax on diesel fuel is six cents per gallon higher than on gasoline. Heavy trucks use diesel fuel almost exclusively, and the added tax helps pay for the wear and tear commercial trucks exact on the highways. As a result of the tax and the limited refining capacity for diesel in the States, the fuel is almost always more expensive than gasoline. And unless you live near the Interstate where there are truck stops, diesel fuel pumps can be hard to find.

In Europe, tax policy is the other way around. Because diesel fuel is more efficient than gasoline, the governments in Europe have long favored diesel fuel with a much lighter tax to encourage its use, so diesel fuel is significantly less expensive than gasoline. On June 1, 2009, diesel averaged $5.00 per gallon in Europe compared with an average of $6.50 per gallon for premium gasoline.

Ford makes diesel-powered cars in Europe and could bring its diesel engines up to U.S. emission standards, but the company has no plans to do so in the near term. Instead it plans to make its EcoBoost gasoline engine available on almost all models.

“Diesel engines cost significantly more than EcoBoost,” said Dan Kapp, director of powertrain research and advanced engineering at Ford. “A s long as diesel fuel is more expensive than gasoline, it erodes an already difficult payback equation for the customer. If he does the math, it probably won’t make a lot of sense.” Even after 2016, diesels will power no more than 10% of Ford’s vehicles, according to Ford’s technology roadmap.

According to Sandra Stojkovski, director of vehicle fuel economy systems engineering at Ricardo, in order to comply with the 35.5 mpg standard over the long term, carmakers operating in the U.S. will lean most heavily on the sale of hybrid vehicles. “Carmakers will choose the biggest efficiency gains for the least amount of cost. To reach the 35.5 mpg target, the electrified technologies are more cost effective than the diesel technologies, which require expensive aftertreatment of exhaust. We do see a home for diesel in the largest light-duty, V8-powered trucks, where electrification is unable to meet the performance requirements.”

Bosch and Volkswagen Support Diesel

A number of the executives I spoke with believe that diesels are a very good answer even for smaller vehicles. “Given the current cost of batteries, diesels are definitely more cost effective than full hybrid vehicles,” declared Johannes-Joerg Rueger, a senior engineering vice president at Bosch, the world’s number-one supplier of diesel fuel-injection systems. “Volkswagen is producing millions of 2-liter diesel engines in Europe. Given those economies of scale, I believe it is possible to achieve the 35.5 mpg fuel economy goal as well as fulfill the customer requirements for torque and driving behavior, and do so economically.”

While that may be true, today’s economics favor at least one hybrid. In the U.S., the Prius, starting at $22,000, is slightly less expensive than the VW Jetta turbo diesel (from $22,270) and gets significantly better mileage—48/45 mpg city/highway for the Prius vs. 29/40 mpg for the Jetta, according to EPA guidelines.

But, says VW spokesperson, Jill Bratina, “Diesels are more fun to drive, an experience some customers are still looking for in their vehicles. Lots of people have especially long commutes to work, and that’s where diesels are very attractive. There are certainly advantages to a battery-powered vehicle in the city, but diesel has advantages on the highway.”

Currently about 10% of the vehicles Volkswagen sells in the U.S. are diesel, a percentage that will go up. Volkswagen offers the Jetta TDI (Turbo Direct Injection), the Jetta SportWagon TDI and the Touareg TDI. A diesel Golf will be available later this summer. For models where a diesel engine is an option, Volkswagen of America is committed to selling 30% of them as diesels. Audi recently introduced a V6 diesel Q7 in the U.S. and will be out later this year with a diesel A3.

Turn to Diesel, page 3
Diesel...

Elsewhere, small engine diesels make a lot of sense. “In India, there are tax incentives that favor diesel fuel at the pump, similar to some places in Europe,” pointed out Pascal Dutfoy, strategy and planning director for diesel products at Delphi. “So in India diesels are growing fast. Tata is expected to come out with a two-cylinder diesel Nano in 2010.”

Diesels Require More Electronics

Bringing diesel engines into compliance with stringent emissions standards requires much more electronics than a typical gasoline engine, according to Stuart Johnson, an engineering manager in VW’s environmental office in the U.S. If California toughens the standard even further, “That’s going to be a challenge for us,” he said. “That means more electronics for more control over the fuel injection system to precisely control the combustion chamber events.”

The VW Jetta diesel engine for the U.S. market comes with one combustion pressure sensor per cylinder. The V6 engines in the Touareg and Audi Q7 use one sensor per cylinder bank. The pressure sensor is built into the glow plug, which comes from Beru, now part of BorgWarner.

“The Jettas that ship to the United States have first generation NOx (nitrous oxide) sensors, and those will be updated to meet more stringent onboard diagnostics regulations. In addition, VW is developing particulate (soot) sensors that will monitor the particulate trap. There will be more work done to make EGR exhaust gas recirculation) actuators more precise, and turbocharger control will be even more critical,” said M r. Johnson.

Meanwhile in the States, work on diesels has slowed. “A number of diesel engine projects involving small engines have been put on hold,” said Delphi’s Mr. Dutfoy. H onda, Ch rysler, Ford, GM, N issan and Toyota have canceled or postponed diesel programs that would have brought nine more diesel models to the U.S. market.

“A t the end of the day,” M r. Dutfoy observed, “diesel [penetration] is not only legislation driven; it is also dependent on the cash availability of the big O E M s in North America. The European penetration of diesels has flattened. It won’t get much above 55%, so I am putting my hope more now on the Western European O E M s pushing diesels in North America.”

Infotainment...

the world’s third-largest carmaker, produced 6.1 million cars in 2008.

Genivi

The three paths to open infotainment systems was one of the hottest subjects under discussion at the prestigious annual gathering of the German auto industry’s top electrical engineers and executives in Ludwigsburg in July. There I spoke with Gerulf Kinkelin, responsible for electronics architecture and telematics at PSA, one of the three carmakers in the Genivi alliance working with a number of suppliers to develop an open source infotainment platform. Not wanting to present Genivi as in head-to-head competition with Microsoft, Mr. Kinkelin suggested that it would be good for the industry to have at least two offerings. “What if Microsoft someday decides they want to get out of the automotive industry? Carmakers would need a backup. Both environments are open or at least very standard on the A P I side. A nd like Microsoft, Linux is a popular environment with tools that make it easy for application developers,” he said.

H ans-G eorg Frischkorn, General Mo tor s’ top electrical engineer, is less inclined toward a Microsoft option.

“The industry needs to get away from proprietary standards, including those from Microsoft,” he advised. “The point is, who sets the development priorities? Microsoft controls Microsoft Auto and sets its own priorities. In a truly open world, anybody who wants to contribute software can become part of the available spec. Being open means being well documented, which means very short adoption times,” he added.

BMW’s Graham Smethurst asserted that Genivi is uniquely open in the way the architecture is being defined, in how the product will be brought to market, and in how it will be maintained and enhanced. “Genivi is building an ecosystem as a community, not as a vendor, whereas the alternatives are focused on a specific supplier dependency,” he said.

G M’s next-generation infotainment system will be based on Linux. “In our state of requirement (SOR) to suppliers we asked for a Genivi solution or a solution that at least follows the Genivi structure. We received a surprising number of responses for a Linux-based solution,” Mr. Frischkorn said. “With open systems the learning curve is very short. The most convincing proof of that is we received full-functionality A samples in just half a year. I’ve seen enough infotainment system development projects where there was nothing after two years,” he added.

Despite the openness, open-source code is of high quality, noted Mr. Kinkelin. “A nything that you take from Linux is very robust, because it has been used and used in many different environments. Cisco routers are operating on Linux.”

At Ludwigsburg, the Genivi alliance announced the addition of some important new members: Freescale Semiconductor, Texas Instruments and the embedded Linux software company MontaVista. X S Embedded, a division of Harman International, and software developer K PIT Cummins have also joined. The alliance now has 21 members.

Genivi participants expect more carmakers will soon become members, joining BMW, GM and PSA, but their membership level has yet to be determined. Charter members pay $150,000 for the first year. Possible carmakers include Honda, Nissan and Renault.

At least five tier-one infotainment system suppliers including Visteon, Magneti Marelli, Delphi, Bosch and Continental have demonstrated Linux-based infotainment systems.
Magneti Marelli

Background
Magneti Marelli traces its automotive electronics history back to the early 20th century when, as a partnership between Fiat and Ercole Marelli, it began producing magnets, electrical equipment, spark plugs and batteries for automobiles. In the 1930s the company expanded into radios, submarine batteries, electric vehicles and train lighting. Enrico Fermi joined the company in 1938 as head of the research laboratory, and in the 1940s Magneti Marelli was a supplier to the Italian Air Force. The company became a wholly owned Fiat subsidiary in 1967.

A series of acquisitions, divestments and joint ventures since the mid-1980s refined and focused the company's product portfolio and expanded its global manufacturing footprint. Today, Magneti Marelli employs some 33,000 people at 67 production sites, 10 R&D centers and 28 application centers in 18 countries. It manufactures electronics in several low-cost countries: China, Slovak Republic, Brazil and Mexico. The company will open a new electronics manufacturing facility with a joint venture partner in India by the end of 2009. That facility will also support R&D and sales activities.

We asked Eugenio Razelli, CEO since 2005, why customers buy from Magneti Marelli rather than from Denso, Bosch or Continental. “On a global supplier list we are number 23, so we are not the biggest and we are not the smallest,” he said. “But our technology is strong and that helps us achieve a good balance between performance and cost. Plus, we are more open-minded and more flexible than the big guys, so we can be more responsive to what our customers want.”

Magneti Marelli relies on its parent, the Fiat Group, for nearly half of total sales, but it also supplies leading carmakers in Europe, the Americas and China. Magneti Marelli accounted for 9.1% of Fiat Group revenue in 2008.

For the first quarter of 2009, Magneti Marelli reported €1 billion in revenue, down 26.7% compared with the first quarter of 2008, and a trading loss of €40 million, compared with a trading profit of €45 million in Q1 2008.

Of the company’s nine major business groups, the largest (in order) are Lighting, Powertrain, Suspension and Exhaust Systems, which together account for nearly three-quarters of Magneti Marelli’s sales. Electronic Systems, primarily instrument clusters, body electronics, infotainment and telematics, accounted for 11% of sales in 2008. Electronics is a core competence of Magneti Marelli, and this profile focuses on electrical and electronics components and modules business acquired in December 2007 and consolidated in April 2008.
Magneti Marelli Supplies Injection Systems. Magneti Marelli sells start electronics, dual-clutch transmissions, and engine injection systems. The company has been among the world’s top automotive suppliers since the early 1990s, when it developed engine control units (ECUs) for Freechoice in China. Magneti Marelli supplies its electronic control units for Freechoice in Guangzhou, China.

According to market research provided by the company, in 2007 Magneti Marelli developed the world’s first full-LED headlamp for a series production vehicle, the Audi R8. Magneti Marelli supplies fuel injectors for 11 out of 12 Formula One racing teams. Renault’s new Scenic compact MPV is the world’s first vehicle in its price range to employ a configurable LCD instrument panel. The panel is from Magneti Marelli.

The company is the world’s first infotainment supplier to support two open platforms: Microsoft Auto and Genivi, the open-source Linux platform championed by BMW, Intel and Wind River.

Magneti Marelli’s Major Customers

<table>
<thead>
<tr>
<th>#1 Fiat Group Automobiles</th>
<th>Others listed alphabetically</th>
</tr>
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<tbody>
<tr>
<td>BMW</td>
<td>PSA</td>
</tr>
<tr>
<td>Chrysler</td>
<td>Renault/Nissan</td>
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<tr>
<td>Daimler</td>
<td>Sevel (Fiat/PSA) joint venture</td>
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<tr>
<td>Ford</td>
<td>General Motors</td>
</tr>
<tr>
<td>Volkswagen Group</td>
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</tbody>
</table>

Transmission Applications in Europe by Type

- Automatic, 25%
- Manual, 75%
- Dual clutch, 2%
- CVT, 2%
- Classic automatic, 17%

Flex-Fuel Solutions

Since 2007, all new cars produced for the Brazilian market must run on either gasoline or alcohol (ethanol) derived from sugar cane or any mixture of the two. Magneti Marelli’s flex-fuel engine controllers have a 58% share of that market.

Magneti Marelli is also positive about dual-clutch transmissions, which provide a 5% to 10% efficiency improvement compared to conventional automatics. The company is developing a dual-clutch transmission with the Fiat Group.

The Hansen Report on Automotive Electronics, Portsmouth, NH USA www.hansenreport.com
Electronic Systems

◆ Instrument Clusters

By far the largest product line in Magneti Marelli’s Electronic Systems business, instrument clusters have been part of Magneti Marelli’s product portfolio from the company’s founding in 1919. The product line is a convergence of three instrumentation brands: Jaeger, Veglia and Borletti.

Today the company produces a full range of instrument clusters—about five million clusters per year—at prices that start at less than €20 and go up to approximately €200 each. At the low end, Magneti Marelli makes clusters for vehicles such as the Renault/Dacia Logan and the Volkswagen Fox. At the high end are clusters for Porsche, Maserati and Ferrari. Magneti Marelli supplies 75% of the clusters used by A udi. Production facilities for instrument clusters are located in Europe, M ercosur, China, N A FTA, Russia and India.

The company also produces 800,000 to 900,000 stand-alone displays a year, including single-color dot-matrix displays, LCDs, and TFT LCDs. “In some cases we purchase a display assembly, add an electronics board, assemble and test. In other cases, when we want to be especially competitive, we buy a more basic display component and integrate all of the electronics ourselves,” said Giuseppe Rosso, CEO of the Electronic Systems business line.

◆ Configurable Instrument Panels

The idea to replace electromechanical instrument clusters with solid-state instrument panels has been around for well over a decade. Visually appealing and infinitely configurable, they give carmakers the ability to safely present the information that traditional clusters usually present and much more. But they haven’t caught on in high-volume applications because they have been too expensive.

In February 2009, Magneti Marelli began shipping a 230mm x 38mm configurable display to Renault for its new Scenic, a moderately priced five-passenger MPV. “The Renault Scenic demonstrates that we are finally able to offer a product at a competitive price, roughly comparable to the price of a high-end electromechanical cluster,” declared M r. Rosso.

“That is because TFT displays are used in such high volumes on laptops, smart phones and portable navigation devices. Part of the appeal of configurable displays is that carmakers can now develop the HMI in house using Photoshop or other graphics software.”

The customizable, full color, 960 x 160 pixel TFT display handles data such as vehicle speed, cruise control and speed limiter settings. The Scenic also comes with an optional 7-inch color TFT LCD display (not from Magneti Marelli) for the navigation system and to monitor a rear-facing camera for parking assist. Magneti Marelli says it is talking to other carmakers about configurable instrument clusters and is quite close to receiving additional orders.

◆ Open Infotainment, Telematics and Connectivity Systems

Considering all of its new and relatively new electrical and electronics products, Magneti Marelli sees open infotainment systems, including telematics and connectivity to portable devices, as the most promising. “Today the market penetration for these products is relatively low, so we see a huge potential in front of us,” said M r. Razelli. “Sooner or later, every car will have an electronics box for telematics and connectivity to support functions like eCall, stolen vehicle tracking and navigation, and to manage connectivity with personal consumer electronics devices,” he predicted.

Magneti Marelli offers the complete range of products in this category, everything from Blue&M eT™ and telematics boxes up to full infotainment systems. Typically Magneti Marelli’s infotainment products range in price from roughly €150 to €1,000.

Developed by Fiat and M icrosoft and installed so far on 500,000 Fiat, A lfa Romeo and Lancia vehicles, Blue&M e is made by Magneti Marelli. Based on the M icrosoft A uto software platform, Blue&M e is similar to the Ford Sync system, which came out later. “We in the Fiat Group were first to work with M icrosoft and help make them successful in the automotive world,” said M r. Razelli.

Blue&M e, first introduced on the Fiat Grande Punto in 2006, is a low cost, hands-free connectivity platform that lets drivers safely operate their Bluetooth mobile phone and U SB-connected media player by voice or with steering-wheel mounted switches. Blue&M e N av adds navigation capability plus telematics features such as S OS, concierge and insurance services. Blue&M e MAP combines the convenience of a portable navigation device with the safety of the Blue&M e speech and steering-wheel mounted interface. It is connected to the vehicle’s audio system via the basic Blue&M e package.

Since the products were launched, about 60,000 customers have opted for Blue&M e N av or Blue&M e MAP. Blue&M e N av first became available in 2007 on the Fiat Bravo; Blue&M e MAP followed in 2008, on the Fiat 500.

Magneti Marelli believes that Blue&M e is the beginning of a trend toward open hardware and software platforms capable of supporting numerous infotainment applications available not only from the tier-one automotive electronics suppliers who build the platform, but also from third parties including consumer electronics suppliers. “Magneti Marelli has two open platforms, one based on M icrosoft and the other on Linux,” noted M r. Rosso.

While Magneti Marelli remains highly committed to the M icrosoft platform, it is a member of the G enivi consortium, a group that includes B MW, G M, P SA, A udient and W ind R ever. G enivi is developing an open source infotainment platform based on the Linux operating system.

G enivi goes much farther in openness than M icrosoft because the technology it develops can be modified by anybody within the open source community. A s a proprietary product, M icrosoft software can only be modified by M icrosoft.

“With platforms such as M icrosoft’s and G enivi, carmakers will be able to reduce the cost of infotainment systems from approximately €1,000 now, to a price closer to that of a portable navigation system,” promised M r. Rosso. “It is completely different from what carmakers are used to, but step by step they will arrive at this open approach.”
The Company Profile Continued

**Major Products and Technologies with Significant E/E Content**

<table>
<thead>
<tr>
<th>Category</th>
<th>Products/Technologies</th>
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</thead>
<tbody>
<tr>
<td><strong>Lighting</strong></td>
<td>Headlamps, Halogen, Xenon, Vertical aim control systems, Adaptive front lighting systems, LED, Rear Lamps, LED, Neon, Adaptive rear lamp systems</td>
</tr>
</tbody>
</table>

**Ford Work Solutions**

Magneti MARELLI helped develop and now manufactures the in-dash computer at the heart of the Ford Work Solutions productivity platform introduced in the North American market last fall on the 2009 F-150, F-Series Super Duty, and E-Series vans. The computer, which provides internet access via the Sprint Mobile Broadband Network and navigation by Garmin, runs on the Microsoft Auto platform. The system includes a wireless connection to peripheral devices such as a printer and a hands-free Bluetooth connection to the user's cell phone. It comes equipped with a 6.5-inch color touch-screen display. Still in the ramp-up mode in 2009 in a very difficult economy, Magneti MARELLI expects to ship 30,000 Ford Work Solutions computers in 2010.

**Brazil Telematics Mandate**

As the technology leader for flex-fuel engine management solutions in Brazil, Magneti MARELLI is well known to carmakers in Brazil, as well known as its much larger competitors Continental and Bosch. It also doesn't hurt that Fiat is a major vehicle manufacturer in Brazil, responsible for nearly one out of every four vehicles made there.

Given that background, it stands to reason that Fiat subsidiary Magneti MARELLI could win nearly one-third of the market for satellite tracking devices that will be required on every automobile and motorcycle sold in Brazil starting in 2010. The initial phase-in period starts at 20% of new vehicles and ramps up to 50% and then 100% by the end of the year. With support from a satellite tracking service, the device is capable of immobilizing the vehicle. “Soon there will be an available market in Brazil for four or five million telematics boxes per year,” pointed out Mr. Razelli.

**Growth in Asia**

A $1.5 billion acquisition of Magneti MARELLI by Fiat last year was an opportunity for Mr. Razelli to increase its business with Chrysler. However, it will take at least until 2013 before Magneti MARELLI can realize the full potential of the Fiat-Chrysler alliance. That's because Chrysler is already in a long-term supply agreement with Continental for the products that are manufactured at its former Huntsville Electronics division. In 2004, when Siemens Automotive (now part of Continental) purchased the Huntsville Electronics division, Chrysler agreed to keep its business with Siemens until 2012. At the time it was acquired by Siemens, Huntsville was shipping nearly $1 billion worth of parts to Chrysler annually. After 2012 Continental has a right to last refusal for another four years.

“We were already in discussion with Chrysler before this deal, for applications like connectivity, navigation and infotainment,” pointed out Mr. Rosso. “This will be an opportunity for us to grow even faster at Chrysler.”

**Chrysler Business to Grow after 2012**

In June of 2009, Chrysler completed its alliance with Fiat, which essentially placed Fiat in charge of the troubled North American carmaker. The deal presents a huge opportunity for Magneti MARELLI to increase its business with Chrysler. However, it will take at least until 2013 before Magneti MARELLI can realize the full potential of the Fiat-Chrysler alliance. That's because Chrysler is already in a long-term supply agreement with Continental for the products that are manufactured at its former Huntsville Electronics division. In 2004, when Siemens Automotive (now part of Continental) purchased the Huntsville Electronics division, Chrysler agreed to keep its business with Siemens until 2012. At the time it was acquired by Siemens, Huntsville was shipping nearly $1 billion worth of parts to Chrysler annually. After 2012 Continental has a right to last refusal for another four years.

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*The Hansen Report on Automotive Electronics, Portsmouth, NH USA  www.hansenreport.com*
supply LED headlamps for the Lexus RX 450h and the third generation Prius.

According to A udi, by 2012 a car lighting system that uses LEDs for every one of its lights, including the headlamps, will consume just 168 watts of power, compared with 652 watts for a vehicle lit entirely by incandescent light bulbs. That’s a 74% reduction in power consumption.

But today, headlamps made from LEDs are very expensive and will remain so for many years. A udi charges customers $5,600 for the LED headlamp option in the new R8 sports car. The feature is standard on the V10 version of the R8.

A total of 54 LEDs in the A udi light assembly hande low beam, high beam, daytime running lights and turn signals. According to W olfgang Huhn, responsible for lighting and vision systems at A udi, in addition to numerous technical challenges, the greatest challenge in bringing the all-LED headlamp to production was finding the funds to cover the cost of such a big development project. One supplier estimated the OE development effort at 24 man-years.

Thermal Management Required

“One of the biggest technical challenges is cooling the LEDs,” pointed out Dr. Huhn. “They don’t require very much electrical power, but the thermal losses are very concentrated. Each device is only one square millimeter and must handle 700 milliwatts of current. We use a fan and airflow to cool them, similar to what is used in computers.”

According to Dr. Huhn, Toyota’s headlamp in the Lexus LS600h hybrid, which uses LEDs for low beam only, employs an aluminum heat sink that weighs 1.5 kilograms (3.3 pounds). “Since ours is a full-LED headlamp, we would have needed a 3 kilogram heat sink, something we wanted to avoid,” he said.

In four years or so, A udi’s all-LED headlamps will no longer require active thermal management. “We’ve invested in this technology because we do expect progress in LED technology. Our first, second and third LED headlamps will have fans. But by 2013, when LEDs are capable of 100 to 150 lumens per watt, we will need less current and we’ll be able to get rid of the fan,” Dr. Huhn noted.

LEDs Began with CHMSLs

Derek M allory, assistant general manager at N orth A merican Lighting, a division of Koito, remembers when red LEDs were first used for vehicle lighting. “Nissan did their first LED high mounts back in 1993. From that point LED applications have been continually growing. The first LED high mounts were roughly $50 for the LEDs and the circuit board. In the first ten years, that price went down under $2, and penetration of LED high mounts in the U.S. went from zero to 60%,” he said.

LEDs have been moving aggressively into applications in the vehicle interior for some time. “The mid-size vehicles and above are all LED,” noted Leonard Livschitz, who ran Lumileds’ global automotive lighting business as the industry was getting underway. “They are especially attractive for the instrument panel, because the cost of replacing a bulb is so high; you need to take the whole instrument panel apart. I don’t think anybody uses bulbs any more.” Mr. Livschitz is presently working in the general LED lighting market for a small Silicon Valley startup, LEDengin.

Rear combination lamps are considerably more expensive than standard incandescent technology, so the drive into production has been slower than for CHMSLs. “Applications of LED rear combination lamps started with the luxury brands and then moved down to mid-range vehicles. After ten years, the penetration of those today is about 20%. That is a good model of what will probably happen with LED headlamps, which are next,” suggested M r. Mallory.

Dr. Huhn believes that by 2020, LED headlamps will cost less than xenon lamps, and they will be competitive in price with halogen. A large part of the cost reduction will be driven by technology advances and wider application of LEDs in general lighting, for example in residential, commercial and factory buildings. “Some years later [than 2020] I think LED has the potential to be the one, single light source for both low and high beams,” he predicted.

China Is Especially Ripe for LEDs

Possibly the hottest market for automotive LEDs right now is China. Not only is China aggressively developing electric vehicles, for which LEDs are a perfect fit, but China is already a major player in LED device packaging. “There are a lot of LED companies in China. They are not as far along as the three major players—Philips Lumileds, Osram and Nichia— but they are growing and learning,” said A udi’s Dr. Huhn.

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