Combustion Pressure Sensors Find Production
The idea to use in-cylinder pressure sensors as part of a feedback control loop to manage the combustion event has been talked about for decades. Now it appears that they will finally be put into production applications starting with Volkswagen/Audi and General Motors V6 diesel engines. Both new engines will go into production by the end of 2007.

The end of 2007 is also when Beru (Ludwigsburg, Germany) will begin shipping its intelligent glow plugs with integrated strain gauge pressure sensors to GM Europe and another European customer. According to Automotive Engineering International, GM’s 2.9-liter engine “will debut in the 2009 Cadillac CTS in Europe, and will also power Opel, Saab and Vauxhall models.”

In 2008 Volkswagen will begin shipping the new Touareg with its clean diesel engine, the BlueTDI, which meets even the most challenging U.S. exhaust emission standards, the so-called Tier 2 Bin 5 limits adopted by California, Massachusetts, New York, Vermont and Maine. The engine will use an in-cylinder pressure sensor to optimize injection and combustion.

Stricter emission limits on nitrogen oxides (NOx) and particulate matter (PM) in Europe have forced some diesel engine-makers to consider using pressure sensors in anticipation of Euro 5 limits, which are scheduled to go into effect in 2009. Euro 6, which as proposed would take effect in 2014, will place even stricter limitations on NOx and PM. By then pressure sensors will be used more widely.

What’s special about the Beru implementation is the way the pressure sensor and signal-conditioning circuitry is integrated into the glow plug, which at its tip

Siemens VDO Electronic Wedge Brake—Industry Is Skeptical
Compelling Reasons Needed to Switch from Hydraulic
Ford and General Motors are seriously considering Siemens VDO’s Electronic Wedge Brake (EWB). General Motors has a particular program in mind, a 2011 or 2012 fuel-cell hybrid. And Ford—once Siemens can demonstrate production-intent actuator prototypes—will probably give Siemens a development contract, “so we can do some rough testing and see what fails,” said Pim van der Jagt, Ford manager of global vehicle dynamics. Dr. van der Jagt would first consider the EWB for a low-volume hybrid vehicle, in order to get field experience with it. “EWB is interesting enough to put resources and money toward developing it, but we’re not 100% convinced it will work,” he noted.

While the wedge brake is a well-publicized German invention, we could find no German Carmakers willing to champion the technology as an alternative to hydraulic brakes in conventional vehicles. That was somewhat surprising given the propensity of the German auto industry to pioneer new technology.

Stephan Wolfsried is head of electricalelectronics and chassis development for the Mercedes car group. “The guy who invented it [Bernd Gombert] came to Conti Teves, came to Bosch, to all the big brake suppliers. All of them are very suspicious about whether the wedge is a working principle. I have my doubts about whether Siemens will be successful, because after discussing it a couple of times in this µ-Club, the community of all the brake guys in Europe, we don’t see a real benefit in cost, weight or functionality. So why would we bring an actuator into a rough environment, with vibration, shock and temperature?”

Electronic Wedge Brake is the Siemens VDO brand name for an implementation of a concept that has been around for a long time. EWB is an electromechanical brake that can be operated at 14 volts, because it relies in part on the mechanical advantage of the wedge. To actuate braking, an electric motor moves a wedge connected to a brake pad located between the brake caliper and the brake disc. The rotation of the wheel and the resulting friction automatically reinforce the wedge effect. Siemens began its efforts to industrialize the wedge brake when it purchased Bernd Gombert’s firm, eStop, in early 2005. In late 2006 Siemens wrote in a press release, “The EWB is set for inclusion in every vehicle class, from economy up to large trucks, in the medium term.”

Currently, 98 Siemens engineers are working on the Electronic Wedge Brake. However, even high-tech pioneer BMW isn’t jumping at the chance to adopt the EWB. “We investigated electromechanical brakes in the early 1990s. We looked thoroughly at the pros and cons and came to the conclusion that there is really no hard argument you can use to justify the electromechanical brake,” noted Heinz Leffler, in charge of brake and chassis development at BMW. “My personal view is, if I do not have a driver that really requires power brakes it will be

Turn to Braking, page 3

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Sensors...

reaches 1,000 degrees Celsius. “The first challenge was how to integrate a pressure sensor with a diameter of 20 mm into a glow plug with a diameter of 10 mm,” said Ron de Groot, global powertrain strategy manager for Sensata, whose micro-fused silicon strain gauge (MSG) pressure sensor is built into the Beru glow plug.

“Normally, the glow plug has a heat rod, or pin, that’s press fit into the body,” explained Hans Houben, vice president in charge of engineering at Beru. “To transmit the pressure from the plug’s tip to the pressure sensor at the other end we made the pin moveable by means of a metal bellows, similar to the part used in piezoelectric fuel injectors. “We chose Sensata’s pressure sensor because it is proven technology already used by the millions,” said Mr. Houben. Sensata’s MSG sensor derives from the piezoresistive effect of silicon, which changes in resistance as a function of mechanical stress. It is widely used to measure brake and fuel pressure.

Honda has developed a prototype of a super-clean diesel engine slated for introduction in the U.S. market in 2008. The prototype includes a cylinder pressure sensor to detect the cetane number, a measure of diesel fuel’s ability to quickly ignite. However, Honda hasn’t yet decided, or isn’t saying, if the production version will also include pressure sensing, either one sensor per engine for cetane detection, or one sensor per cylinder for combustion control, as in premixed charge compression ignition (PCCI) engines. Cetane level detection may be necessary in the United States, where the quality of diesel fuel varies more than it does in Europe.

Ludwigsburg Automotive Electronics Conference Worth the Trip

As automotive electronics conferences go, this one, programmed by VIPs of the German car industry, is among the best. The Eleventh International Congress on Advances in Automotive Electronics, to be held July 17 and 18, 2007, in Ludwigsburg, Germany, features two days of presentations by some of the leading lights of the German auto electronics industry.

Among the ten presenters at this year’s conference, all from top management, are Wolfgang Ziebart, president and CEO of Infineon Technologies; Will Specks, manager, research electronics, Volkswagen; Willibert Schleuter, chief executive engineer, electrical/electronics, Audi; Uwe Michael, director electrical/electronics systems, Porsche; and Walter Kuffner, director electronics driving dynamics, BMW.

Each presentation is followed by a lively and illuminating question and answer session. Simultaneous English translation is available.

The conference and exhibition is intimate and very friendly with ample opportunities to network and learn about what’s next in automotive electronics. About 400 management-level attendees are expected, almost all of whom are multilingual Germans.

Exhibit space for about 35 suppliers is sold out. While few papers from the conference are in English, every paper will have an English abstract.

The conference is programmed by Peter Thoma, supervisory board member of ELMOS Semiconductor and formerly BMW’s top electrical engineer, and by Heinz Leiber, former director of overall electrical/electronics development, Mercedes-Benz.

It is produced by the German publication Automobil Elektronik and the Management Information Center. The conference manager, Marcus Dworak, can be reached at m.dworak@m-i-c.de.

For more information, please visit www.elektronik-tagung.de.

THE HANSEN REPORT
ON AUTOMOTIVE ELECTRONICS

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Braking...

difficult to introduce such systems on a broad basis in the passenger car market.” Despite Dr. Leffler’s disinclination toward EM braking, after a test drive this winter he had a positive reaction to Siemens’ EWB. “The guys at Siemens did a nice job. It brakes perfectly and the pedal feel is okay.”

We asked Heinz Leiber, formerly Mercedes’ top electrical engineer, if any German carmakers are seriously considering EWB. “In Germany, I don’t know one carmaker. They all had initial interest and considered it, but at the moment there is no serious interest.” As a consultant Mr. Leiber has analyzed the Wedge Brake’s potential on behalf of some of his clients.

Siemens VDO Claims Significantly Shorter Stopping Distances

Without compelling reasons, carmakers are not inclined to switch from hydraulic to electromechanical brakes; too many assets are in place, and there is the risk that complex new technology will be unreliable. As Conti Teves vice president of control systems software, Helmut Fennel, pointed out, hydraulic brakes have served the industry well for more than 80 years. “I have been working in the brake business for thirty years and I do not foresee any advantage of the wedge brake compared to today’s hydraulic brakes, in terms of function, for the cars we are driving today,” he said.

But Siemens has been asserting for some time that there is a compelling reason to switch and that reason is shorter stopping distances with the Electronic Wedge Brake. Shorter stopping distances would save thousands of lives every year. According to Siemens, EWB’s advantage is that it responds more quickly and therefore starts braking sooner; and once it begins to brake, it more accurately controls slip, because it can cycle on and off faster than hydraulic brakes.

“We can control the ABS braking forces very accurately to minimize slip,” noted Dirk Neunzig, in charge of Siemens’ EWB technical development. “There are two reasons for that. First we measure the braking force directly, which is much more accurate [than measuring hydraulic fluid pressure]. Second, with the high-performance electric motors and self-reinforcement of the Wedge Brake you can apply exactly the force you need.” This is because the EWB can cycle on and off at about 30 hertz, compared with 5 to 15 hertz for hydraulic brakes.

“And, with the Wedge Brake you have much improved dynamics in getting the first braking force on the calipers and onto the road,” explained Mr. Neunzig. EWB initiates braking in just 80 milliseconds compared with 200 to 400 ms for premium hydraulic brake systems. “To be fair, the fastest hydraulic systems, those that pre-load the brakes, are about 250 ms., but that is under normal weather conditions. In the winter it takes longer, because the braking fluid gets like honey.”

In recently concluded winter tests at Arjeplog in northern Sweden, an EWB-equipped BMW 530i achieved a braking distance “almost 15% shorter compared with the average of the [four] comparison vehicles tested... on low coefficient of friction and split-µ surfaces,” according to a written report dated April 16, 2007 from Dekra Automobile GmbH, an independent automobile test center. During those tests, the air temperature was roughly 5 degrees Celsius. All of the vehicles tested had automatic locking prevention (ABS), traction control and electronic stability control.

According to Mr. Neunzig, the EWB-equipped vehicle was even more advantageous when the temperature was at minus 5 degrees Celsius. “At that temperature we were 20% better in stopping distance from 80 kilometers per hour to zero on what we call scraped ice.”

At warmer temperatures EWB-equipped vehicles still stop in shorter distances, according to Mr. Neunzig. “In normal temperatures where an average car has about 38 meters stopping distance from 100 km/h to zero, we are something like two and a half meters less.” That’s a 6.6% improvement, though Mr. Neunzig expects to better that in upcoming tests this summer.

Tom Zebehazy, senior manager, advanced technology development for General Motors, which is considering the Siemens EWB for a 2011 or 2012 hybrid fuel-cell vehicle, is a believer. “I’ve experienced the improved stopping distance compared to the conventional car on dry pavement, ice and snow,” he declared.

Some other well-informed people have found Siemens’ earlier assertions about stopping distances hard to swallow. One such person is Heinz Leiber. Though he is now retired from Mercedes, Mr. Leiber is still active in the automotive electronics community in Germany. “It is possible with conventional systems to improve the stopping distance by using the full braking effort. But braking is a compromise between optimal braking force and optimal lateral force for steering.”

Even Bosch, who purchased a license to develop the wedge brake and is presently researching its feasibility, is confounded by Siemens’ assertions about its EWB. “We have found no physical reason why such an electrical system should do any better than a hydraulic one,” suggested Günther Plapp, executive vice president, development for the chassis systems, brake division of Bosch.

He further explained: “We exploit 97% of the possible friction that can be transferred from the road. That [the percentage isn’t higher] isn’t because of a slow actuator. It is simply that you need a little bit of time to measure the speed and decide if the wheel is locked or running, and then you can act on the system. The electrically operated wedge also has to reverse if you want to lock or unlock the wheel. And since the wedge has a fairly large mass that must be accelerated and reversed you can easily imagine that just increasing and releasing the pressure on a small electrical valve with the hydraulic fluid is at least as fast as or faster than the electrical system.”

Bosch will study the wedge brake’s feasibility until the end of 2008, after which it will make a decision on whether or not to put a wedge brake into series production. The only electromechanical brake Bosch is considering is the wedge brake. “If we go into serial production it will most likely be a wedge type,” said Günther Plapp.

Concerns about Durability Are the Greatest Obstacle

In some respects Siemens’ decision to enter the electromechanical brake business at the end of 2005 couldn’t have continued on page 8
The Company Profile...

Pioneer Corp.

Headquarters: 4-1, Meguro 1-chome, Meguro-ku, Tokyo 153-8654, Japan; Phone: 81-3-3494-1111; Fax: 81-3-3495-4428

Products: Car electronics and home entertainment electronics, including plasma displays
FY 2007 Sales: ¥797.1 billion ($6.7 billion)
FY 2007 Net Loss: ¥6.8 billion ($56.9 million)
R&D: 7.4% of sales
Employees: 37,622 as of March 2007
FY 2007 Sales per Employee: ¥21.2 million ($178,400)
FY 2007 Net Cash from Operations: ¥16,752 million ($141.1 million)
FY 2007 Working Capital: ¥151.4 billion ($1.3 billion), as of March 31, 2007
Stockholders' Equity as of March 31, 2007: ¥268.1 billion ($2.3 billion), a decline of 1.9% from the prior year
Market Capitalization as of May 8, 2007: ¥270.1 billion ($2.3 billion)

Car Electronics
FY 2007 Sales: ¥358 billion ($3 billion)
FY 2007 Sales by Region: Japan, 35%; ROW, 65%
Products: Navigation and car audio systems and components
Largest Tier-One OEM Customers (alphabetically): Ford, GM, Honda, Toyota

Background
The roots of Pioneer go back to 1937, when founder Nozomu Matsumoto developed the A-8 dynamic speaker. A year later he established the business Fukuin Shokai Denki Seisakusho in Tokyo. In 1961 the company changed its name to Pioneer, and its shares were listed on the Tokyo Stock Exchange. The following year Pioneer introduced the world's first component stereo system, and five years later set up operations in Europe and the United States. In 1975 Pioneer introduced the world's first component car stereo system, followed by the first car CD player, in 1984, and the first CD-player-based car navigation system, in 1990.

Today Pioneer manufactures a full range of audio visual products for the home and automobile. Worldwide the company operates 32 manufacturing sites, and the Pioneer Group comprises 127 subsidiaries. The main home-entertainment products include plasma displays, DVD products and audio systems.

Pioneer, who says it maintains a stable dividend policy, paid a ¥10 per share dividend for FY 2007, the same as it paid in FY 2006.

Among Pioneer's biggest-selling products in FY 2007 were plasma displays, 640,000 units shipped; DVD recorders for the home, 620,000 units shipped; and recordable DVD drives, 12 million units shipped.

Car Electronics sales, which represent nearly half of Pioneer's total sales, increased 8.3% in FY 2007. Thirty-five percent of Car Electronics sales were in Japan. Pioneer's aftermarket navigation sales growth came primarily from Japan; most of the OEM navigation growth was in North America. OEM car audio sales in North America declined. OEM sales in the Car Electronics segment accounted for 36% of the total segment sales.

Brand Emphasis
Pioneer launched a concerted effort to raise its brand image in 2001, when the company increased its advertising spending to $120 million, nearly 50% more than the prior year. According to a press release, in 2001 Pioneer created its slogan “sound.vision.soul” to capture its philosophy that "sound and vision can move the heart and touch the soul." “Sound” relates to Pioneer's origins in the audio field; “vision” refers to the company's commitment to the video business; and “soul” emphasizes Pioneer's determination to elevate entertainment to the level of pure emotion.

In 2006 Pioneer reiterated its intention to invest in its audio brands in response to the entry of low-priced Korean and Chinese competitors. Pioneer's brands include Pioneer premium sound systems for both global OEM customers and the North American and European aftermarkets, including big box retailers. The Premier brand is offered to custom car audio in-
Pioneer's approach remains to develop and deliver optimum sound performance through a total system design strategy. "We are able to match the consumers' desires for premium audio with our ability to develop high-end, high-performing premium sound," said Mr. Moerner. "In the last several years our OEM business has gone from very limited sales of Pioneer branded audio systems to the point where now all Scion vehicles have Pioneer branded audio systems, as do a number of Chevy and Pontiac vehicles." Pioneer branded audio is also offered on the Ford Ranger.

In 2002 Pioneer and Toyota announced their partnership to develop branded car audio systems designed for Toyota's new line of Scion vehicles. At the time Scion's national manager, Brian Bolain, said, "We believe that Pioneer is a respected brand whose name resonates well with Scion's target buyer."

Pioneer Navigation at Ford
While not branded in Ford vehicles, Pioneer navigation products are presently in use on 23 different Ford, Lincoln and Mercury models.

After a long qualification process, in 2006 Ford North America selected Pioneer as its only navigation system supplier. "We introduced an all-new [Pioneer] navigation system in the 2006 model year, and within about 18 months we rolled it continued on following page
Jablonski noted. In J.D. Power’s Mercedes, Lexus or Infiniti vehicles, “Mr. isfying navigation systems than those in So our affordable vehicles have more sat-
satisfaction by J.D. Power and Associates. claimed Mr. Jablonski. actually designed the HMI for the naviga-
tion systems around the globe from a systems at Ford. “We benchmarked navi-
gation engine, software, transport mechanisms, acoustics or speakers.

Aftermarket Car Electronics Products Mature
Nearly two-thirds of Pioneer’s car electronics products are sold in the aftermarket. With a 24% share of the worldwide market, according to the company, Pioneer is the number-one supplier of aftermarket mobile electronics including audio/video entertainment and navigation products.

Pioneer's biggest product category by unit volume is single-CD car radios—the company produces about 10 million units each year. That business is growing most significantly in Brazil, Russia, India and China. In contrast, in the developed nations of Europe, in Japan and in the United States, the market for integrated audio/navigation products is beginning to grow. According to Steve Moerner, integrated audio/navigation products are in-
creasing both in volume and strategic im-
portance to Pioneer, on the OEM side as well as in the aftermarket.

The aftermarket, especially in Japan, is seeing increasing integration of navigation and audio, often in hard disk-based systems. Makers of these integrated systems might allocate half of a 20-gigabyte hard drive to music and half to navigation map data storage. “Demand for HDD-equipped audio/navigation systems is beginning to expand substantially, even beyond Japan,” Mr. Moerner said. “The reason is that not only has the cost come down, but the value to the consumer has gone up—in terms of music storage capability, faster access to navigation data and larger points-of-interest libraries.” Map data updates are made to Pioneer’s HDD navigation systems by means of an update disc, which is read by the DVD player embedded in the head unit.

Pioneer has high expectations for a new DVD-based audio/video navigation system introduced to the U.S. aftermarket in March 2007, with a suggested retail price of just $1,000. The AVIC-D3 is a 2-DIN unit with a 6.1-inch customizable touch screen color display. It handles audio discs in multiple formats including MP3, WMA and AAC music files, as well as DivX video format on DVD and DVD-video. Navigation and multimedia functions can be enjoyed simultaneously, thanks to the memory navigation feature, which allows you to eject the navigation disc once you load your current route into memory, and pop in a CD or DVD. The system includes an AM/FM tuner, it is iPod ready, steering remote control ready, Bluetooth ready and XM and Sirius satellite radio ready. AVIC-D3 comes with two DVDs that hold a TeleAtlas map database for the United States, which also includes 12 million points of interest.

Pioneer has not yet made a decision to come out with HD Radio capable head units. “While I am usually a strong proponent of integrating new features into our car electronics, we are still waiting and watching the digital AM/FM radio market,” said Mr. Moerner. “We will support the market as soon as we see that the consumer demand is real.”

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Study Average: 767

Beyond brand recognition, why do OE customers buy from Pioneer rather than from its competitors? Steve Moerner answered the question this way: “It’s our unique position of being a major player in both the aftermarket and the OE market. Our aftermarket experience gives us insights to the consumer that are very helpful to the OEs. And it’s also our ability to execute according to what is expected in terms of quality and development. We are one of the few major aftermarket consumer electronics companies that still does almost all of our own manufacturing. We develop the core technology in house, whether it’s the navigation engine, software, transport mechanisms, acoustics or speakers.

Pioneer Corp.

Why Pioneer
Pioneer’s largest OEM customers, not ranked by sales, are Ford, GM, Honda and Toyota, all tier-one customers. Tier-one customers account for about 85% of Pioneer’s OE Car Electronics business. Pioneer also has a significant tier-two business. For example, the company sells media playback mechanisms to Delphi and Visteon, their largest mechanism customers. Tier-two parts customers account for about 15% of OE Car Electronics sales.
Car Electronics Products

Navigation systems
- DVD-based
- Off-board
- Portable
- Turn-by-turn
- Hard disk drive
Audio/visual systems
- Audio systems
- Speakers
- Head units
- Hard disk drives
- Organic LEDs
- Receivers
- DAB (digital audio broadcast)
- SDAR (satellite digital audio radio)
- Tuners
- GPS receivers
- Amplifiers
- CD and MD single and multi-disc players
- Cassette players
- Rear seat video
- Navigation maps
- Traffic data

Research

Pioneer’s research activities related to the auto industry go well beyond audio and navigation, the two product categories that account for almost all car electronics sales. For example, the company has been working on field emitter array image sensor technology that’s capable of producing high-quality images in poor light conditions. Among the applications for such a device would be night-vision cameras for automobiles.

Pioneer has also been working on predicting drowsiness by measuring changes in the heart rate using electrodes attached to the steering wheel. According to Pioneer, heart rate is affected by the ambient temperature, the posture of the driver and the driver’s mental state.

Restructuring

In December 2005, following a loss of ¥8.8 billion in fiscal 2005 and further losses in FY 2006 in its Home Electronics business, Pioneer announced plans for major restructuring:

- Consolidate worldwide manufacturing, bringing the number of production sites down from 40 to 30, thereby reducing employment by 2,000.
- Reduce R&D from 8.5% of sales in FY 2006 to below 7%.
- Offer early retirement for 777 employees.
- De-list from the New York, Amsterdam and Osaka stock exchanges to save costs and clerical burdens.
- Cancel plans to mass produce active-matrix OLED display panels.
- Consolidate offices and streamline sales channels.
- Expand the OEM business.
- Develop new products and services outside automotive markets.

Pioneer also made a number of decisions affecting its Car Electronics business strategy:

- Shore up its aftermarket car audio business, from which the bulk of company profits are derived.
- Aggressively expand aftermarket sales in Brazil, Russia, India and China, whose economies are growing faster than those of Japan, the United States and Europe.
- Aggressively develop aftermarket navigation sales in overseas markets; adapt technology applied to the Japanese market.
- Expand the OEM business.
- Expand into telematics and ITS. Consider collaborations and alliances to support this.
Braking... come at a worse time. That was the year when Mercedes issued a global recall of all 1.3 million cars equipped with the Bosch-built electrohydraulic (Sensotronic) brake control system, a brake-by-wire application. According to the NHTSA recall summary, that system may prematurely shift to hydraulic backup mode due to deterioration of the wiring harness connection or due to premature failure of the hydraulic pump.

In hydraulic backup mode, the driver has braking power sufficient to stop, but stopping requires more pedal pressure and longer pedal travel. Mercedes has since stopped using the system in the E-Class and will also stop using it on the SL and the Maybach when those vehicles are redesigned.

"Those kinds of field problems that Mercedes had with the electrohydraulic brake system are not something I want to happen with a brake system from BMW," declared Heinz Leffler. "The [durability] of any new electromechanical brake system must be at least the same as with today's conventional systems." With electrohydraulic brakes there is no mechanical connection to the brakes. Instead, as the driver depresses the brake pedal, he activates a feel simulator and a pedal-position sensor. The sensor sends a signal to a computer that controls a hydraulic valve, which then delivers optimal pressure to the brake calipers.

"Durability is our main worry with the Wedge Brakes," noted Ford’s Dr. van der Jagt, who could develop the new brake for a future, unnamed hybrid program. "They need to survive in a very harsh environment with dirt, water and temperature shocks. Even with conventional brakes, our warranty costs and issues with vibrations are relatively high."

Cost, of course, is also a major concern. Ford has already done extensive analysis of the cost of implementing the Wedge Brake on a production vehicle. After a three-day workshop with Siemens VDO, largely devoted to studying the cost issue, Dr. van der Jagt’s team concluded that implementing the Wedge Brake on a Mondeo-type vehicle would cost between $100 and $150 more than conventional brakes.

Possible Drivers of Electromechanical Brake Implementation

Despite the obstacles, Dr. van der Jagt believes Siemens’ EWB represents the future. "We see it in the long term. If it really evolves, and they get the price right, it could end up in high-volume vehicles. Of course if we now start thinking about a possible implementation route, we think about hybrids first—we already lose a lot of money on them. With things that have so much impact, you prefer to roll them out on a low-volume vehicle. You thoroughly test them, get field data and then roll them out to higher volume."

GM’s Tom Zebehazy also thinks electromechanical brakes are well-suited to hybrid vehicles. "If you add up what it costs for the base [hydraulic] brake system with stability control and you add on brake regeneration capability, you are talking about a very expensive brake system. We feel electromechanical brakes not only get rid of a lot of hardware, they also have the potential to be very cost competitive." GM is also considering Delphi’s dual-disc electromechanical brakes, which like the EWB, are forceful enough operate at 14 volts.

The industry’s interest in applying electromechanical brakes to conventional vehicles could be spurred on by demand for autonomous full braking, according to BMW’s Dr. Leffler. "In five or ten years, when we have a system that precisely detects [obstacles], or if we have car-to-car communications, or a change from the foot actuated brake pedal to some other means of operating the brakes, that could stimulate the introduction of such power brakes."

Delphi’s 14-Volt Dual-Disc Brake

By coupling the dual-disc brake technology it acquired from Federal Mogul in 2004 with its own electric caliper, Delphi has created a 14-volt electromechanical brake that is powerful enough to stop a vehicle the size of a Range Rover. Currently 50 engineers are working on the Delphi Electric Max Torque Brake. They report to Nick Jones, manager of advanced development, who is in charge of the program. "Our actuator is in its fourth generation, but in many ways the system level is far more complex. That’s where we’re spending a lot of resources, in going from centralized to local control at the wheels. That allows us much finer and faster control of this very powerful actuator for the right level of comfort and performance."

Delphi’s brake and chassis business has been deemed non-core by the company and is available for sale. Mr. Jones, who is working with customers on several development contracts, expects to have the Electric Max Torque Brake ready for production by 2012. Not long after that, he believes, the market for electromechanical brakes will take off.

“You’re courageous to introduce a new technology these days, especially one as fundamental as a braking system. But there is a lot of built-up pressure toward electromechanical braking. Once the first carmaker is courageous enough to put this into production, the floodgates will open.”

Continued from page 3

Aisin Seiki FY 2007 Financial Results

Fiscal year April 1, 2006 through March 31, 2007

Aisin Group
FY 2007 Consolidated Net Sales: ¥2,378.6 billion ($19.8 billion)
Change from FY 2006: up 12.2%
FY 2007 Consolidated Net Income: ¥66.9 billion ($557 million) or 2.8% of net sales, the same margin as the prior year.
Outlook for FY 2008: ¥2,500 billion ($20.8 billion) in net sales, a 5.1% increase over FY 2007; net margin is forecast at 2.7%

Toyota accounted for 66% of Aisin Group’s automotive sales in FY 2007; GM, the distant second-largest customer, accounted for just 3%. Regionally, Japan accounted for 70% of Aisin Group sales. In spite of declining vehicle sales in Japan, Aisin grew domestic sales 10% over the prior year, buoyed by increasing exports. Aisin’s sales also increased in North America and Europe, but its rest of Asia market segment showed the most growth, 43%.

Transmission related products accounted for 42.6% of Aisin sales.