AMI-C Nearly Spent

With just GM, Toyota, Nissan, Honda and PSA Peugeot Citroën still on board and very little of its work yet adopted in production vehicles, the Automotive Multimedia Interface Collaboration (AMI-C) is presently winding itself down. Founded in October 1998 to create standard, open hardware and software interfaces for plug-and-play infotainment and electronics, the members have decided to shut down their facilities and shrink their budget from a peak of nearly $5 million for the year ending July 2001 down to just $350,000 for the year ending July 2006. Although AMI-C will no longer develop new standards, it is completing some of the work outlined in release 2.0, such as the 1394 wireless communications protocol, and it will maintain a website where AMI-C’s output can be accessed.

Dave Acton, who has been AMI-C’s guiding light from the beginning when he first broached the idea of industry cooperation to advance telematics in a meeting with Toyota in 1997, will step down as president of AMI-C this coming June 30. He recently took an early retirement from General Motors, where he last served as director of global telematics planning. Mr. Acton is still representing GM’s interests at AMI-C and other external organizations.

At its peak, when interest in telematics was at its highest, AMI-C included 12 Japanese, German, French, Italian and American carmakers. But carmakers started leaving in October 2000, with the exit of DaimlerChrysler, BMW and Volkswagen, citing high costs and lack of progress.

AMI-C says it is winding down the operation because its pre-competitive work is essentially complete. It has written and

Turn to AMI-C, page 8

Solid-State Relays Poised for Growth

Power semiconductor makers have been talking for over a decade about replacing electromechanical (EM) relays with solid-state devices. But according to EM relay makers, all but a few percent of automotive relays above one amp are still electromechanical. We spoke with leading EM relay makers Omron and Tyco, with semiconductor suppliers Freescale Semiconductor (the Motorola SPS spin-off), Infineon Technologies, International Rectifier and with Yazaki, the world-leading electrical distribution system maker. Recent developments in the automotive relay market indicate solid-state relays (SSRs) are finally gaining traction and electromechanical relay makers may finally be losing their tight grip on the market. Solid-state devices will increasingly be applied in junction boxes, engine cooling and lighting control. Globally, about $800 million worth of relays are purchased each year for automotive applications.

Junction Boxes an Important First Step

Ford and Chrysler recently issued production orders for junction boxes with more solid-state relays. With SSRs, junction boxes can be made a lot smaller while providing considerably more functionality. “Ultimately, the OEMs want to have a small box that dissipates very little power so they can package it anywhere in the vehicle,” said Ray Notarantonio, Infineon marketing manager for high-side switches. He added, “All the OEMs are reducing the number of EM relays in some of their next generation smart junction boxes.”

Chrysler’s new junction box is scheduled to appear first in the 2006 model year, with higher volumes coming in 2007. The carmaker will eventually apply the new box across a number of platforms. The newly designed junction box will eliminate 60% to 70% of the mechanical relays used in the junction box it replaces. With as many as 50 incoming and outgoing wiring circuits, junction boxes typically house about 15 to 20 relays, along with some fuses and high-current copper bus bars, which route current to and from the connectors. Since they are usually installed within the vehicle’s cabin, protected from the engine compartment’s high temperatures, junction boxes can also house body electronics control functions.

Chrysler will likely include a number of solid-state relays designed and manufactured by Freescale Semiconductor (Farmington Hills, Michigan). Freescale first announced its new 2-milliohm

Turn to Relays, page 2

Solid State vs. Electromechanical Relays

Advantages of Solid-State Relays
- Relative costs improving
- Much smaller and lighter
- More reliable
- Devices can come with diagnostics and control functions
- Possible fuse replacement
- No acoustic noise
- Less power needed to operate
- Faster operate and release times
- No arcing
- Less electromagnetic interference
- No relay pre-driver needed

Advantages of Electromechanical Relays
- Long history of proven automotive applications
- Have been lowest cost on average, EM relays cost from $0.55 to $0.65 each
- Provide simpler low-cost reverse-battery protection for seat and window controls
- No heat-sink needed
- Plug-in relays can easily be replaced by a service technician

Turn to Relays, page 2
Freescale has extended that device into a family of multichip devices packaged in its Power Quad Flat pack, No leads (PQFN). One two-chip device contains the 2-milliohm chip. Freescale also offers a three-chip device containing two 4-milliohm switches. Each device includes a mixed-signal chip that does diagnostics and controls the switching functions. Because the lead frame that connects the chips can be modified by laser trimming for the correct pin-outs, Freescale can build other devices within the family in a short time.

Freescale devices may also be employed in a new Ford junction box, where perhaps 20% to 30% of the electromechanical relays will be replaced. Both Ford’s and Chrysler’s junction boxes will probably be produced by Motorola A C E S.

J.D. Power 2003 Emerging Technologies Study

Consumers responding to J.D. Power and Associates’ 2003 Automotive Emerging Technologies Study in both Europe and the U.S. expressed high interest in high tech safety systems. In Europe, 82% of consumers were definitely or probably interested in what J.D. Power calls external surround sensing systems, which include blind spot warning, lane departure warning and back-up aids. In the U.S., 75% of consumers were interested. Interest in both regions dropped when the €1,300/$1,500 price tag was attached. Night vision systems drew a similar response: without a price attached, night vision ranked #1 in the U.S. and #2 in Europe.

Oddly, in both regions brake-by-wire systems, which should be mostly transparent to the driver, rose in the ranking when attached to a realistic price of €350/$400. Consumers were told the feature would improve braking comfort and pedal feel, eliminate the need for brake fluid and reduce brake pad wear.

For more on the study, contact Michael Greywitt at 805-418-8000 or through the J.D. Power website: www.jdpa.com.

### 2003 U.S. Ranking of Feature Interest When Market Price Is Attached

<table>
<thead>
<tr>
<th>Rank</th>
<th>Feature</th>
<th>Market Price in $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adaptive headlights</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Electronic stability control</td>
<td>600</td>
</tr>
<tr>
<td>3</td>
<td>Brake-by-wire</td>
<td>400</td>
</tr>
<tr>
<td>4</td>
<td>Anti-whiplash seats</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>Personal assistance 10/month</td>
<td>safety service</td>
</tr>
<tr>
<td>6</td>
<td>Wireless connectivity</td>
<td>300</td>
</tr>
<tr>
<td>7</td>
<td>Heated/cooled seats</td>
<td>700</td>
</tr>
<tr>
<td>8</td>
<td>Digital surround sound</td>
<td>400</td>
</tr>
<tr>
<td>9</td>
<td>Driver recognition system</td>
<td>500</td>
</tr>
<tr>
<td>10</td>
<td>Flexible format audio system</td>
<td>300</td>
</tr>
<tr>
<td>11</td>
<td>Remote vehicle diagnostics</td>
<td>300</td>
</tr>
<tr>
<td>12</td>
<td>Digital broadcast radio</td>
<td>300</td>
</tr>
<tr>
<td>13</td>
<td>Advanced temperature 600</td>
<td>management</td>
</tr>
<tr>
<td>14</td>
<td>External surround sensing</td>
<td>1,500</td>
</tr>
<tr>
<td>15</td>
<td>Reconfigurable cabin</td>
<td>600</td>
</tr>
<tr>
<td>16</td>
<td>Navigation</td>
<td>1,500</td>
</tr>
<tr>
<td>17</td>
<td>Smart-sensing windows</td>
<td>200</td>
</tr>
<tr>
<td>18</td>
<td>Night vision system</td>
<td>1,800</td>
</tr>
<tr>
<td>19</td>
<td>Universal vehicle control</td>
<td>750</td>
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<tr>
<td>20</td>
<td>Satellite radio 12.95/month</td>
<td>300</td>
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<tr>
<td>21</td>
<td>Rear-seat entertainment</td>
<td>1,100</td>
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<tr>
<td>22</td>
<td>Steer-by-wire</td>
<td>1,000</td>
</tr>
<tr>
<td>23</td>
<td>Four-wheel steering</td>
<td>1,850</td>
</tr>
<tr>
<td>24</td>
<td>Interior occupant detection</td>
<td>400</td>
</tr>
</tbody>
</table>

### 2003 European Ranking of Feature Interest When Market Price Is Attached

<table>
<thead>
<tr>
<th>Rank</th>
<th>Feature</th>
<th>Market Price in €</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brake-by-wire</td>
<td>350</td>
</tr>
<tr>
<td>2</td>
<td>Flexible format audio system</td>
<td>250</td>
</tr>
<tr>
<td>3</td>
<td>Wireless connectivity</td>
<td>250</td>
</tr>
<tr>
<td>4</td>
<td>Driver recognition system</td>
<td>425</td>
</tr>
<tr>
<td>5</td>
<td>Heated/cooled seats</td>
<td>600</td>
</tr>
<tr>
<td>6</td>
<td>Smart sensing windows</td>
<td>170</td>
</tr>
<tr>
<td>7</td>
<td>External surround sensing</td>
<td>1,300</td>
</tr>
<tr>
<td>8</td>
<td>Night vision system</td>
<td>1,500</td>
</tr>
<tr>
<td>9</td>
<td>Satellite radio</td>
<td>9/month</td>
</tr>
<tr>
<td>10</td>
<td>Navigation</td>
<td>2,000</td>
</tr>
<tr>
<td>11</td>
<td>Rear-seat entertainment</td>
<td>2,300</td>
</tr>
</tbody>
</table>
Lighting Control

Several carmakers have been working on solid-state relay based controls for exterior and interior lighting applications including high beams, low beams, interior dimming lights, emergency flashers, daytime running lights and fog lamps. Freescale has developed a part called Lux especially for lighting. Lux packages two 10-milliohm high-side switches and two 40-milliohm high-side switches in one device. That device is already slated for production lighting applications starting in the 2006 and 2007 model years.

Infineon Technologies (Northville, Michigan) has also received production orders for lighting applications. A coring to Infineon’s Ray Notarantonio, pulse width modulation controls extend the life of incandescent bulbs. “When our circuit senses that battery voltage is high, PWM controls bring the voltage level back to normal.” While Infineon’s relay-integrated diagnostic circuits can digitally indicate open circuits, short circuits and over-temperature conditions, they can also output an analog signal that’s proportional to current. Bob Beier, an automotive relay application specialist at Infineon, explained: “If you’re driving two bulbs in parallel, and one bulb fails due to an open circuit, the relay can detect that by seeing that the current has decreased by about one-half. To do that with an EM relay would require a lot of additional circuitry.” Other promising solid-state relay applications include door locks, the fuel pump, electric power steering, A BS, HVAC fans and eventually, fuses.

Low On-Resistance MOSFETs

A coring to Myron Trenne, vice president of R & D at wiring harness-maker Yazaki North America (Canton, Michigan), the trend toward using solid-state devices to control one amp or more of current has been underway for at least ten years, starting with bipolar power transistors, after which planar MOSFETs came along. While those devices didn’t lead to wholesale replacement of electromechanical relays, newer MOSFET technology has been developed with sufficiently low on-resistance that smaller, less-expensive chips can now be produced that don’t cause heat dissipation problems.

A MOSFET in the “on” position has inherent resistance to current flow. That resistance creates heat that must be dissipated to keep the semiconductor from burning up. SA E Fellow and power semiconductor expert Randy Frank, of Randy Frank & Associates, Scottsdale, A rizona, remembers that on-resistance was typically about 30 milliohms back in 1988. Today, trench MOSFETs can now be produced with less than one milliohm. A t 60 amps, today’s device would generate less than 3.6 watts of I^2R (power) losses compared with 108 watts with 1988 technology. According to Infineon’s Bob Beier, that’s now comparable to some EM relays, which can generate as much as three watts in the electromagnetic coil that holds the relay closed.

Ultra-low on-resistance MOSFETs, which are required only for switching high currents, still come with a significant price disadvantage compared with electromechanical relays—unless additional electronics features such as diagnostics or PWM control packaged with the SSR yield compensating benefits. That’s one reason why Infineon’s Mr. Notarantonio wants to focus on automotive applications at 10 amps or less, where solid-state relays are already cost effective vs. EM relays.

Solid-State Relay Applications

Various junction-box relays
Engine cooling fans
Lighting controls, including headlamps, stop lights, parking lights, fog-lamps, flashers, daytime running lights, interior “theater” dimming
Door locks
Electric power steering
Fuel pumps
Fuse replacement
HVAC blower motors
ABS

EM Relays a Moving Target

While momentum is building, the transition to solid-state relays won’t happen quickly, even as electrical engineers get more comfortable designing with SSRs and conformance engineers learn how to test them. Electromechanical relay quality keeps improving.

According to Jerry Bricker, O mron vice president of sales and marketing for the A mericas, “Last year our company shipped about 100 million relays to North American customers for automotive uses and the quality level ran from one to three parts per million.” Mr. Bricker is based at O mron A utomotive Electronics in N ovi, Michigan.

Carol Slinker, director of sales and marketing for Tyco Electronics (H arrisburg, Pennsylvania), a company that has achieved quality performance similar to O mron’s, noted that new relay contact materials, new spring materials and better welding processes all factor into quality improvements. “Five years ago, average PPMs were at 15,” Ms. Slinker said.

Further, the price and size of EM relays have shrunk as relay makers transition from plug-in relays to smaller printed-circuit board mounted relays, either through-hole or surface mounted types, which handle more current. A coring to Tyco, micro-sized relays now handle what mini relays used to handle. 

The Company Profile...

**Thumb Sketch**

**Headquarters:** 600 N. Centennial Street, Zeeland, Michigan 49464, USA; telephone: 616-772-1800; fax: 616-772-7348; website: www.gentex.com

- **2003 Sales:** $469 million
- **2003 Net Cash Provided by Operations:** $117 million

**Principal Product:** Automatic-dimming rearview mirrors for automobiles

**R&D:** 6% of sales

**Largest Customers:** General Motors accounted for 38% of sales in 2003; DaimlerChrysler and Toyota together accounted for 25%.

**Current Ratio: 8.2 as of March 31, 2004**

**Stockholders’ Investment:** $720 million as of March 31, 2004

Stockholders’ Investment: $720 million as of March 31, 2004

**Employees:** 2,012 at year-end 2003; all are non-union

**Sales per Employee:** $233,101

**Manufacturing Footprint:** About 336,000 sq. ft., all located in western Michigan

- **Current assets divided by current liabilities:**
- **Current assets minus current liabilities:**

**Background**

Gentex was organized in 1974 to make residential smoke detectors. In 1982, after making an initial public offering the prior year, Gentex became the first company to produce a commercially successful rearview mirror with automatic glare control, a motorized alternative to conventional manual day/night mirrors. By 1985, Gentex was selling more than 200,000 motorized auto-dimming mirrors annually to Ford and General Motors.

The company’s electrochromic (EC) auto-dimming mirror was introduced in 1987, another world’s first. Electrochromic rearview mirrors automatically darken to limit the amount of headlight glare reflected into the driver’s eyes. The dimming process is controlled continuously by an electro-optic sensor and an electronic circuit that increases current to the electrochromic material to darken the mirror in proportion to amount of light hitting the mirror’s surface. Gentex’s EC mirror takes a few seconds to go from its most reflective state (85%) to its least reflective state (7%).

The company owns a total of 196 U.S. patents, 189 of which relate to electrochromic mirrors or rearview mirrors. Additionally, Gentex has made 134 applications for new U.S. patents. Forty-three of the company’s 44 foreign patents relate to rearview mirrors.

Today the company’s electro-optic auto-dimming mirrors for the auto industry provide the bulk of revenues. Gentex’s automotive segment accounted for 95% of sales, 97% of operating profits, 97% of assets employed and 99% of capital expenditures in 2003. While Gentex still makes fire protection products, mostly for the commercial building industry, fire protection contributed just 5% of sales in 2003.

Gentex has been working since the 1980s to extend its electrochromic technology to other applications including sunroofs, sunglasses and windows for buildings. Among the obstacles to architectural applications is coming up with technology that remains stable for 20 years or more. According to Gentex, that effort will require several more years of research, testing and intellectual property development to reach commercial applications.

While today more than half of sales come from GM, Toyota and Chrysler, in three or four years Gentex expects its global sales to be equally balanced with the Big Three, Europe-based customers and Japan-based customers each accounting for one-third of sales.

Gentex markets its products through a direct sales force to carmakers operating in North America and abroad. The company’s interior auto-dimming mirrors are available on 90 car models made in North America and 111 car models made elsewhere. Gentex auto-dimming exterior mirror subassemblies are available on 59 car models. General Motors is Gentex’s largest customer, representing 38% of sales, followed in order by DaimlerChrysler and Toyota, which together account for 25% of sales. The company has agreements with General Motors and DaimlerChrysler to supply auto-dimming mirrors through the 2006 model year.

One-hundred percent of Gentex’s automotive shipments globally are manufactured at one of three company facilities located in Zeeland, Michigan. Gentex outsources no jobs, not because of a political view that outsourcing is bad for American workers, but rather, so it can be certain that its products are made to the highest quality standards. “We apply lead-

The Company Profile Continued

**Automotive Products**

Auto-dimming interior rearview mirrors with:
- SmartBeam headlamp control*
- Compass
- Dual display compass/temperature
- Lighted mirror with LED map lamp
- Remote keyless entry electronics
- Microphone
- Homelink**
- Active Light Sensor
- Tire pressure monitor*
- Push-button switches

Exterior rearview electrochromic mirror subassemblies
- Flat-glass
- Convex
- Aspheric

*Not yet in high volume production
**Homelink Wireless Control System is a universal garage door opener branded by Johnson Controls Inc., Milwaukee, Wisconsin.

Gentex Automatic-Dimming Mirror Unit Shipments in 000s

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interior</strong></td>
<td>5,000</td>
<td>6,305</td>
<td>7,132</td>
</tr>
<tr>
<td><strong>Exterior</strong></td>
<td>2,181</td>
<td>2,500</td>
<td>3,128</td>
</tr>
</tbody>
</table>

Largely self-funded, on March 31, 2004, Gentex had $487 million in working capital and zero long-term debt. In fact, Gentex has shown zero long-term debt at year-end since 1992.

At the core of Gentex's financial strength is its profitability, and that is largely the result of the company's 77% share of the market for its principal product, electrochromic automatic-dimming mirrors. While Gentex's market share has declined from 90% in 1997, and will continue to decline, auto-dimming mirrors are expected to penetrate a greater percentage of the world's vehicles. According to Gentex, interior auto-dimming mirrors are installed in 16% to 17% of new vehicles worldwide, and exterior auto-dimming mirrors are installed in 6% of new vehicles. The market for auto-dimming mirrors is expected to grow, predicted Garth Deur: "There's a good chance autodimming mirrors will get to 50% penetration within a decade or more."

Gentex shipped a total of 10.3 million auto-dimming mirrors and subassemblies in 2003. The company expects to grow that number by 15% in 2004 and by a significant percentage annually for at least the next decade. Gentex's existing mirror business gives the company an excellent platform on which to expand its product line by integrating additional features with the mirror. The interior mirror's location within easy reach of the driver gives carmakers a place to hang displays, push-button switches and other electronic components. For example, Gentex makes auto-dimming interior mirrors that include voice recognition microphones, switches to access OnStar and other telematics services, map lights and displays of compass heading and the outside temperature.

In 2003, 56% of the interior auto-dimming mirrors shipped by Gentex included at least one additional electronics feature. GM uses the mirror for the OnStar buttons on roughly 90% of its OnStar installations and Gentex has most of that business, according to Mr. Deur. Chrysler uses Gentex mirrors with built-in switches and voice-recognition microphone for its U-Connect telematics option.

Gentex's next major new product, SmartBeam, an intelligent high-beam headlight controller, is designed to be integrated into the mirror assembly. SmartBeam is a prime example of Gentex's careful approach to new product planning. Mr. Deur explained: "When somebody brings in an idea we ask, 'Can someone else develop a similar solution? Does the idea take advantage of our skills in combination with the unique [mirror] real estate that we own? Will we have a proprietary solution?" According to Mr. Deur, a question chairman and CEO Fred Bauer often asks is, "Can this thing grow up to be an elephant?" Because in his experience, "everything you do costs twice as much as you thought it would, takes twice as long, and the market is half as big when you finally get there, so you’ve got to start with an elephant just to make sure you get lunch."

What Makes Gentex Successful

By many standards Gentex is a very successful automotive supplier. It has consistently grown much faster than the market, while maintaining high profitability in an industry that grows slowly and squeals profits. Company sales have grown over the last five years at the rate of 16% annually while consistently maintaining net margin percentages in the low- to mid-twenties. Despite its growth, the company is financially quite strong.
Mr. Deur reports to Fred Bauer in what he describes as a very flat organizational structure. “Mr. Bauer and I share management duties; together we have 30 people reporting directly to the two of us,” said Mr. Deur. Mr. Bauer runs manufacturing operations and engineering. Garth Deur is in charge of the commercial side of the business including finance, marketing, sales, purchasing and human relations. He joined Gentex in November 2000 from the Landmark Group, an investment management company where he was a principal. Before joining Landmark, Mr. Deur served as vice president for Chrysler business operations at Johnson Controls.

Gentex doesn’t necessarily see itself as an automotive supplier. “Obviously 95% of our revenues come from the automotive industry,” said Mr. Deur, “but we are really a developer and manufacturer, a pioneer of electro-optical products. We focus on technology and innovation.” Gentex’s reliance on technology forms the basis of its financial conservatism as evidenced by its very strong balance sheet with no long-term borrowing and a huge store of liquid assets. “Since we are very aggressive technically, we are very conservative financially,” said Mr. Deur.

With nearly half a billion dollars in working capital and no long-term debt, Gentex would be considered a good acquisition candidate. But on March 8, 2004, Gentex declared a quarterly cash dividend of $0.15 per share for any shares purchased before March 30, 2004. Also in March, Gentex announced that the company purchased 415,000 shares at prices in the low $30s. Under the plan, the company will continue to purchase shares, not at the price at which it will repurchase its shares under the repurchase plan announced in October 2002. According to the statement, under the plan the company may from time to time purchase shares, not at prices in the mid $20s, as it has done, but at prices in the low $30s. Under the plan, the company purchased 415,000 shares during the first quarter of 2003.

As to whether Gentex could be acquired, Mr. Deur said: “As long as we do a good job and keep our price-to-earnings ratio where it is, no mega-automotive supplier can afford us. Those companies have P/Es of from 10 to 16 and they’re much bigger. So the day after they bought us we’d be worth half of what they paid.” On April 20, 2004, Gentex posted a P/E ratio of 30.95 and a closing stock price of $42.40. Gentex is traded on the NASDAQ. At stock prices topping $40 per share, Gentex isn’t doing much buying. Rather, top executives are selling. On March 19, 2004, retired executive vice president and board of directors member Kenneth LaGrand sold more than $1 million worth of stock at $41.16 per share.

A nother key strength comes from Gentex’s size. Mr. Deur believes that Gentex is innovative because it is relatively small. And further, “Because 95% of our operation is located on a single city block in Zeeland, Michigan, our ability to communicate is outstanding.”

T he Competition

Gentex’s strongest competition comes from Magna Donnelly, which offers auto-dimming mirrors based on hybrid or solid polymer matrix technology. Between 1990 and April 1996, Gentex and Donnelly were locked in patent infringement lawsuits over electrochromic mirror technology that culminated in Gentex paying Donnelly a $6 million settlement. Magna International acquired Donnelly in 2002.

Murakami-Kaimeido and Tokai Rika make automatic-dimming mirrors for some Japanese carmakers but together account for just 2.1% of the global market.

SmartBeam

For the last 15 years Gentex has been living off its proprietary electrochromic mirror technology. While sales of its auto-dimming mirrors and assemblies will continue to grow over the next decade, competitive offerings will gain share and prices will slowly erode as the market matures. Gentex’s core electrochromic auto-dimming patent expires in 2009. Nevertheless, explained Garth Deur, “Gentex has filed so many improvements and continuations that there is a patent portfolio that is going to live in virtual perpetuity, making it very difficult for anyone new to get into this approach.”

By far the most promising new technology in terms of future sales is Gentex’s SmartBeam. In development since the mid-1990s, SmartBeam is a proprietary new technology to automatically control headlamp high beams. “We’ve been selling auto-dimming mirrors for about 15 years. If you look out another 15 years ... this SmartBeam technology could be as big as our mirror business is today,” predicted Mr. Deur. The high-beam control feature will be sold to carmakers for $65 to $75 each, approximately three times the price of a base auto-dimming mirror. According to the 2003 U.S. Automotive Emerging Technology survey published by J.D. Power and Associates, adaptive headlight systems ranked first of 24 features in consumer interest, when adaptive headlights were assigned the market price of $100. For the survey, J.D. Power and Associates defined an adaptive headlight system as one that “automatically adapts your vehicles’ lights (low beams, high beams or fog lights) to best suit the driving conditions and surrounding traffic.”

SmartBeam headlamp control will be brought to market as an option on three 2005 models from two carmakers, two of which have been announced publicly: Cadillac STS (part of the HID package) and the new Jeep Grand Cherokee.

SmartBeam combines a custom active-pixel CMOS optical detector with a software algorithm and microcontroller that automatically turn on the high beams only when it is appropriate. To avoid dazzling oncoming motorists as well as those traveling ahead of the vehicle, the system distinguishes between different types of light based on the brightness, color and position of the light within each video frame. With about 1,000 active pixels, the optical detector knows to automatically communicate its findings to the microcontroller. Gentex owns 100% of the technology.

Notes:

1. Gentex has distribution agreements with Murakami-Kaimeido and Ichikoh.
2. In August 2003 Murakami and Tokai Rika agreed to collaborate globally on the production, development and marketing of automotive mirrors.

2004 Global Market Share of
Automatic-Dimming Mirrors

<table>
<thead>
<tr>
<th>Company</th>
<th>1997</th>
<th>2004</th>
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</thead>
<tbody>
<tr>
<td>Gentex</td>
<td>90%</td>
<td>77%</td>
</tr>
<tr>
<td>Donnelly</td>
<td>3%</td>
<td>21%</td>
</tr>
<tr>
<td>Tokai Rika</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Murakami</td>
<td>0.5%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Toyota</td>
<td>3.5%</td>
<td>0%</td>
</tr>
</tbody>
</table>

The Hansen Report on Automotive Electronics, Portsmouth, NH USA www.hansenreport.com
switch to low beams when it sees red tail lights, even though they may not be nearly as bright as surrounding light from headlight, street lamps or roadway signs. The detector can tell the difference between white light that’s powered by alternating current and light coming from an oncoming vehicle’s headlamps. The Gentex technology is described in detail in an SAE technical paper, “A automotive Vehicle High-Beam Headlamp Control System,” 2001-01-0318, published in March 2001.

The core of SmartBeam, the CMOS active-pixel image sensor, was developed by Gentex from technology licensed from Photobit of Pasadena, California. A leading developer of CMOS image sensors, Photobit owns the rights to high-performance image-capture technology invented at NASA’s Jet Propulsion Laboratory. While Photobit is developing several markets, the company has partnered with Gentex to develop imaging systems specifically for the automotive industry. In 1997 Gentex purchased approximately 10% of Photobit. In 2002, Photobit was purchased by Micron Technology; Gentex no longer has an ownership interest in the company.

The SmartBeam feature is integrated with Gentex’s automatic-dimming interior rearview mirror. The active-pixel image sensor, where each pixel is amplified at the sensor, is mounted in a pod at the foot of the mirror and looks out the windshield from a place kept clean by the wipers. The signal from the camera is processed by a microcontroller packaged inside the mirror. The output of the microcontroller is connected to the lighting control module (located outside the mirror), which uses a pulse width modulator to slowly adjust or fade the power sent to the high beams. A ambient light sensor is packaged within the mirror to automatically detect when it is dark enough to use the high beams. SmartBeam can also provide low-beam control, automatically turning the low beams on and off at dusk.

Most drivers don’t take full advantage of their high beams. According to a U.S. Department of Transportation study, drivers use their high beams less than 25% of the time that conditions would indicate they should be used, for a variety of reasons. They may simply forget, they may fear accidentally leaving them on or not reacting quickly enough to turn them off, or they just don’t bother. With automatic control of the high beams, drivers could take advantage of high beams’ greater light intensity and longer throw, which should yield significant safety benefits.

White LED Illumination

In 1999 Gentex announced it was developing its second-generation white LED interior illumination technology. That led to the development of a Gentex auto-dimming mirror with white LED map light, which since 2002 has been purchased by Chrysler for the Sebring coupe. Believing its white LED capability will eventually lead to other illumination applications in the vehicle, Gentex continues to research the technology. However, in 2003 the company realized the automotive market for white LEDs was going to take longer to develop than they originally thought. Mr. Deur explained: “While we are intrigued with the potential for high-output LEDs, creating a high output white lighting business is going to be a long haul. Since there are already several other players going after that market, we will let them pioneer, and when we think the time is right, we will re-enter the market. There’s just not a lot of business out there right now.” Compared with incandescent lighting, LED interior lighting lasts longer, draws less current, runs cooler and is less prone to damage from vibration.

Small Technology-Focused Acquisitions

Despite its large store of liquid assets, Gentex is not even slightly inclined toward a major takeover in the auto industry. Rather, it is interested in acquiring a very small business entity with very tight technical synergies. “We don’t see ourselves necessarily as God’s gift to management, in the sense that we can buy a troubled automotive supplier and turn it around,” explained Mr. Deur. “But if we saw a company we thought was additive to something we are already doing, or something that created unique access to a new market for technologies we understand, we’d consider an acquisition, but only one small enough not to warrant disclosure.”

The Company Profile Continued
October 18–20, 2004 marks the 30th anniversary of Convergence, the world’s premiere automotive electronics conference. Held every two years since its founding in 1974, Convergence brings together the brightest minds in automotive electronics, the gatekeepers of new technologies for the vehicle and thousands who recognize the unique opportunity for learning and networking that this three-day event offers. If you attend only one conference this year, make it this one.

With nearly 200 exhibitors, 15 technical sessions, 87 technical papers to be presented and three major panel discussions, Convergence 2004 organizers expect the conference will draw an even larger audience than Convergence 2002, which registered over 8,900 participants.

On Tuesday, October 19, Paul Hansen will again moderate the Luncheon Panel, which features top EEs from the world’s major carmakers in spirited and informative discussion on some hot issues facing OEMs today as well as what’s coming next in automotive electronics. The Convergence 2004 Luncheon Panel welcomes Masaharu Asano, General Manager, E/E Systems Engineering, Nissan; Jim Buczkowski, Director, E/E Systems Engineering, Ford North American Product Creation; Ronn Jamieson, Executive Director, Electrical Controls and Software, General Motors, North America; Bill Mattingly, Vice President E/E Engineering Core, Chrysler Group, DaimlerChrysler; Toyohei Nakajima, Director of IT Research & Advanced Research, Honda R&D Americas Inc.; Karl-Thomas Neumann, Director of Electrical/Electronics, VW and Director, Electronics Competence Center, VW Group.

Trevor Jones, founder of Convergence, will moderate the Blue Ribbon Panel on October 18, with former Convergence conference chairs looking back over the last four decades of automotive electronics, plus an announced panelist who will look at the coming decade. On October 20, Susan Cischoke, Vice President, Ford Motor Co., and her panelists will address the problems of driver distraction. To register or for more information, visit www.convergence2004.org.

AMIC-C ...

published 3,000 pages of specifications including use cases, message sets, Java based APIs (application programming interfaces) and other standard interfaces. AMIC-C is now working with organizations that will take pieces of the specifications, maintain them and develop them further, as required. Such organizations might include OSGi, Bluetooth, 1394 and MOST, as well as the SAE and ISO. AMIC-C’s work on interoperability and other problems with the Bluetooth hands-free profile has already been passed on to the Bluetooth Car Working Group, which is incorporating some of those recommendations into the Hands-Free Profile 2.0.

AMIC-C’s work on standards was designed to invigorate and promote the market for telematics products including general purpose computing terminals that would access wireless services and the Internet. But none of the AMIC-C officials we spoke to were able to cite specific cases where AMIC-C specs have been applied. With the exception of OnStar, General Motors’ location-based emergency call/information service provider, the telematics market has not yet materialized in a big way anywhere in the world.

A ccording to AMIC-C’s former program manager, Ponn Malhotra, who now handles Dave Aiston’s telematics job inside GM, both GM and OnStar are still strong supporters of telematics. “The work done by AMIC-C has actually been looked at by several parts of the company to digest what we can use in the near term, medium term and long term,” Mr. Malhotra said. Toyota, Honda and Nissan have set up telematics services in Japan, but they haven’t attracted nearly as many subscribers as OnStar, which had roughly 2.5 million, as of April 2004.

One key AMIC-C objective was to develop specifications for a gateway that would allow aftermarket suppliers to participate in and enliven the market for telematics. With standard AMIC-C interfaces, suppliers could develop applications that would easily plug into a standard AMIC-C connector and play in the vehicle, similar to the way PC applications and peripherals plug into computers. Suppliers who cut deals with carmakers would get authorized vehicle access codes and wouldn’t need to splice into the vehicle’s electric cables, which can cause quality problems. But the concept has not been realized, essentially for lack of interest. “I don’t think any automaker has a vehicle out there with a gateway built in, at least not an open gateway,” said Mr. Malhotra. Despite the lack of implementations thus far, don’t write AMIC-C off quite yet. “While the time between the concept and implementation has dragged out, the book is not closed,” noted Dave Aiston.

“AMIC-C is an enabler. I know for a fact that there are multiple carmakers out there using the specs. We just haven’t seen it hit the streets. Once we get it into ISO and different places, AMIC-C will be the reference point.”

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