People are getting into iPod portable digital music players in a very big way. Consumers, especially young people, have already purchased four million iPods since they were first introduced by Apple Computer (Cupertino, California) in October 2001, and sales are still accelerating. In the last quarter alone Apple sold 860,000 iPods. A ready iPods account for over half the unit sales of digital music players worldwide.

I love iPod. My $299, 20-gigabyte player holds up to 5,000 songs—more than my entire CD collection, with enough headroom for ten more years of collecting. (Apple also offers a 40 GB hard drive iPod for $399, which can store 10,000 songs.) Using iTunes software, I easily copied all my CDs onto my laptop's hard drive and then downloaded all that music onto my iPod's hard drive. In the process, my Internet connected laptop automatically downloaded from a database developed by Gracenote (Emeryville, California), the data to identify each track: album name, song title, recording artist and music genre. That information is displayed on the iPod along with "playlists" of selections I've created. iPod is small enough to use with earphones and I "playlists" without getting distracted from driving.

Several iPod car adapters are available in the aftermarket, but none is completely satisfying. Most offer connections to

### iPod Comes to Cars

Mercedes and Chrysler United on E/E Quality Imperatives

#### Fewer Functions, Greater Simplicity but Still More Electronics

Given the seemingly inevitable march toward complexity in vehicle electrical and electronics systems and networks, one of the greatest issues facing our industry is: How do we optimize the benefits offered by advanced electronics and software without sacrificing vehicle quality? The DaimlerChrysler Group is addressing the problem aggressively and publicly.

For over a year DaimlerChrysler engineers have been working on ways to improve E/E quality. This spring, Mercedes' top electrical engineer, Stephan Wolsfried, began to talk openly about the steps Mercedes is taking to improve the quality of its vehicles. More recently Chrysler Group's top electrical engineer, Bill Mattingly, told The Hansen Report that Chrysler has been an equal partner in developing what became the "categorical imperatives" to improving quality and that Chrysler has already been implementing some of them.

Over the years Mercedes-Benz engineers have created some of the world's most technically advanced passenger vehicles. Chrysler's Bill Mattingly said, "Their claim has always been: 'First and foremost.'" For a long time that philosophy worked. Mercedes delivered engineering marvels to car buyers more than willing to pay luxury prices for groundbreaking technology and impeccable quality. But lately, as Mercedes has loaded up its vehicles with multiple interacting communications networks, great quantities of software and scores of motors, sensors and microprocessors, the vaunted quality of Mercedes vehicles has seriously suffered. In an analysis of Consumer Reports' model year 2003 survey data on electrical and electronics quality published by The Hansen Report in April 2004, Mercedes scored last among 13 major carmakers selling vehicles in the United States. Mercedes passenger vehicles averaged 4.9 serious E/E problems per 100 vehicles. In contrast, Honda/Acura had 1.0 E/E problem per 100 vehicles, Toyota/Lexus had 1.0, Subaru 1.1, Hyundai/Kia 1.3, Nissan/Infiniti 1.4 and Mazda 1.5. Chrysler vehicles had 2.5 problems per 100, significantly fewer than Mercedes.

While vehicles with high electronics content tend to have more quality problems, it should be pointed out that on average carmakers do significantly better with electronics quality today than they did in years past, despite huge increases in electronics content for everyone.

Mercedes quality problems are related not only to complexity, but to the carmaker's aggressiveness in introducing new technology in production vehicles. For example, Mercedes A active Body Control system, first introduced on the 2000 C.L coupe, had some problems with leakage in its air springs. Mercedes was the first to market with an electronic stability control system, which recently had some problems with a steering angle sensor. A nother quality problem involved a handful of E-class electric braking systems that prematurely defaulted to hydraulic backup. "Putting in a lot of technology always runs the risk of having some failure and we've tried maybe too much at one time," mused Stephan Wolsfried. He noted that the worldwide E-class brake recall will be completed this August.

Mercedes' struggle with E/E quality is important to the entire automotive electronics community, because Mercedes has reached a level of complexity with its vehicles that other carmakers will eventually face, if they are not doing so already. "Mercedes switched over to networked cars five years ago, to support a wide range of options, and that caused some hiccups," said Mr. Wolsfried. "One reason Toyota Turn to Quality, page 2
Quality...

Continued from page 1

DaimlerChrysler's Seven E/E Quality Imperatives

In May 2004 Mercedes issued a press release that describes seven quality “categorical imperatives” that should dramatically improve the electrical/electronics quality picture for all DaimlerChrysler vehicles. “The imperatives are consistent with the strategy we have both come up with,” said Chrysler’s Bill Mattingly. “We’ve had some of these ongoing for quite a while; some are more recent.”

Industry-wide, the competition over quality has become as intense as the battle over prices. Other carmakers will surely look at these imperatives and consider how they might be applied in their own organizations.

1. The reliability of electronics must be at least equal to that of comparable mechanical systems.

Because electronics don’t wear out like moving mechanical parts, it was right to assume that electronics alternatives would be more reliable. However, as electronics systems become more interdependent and software content skylifts, the quality improvement in going from mechanical to electromechanical or all electronic is no longer obvious. Given this imperative, new Mercedes brake-by-wire and steer-by-wire systems are likely to come out later rather than sooner.

2. Unless it distinguishes the vehicle brand, standard systems will be used.

DCX will implement hierarchical bus systems based on CAN, LIN, MOST and FlexRay network standards and on the AUTOSAR standard software architecture. While all of these standard protocols were pioneered in Germany, they are becoming global standards. CAN already is a global standard. Future MOST implementations will be based on a copper physical layer, not on plastic optical fiber cables, because fiber optic cables are “very sensitive and less suitable in cars due to dispersion losses when bent into tight spaces,” according to the Mercedes press release. Standards will lead not only to better quality but also to lower costs.

3. Software errors are not preordained.

A vowing zero tolerance for software errors, DCX will use software certification tools such as CMMI (Capability Maturity Model Integration) to determine the quality of supplier software.

4. Software validation tools must improve to catch up with the progress made by software development tools.

Mercedes writes that in the past they paid too little attention to the interaction between systems. Even if individual systems appeared to be error free, their interaction with others was not. “We’re on the exact same page with that,” said Chrysler’s Bill Mattingly. “A s networking in the vehicle became more complex, we found you could have a perfectly good subsystem operating on a bench that, once employed in a vehicle system, would no longer operate as expected.”

5. Certification and systems integration are matters for the OEM.

Systems integration is a DCX core competence. According to the press release, Mercedes no longer writes a single line of code. Instead they provide suppliers with precise specifications, written not as text, but as computer models, which prescribe the expected behavior of the functions.

6. No more hardware faults.

Mercedes has scaled down the number of semiconductor suppliers it deals with to a few strategic partners who can guarantee the necessary specifications, especially temperature and vibration, over a six- to eight-year period.

In a departure from its former practices, DCX says it is no longer interested in frequently updating electronics modules with ICs that have been made smaller and more feature-rich. The modest cost advantages of integration don’t usually pay for the additional engineering cost and quality risks of making a change. “While we like to update our electronics every three years, we can’t be tearing up the vehicle for changes that would save only a few dollars in one particular module,” explained Mr. M. Mattingly. Rather, Chrysler will make those changes only with a new or refreshed platform. “We want to be in step with the vehicle teams and with them look at the entire vehicle to be sure that all parts—chassis, powertrain, electrical—are in harmony,” he said.

Stephan Wolfsried said that Mercedes has faced difficulties sourcing microcontrollers with embedded flash memory. “I think the Japanese set the pace there, and we have to convince our European and American suppliers to make the same efforts,” he said.

A nother area of concern to DCX engineers is the reliability of CDs and DVDs, which can deform at temperatures higher than 45 degrees C. Except in audio-video entertainment applications, DCX will instead favor PCMCIA cards and SmartMedia cards as well as hard-disc drives (HDDs) for media storage. HDDs are already widely used in Japanese navigation systems to store map data and increasingly will be used as music media players, not only in Japan, but globally. A ccording to Mr. M. Mattingly, consumers will continue to demand DVD and CD players for audio or video entertainment but will eventually transition to HDD and other media players. Chrysler will be ready for that.

7. Unnecessary functions are out.

Mercedes says it will stop programming extra features into vehicles just because it can. While embedded software code bears almost no variable costs, “the result was worse.”

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power via the cigarette lighter, to keep the iPod’s battery charged, but none connect directly into my car audio system. Some adapters transmit the iPod audio on the least used of three FM frequencies, and the audio signal is picked up by the car’s radio if it is tuned to that frequency. However, that modulation-demodulation step adds noise. iPod adapters can also be plugged into the tape cassette player, but that also degrades sound quality, and anyway, my car doesn’t have a cassette player.

Given how hot the iPod is, particularly in the States, carmakers have been considering whether or not to offer consumers an integrated docking system. In July 2004, BMW introduced a dealer-installed iPod adapter on a limited number of BMWs in the U.S.: model year 2002 or later 3 series, X3 and X5 SUVs, Z4 roadsters and later this summer, on the MINI Cooper. The iPod isn’t available on vehicles with a navigation system, CD changer, DSP cassette player or satellite radio.

While not yet perfect, the BMW integrated iPod connects directly to the audio system, so there is no loss of sound quality. It also makes some of iPod’s controls and displays available to the driver. You can control volume and next and previous play from steering-wheel-mounted switches. Eight additional hard buttons are available on the radio: five are dedicated to selecting playlists, one selects “all play” and the last two are for “random” and “repeat.” The radio display shows track and playlist number, but not the song title, album or artist’s name. The iPod plugs into a proprietary cable located in the glove box. The BMW adapter retails for $149 plus installation at authorized BMW or MINI dealers.

A pple and Alpine Electronics of America (Torrance, California) collaborated on a $100 iPod adapter, which will be available in late September 2004. The adapter only works with a new Alpine head unit that’s priced starting at $200. Unlike the BMW radio display, Alpine’s head unit displays artist, album and/or song name and finds tracks through the receiver’s Quick Search interface. The adapter can be installed under the seat, in the glove box or behind the dash. One cable connects the adapter to the head unit, another connects the adapter to the iPod.

For carmakers, one serious downside of factory or dealer installation of iPod adapters is that the connector is proprietary, as are the protocols that link iPod’s display and control messages to the vehicle’s audio head unit, to speech-operated controls or to a separate display. In order to integrate the adapter, the carmaker has to cut a deal with Apple. iPod product manager, Stan Ing, wouldn’t say if fees are required to license the Apple interface technology. The iPod’s hard drive supports a number of music storage formats: A AC, which is Apple’s proprietary format, M P3, A udible, W AV and others. Most widely available in the States, iPods are also sold in France, the U.K., Germany, and most recently in Japan.

More Digital Music Players PhatNoise (Los Angeles, California) makes a wallet-sized, 20 GB digital music player that was first made available on VWs and Audis in May 2003 through U.S. dealers at a price of $795. In August 2004, Mazda North America began selling the 20 GB PhatNoise players through dealers, and GM announced it would offer 40 GB PhatNoise players on four 2005 crossover sports vans.

While the PhatNoise hard-drive cartridge is easily removable to download songs from your PC, it is not necessarily designed for portability.

Japanese navigation suppliers use hard disc drives (H DDS) to store navigation data. According to a study by SRD Japan, of the latest navigation products offered by ten companies who serve both car dealers and aftermarket stores, all but two use HDDs. Every navigation unit with an HDD also provides some music functions; some could store as many as 1,500 songs. The SRD Japan report says that 2.5 million navigation units were sold in Japan in 2003.

## Asian Embedded Telematics Market Predictions

<table>
<thead>
<tr>
<th></th>
<th>Thousands of units</th>
<th>2003</th>
<th>2006</th>
<th>Annual Growth</th>
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<tr>
<td>Japan</td>
<td></td>
<td>105</td>
<td>490</td>
<td>22.4%</td>
</tr>
<tr>
<td>South Korea</td>
<td></td>
<td>18</td>
<td>175</td>
<td>113.4%</td>
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<tr>
<td>Taiwan</td>
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<td>21</td>
<td>80</td>
<td>56.2%</td>
</tr>
<tr>
<td>China</td>
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<td>100</td>
<td>600</td>
<td>81.7%</td>
</tr>
<tr>
<td>Hong Kong</td>
<td></td>
<td>7</td>
<td>40</td>
<td>78.8%</td>
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<tr>
<td>Malaysia</td>
<td></td>
<td>1</td>
<td>150</td>
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<tr>
<td><strong>Total</strong></td>
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<td><strong>1,355</strong></td>
<td><strong>82.6%</strong></td>
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</tbody>
</table>

Data: Asian Telematics & Navigation Market, published May 2004, in English, by SRD Japan, Inc., Tokyo, Japan. The 155-page report is available for $2,500. For more information, contact SRD Japan, telephone 81-3-5627-7045; email info@srdj.co.jp.
Renesas Technology

**Background**
Renesas Technology Corp. was founded on April 1, 2003, as a joint venture that merged the semiconductor businesses of Hitachi and Mitsubishi Electric. Hitachi Ltd. owns 55% of Renesas, Mitsubishi Electric Corporation owns 45%. The name is a derivation of Renaissance Semiconductor for Advanced Solutions. Renesas' corporate vision is to realize a "ubiquitous network society." With its guiding principle, "Everywhere you imagine," Renesas intends to make semiconductors that can serve consumers wherever they happen to be. To accomplish that goal, the company plans to satisfy a wide range of applications with the semiconductor industry's broadest range of microcomputers. In particular, Renesas has selected three major markets on which it will focus its worldwide resources: the automotive industry, mobile electronics and the personal computing/audio visual market.

Renesas combines most of the semiconductor businesses of its parents, excluding DRAM (dynamic random access memory). Both Mitsubishi Electric's and Hitachi's flash and SRAM (static random access memory) product lines went to Renesas, along with MCUs (microcontroller units), ASICs (application specific integrated circuits) and ASSPs (application specific standard products) from Mitsubishi Electric and A SICs, logic devices, MCUs, IC cards, LCD drivers, RF modules and mixed signal devices from Hitachi.

Microcontrollers and microprocessors are Renesas' largest product line. The company now leads the industry in MCU production, with $2.5 billion in MCU shipments in calendar year 2003, according to iSuppli Corp., an El Segundo, California-based market researcher. Renesas says it offers the widest MCU product portfolio available anywhere, from 4-bit to 32-bit devices.

Today Renesas is the third largest semiconductor maker in the world, after Intel and Samsung Electronics, and the largest semiconductor supplier in the domestic Japanese market, according to iSuppli. In automotive semiconductors, which account for just 10% of Renesas' total sales, Gartner Dataquest ranks Renesas fourth in the world, behind Freescale, ST Microelectronics and Infineon, in that order.

Profitable in its first year with a 4.5% operating margin, due to the restructuring costs in the first year, Renesas expects to raise its operating margin to 5.5% in FY 2004 and 10% in FY 2005. The company plans to make 20% return on equity by FY 2007. Renesas will likely become a public company within the next several years.

Automotive suppliers are defined by The Hansen Report on Automotive Electronics, Portsmouth, NH USA www.hansenreport.com

**Distinctions Claimed by Renesas**
- Number one worldwide share of MCUs (microcontroller units)
- Number one worldwide share of embedded flash MCUs
- Number one worldwide share of MCUs in car navigation systems
- Number four worldwide share of automotive semiconductors
- Renesas' SuperH MPUs are installed in 80% of the navigation units sold in Japan, 86% of those sold in Europe.
- Renesas MCUs have won a 75% share of the Japanese airbag market, 30% of the global airbag market.
- Renesas MCUs hold a 56% share of the Japanese engine and transmission control market.
- In June 2003, Renesas won the Outstanding Performance (quality) Award from Toyota for its M16C MCU.
- World's first volume producer of 300 mm (approximately 12-inch) wafers

Honda, Nissan and Toyota. Its three biggest tier-one customers are Denso, Hitachi Automotive and Mitsubishi Electric. Through its forebears, Renesas has been making automotive semiconductors for over 20 years. Hitachi Semiconductor's automotive activity began with a close relationship with Nissan. Mitsubishi Electric was closely associated with Mitsubishi Motors.

**Automotive Semiconductor Division**
In April 2004, Renesas established the Automotive Semiconductor Division as a business unit. The division will focus market development efforts on applications in powertrain, body, chassis, airbag,
Renésas Automotive Semiconductor Division

**Headquarters:** Nippon Bldg., 2-6-2 Otemachi, Chiyoda-ku, Tokyo 100-0004, Japan; Telephone: 81-3- 6250-5500; Fax: 81-3-3270-6254

**FY 2003 Automotive Sales:** ¥98.6 billion ($906 million), roughly 15% over FY 2002

**Automotive Employees:** 800, not including employees in administration, common technology development and production. Three hundred automotive employees are in sales, marketing or technical support; 500 are in design and development of CIS/Nav LSIs, MCUs, mixed-signal and discrete semiconductors.

**Automotive Sales by Product**

FY 2003 Automotive Sales: ¥98.6 billion ($906 million)
- **MCUs, 66%**
- **MPUs and SOC, 15%**
- **Power MOS and discretes, 10%**
- **Other, 1%**
- **Mixed signal devices, 8%**

**Automotive Sales by Application**

FY 2003 Automotive Sales: ¥98.6 billion ($906 million)
- **Safety, vehicle dynamics, instrument clusters and body, 35%**
- **Navigation, CIS and car entertainment, 32%**
- **Powertrain, transmission and ACC, 33%**

**Renesas Top Five End-Users**

1. **Hitachi Automotive**
2. **Magna**
3. **TRW Automotive**
4. **Continental**
5. **Bosch**

**Renesas Top Ten Automotive Customers**

**North America**
1. Hitachi Automotive
2. Calsonic Kansei
3. Magneti Marelli
4. Johnson Controls
5. Bosch
6. Continental
7. Panasonic/Matsushita
8. Harman Becker
9. Pioneer
10. Toyota

**Europe and Asia**
1. Delphi
2. Daihatsu
3. Magneti Marelli
4. Siemens VDO
5. TRW Automotive
6. Meidensha
7. Hitachi Automotive
8. Pioneer
9. Sharp
10. Mitsubishi Electric

**Japan**
1. Denso
2. Toyota
3. Nissan
4. Honda
5. Mazda
6. Mitsubishi
7. Nissan
8. Honda
9. Toyota
10. Suzuki

**Renesas Customers**

**Top Three Automotive Customers**
- **Hitachi Automotive**
- **Honda**
- **Nissan**

**Top Three (alphabetically)**
- **Hitachi Automotive**
- **Honda**
- **Mitsubishi Electric**

**Fourth and Fifth (alphabetically)**
- **Johnson Controls**
- **Kostal**

**Top Ten (alphabetically)**
- **Aisin Seiki**
- **Calsonic Kansei**
- **Denso**
- **Hitachi Automotive**
- **Magna**
- **Johnson Controls**
- **Kostal**
- **Magneti Marelli**
- **Mitsubishi Electric**
- **Pioneer**

**Top Ten (alphabetically)**
- **ASL/Takata**
- **Bosch**
- **Calsonic Kansei**
- **Continental**
- **Clarion**
- **DaimlerChrysler**
- **Fujitsu Ten**
- **Hitachi Automotive**
- **Honda**
- **Kostal**

**Top Ten (alphabetically)**
- **Johnson Controls**
- **Kostal**
- **Magneti Marelli**
- **Magneti Marelli**
- **Mitsubishi Electric**
- **Panasonic/Matsushita**
- **Matsushita**
- **Matsushita**
- **Mitsubishi Motors**
- **Nissan**

**Top Ten (alphabetically)**
- **Aisin Seiki**
- **Calsonic Kansei**
- **Denso**
- **Hitachi Automotive**
- **Magna**
- **Johnson Controls**
- **Kostal**
- **Magneti Marelli**
- **Mitsubishi Electric**
- **Pioneer**

**A SICs for airbag squib drivers and power supply functions. The center provides failure analysis services and even provides initial onsite verification in the U.S., which is sometimes required before sending products to Japan. Renesas also operates design centers in San Jose, California; London, England; Düsseldorf, Germany; Singapore; and several locations in Japan. In June 2004, Renesas announced it was shutting down its manufacturing facility in Alsdorf, Germany; 40% Mitsubishi (Japan), 30% Denso (Japan), 15% General Motors.**
Renesas Technology

The company, and plans to move that production to Japan before the end of this year.

**Most Promising Auto Applications**

In the future, Renesas expects significant sales growth from a number of automotive applications, but navigation and car information systems are today the most promising. The company believes more cost-effective and reliable telematics systems are gaining in popularity, and with the acceleration of the telematics markets in Korea and China, global penetration of some form of telematics in new cars will reach 50% by 2010. Other applications where Renesas expects to see increasing revenue are safety systems—adaptive cruise control, camera systems, tire-pressure monitoring and occupant monitoring for airbag systems—plus electric power steering and hybrid vehicles. A recording to the company, by the end of 2005 nearly a half million hybrid vehicles will be produced globally per year. Renesas makes 27 devices for Toyota's second generation Prius and at least three for Ford's Hybrid Escape.

**CIS/N avigation**

In terms of sales, navigation is Renesas' number-one automotive application. Particularly strong in Japan, navigation units are fitted on 70% to 80% of all new vehicles.

A recording to the company, Renesas SuperH (SH) microprocessors run more than 80% of the navigation units sold in Japan and 86% of the navigation units sold in Europe. Of the 11 companies that make navigation units in Japan, Renesas says that eight of them use its SH architecture. Renesas plans to take advantage of its dominance in the Japanese market to pursue the navigation market in Europe and North America. A recording to Japan's VICS Center, over three million navigation units were sold in Japan in the fiscal year ending March 2004.

The SuperH microprocessor has an open architecture capable of supporting leading real-time operating systems including QNX, VxWorks, WinCE and µTRON. A nand Ramamoorthy, Renesas director of telematics for the Americas, observed, “If you look at the hardware specifications of the top three manufacturers, there are only small differences between them. In the case of SuperH architecture, we believe that software support is the main differentiator.”

A recording to Renesas, the QNX operating system is well-positioned today to establish global leadership in car information system applications. QNX is most popular in U.S. car information system applications because of its fault-tolerant micro-kernel architecture. QNX is now making strides in Europe, where VxWorks has held sway. In Asia, µTRON and Windows CE are most popular, though WinCE is especially suited to applications that have rich GUIs (graphical user interfaces). Renesas is watching to see if Linux-based applications will answer the reluctance of some customers to pay operating-system royalties.

For navigation and telematics products, Renesas micros cover a lot of ground. “Some of our competitors only have one or two devices and try to stretch them to fit low- and high-end navigation, low- and high-end telematics applications,” Mr. Ramamoorthy told us. But Renesas offers a range of SH devices, so one can be selected that perfectly fits the application. “We are developing the SH 7770, a 400 MHz A SSP with 2D and 3D graphics capability, a GPS base-band processor plus over 50 peripheral functions. While that device is perfect for highly-featured navigation equipment, it would be overkill for someone trying to do a simple hands-free CIS. For something like that we developed the SH 7760, a 200 MHz device,” he said. Due out later in 2004, Renesas is also developing the SH 7780, a 400 megahertz A SSP with PCI (peripheral component interconnect).

We asked Shiro Baba, general manager and executive manager of Renesas Automotive Semiconductor Division’s global operations, which regions of the world require the most sophisticated microcontrollers and microprocessors. “Domestic Japan, especially for navigation equipment, demands the greatest sophistication. Powertrain controllers also require relatively complex micros but for those, all regions, Europe, Japan and the U.S. have similar requirements,” he said.

**Bit Inflation**

Most automotive MPUs and MCUs are graduating to higher bit sizes, from 8- to 16-bit or from 16- to 32-bit, says Renesas. For example, today's airbag systems require faster and more complex processing, especially for occupant detection. A nd many tier-one suppliers are starting to depend on a single electronics control unit to perform multiple duties, such as instrument panel control combined with network gateway management. The gateway
manages the data transfer between several networks in cars such as high-speed/lowspeed CAN and LIN.

The use of multifunction devices will lead to fewer computers used in each vehicle and lower overall costs. Applications that require higher bit sizes include smart sensors for tire pressure monitoring, anti-pinch window lifters, and smart actuators for motor applications such as a 4-wheel-drive transfer case. Still, the need for controlling simple electromechanical functions will continue to drive demand for 8-bit devices.

Embedded Flash
On-chip flash memory capability is a key Renesas strength. Indeed Renesas is the world's number-one supplier of flash MCUs.

By the end of 2003, Renesas had already shipped a total of 104.2 million embedded flash devices, 22.5 million for automotive applications. In 2003, 19 carmakers were using the SH 705x/M 3217x M CU with embedded flash in powertrain applications.

The use of flash, electrically-erasable read-only memory that can be rewritten only a limited number of times (10 to 100, or so), has become a definite trend in the auto industry. Flash is used to store program code or semi-permanent data. Microcontrollers with embedded flash memory can be quickly and easily updated to fix a software problem or add a new feature. With on-board flash, fewer MCUs need to be inventoried because versions of the part can be implemented entirely with software.

Almost all of the MCUs and MPUs offered by Renesas for automotive applications, from 8-bit devices to 32-bit, come or soon will come with flash memory— from as little as 4 kilobytes in a 16-bit device up to 1 megabyte in a 32-bit device. A ll but the H 8 S series provide on-chip flash. “Our SH 7058, 80 M H z M CU with 1 megabyte of on-chip flash memory is right now one of the dominant engine control processors used by Japanese carmakers,” said Doug Pigott, director of the Renesas automotive sales groups based in Southfield, Michigan.

Renesas Shipments of Automotive MCUs with On-Chip Flash

<table>
<thead>
<tr>
<th>Year</th>
<th>8-bit</th>
<th>16-bit</th>
<th>32-bit</th>
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<tbody>
<tr>
<td>1996</td>
<td>0.1</td>
<td>2000</td>
<td>7.3</td>
</tr>
<tr>
<td>1997</td>
<td>0.4</td>
<td>2001</td>
<td>11.1</td>
</tr>
<tr>
<td>1998</td>
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<td>1999</td>
<td>3.6</td>
<td>2003</td>
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</table>

*Hitachi and Mitsubishi Electric combined shipments

Renesas is developing next-generation memory technology that uses a MONOS-type (metal oxide nitride oxide silicon) memory structure, which significantly reduces the module size to half that of N OR memory, while maintaining high read speeds of 100 M Hz and programming speeds of five to 10 seconds per megabyte. Renesas considers MONOS to be one of its most important R & D programs, likely to provide breakthroughs in auto electronics. Renesas' flash technology roadmap suggests that the company will first offer a 100 M Hz automotive MONOS device in early 2005 based on 0.15 micron geometries, and 0.09 micron geometries by 2007.

Wafer Production Capability
Renesas operates eight wafer-fabrication facilities in Japan and two in Germany (one of which will close before the end of 2004) that together make wafers for these devices: MPUs, MCUs, SoCs (system on chip), AND flash, NOR flash, SRAMS, LCD drivers, RFICs, H PA s (high performance amplifiers), linear, smart-card ICs, and mixed signal devices. The Renesas-owned Trecenti Technologies facility in Japan is among the world's most modern fabs. Trecenti features the world's first 300 mm (12 inch), high-volume wafer production line, which is capable of creating 130 nanometer and 90 nm features sizes. Its single-wafer process (as opposed to 20- or 25-wafer batches) enables production efficiencies that are particularly helpful with multi-lot, small volume jobs.

Standards-Making Activities
Renesas is plugged into several automotive standards-making consortia. According to Doug Pigott, "We’re finding that being involved with standards-making is key to understanding what's going on, and that helps drive our new technology.” Renesas is active in C AN/ISO, LIN, FlexRay and Safe-by-Wire, which is joining forces with BST (Bosch, Siemens, Temic) to develop standard airbag network technology. A ccording to Renesas, C AN is widely used in Japan and LIN is in the development stage there. Safe-by-Wire is being investigated in Japan with product implementations potentially set for 2008. FlexRay is being looked at as well with possible implementation in Japan by 2010. Renesas believes that like C AN, FlexRay is likely to become a worldwide standard.

In July 2004, Renesas joined the AUTOSAR (A utomatic O pen System A rchitecture) partnership as a premium member. A utosar is working to standardize software interfaces and modules for vehicle electronic control systems.
Sensor Improvements Coming

A utomotive suppliers are providing more and better sensing options for systems engineers. A t the Sensors Expo & Conference 2004, held June 7-10 in Detroit, Michigan, several exhibitors presented the newest of these possibilities.

Today’s average vehicle already has 30 or more sensors to provide inputs to powertrain, airbag, A BS and other control systems on the vehicle, and as electronic systems and features become more sophisticated, additional sensor inputs will be required. Driven by the need for better performance, higher reliability and lower costs, suppliers are investing in next-generation sensors that will provide digital interfaces, better accuracy and resolution and will help reduce overall system cost. Sensors that combine multiple sensing functions in one device are also being developed.

For tire pressure monitoring (TPM) systems, direct measurement of tire pressure has performance advantages over indirect systems, which use wheel-speed measurements. Those advantages include pressure readings when the vehicle isn’t moving, higher sensitivity and the ability to detect multiple under-inflated tires. In August 2003, a U.S. Court of Appeals ordered NHTSA to rewrite its rules on tire pressure monitoring, which had allowed carmakers to choose direct or indirect sensing systems to comply with the TPM requirements of the TREAD Act. The final rule, eliminating the indirect sensing option, should be completed by the end of July 2005, according to NHTSA’s status report.

To cope with more stringent emissions standards, a transition from passive variable reluctance (inductive) sensors to active Hall effect sensors is underway for electronic throttle control and other powertrain measurements. While these devices have competed with each other for this application over many years, the need for more precise measurements is now more critical than ever and is driving designers toward the solid-state solution. Hall effect sensors, with size, weight and sensitivity advantages, have the capability to measure down to zero speed with true power on (the ability to determine absolute position at power-up), detect direction and provide a digital output without a separate A/D converter.

Using data from Strategy Analytics (Milton Keynes, U.K.), Werner Roessler, applications engineer at Infineon Technologies, noted that from 2000 to 2007 active sensors would experience an annual growth rate of 9% for camshaft sensing and 30% for crankshaft sensing.

Contact potentiometer-based pedal sensors are being challenged by a new non-contact inductive sensor from Hella that uses electromagnetic alternating fields. The design uses planar technology for the stator’s excitation and receiver coils and a rotor consisting of one or more conductive loops in a specific geometry—easily manufactured using metal stamping technology. The technology also allows the integration of a steering-angle sensor and a steering-torque sensor into a single assembly.

Sensor suppliers are exploring the potential for wireless sensors that would use emerging standards such as Zigbee, a wireless technology that promises lower cost and longer battery life than existing technologies such as Bluetooth. Batteries limit the useful life of battery-powered sensors such as those in tire pressure monitoring systems. A s a result, several suppliers are working on approaches that don’t require batteries, typically using surface acoustic wave technology with high frequency radio waves. Strategy Analytics forecasts that by 2010 over 10% of tire pressure systems will not require batteries.

Mark Fitzgerald, senior industry analyst for Strategy Analytics, told attendees at the A utomotive Sensors Symposium that the global sensor market will annually grow at the rate of 7.3% from 2002 through 2007, increasing from $7.21 billion to $10.25 billion. Position, pressure and other sensors will grow the fastest. In the “other” category, parking/blind spot detection will grow from just under 5 million units in 2003 to almost 12 million units by 2009. While ultrasonic types will continue to dominate, radar and camera technology will grow to 1.5 million and 1.7 million units, respectively.

Fuji Chimera Studies Japan’s Auto Parts Market

In April 2004, Fuji Chimera Research Institute published its 271-page Auto Parts Market Data Book 2004, which looks at supply relationships, market share, technology and market trends in Japan for 56 auto parts including electrical/electronic, mechanical, plastics, seats and others. For more information or to order the ¥97,000 ($864) report, in Japanese only, visit www.fcr.co.jp or fax 81-3-3661-5134. Fuji Chimera is a market research and consulting firm with headquarters in Tokyo.