In the United States, more than 100,000 people are killed in drowsy-related crashes each year. The driver is alerted by an audio alarm and a warning on the navigation system's gyro sensor and speed sensors to detect any abnormal driving patterns. The system also uses the navigation system's gyro sensor and speed sensors to detect any abnormal driving patterns. The system also uses the navigation system's gyro sensor and speed sensors to detect any abnormal driving patterns.
Delphi Performs Poorly

Since its spin-off from General Motors, in February 1999 when it became a publicly traded company, Delphi Automotive Systems Corporation has not performed well. In the first half of 2001 Delphi suffered a net loss of $265 million as sales declined to $13.5 billion, compared with $15.6 billion in the first half of 2000. From 1998 through 2000, Delphi’s annual sales have grown slowly, from $28.5 billion in 1998 to $29.1 billion, a 1.2% annual increase. As of June 30, 2001, net liquidity, measured as cash and cash equivalents less total debt was minus $2.7 billion. It appears that Delphi will not meet its goal of 5% profit margin by 2002.

Last December, Delphi decided it needed to fix, close or sell businesses that in 2000 generated $4 billion to $5 billion in sales. As part of that portfolio review, Delphi is in the process of weeding out unpromising businesses, which together account for $900 million in sales. Scheduled to be completed by March 31, 2002, this restructuring will eliminate 11,500 positions, worldwide. Nine plants, two of them in the U.S., will be sold, closed or consolidated. (During the period from 1992 to the spin-off from GM in 1999, Delphi sold businesses representing over $6 billion in sales.)

Given all the bad news, it’s no wonder that Delphi’s stock is trading at such a low price, $10.59 at day’s end, September 19, 2001. With 560 million shares outstanding, that put Delphi’s total market value at just $5.9 billion dollars, only one-fifth of sales. Delphi’s stock price was $19 when it was first offered to the public in February 1999, and it reached a 52-week low of $10.50 back in December 2000, well before the September 11 World Trade Center bombing and the subsequent stock losses.

Delphi’s stock price is likely to go down even further. The company has already stated that sales will decline at least by 10% in 2001. Sales for the year 2002 and beyond won’t get much better, unless car production suddenly takes off. Putting even more pressure on Delphi is the upcoming expiration of an agreement with General Motors that gave Delphi preferential treatment over its competitors. When that agreement expires on January 1, 2002, Delphi will have to bid for GM business on the same basis as its competitors. The playing field will finally be level, and Delphi will have to learn how to profit even as its business with General Motors declines. In 2000, General Motors accounted for 71% of Delphi’s sales; GM North America accounted for 59% of Delphi’s total sales. It is unlikely that Delphi will be able to pick up enough market share from the more competitive merchant market as fast as it will lose General Motors’ business.

Even Delphi’s Electronics and Mobile Communications sector (formerly Delphi Delco Electronics) is losing market share. While the worldwide demand for automotive electronics grew 6.7% per year between 1995 and 2000, according to The Freedonia Group, Delphi’s Electronics sector sales was totally flat. In 2000, the Electronics sector had sales of $5.3 billion (the same as in 1997) and operating income of $470 million, down 18.5% from $577 million in 1999.

To show investors its success in one up-and-coming market, Delphi has been breaking out sales for its Mobile Multimedia business from the Electronics sector results. Mobile Multimedia develops products that bring the Internet, telematics, entertainment and mobile communications technologies into vehicles. While Mobile Multimedia sales have multiplied from $40 million in 1999 to $322 million in 2000, the business had an operating loss of $23 million in 2000. In the first-half of 2001, Mobile Multimedia had $213 million in sales, with a $10 million operating loss. Slow to emerge, the telematics market isn’t likely to blossom until 2004 or 2005.

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3.2 Million VICS Units in Use in Japan

Launched in 1996 in Tokyo, VICS (Vehicle Information and Communication Service) now provides real-time traffic information to drivers in Japan’s major cities. Most navigational equipment sold in Japan today is VICS-compatible, and the free service continues to grow in popularity.

<table>
<thead>
<tr>
<th>Cumulative Car Navigation Shipments and VICS Units in Japan in millions of units</th>
<th>March</th>
<th>Cumulative Navigation VICS Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>March</td>
<td>Navigation Units</td>
</tr>
<tr>
<td>1993</td>
<td>80,000</td>
<td>0</td>
</tr>
<tr>
<td>1994</td>
<td>160,000</td>
<td>0</td>
</tr>
<tr>
<td>1995</td>
<td>490,000</td>
<td>0</td>
</tr>
<tr>
<td>1996</td>
<td>1,106,391</td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td>1,902,255</td>
<td>128,482</td>
</tr>
<tr>
<td>1998</td>
<td>2,796,199</td>
<td>442,492</td>
</tr>
<tr>
<td>1999</td>
<td>3,931,365</td>
<td>1,019,659</td>
</tr>
<tr>
<td>2000</td>
<td>5,352,386</td>
<td>1,815,431</td>
</tr>
<tr>
<td>2001</td>
<td>7,200,325</td>
<td>2,804,190</td>
</tr>
<tr>
<td>June 01</td>
<td>7,600,000</td>
<td>3,170,000</td>
</tr>
</tbody>
</table>

Source: Japan Ministry of Land, Infrastructure and Transport, Road Bureau; VICS Center, Tokyo

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The Hansen Report on Automotive Electronics

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Circulation Manager

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Drowsy...

Suppliers in the U.S. have also shown interest. In 1999 TRW Automotive Electronics and Biosys (Sweden) collaborated to develop a drowsy warning system based on Biosys' technology. Johnson Controls and Circadian Technologies (Cambridge, Massachusetts) developed a drowsiness monitor that measures head movements associated with drowsiness.

Johns Hopkins University's Applied Physics Lab is working on a drowsy detection system that uses low-power Doppler radar. The product is small enough to be mounted in an overhead panel and measures eye-blink frequency and duration, eyelid movement and general fidgeting.

PERCLOS Method

In the United States, drowsy-driver warning systems have been getting a big boost from NHTSA, which could spend a few million dollars before it is finished developing technology and determining, validating and analyzing the safety benefits of such technology. NHTSA has done a number of studies relating eye closure with fatigue and has already outfitted a number of trucks with drowsy monitors for field testing.

NHTSA hired Carnegie Mellon University's Robotics Institute to do much of the research, with additional funding coming from the Federal Motor Carrier Safety Administration. Carnegie Mellon's assignment was to pick the most appropriate drowsy-driver technology and develop a vehicle-based detection and warning system. Carnegie Mellon researchers selected six candidate technologies and then had the University of Pennsylvania conduct double-blind laboratory tests of each technology against one of the best standards for measuring fatigue, the psychomotor vigilance test or PVT.

In the laboratory PVT, people were kept awake for 42 hours and every two hours they were given a battery of tests that measured performance at various stages of sleep deprivation. In the test, people were asked to respond as quickly as they could to a light turned on and off roughly once every ten seconds, but randomized over a period of 20 minutes. Over time, people tended to respond more slowly, a sure sign of loss of attention.

One of the technologies tested, a PERCLOS (percent closure) monitor, which keeps track of the percentage of time the eyes are closed during a specified period, correlated almost perfectly with the PVT analysis. "PERCLOS was able to predict the PVT response times to about the 90% level," said Carnegie Mellon researcher Dr. Richard Grace, a senior systems scientist. "The next-best technique had only a 60% prediction rate."

Carnegie Mellon researchers ruled out lane wandering as an indicator of fatigue among truck drivers operating at night.

Dr. Grace: "We had a problem with performance-based measures (lane-keeping and steering-wheel monitors) because truck drivers perform differently late at night than do car drivers. Truck drivers don't respect lane barriers even when they're wide awake." Since there is much less traffic, truck drivers tend to straddle lanes, using the whole highway to minimize curves and keep their vehicles safely on the road.

"The magic in the PERCLOS monitor is in the way the face is illuminated by infrared light," said Dr. Grace. "Our marching orders from NHTSA were to make a device that works at night." The PERCLOS monitor does—by using two different frequencies of IR illumination. The first video camera picture is acquired using infrared illumination of 850 nm (nanometers), which produces the "red eye" effect, that is, a distinct glowing of the driver's pupils. The second image is illuminated with a 950 nm source, which produces an image that is identical to the first, except the pupils are dark. A third image calculates the difference between the two images, enhancing the bright-eye effect, while diminishing other bright lights, for example, headlamp reflections on the driver's eyeglasses. The two frames are shot within 20 milliseconds, and after a third of a second, the process repeats.

If drowsiness is detected, a gauge shows the driver the level of fatigue and an audible alarm is sounded. The warning system is designed to be installed on the dashboard, just to the right of the steering wheel.

Given the success of the PERCLOS monitor tests, Carnegie Mellon had a number of drowsy-driver monitors built for actual field testing. DaimlerChrysler purchased a system about one month ago. For more information about the PERCLOS monitor, or to purchase samples of the device, contact Dr. Richard Grace, rgrace@rec.ri.cmu.edu.

Electrical/Electronics Recalls

If a vehicle or any item of motor vehicle equipment is shown to have a safety-related defect or is found to be in violation of a federal motor vehicle safety standard, a safety recall can be ordered by the manufacturer or NHTSA (National Highway Traffic Safety Administration). NHTSA monitors all recalls. The following electrical or electronics-related recalls, issued from November 1999 to September 2001, are a small sample of the total.

Kia Motors recalled 16,231 MY 2001 Optimas to check the door wiring harness. Misrouted wiring in the door could lead to damaged wires, which could prevent the side airbags from deploying.

Filed in February 2001, Honda recalled 47,158 Acura Legends, MY 1991-1992, because in certain sedan and coupe models equipped with a Bose audio system that has separate speaker amplifiers mounted behind the rear seat, the transistor in the speaker amplifier could overheat, resulting in smoke or possibly a fire.

BMW recalled 17,000 M3s, MY 1997-1999, because the side airbag is unduly sensitive to non-crash impacts, such as hitting a large pothole or curb, which can cause unintentional deployment. Dealers will reprogram the central computer control module to correct performance.

In 2000, General Motors decided to recall about 225,000 MY 1999 Cadillac DeVille to replace crash sensor modules that could cause the side airbags to deploy for no good reason. GM also recalled 477,011 minivans equipped with passenger-side power sliding doors that close but may not latch; models included Chevrolet Venture, Pontiac Montana, Pontiac Transport and Oldsmobile Silhouette, from MY 1997 to 2001.

Ford has recalled more than 1.1 million MY 1999 - 2001 Windstars, Mercury Cougars, Contours and Mystiques due to fires in wiper motors and climate control systems.

Honda recalled 10,600 MY 2002 TLs to replace window-lift controllers that are associated with the power-up feature. The window-lift mechanism could either fail outright or fail to automatically reverse.

In September 2001, Chrysler Truck recalled the MY 2002 PT Cruiser for a software error in the instrument cluster microprocessor. The error could make gauges, illumination and warning lamps inoperative.
The company, with manufacturing facilities in North America and Japan, realizes that carmakers are global, so Unisia JECS uses ZF Lenksystems GmbH (50–50 JV of Robert Bosch and ZF) and Kolbenschmidt Pierburg AG for European production of some of its products. Unisia JECS will also look for other companies to form alliances with in order to pick up manufacturing capability in Europe.

The company has 11 overseas subsidiaries; most serve both automotive and non-automotive activities, and five make mostly automotive electrical and electronics parts or systems. (See table on page 7.) In addition, the company has overseas administrative offices for sales and marketing in the U.S., the U.K., Korea, and Belgium. There are 11 manufacturing plants in Japan, all make materials and parts used in the automotive industry, as well as some parts for other Unisia JECS businesses.

Financial Fallout from Nissan Restructuring

In 1999, Renault bought 36% of Nissan Motor Co. and Carlos Ghosn, who joined Renault in 1996 and served as ex-
Unisia JECS' fiscal year 1999, which ended on March 31, 2000, saw net income fall from a loss of ¥1,168 million ($9.8 million) in FY 1998 to a loss of ¥13,965 million ($117.4 million), while sales remained flat. The company has been unable to pay dividends to its shareholders since FY 1999.

As a result of Nissan’s restructuring, Unisia JECS is reorientating its business strategy to regain profitability. To cope with Nissan’s demands for cost reductions, Unisia JECS has prioritized its automotive products, sold its clutch business, and acquired a die-cast maker to strengthen its basic technologies and relocate some of its production sites. The company intends to expand its customer base worldwide and sell more integrated systems. While 75.5% of total shipments went to Nissan in 1996, currently just 63.7% do, and Unisia JECS expects that only 55% will go to Nissan five years from now.

In FY 2000, product lines increasing their sales in Aisan markets were A B S, valve timing control systems, power-steering gears, and N orth American fuel pumps. However, total FY 2000 sales decreased by 5.5%, due largely to the transfer of drivetrain products (clutches and flexible flywheels) to Valeo in April 2000.

A iso troubling, current liabilities exceeded current assets by ¥10,982 million ($92 million) at fiscal year-end 2000. Unisia JECS’ restructuring is showing some positive results. Price per share has increased slightly since late 1999, and profit per share has gone from a loss of ¥91.17 ($0.77) in FY 1999 to ¥17.8 ($0.15) profit in FY 2000. Operating profit in FY 2000 was ¥2,501 million ($21 million), or 1.4% of net sales; net income was ¥2,727 ($23 million), or 1.6% of net sales. The company pointed out in its FY 2000 annual report that net income benefited from a one-time gain of profit from the sale of the clutch business, and at the same time, net income was hurt by extraordinary losses associated with the early-retirement incentive program.
### U nisia JECS

**Shares from N issan:**
**H itachi Buys Equity**

In late 1998, Hitachi and Nissan explored how they might work together more closely: Nissan was looking for cash and Hitachi wanted a bigger presence in the automotive industry. About 40% of Hitachi's automotive product sales already went to Nissan, Unisia JECS' largest shareholder. In 1999, Hitachi and Unisia JECS agreed to increase their joint development work in vehicle control systems for ITS (Intelligent Transportation Systems). Hitachi increased its equity in Unisia JECS to 16.7%, the same percentage it holds today. Shares were transferred to Hitachi from Nissan and from other major shareholders. Hitachi's equity in Unisia JECS is greater than that of Robert Bosch GmbH, which holds 10.1%, but less than Nissan's. In February 1999, Nissan had 29.7% and on March 31, 2001, the company had 25.3%.

Hitachi has provided capital, as well as R&D and manufacturing personnel, to help develop these products for global distribution: powertrain, including next-generation fuel injection systems, HEV (hybrid electric vehicle) and EV (electric vehicle) components, brake-by-wire systems, electric power steering systems, as well as vehicle control systems combining controls for powertrain, braking and steering. At this time, Unisia JECS feels the companies are working well together and considers their adaptive cruise control and electromechanical brake products as most promising.

**Joint Ventures and Business Transfers**
- In April 2001, Unisia JECS and Bosch Braking Systems established an 80% - 20% joint venture called Unisia JKC Steering Systems to develop, manufacture and sell hydraulic and electric power steering systems for passenger cars and trucks. In addition to the investment that Bosch will make in the JV, Bosch Braking Systems will transfer its power steering systems business to the joint venture. The company will locate in Kanagawa and expects to employ 1,500 people there.
- ZUA Autoparts, Inc. (Oakwood, Georgia), founded in 1990, is a joint venture between ZF (Zahnradfabrik Friedrichshafen) A G, Germany (51%) and Unisia JECS (49%). The JV makes conventional power steering gears and pump products, not EPS (electric power steering) products. Tim Clark, sales manager for Unisia JECS North America, told us, “The company has not decided if the ZF joint venture or Unisia JECS alone will make EPS.” In 2000, Unisia JECS and ZF jointly developed a small power-steering pump. The two companies also have a JV in Chachoengsao, Thailand. A nother joint venture, ZF Steerings Malaysia, supplies steering gears for Malaysian carmakers (Proton and Perodua), for Tan Chong M otor A ssemblies and for Ford in Malaysia. The company also exports products to Nissan and Mitsubishi car assembly plants in Taiwan, Thailand, Philippines, Indonesia and Mainland China.
- On April 3, 2000, Unisia JECS agreed to transfer its clutch business to Valeo, and set up a JV called Valeo Unisia Transmissions K.K. Valeo is the majority shareholder with a 66% stake. Unisia JECS’ clutch business consisted of the manufacture and sales of clutches for manual transmissions, lock-up clutches for automatic transmissions, flexible flywheels and dual-mass flywheels. Unisia JECS believes the two flywheel products will be highly profitable, because they use advanced technologies that the company has developed. A Unisia JECS goal is to expand its customer base globally through the establishment of alliances with top companies around the world. Unisia JECS concluded that transferring its clutch business to the Valeo joint venture fits in with that goal. Manufacturing is located at an existing plant with about 230 employees in Atsugi, Kanagawa. With the JV, Valeo will gain its first production base in Japan. Valeo and Zexel have formed an alliance in climate control and engine cooling that will also be located in Japan.
- AUT ECS, set up in Anderson, South Carolina, in 1988, as a JV with Robert Bosch (51%), produces engine control units, transmission control units and throttle control products, mostly. Unisia JECS has decided to limit its involvement in AUT ECS; in the future only shared technology that already exists will be used to create new AUT ECS products. Unisia JECS wants the freedom to sell anywhere in the world new products based on its technologies. The agreement, under which AUT ECS was established, limits the partners' markets for products

### Unisia J ECS Products

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<th><strong>Brake Products</strong></th>
<th><strong>Engine Products</strong></th>
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<tbody>
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<td>Valve rocker arms</td>
<td>Valve Timing Control</td>
</tr>
<tr>
<td>Water pumps</td>
<td>Systems</td>
</tr>
<tr>
<td>Anti-skid speed sensors</td>
<td>VTC (valve timing control)</td>
</tr>
<tr>
<td>Decompression brake systems</td>
<td>VVL (variable valve lift)</td>
</tr>
<tr>
<td>Hydraulic units with ECU</td>
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<tr>
<th><strong>Drive train Products</strong></th>
<th><strong>Steering Products</strong></th>
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</thead>
<tbody>
<tr>
<td>Suspension shafts</td>
<td>Hydraulic Power Steering Systems</td>
</tr>
<tr>
<td>Propeller shafts</td>
<td>Control units</td>
</tr>
<tr>
<td>Air flow meters</td>
<td>Active Damping Control</td>
</tr>
<tr>
<td>Air regulators</td>
<td>Suspension Systems</td>
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<td>Cam angle sensors</td>
<td>Actuators</td>
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<tr>
<td>Crank angle sensors</td>
<td>Adjustable dampers</td>
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<tr>
<td>Engine control units</td>
<td>Control units</td>
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<tr>
<td>Front covers</td>
<td>Vertical acceleration sensors</td>
</tr>
<tr>
<td>Fuel injectors</td>
<td>Gas springs</td>
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<tr>
<td>Fuel pumps</td>
<td>Printed-Circuit boards</td>
</tr>
<tr>
<td>Knock sensors</td>
<td>Stroke sensors</td>
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<tr>
<td>Oil pumps</td>
<td>Others</td>
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<tr>
<td>Oxygen sensors</td>
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</tr>
<tr>
<td>Pistons</td>
<td></td>
</tr>
<tr>
<td>Throttle chambers</td>
<td></td>
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<tr>
<td>Throttle position sensors</td>
<td></td>
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</tbody>
</table>

**Unisia JECS Products**

### Exploded View

- **Brake Products**
  - Valve rocker arms
  - Water pumps
  - Anti-skid speed sensors
  - Valve Timing Control
  - Decompression brake systems
  - Systems
  - Hydraulic units with ECU
  - VTC (valve timing control)
  - VVL (variable valve lift)

- **Engine Products**
  - Suspension shafts
  - Propeller shafts
  - Air flow meters
  - Air regulators
  - Cam angle sensors
  - Crank angle sensors
  - Engine control units
  - Front covers
  - Fuel injectors
  - Fuel pumps
  - Knock sensors
  - Oil pumps
  - Oxygen sensors
  - Pistons
  - Throttle chambers
  - Throttle position sensors

- **Drive train Products**
  - Suspension Products
  - Active Damping Control
  - Suspension Systems
  - Actuators
  - Adjustable dampers
  - Control units

- **Steering Products**
  - Hydraulic Power Steering Systems
  - Control units
  - Active Damping Control
  - Suspension Systems
  - Actuators
  - Adjustable dampers
  - Control units

- **Others**
  - Gas springs
  - Printed-Circuit boards
  - Stroke sensors
based on shared AUTECS technology. Unisia JECS can’t sell AUTECS technology in Germany, and Bosch can’t sell AUTECS technology in Japan.

New Products

The company’s “basic development themes,” or objectives for new product development, are improved safety, driving comfort and environmental friendliness. Goals include:

- Improving the performance of the basic automotive functions of driving, turning, and stopping in order to augment the vehicle’s accident-prevention capabilities
- Ensuring excellent driving stability and comfort so that passengers feel safe and secure
- Making products that can be recycled, and protecting the environment through the use of safe technology.

The company is an integrated systems manufacturer, as well as a supplier of parts and components for engines, drivetrains, suspensions, steering and brakes. Please see products list on page 6. In FY 2000, the company saw increases in orders for VTC (valve timing control) systems, control units for automatic transmissions, A BS and power steering gears.

Electromechanical Brakes (Brake-by-Wire): The system, with an electric motor-driven caliper on each wheel and an ECU, was developed in collaboration with Tokico and Hitachi. The new product is expected to be released in 2006.

EPS (Electric Power Steering): Unisia JECS expects product release in 2003. EPS has these advantages: simplified installation, since the system is motor driven not belt driven; less fuel consumption, due to better energy efficiency; and lower cost because the configuration is clutch-free. Unisia JECS provides the complete system, including a DC brushed motor and ECU. The company offers either column assist-type EPS or pinion assist-type EPS. Customers include Mitsubishi Motors and Daimler Chrysler.

Electric Water Pump: The company will soon offer a new electric water pump for use in belt-less applications. It could be used as a pump to assist cooling of power electronics in a hybrid vehicle, or it can replace the conventional belt-driven water pump in engines in small to mid-sized vehicles.

Power-Assist Brake: Provides power-assist braking and hill holding at a reduced cost. Volume production is expected to start in 2004.

Complete Fuel Pump System: This is a promising new product in development, according to Unisia North America. Packaged together compactly in one small, in-tank unit are the level sensor (sensor), filter, pressure regulator and pressure sensor. North American sales and marketing manager Tim Clark told us that while other integrated fuel pumps are in production, the company believes its product is unique because it is very small, compact and inexpensive.

VTC Systems: In FY 2000, the company saw an increase in orders for VTC systems, although it saw a decrease in engine control units and other electronic fuel injection products and control valves. Performance data for the company’s VTC systems, powered by hydraulics, show increased low-to-middle speed torque of 10% or more, fuel economies of 4% or more, and reduced emissions for HC of 12% or less and for NOx of 30% or less. VTC systems, which offer tier-ones and OEM’s cost improvements, can be installed on any engine without modification, on both the intake and exhaust camshafts, and can be combined with VVL (variable valve lift) and VVE (variable valve event).

U.S. customers are most interested in the VTC, and to a lesser extent, water pumps and oil pumps. M r. Clark noted that in Unisia JECS’ newly-designed VTC, there are no pins, so it doesn’t have to return to the off position every time you turn off the car, unlike a typical VTC, which has a pin that must lock in. Most competitors rely on oil pressure to power the pin in place; an electric stepper motor powers Unisia JECS’ newly-designed VTC. M r. Clark explained: “With ours, you have much less risk of failure, quicker response time and it’s cheaper than conventional VTC. ... The problem with the hydraulic VTC is that it has to wait for a certain buildup of oil pressure before it can actually phase, and you can’t put a monster oil pump on the engine to get it to move at low RPM.” The VTC does not require a separate control unit if the VTC can be integrated into the carmaker’s engine control unit.
who are dedicated to specific technologies; but the general design work on the details, that work we give to our full-service suppliers.”

GM and Ford rely more heavily on outside electronics and software suppliers than does Chrysler. Ford maintains some design expertise in house and tries to outsource everything from system-level designs to components. GM wants to hold close to the vest all technologies that it considers strategic—those that shape the character of the vehicle.

Compared with Ford and GM, Chrysler is the most vertically integrated of the U.S. carmakers. Huntsville Electronics, which designs and manufactures powertrain control units, audio head units and instrument clusters almost exclusively for Chrysler, is still a wholly-owned Chrysler facility. Chrysler is determined to maintain the ability to create electronics intellectual property within the company. Bob George, a top electrical engineer at Chrysler, confirmed that Chrysler has committed to “understanding” not only software, but the technology of the parts it uses. Chrysler will continue to be the release engineer for software and for certain key chips. Engineering for less sophisticated, non-critical components and circuit board layouts will be done outside the company.

Not only are the carmakers pushing more engineering onto tier-one suppliers but the top tiers are passing it down the line as well, shifting more engineering work to the second tier. Often lacking sufficient skilled manpower, both top-tier and some second-tier suppliers have been shopping for contract engineering talent. Donald Sesnie, who handles new business for Modern Engineering, (Troy, Michigan), a major supplier of contract engineers, told us: “Some tier-one suppliers are tackling these programs without the technology or brainpower to do it, which is why demand for contract engineers from tier-one suppliers is on the rise. That has kept us busy, even as the Big 3 have laid off a great number of contract engineers. ... This has been going on for 18 months or so and is likely to continue for the next five or six years.”

Finding engineers, particularly electrical and software engineers, willing to work in Detroit, has been especially hard. “The premium engineer out there right now is somebody with an RF background and experience in both hardware and software development,” said Modem’s M. r. Sesnie. Modern Engineering is working on an open requisition from interiors supplier Tier A utomotive, a subsidiary of Magna International, to provide 200 contract engineers by February 2002.

The decline in electrical engineering capability is being felt throughout the industry. Motorola vice president Neil Krohn, in charge of field engineering for Motorola Semiconductor Products Sector’s Transportation Systems Group, elaborated: “I have witnessed this brain drain in our industry as my group responds to technical questions. People are having trouble doing even basic things like bringing up computer-aided tools. People don’t seem to understand things as they used to; many are unable to do their own troubleshooting as production nears. We [at Motorola] are doing lots more handholding.”

The engineers we spoke with from each of the Big 3 carmakers agree that engineering capability is somewhat spotty at the tier-ones. Ford’s Tim Donovan told us: “Not all top-tier suppliers are necessarily equipped to take on the added responsibility. We have had to spend more time than we want helping some of them with the designs. ... That is something we are not going to be able to maintain, because of the competitiveness in the industry.”

Chrysler’s Bob George said he will cope with ongoing engineering attrition and inexperienced top-tier suppliers by applying more design tools that increase engineering productivity. “We need computer-aided design tools and a smart electronic architecture so we can reuse parts many times, across platforms and across vehicle models.” (Please refer to the June 2001 Hansen Report article on tools.)

Salim Momin, in charge of Motorola SPS’ Virtual Garage and a key advocate of automotive electronics engineering tools agreed with Mr. George: “Given the complexity and the shortage of experienced engineers, one answer is model-based engineering using tools. With models I can release more robust specifications to my supplier. If the supplier is savvy and also is competent with tools, he can use that model to automatically generate code.”

### Telematics Market Growth 2000-2006

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<thead>
<tr>
<th></th>
<th>2000</th>
<th>2006</th>
<th>Annual Growth</th>
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<tbody>
<tr>
<td>System Revenue</td>
<td>537</td>
<td>3,542</td>
<td>36.9%</td>
</tr>
<tr>
<td>Service Revenue</td>
<td>296</td>
<td>3,815</td>
<td>53.1%</td>
</tr>
<tr>
<td>Total Telematics Revenue</td>
<td>833</td>
<td>7,358</td>
<td>43.8%</td>
</tr>
</tbody>
</table>

Source: Telematics Research Group

In a report entitled Telematics: Technologies, Trends and Markets, published in September 2001, the Telematics Research Group forecasts total telematics revenue will reach $7.4 billion in 2006. The authors define telematics as “the wireless exchange or delivery of communication, information and other content between the auto and/or occupants and external sources.”

The study is available for $2,995 from Telematics Research Group, Minnetonka, Minnesota. For more information or to order, visit www.telematicsresearch.com or call 952-935-0400.

### Estimated Annual Growth of Vehicle Production by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>2000 (in millions of units)</th>
<th>2006 (in millions of units)</th>
<th>Annual Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>17.66</td>
<td>18.99</td>
<td>1.2%</td>
</tr>
<tr>
<td>West Europe</td>
<td>17.32</td>
<td>17.98</td>
<td>0.6%</td>
</tr>
<tr>
<td>Japan &amp; So. Korea</td>
<td>13.25</td>
<td>13.68</td>
<td>0.5%</td>
</tr>
<tr>
<td>Rest of World</td>
<td>11.16</td>
<td>17.91</td>
<td>8.2%</td>
</tr>
<tr>
<td>World Total</td>
<td>59.39</td>
<td>68.56</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

Note: The categorization of cars and trucks is becoming more difficult as vehicle registration classification continues to change and as increasing numbers of vehicles perform a dual purpose. For example, light trucks in the U.S. fall under the Truck category, even though about 95% of vehicles in the U.S. are for passenger use; about 5% of vehicles are medium and heavy trucks and buses.

Source: Pemberton Associates, Rugby, Warwickshire, UK; Phone and fax: +44 1327 260374