Voice Texting May Reduce Distraction

Hyundai’s Agent-Assisted Speech Recognition a First

Distracted driving is getting a lot of scrutiny by government regulators in the United States, with texting while driving being a particularly egregious example of risky behavior. Hyundai’s new Blue Link telematics platform, available this June on the 2012 Sonata and the brand new Veloster coupe, offers a potentially lifesaving answer—voice texting. Instead of thumbing text messages into a cell phone, which requires both hand and eye attention, the driver can speak his outgoing message, which is converted to text using speech recognition, and then sent.

The ground-breaking speech recognition feature was developed by Hyundai’s telematics service provider, ATX. It uses both an embedded speech platform and connected speech services provided by Nuance Communications.

Hyundai’s voice texting is only for outbound messages at this time, so the danger from people reading incoming texts on their phones remains.

Barry Ratzlaff, who is responsible for the Blue Link telematics program at Hyundai, described how the agent-assisted text messaging works: “A field indicating you want to send a text message and to whom, you can say anything you want—there is no list of preconfigured phrases. Speech recognition software in the cloud tries to recognize as much as it can and calculates the probability that it got the message right. If the assessment doesn’t meet our accuracy threshold, Blue Link sends a recording of what you said to the live agent [at ATX] who transcribes your message. It is then read back to you in the car through text-to-speech to confirm this is what you wanted to say before the text.

Copper Price Rise Renewed Interest in Wiring Alternatives

The price of copper has more than tripled since December 2008, and carmakers and their wiring suppliers are once again seriously considering what steps they can take to minimize the cost increase. A similar price increase occurred between January 2004 and August 2007, stimulating interest in finding alternatives, but the level of interest quieted as the recession took hold. On February 14, 2011, copper hit $4.60 per pound, even higher than it was before the recession. At that price, the raw copper in an Audi A4’s wiring harness would cost $219 more than it did in December 2008. Copper prices are likely to go even higher, and the industry is even more motivated than it was four years ago to reduce the copper content in vehicles.

Carmakers are taking simultaneous approaches to minimize the amount of copper used in wiring harnesses. With the help of computer aided design tools they are optimizing harness architectures and, where possible, reducing the cross section of each wire. “We look at each circuit to see what the smallest size wire we can use is,” said Chris Burns, engineering director at Delphi Packard. “That might mean you have to change the circuit protection scheme and maybe use smaller fuses.”

Optimization could potentially reduce the amount of copper in a harness by 3% to 5% according to Götz Roderer, S-Y Technologies. “You need to have a system approach where you work with the electronics guys, the power distribution guys and the harness guys. To get the architecture right, it’s best to have teams running about one and a half to two years before RFQs are issued,” he said. Based in Regensburg, Germany, S-Y Technologies is a 50-50 joint venture between Yazaki and Continental.

Downsizing Signal Wire

A according to an analysis by the German cable maker Auto Kabel, the copper in signal wires, which are typically those with cross-sections between 0.35 mm² and 0.75 mm², weighs 16.5 kg, accounting for 43% of the copper used in a midsize vehicle’s wiring. These signal wires could potentially be replaced with 0.13 mm² wire made from copper alloy or copper with a stainless-steel core to keep them strong despite being very thin. “You don’t need a whole lot of copper for signals,” said Eric Leszczynski, senior manager of EDS engineering for Yazaki North America. “Everyone, including Ford, GM, Toyota and some other Japanese carmakers, has started working toward 26 gauge (0.13 mm²) wires.”

Delphi’s Chris Burns identified the same trend: “A II the O EMS in all regions of the world, are either going into production with 0.13 or are already in production.” Delphi Packard offers a line of 0.13 mm² wiring with physical properties comparable to current 0.35 mm² cable constructions.

Aluminum

The second path to reducing the amount of copper in automotive wiring
Rebounding from the global recession, light vehicle production worldwide increased by 25% in 2010. Several major automotive electronics suppliers exceeded that rate of growth, for example, Autoliv, with a 40% increase in sales, and Gentex, whose automotive sales shot up 52%. According to IHS Automotive, global light vehicle production is expected to rise 5.1% in 2011.

Autoliv

2010 Consolidated Sales: $7,170.6 million
Change from 2009: up 40%
2010 Net Margin: 8.3% of sales


Gentex

2010 Net Sales: $816.3 million, of which $797.1 million, or 98%, is automotive
Change from 2009: up 50%
2010 Net Margin: 16.9%, compared with 11.9% in 2009

Outlook for 2011: The company has not provided full year guidance, but said it expects first quarter 2011 revenue will increase 30% to 35% over Q1 of 2010.

Gentex's remarkable growth is due primarily to increased vehicle production and increased penetration of its main product, auto-dimming mirrors, into more models. A auto-dimming mirror shipments were up 46% over 2009, and Gentex's share of that market edged up another two percentage points to 85%. Toyota and GM each account for 15% of Gentex's sales; Volkswagen/Audi accounts for 13%.

Gentex adds value to its mirror assemblies with the integration of electronics such as a CMOS camera for its SmartBeam headlamp control feature and microphones, which Gentex supplies for Ford Sync and other telematics systems.

Sales of the company's Rear Camera Display (RCD) mirrors, which show the driver the view behind the vehicle when it is shifted into reverse, will grow as carmakers implement expected U.S. requirements to equip all vehicles with rear view cameras by September 2014. (NHTSA's final ruling on back-up cameras was due February 28, 2011, but has been delayed.) While the penetration of multifunction displays that could also be used to meet the rear view requirements continues to grow, Gentex believes it has a competitive solution, especially for the middle and lower segments of the market. In 2010, Gentex shipped 1.25 million RCD mirrors.

Harman International

FY 2010 Net Sales: $3,363.4 million
Change from 2009: up 17.8%

FY 2010 Net Profit: $164.1 million or 4.9% of sales, compared with a net loss in FY 2009 of $430.8 million
FY 2010 Automotive Sales: $2,468 million, up 23% from fiscal 2009
FY 2010 Automotive Operating Income: $88.1 million or 3.6% of automotive sales
FY 2011 Half Year Automotive Sales: $1,271 million, up 4.9% from the same period in fiscal 2010

Harman attributes its strong growth in FY 2010 automotive sales to a number of factors including increased mid-level infotainment business resulting from the launch of new platforms, the ramp-up of new infotainment business and overall vehicle production improvement.

For the first half of fiscal 2011, the six-month period ending December 31, 2010, Harman reported its fifth consecutive quarter of both top and bottom line growth. The Automotive Division’s revenue for the first half of FY 2011 was $1,271 million, 5% better than the same period in FY 2010. A automotive sales in the second quarter dropped 1%, mostly due to unfavorable currency rates and Harman’s exit from the PN D (personal navigation device) business, according to the company.

Harman announced in the second quarter of FY 2011 a new, $1.2 billion contract with Volkswagen Group to provide high-end infotainment systems to Bentley, Lamborghini, Seat, Skoda and Volkswagen vehicles.

Harman will supply head units for some of Toyota's new Entune connectivity platform. Harman’s units, featuring a six-inch display, will go in two mid-level classes of Entune later this year.

Outlook for FY 2011: 5% growth in Automotive Experience sales driven in part by new seating and interiors launches. Net margin is expected to increase to at least 4.5%.

A utomotive Experience has a backlog of $1.1 billion in net new incremental business for fiscal 2011. Seventy nine percent of Automotive Experience sales come from seating products. Interiors accounts for 15%, and electronics, 6%.

JCI Automotive Experience

Fiscal year ended September 30, 2010.
FY 2010 Net Sales: $16,610 million
Change from FY 2009: up 38.2%; sales for the first quarter of FY 2011 increased 11.7% compared with same period the prior year.
FY 2010 Net Margin: 3.6%; in FY 2009, Automotive Experience recorded a loss of $541 million.

Outlook for FY 2011: 5% growth in Automotive Experience sales driven in part by new seating and interiors launches. Net margin is expected to increase to at least 4.5%.

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JCI’s top three customers in 2010 were Ford, General Motors and Daimler. The company also prospered from the automotive industry's recovery and increased vehicle production: A utomotive Experience sales in North America were up 46%. In Europe they grew 28%, and growth in Asia was 66%. A sia now accounts for continued on page 3
Voice...

is sent. ... We think we have a system that maximizes the available technology for automation and from the user perspective feels like automation. In the background we've got that human capacity to understand context and dialect and slang. And the system learns. A s agents type things into the system the software learns what you meant so the automated recognition will improve over time.

Designed with the help of ATX's voice technology leader, Tom Schalk, the remarkable system knits agents together with speech recognizers resident in three different locations: the vehicle, the ATX call center and in a speech cloud hosted by N uance. “It’s cool to use. Gives me chills it’s so cool,” Dr. Schalk said. “I wouldn’t call it conversational but it certainly is simple and safe to use. ... We are getting impressive latencies, which is the time it takes to complete the interaction. If it takes 30 seconds, something is wrong,” he said.

Destination Entry

N uance equipment suppliers have been featuring embedded voice destination entry for at least five years. The feature defines the state of the art of automotive speech recognition. But for its Blue Link Guidance (navigation) package, Hyundai will instead use agent-assisted voice recognition for destination entry. “Our navigation penetration is high,” said M r. Ratzlaff. “In the vehicles where we offer it, it’s over 30%. Those systems have voice-enabled destination entry and point-of-interest search, but they are not as smooth and seamless as we’d like. A fter just a few days of playing with Blue Link, I greatly preferred using the agent-assisted destination download vs. the onboard voice recognition download. With Blue Link I have the ability to say anything and the system has a high probability of finding a match for it. It is quicker and safer than the step-by-step voice driven menu that’s in our embedded navigation, and the embedded one is state of the art.”

Roundup...

Continued from page 1

Continued from page 2

11% of total A utomotive Experience sales.

A t the 2011 Detroit Auto Show, JCI demonstrated its new Connected Center Stack concept, which could be ready for model year 2014 vehicles. The scalable infotainment and connectivity platform uses N okia’s Terminal M ode technology to display and control smartphone applications using the vehicle’s H MI.

<table>
<thead>
<tr>
<th>Global Light Vehicle Production by Region, 2010 and 2014</th>
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<tr>
<td><strong>Region</strong></td>
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<tr>
<td>Europe</td>
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<tr>
<td>China</td>
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<tr>
<td>Japan/Korea</td>
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<tr>
<td>No. America</td>
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<tr>
<td>South Asia</td>
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<tr>
<td>So. America</td>
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<tr>
<td>Mid East/Africa</td>
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<tr>
<td><strong>Total</strong></td>
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Data: IHS Automotive Global Production Summary; www.ihs.com

Lear Corp.

2010 N et Sales: $11,954.6 million

Change from 2009: up 22.7%. Lear was in bankruptcy for four months of 2009 and adopted “fresh start” accounting as of N ovember 7, 2009, so the historical financial statements of the predecessor company are not necessarily comparable to those of the successor company.

2010 N et Income: $438.3 million, or 3.7% of sales

O utlook for 2011: Lear expects sales in the range of $12.6 billion to $13.0 billion, which translates to growth in the range of 5% to 8.7%. N et income is forecast in the range of $500 million to $535 million.

Europe accounted for 42% of Lear’s 2010 sales; N orth A merica was 34%; A sia was 16%; R OW was 8%. Lear’s average content per vehicle in N orth A merica was $340; in Europe average content per vehicle was $285. G eneral M otors and Ford remain the company’s largest customers, followed by B M W. Lear attributes its sales growth primarily to increased global vehicle production. Sales in the Electric Power M anagement segment, which accounted for 21.4% of the total, grew 33% in 2010, to $2,599.3 million. Sales in the Seating segment increased 20%, to $9,395.3 million.

Lear’s sales backlog as of January 2011 was $2.2 billion, with $900 million of that for programs in 2011. Of that $900 million, roughly 22% is in Electrical Power M anagement products including wiring, terminals and connectors, smart junction boxes and electronic modules.

In addition to the primary growth drivers— higher global vehicle production and more demand for features and functions even in small cars— Lear sees opportunity in hybrid and electric vehicle systems and components. Its content per vehicle in those vehicles could be more than double what it is in gasoline vehicles. Lear offers high-power charging systems, high-power distribution systems including high-voltage wire harnesses, terminals and connectors, D C-D C con-
TRW Automotive

Background
TRW was created in 1958 with the merger of Thompson Products and Ramo-Woolridge Corporation, an early aerospace technology developer. TRW expanded its automotive business when it acquired Magna International’s steering wheel and airbag business in 1996, and three years later with the $7 billion purchase of LucasVarity plc. The company was acquired by Northrop Grumman in 2002. Northrop sold the automotive part of the business in 2003 to the Blackstone Group, a private equity firm. Blackstone took TRW Automotive public in an initial public offering in February 2004, and has since reduced its holdings in TRW Automotive to 16%.

Blackstone purchased TRW Automotive for $4.9 billion using only $868 million of its own funds; the rest it borrowed in the name of TRW Automotive. Highly leveraged, the company has been devoting much of its cash flow to debt repayment and to interest payments on its debt, spending about as much on interest as it has on R&D. Positive operating cash flow of $1.052 billion in 2010 has allowed the company to reduce its debt at year end to $1.8 billion, an improvement of $525 million compared with the prior year. In November 2010, Standard & Poor’s revised its outlook on TRW to positive from stable and affirmed its BB corporate rating, a non-investment-grade (junk) rating given to companies seen as vulnerable to adverse business, financial and economic conditions.

TRW counts all the world’s major carmakers among its OEM customers, who together account for 85% of sales. In 2010, approximately 78% of TRW sales originated outside the United States. The company operates 185 facilities in 26 countries. TRW is organized in four major business segments: Chassis Systems, Occupant Safety Systems, Electronics, and Automotive Components.

Focus on Safety
Sales of active and passive safety-related products account for 89% of TRW’s sales. In the Electronics business segment, 70% of third-party sales are safety electronics. Increasing penetration of occupant safety systems in more vehicle segments and the growth of vehicle sales in emerging markets are driving sales of TRW’s seatbelt and airbag systems, A BS, stability control and driver assistance products— and the electronics that go into those systems. Government mandates...
but also integrates third-party software. Based on Autosar, the scalable platform supervises all vehicle dynamics: braking, steering and suspensions.

Chassis Electronics totaled $373 million in sales, all accounted for as intersegment sales, primarily to the TRW braking and steering groups.

modules, which vary depending on the options chosen. TRW is the tier-one supplier and the systems integrator. Shipments of the new ECU will begin in 2013 for 2014 model year vehicles.

"Basically this is a controller that takes input from sensors such as yaw-rate, accelerometer, radar and camera and uses that information to manage the overall vehicle dynamics," said Martin Thoone, vice president of electronics engineering. "It is flexible, so you can add software packages from different sub-system suppliers. If the customer selects an advanced suspension system, we'll integrate the software from that supplier."

The OEMs can use standard braking and steering system parts across the platform to gain economies of scale, but simply by loading the ECU with different application software, they can modify system performance according to the optional features chosen by the end consumer.

While TRW could not say which features its first customer will implement, the integrated chassis platform could be used to support features such as lane departure, ACC, stop-and-go and emergency braking systems. Using additional data from a separate camera unit with traffic-sign recognition capability or from radar sensors, the chassis controller ECU could activate seatbelt pretensioners and pre-fill the braking system. "If you weren't slowing down for a stop sign, for example, the brakes could be applied automatically," noted Andy Wydell, senior manager of product planning for the global Electronics unit.

◆ Radar and Camera Sensors
TRW has been investing in radar sensor development since 1994, when it transferred some technology from an aerospace division that was part of the company at the time, but that effort was abandoned a year later. TRW got back into automotive radar development in 1998 when it acquired A utocruise, a 50-50 joint venture of LucasVarity and Thomson-CSF, based in Brest, France. TRW introduced its first radar adaptive cruise control system in 2002.

Likewise, TRW’s experience with camera sensors goes back at least to 2000, when the company started exploring CM O S cameras for use in front-seat passenger occupant sensing. It won a contract with a carmaker in 2006 to develop a camera-based lane-departure warning system. TRW has been supplying cameras to Fiat for the lane-keeping assist system on the Lancia Delta since 2008.

The market for camera and radar sensors has developed very slowly. Despite its pioneering efforts, TRW’s driver assist systems business, which is comprised mainly of radar and camera sensors, has grown to only about $40 million in sales in 2010.
But TRW’s persistence may finally start paying off. “The market for radar and cameras is exploding,” said M r. W hydell. “Two or three years ago we were bidding for business with volumes going from the low thousands up to maybe 20,000 per year. W e now have business awards and customer inquiries that run into the hundreds of thousands of sensors per year.”

W hat has changed? “For one thing,” said M r. W hydell, “the systems are more affordable. T he retail price of follow-to-stop ACC, something that would have cost $2,000 to $3,000 on a luxury car, is now down around $500. Follow-to-stop systems bring the vehicle to a complete stop when the vehicle ahead stops but don’t accelerate the vehicle again by themselves. A t $500, those systems don’t automatically detect pedestrians who walk into the gap between you and the vehicle in front. To do stop-and-go you’d need a camera or an additional radar sensor to handle the short-range pedestrian detection,” he explained.

A single camera can support multiple applications. “W e use one for lane departure warning but you can use the same camera for high/low beam control, for traffic-sign recognition, pedestrian recognition and, as mentioned earlier, for stop-and-go adaptive cruise control,” said M r. T hoone.

G overnment initiatives are also driving interest in cameras and radar. M r. W hydell: “W e’ve already got mandates in Europe for this advanced technology on commercial vehicles. In N orth America, there is a focus from NHTSA to promote the fitment of collision warning and lane departure warning systems through the NCAP rating system. T heir desire to achieve and maintain a high safety rating is really stimulating OEM’s interest in the technology.”

F or object- and pedestrian-recognition applications, TRW will purchase chipsets, vision processors and algorithms from the Israeli firm M obile Eye. “W e make the printed circuit board, housing and other componentry and tune the system for each application,” said M r. T hoone. “W e handle the mounting in the vehicle, we use heaters and airflow to deal with condensation on the windshield, and provide data fusion software when both camera and radar are used.” TRW makes its radar sensors in house.

A ccording to M r. W hydell, the long anticipated growth market for cameras and radar sensors has finally arrived. “T oday the fitment rate globally for radar and cameras is less than 2% of all light vehicles. By 2015, global fitment will rise to between 5% and 10%.” O ver the next five years TRW expects its $40 million driver assistance systems business, comprised chiefly of radar and camera sensors, to grow to $100 million in sales.

◆◆◆◆◆

OM OTHER SENSORS

A mong the sensors TRW produces its three biggest sellers by volume are crash sensors, inertial measurement units for electronic stability control systems and tire pressure monitoring sensors.

TRW makes in excess of 30 million remote crash sensors per year using M EM S (micro electromechanical systems) it purchases from semiconductor suppliers. TRW’s inertial measurement units and tire pressure monitors also use externally-supplied M EM S sensors.

TRW also produces occupant weight sensors used to determine if the front-seat passenger is large enough for safe deployment of the airbag. But demand for such sensors has ebbed with the availability of low-risk deployment airbags, which safely protect even small passengers without injury.

The company anticipates that a continued focus from governments and consumers on safety and fuel efficiency will drive demand for these TRW products: Stability control systems, Brake controls, Regenerative brake systems, Electric park brake, Electrically assisted power steering systems, Front, curtain, side and knee airbags, Front and side crash sensors, Vehicle rollover sensors, Tire pressure monitoring systems, Active cruise control systems, Lane keeping and lane departure warning systems.

Chassis Systems

Steering Gears and Systems
Electrically assisted power steering systems
Electrically powered hydraulic steering systems
Hydraulic power and manual rack and pinion steering gears
Hydraulic steering pumps
Fully integrated commercial steering systems
Commercial steering columns and pumps
Foundation Brakes
Front and rear disc brake calipers
Drum brake and drum-in-hat parking brake assemblies
Rottors
Drums
Electric park brake systems

Modules
Brake modules
Corner modules
Strut modules

Electronics
Front-cross member modules
Rear axle modules
Brake Controls
Four-wheel anti-lock braking systems
Electronic vehicle stability controls
Actuation boosters
Master cylinders
Electronically controlled actuation
Brake controls for regenerative braking (low volume)
Linkage and Suspension
Control arms
Suspension ball joints
Rack and pinion assemblies
Conventional linkages
Commercial steering linkages
Suspension ball joints

Occupant Safety Systems

Airbags
Driver airbag modules
Passenger airbag modules
Side airbag modules
Curtain airbag modules
Knee airbag modules
Single and dual-stage airbag inflators

Seat Belts
Retractor and buckle assemblies
Pretensioning systems
Height adjusters
Active control retractor systems

Steering Wheels
Full range of steering wheels from base designs to leather, wood and heated designs
Steering wheels with multifunction switches and integral airbag modules

The Hansen Report on Automotive Electronics, Portsmouth, NH USA www.hansenreport.com
Demand for pressure sensors to detect side impacts to the doors is picking up, however. Installed in the door cavity, pressure sensors are more sensitive than accelerometer crash sensors to so-called pole events, when a vehicle slides sideways into a tree or post. Without a pressure sensor, the driver’s side door could be breached and the driver injured before an accelerometer could detect the crash.

**Focus on Fuel Economy**

**Electrically Assisted Power Steering**

By eliminating the mechanical and hydraulic components required by conventional power steering systems, electrically powered steering (EPS) can reduce CO2 up to 3.5% and reduce fuel consumption by 0.4 liters per 100 kilometers. EPS systems consume less than 7% of the energy required by conventional hydraulic rack and pinion power steering systems, according to TRW.

TRW’s EPS products fall into two categories. Column drive systems, now in their third generation, are best suited to small car segment vehicles and low cost vehicle markets, according to Matt Roney, TRW vice president for product planning. Rack- or belt-driven EPS is applicable to larger, heavier C-, D- or E-segment vehicles, including pickups and SUVs, where more power is required. "Our belt drive EPS is a big driver of growth for us because it is a high value system," Mr. Roney said. "The technology there is continually pushing the limits of the power capability of the system. We can go up to a kilowatt in terms of power output."

**Advances in Braking**

Now in its fifth generation, TRW’s electric park brake is available to OEMs for roughly one-third the cost it was five years ago, and so is finding its way into a larger segment of the market. A pioneer in the motor-on-caliper parking brake, TRW has been investing in developing TRW’s Major Competitors by Product

<table>
<thead>
<tr>
<th>Chassis Systems</th>
<th>Continental</th>
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<tbody>
<tr>
<td>ADVICS</td>
<td>Denso</td>
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<tr>
<td>Bosch</td>
<td>Automotive</td>
</tr>
<tr>
<td>Continental</td>
<td>Components</td>
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<tr>
<td>JTEKT</td>
<td>Delphi</td>
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<td>ZF</td>
<td>Eaton</td>
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<tr>
<td>Occupant Safety</td>
<td>ITW</td>
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<tr>
<td>Autoliv</td>
<td>Kostal</td>
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<td>Takata</td>
<td>Nifco</td>
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<td>Electronics</td>
<td>Raymond</td>
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<tr>
<td>Autoliv</td>
<td>Tokai Rika</td>
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<tr>
<td>Bosch</td>
<td>Valeo</td>
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With its modular and scalable rack drive EPS, TRW believes it has overcome the major challenges of bringing the technology to heavy vehicles. "You want the maximum assist, which requires more power output from the motor. At 12 volts you run into limitations—how much current is available, the form factor, fitting the motor in the vehicle, and being able to dissipate the heat," Mr. Roney explained. "We’ve optimized the layout of the circuit board, the substrate, the packaging. Essentially a steering actuator, EPS enables other features like lane keeping assist and automatic parking.

**Investing in R&D**

Well directed investments in R&D lead to sales and profit growth when sales based on new technology kick in several years later. Since 2003 when the private equity firm Blackstone purchased TRW Automotive, the company’s investments in pure R&D have declined at an annual rate of 3%. In the short term, this approach can have a positive impact on profit margins and lead to gains as Blackstone cashes out its equity participation in the company. The dollars invested in research, development and engineering, however, increased consistently until 2007 and have declined since then. Compared to some of the firms TRW competes against, TRW’s investment in R&D as a percentage of sales is one of the lowest.

<table>
<thead>
<tr>
<th>Industry Comparison of 2010</th>
<th>RD&amp;E Percentage of Sales</th>
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<tbody>
<tr>
<td>Bosch Automotive Technology</td>
<td>13.0%*</td>
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<tr>
<td>Delphi</td>
<td>9.4%</td>
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<tr>
<td>Denso</td>
<td>9.1%</td>
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<tr>
<td>Continental Automotive</td>
<td>7.7%**</td>
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<tr>
<td>Valeo</td>
<td>5.6%***</td>
</tr>
<tr>
<td>Autoliv</td>
<td>5.0%</td>
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<tr>
<td>TRW</td>
<td>4.7%</td>
</tr>
<tr>
<td>Takata</td>
<td>4.0%**</td>
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*For 2009 and includes development work charged to customers. Long term average is about 10%.
**Includes application engineering, not manufacturing, quality or other engineering.
***Includes all product related engineering.

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<thead>
<tr>
<th>TRW Automotive Research, Development and Engineering Costs and Percent of Sales, by Year</th>
<th>RD&amp;E in $ millions</th>
<th>RD&amp;E % of Sales</th>
<th>RD&amp;E % in $ millions</th>
<th>RD&amp;E % of Sales</th>
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<tbody>
<tr>
<td>2003</td>
<td>164</td>
<td>1.5%</td>
<td>600</td>
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<td>2004</td>
<td>174</td>
<td>1.5%</td>
<td>714</td>
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<td>2005</td>
<td>170</td>
<td>1.3%</td>
<td>780</td>
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<td>2006</td>
<td>168</td>
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<td>2007</td>
<td>187</td>
<td>1.3%</td>
<td>893</td>
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<td>2008</td>
<td>179</td>
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<td>2009</td>
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<td>653</td>
<td>5.6%</td>
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<tr>
<td>2010</td>
<td>132</td>
<td>0.9%</td>
<td>669</td>
<td>4.7%</td>
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Copper...

harnesses is replacing the copper conductor with a conductor made entirely or partially from aluminum. A luminous cables are 40% lighter than their copper equivalents, and most significantly, today raw aluminum is one-fourth the price of raw copper. But aluminum is not a perfect replacement. It is not as good a conductor as copper, so aluminum cables must be 1.6 times larger in cross section to maintain the same resistance, so they take up more precious space in the vehicle. And since aluminum is more reactive than copper, simple crimp connections between wire and terminal will not suffice.

Because aluminum corrodes and the resultant aluminum oxide is not a conductor, and because aluminum isn’t as malleable as copper, the terminals at each end of aluminum wiring must be made of brass or copper. The thermal expansion of copper and aluminum are different, so crimp connections between the two materials can loosen, and since they are dissimilar metals they are also subject to galvanic corrosion. So the terminals for aluminum wires must be specially designed and they must be properly sealed against moisture and salt.

Faced with these challenges and the related development costs of the terminals, carmakers and suppliers are focusing on the largest cables, starting with the battery cable, where the effort required to replace copper wiring with aluminum is having the greatest impact. “If copper prices keep going up, in the next five years all cars will have aluminum battery cables,” said Martin Gloesslein, CEO of Leoni’s North American operations. “We have been in production for many years with aluminum battery cables, beginning with the German luxury carmakers. We have a flexible version with aluminum strands and we also have a bus-bar solution.”

A pioneer in aluminum cable, terminal and battery clamp development, Ato Kabel has seen its production of aluminum cable increase each year by 15%. “We have been working with aluminum cable for ten years,” said M. Schloms, manager of systems integration and R&D for Ato Kabel. “Our friction welding [of terminals] is very robust. So far we’ve supplied 12 million cables to the field with no failures.” Ato Kabel has been producing aluminum wiring for Volkswagen/Audi and BMW since 2001, and starting in 2011, for Ford, GM and a Japanese carmaker.

According to Mr. Schloms, at the price of copper today it makes good economic sense to replace all copper wiring with cross sections of 10 mm² or greater with 17 mm² aluminum, as long as the wire is at least 800 mm long. That would include not just the battery cable but also the starter cable and the ground cables. Two things have made that economically feasible, M. Schloms explained: ”Ato Kabel has developed a new ultrasonic welding connection technology which everybody can use because it is not patented. Plus, we have our new Bimetal Terminal, which can have a galvanic coating. One end of the terminal is made of brass or copper, for bolting to the vehicle. The other end of the terminal is made out of aluminum so it can be ultrasonically welded to the aluminum wire.”

Toyota, which has been experimenting with aluminum sub-harnesses in some of its production vehicles for a while, has installed an aluminum harness in each of the four doors of the new 2011 Verso-S (Ractis in Japan), a small MPV. Those harnesses are being produced by Sumitomo Wiring Systems. Yazaki also makes aluminum harnesses for the Japanese carmaker. Acorning to Toyota, the aluminum harness on the Verso-S is currently more expensive than the copper harness it replaces.

Delphi Packard’s Chris Burns sees a bright future for aluminum: “While today almost all wires are made from copper, in five years 20% to 40%, by weight, could be aluminum. You wouldn’t use aluminum in an airbag or other safety circuits. But if copper keeps going the way we think it is, if it goes to $5 per pound, you will see a lot more wire get converted. In 2020 as we get more electric and hybrid vehicles and vehicle mass gets even more critical, you will see 70% to 80% of the weight of the harnesses will be aluminum.”

Voice...

Link Guidance option also provides point-of-interest searches by voice using agent-assisted voice recognition.

A automated voice recognition is probably adequate for texting from a quiet room but doing it from a vehicle is not possible today. I downloaded Nuvance’s Dragon Dictation application onto my iPad and it does a pretty good job of getting almost everything I say. It was more effective when I spoke within a few inches of the microphone, which isn’t possible using an embedded hands-free application in the vehicle. Hyundai’s microphone is located in the headliner above the driver’s head.

“...In the vehicle you have road and wind noise, people talking, and that is very hard to filter out. In three or four years it may be possible to do voice recognition with less help from the agents,” said M. Ratzlaff.

ATX’s Dr. Schalk, who has worked in speech for over 30 years, was less optimistic about the potential of fully automated voice recognition technology. “My own personal belief is there is so much variation in the audio that comes into the off-board [voice recognition] system, variations from people speaking, or there may be kids in the car, maybe the window is down, someone may have a strong accent that is difficult to understand. There could be a point-of-interest or restaurant names that are not obvious how to pronounce. Those are huge problems that may never be overcome.”

Still, Mr. Weil says Nuance is in the process of bringing a Dragon Dictation-like product to the automotive market next year as a connected service. “Besides the challenges of the noisy environment, we have the additional user interface challenge of developing an eyes-free, voice-driven correction interface. Carmakers across the globe are all looking for that,” he said.