

Automotive Engineering International Presents

# SHOW DAILY



## New SAE President will build on the basics

Capping off what has already been a busy week, Dr. S. M. Shahed, Vice President – Advanced Technology at **Garrett Engine Boosting Systems**, will officially begin his year as SAE President tomorrow at the Board of Directors meeting.

Shahed brings an emissions background and a strong focus on what he calls the “basics” to the SAE presidency. Those basics amount to core engineering practices and principles that have shaped his career from its beginnings as an engineering professor at the University of California at Berkeley. Shahed then spent 18 years at Columbus, IN-based **Cummins, Inc.**, where his early projects included detailed mathematical modeling and analysis of nitric oxide formation and



**S. M. Shahed**

particulate emissions from diesel engines (from which the quantification of the benefits of charge air-cooling and exhaust gas recirculation would lead to a Horning Memorial

*Continued on page 4*



This Lotus Elise is equipped with an MTS (Booths 1011 and 1211) Spinning Wheel Integrated Force Transducer (SWIFT) Ultra 20 on the front driver-side wheel. The unit is from a family of data-acquisition systems from the company that employs technology that radically reduces the time and expense of traditional vehicle instrumentation techniques. Engineered for small and high-performance cars, the SWIFT 20 features optional telemetry for data acquisition without the need for slip rings and anti-rotate devices.

## SAE and MIA sign MOU

The Motorsports Industry Association (MIA), a trade group based in the UK, and SAE International have signed a Memorandum of Understanding (MOU) to collaborate on education and engineering activities in the motorsports community. Both organizations share a common interest in promoting engineering education and inspiring students to become the next-generation of mobility professionals.

“Education is a critical pillar in sustaining growth in motorsports programs worldwide,” said Jeremy Burne, Director of MIA’s North American Operations.

The SAE Foundation and Education Relations Board have established successful programs with the SAE Collegiate Design Series and the A World In Motion program, which is geared toward students in grades 4-6. MIA has enlisted support for the Education Council International, including participation by universities, as part of its efforts.

*Continued on page 3*

## NASCAR driver and 3-D movie at NAC

SAE 2002 exhibit attendees are waiting in long lines to see a 3-D movie playing at the U.S. Army TACOM **National Automotive Center (NAC)** main exhibit (Booth 1429) called *Sim3D—A Virtual Army Adventure*. The film highlights improved modeling and simulation techniques the U.S. Army is employing to develop weapon systems that will meet the challenges of its Objective Force initiative.

According to NAC, the challenges faced by future U.S. fighting forces include the need for reliable protection for soldiers in the field as well as state-of-the-art technologies that can effectively assist in the completion of missions and confront advanced opposition forces. To build support for this initiative, the movie draws parallels to war-game simulations that have long been used by the military to prepare for combat. It also shows how virtual prototyping can shorten product-development life cycles while ensuring that all stakeholders have input in designing vehicles for the battlefield.

The NAC is also highlighting its partnerships with **PTC** and **E.M.P.**, both of which were involved in the making of *Sim3D*. PTC’s Windchill, a Web-based data management tool, and Pro-E (Pro-Engineer), a 3-D animator, were used in the film’s creation. They are also used in real-life Army design reviews, for which teams of engineers, trainers, and soldiers

*Continued on page 3*



**E.M.P.’s display within the NAC exhibit features an electric air pump integrated into a racecar helmet to keep the driver cool. Brian Vickers, the driver of E.M.P.’s racecar, will be on hand today to talk about the helmet technology.**

## The future for hybrids

Niche or mass market, that is the question panelists focused on in a Wednesday morning session on hybrid-electric vehicles (HEV). “The answer is mass market,” Masatami Takimoto, Member of the Board, **Toyota Motor Corp.**, said bluntly. “Hybrids have enormous potential to become mass-market [vehicles].”

Other members of the Executive Panel concurred. Benjamin Knight, VP, **Honda R&D Americas**, presented the Civic Hybrid, which is scheduled for release this spring, as evidence that incorporating gasoline-electric technology into a high-volume, mainstream vehicle is viable. The five-passenger sedan incorporates Honda’s Integrated Motor Assist (IMA) technology that was used in the Insight, and its powertrain achieves 30% greater torque than the Civic’s conventional IC engine.

*Continued on page 3*

## Today's Congress Highlights

- Digital Car Conference Interactive Technology Sessions—Michigan Hall, 8:00 a.m.-4:30 p.m.
- The Diesel Engine of Tomorrow Executive Panel—Room O2-33, 9:00-11:00 a.m.
- National Science Foundation Environmentally Benign Manufacturing Panel—Room D0-03AB, 9:00 a.m.-12:00 p.m.
- Air Force Dual Use Science & Technology Program—Room D2-09/10, 9:00 a.m.-5:00 p.m.
- Foresight Vehicle Technology—Room W2-64, 9:00 a.m.-5:00 p.m.
- Standardized Approach to Supply Chain Product Development—Room M2-30, 10:30 a.m.-12:00 p.m.
- Consumer Electronics Gateway: Open Platform to Success—Room O2-33, 1:00-5:00 p.m.
- Annual Banquet—Riverview Ballroom, 7:00-9:00 p.m.

The future for hybrids ...continued from page 1



SAE 2002 host company Ford (Booth 2127) is exhibiting a Focus-based THINK fuel-cell vehicle, a 2003 Ford Expedition, and this Ford Escape hybrid electric vehicle (HEV). When the Escape HEV goes on sale in 2003, Ford says it will be the most fuel-efficient SUV. It will deliver nearly 40 mpg (less than 6 L/100 km) in city driving and achieve certification under CA's super-ultra-low emission vehicle (SULEV) and partial zero emission vehicle (PZEV) levels. It also will meet Stage IV requirements in Europe before they become mandatory in the 2005 model year. The four-cylinder hybrid is designed to provide similar acceleration and functionality as its 149-kW (200-hp) V6 cousin. Four-wheel drive will be available, and the HEV will have ground clearance and cargo capacity comparable to conventional Escapes.

Likewise, Ford Motor Co.'s Prabhakar Patil, Chief Engineer of the Ford Escape HEV program, said that hybrid technology is the first credible alternative to the IC engine and discussed the automaker's Escape HEV sport utility vehicle that will debut in 2003. Capable of being driven over 805 km (500 mi) before refueling, it will have a 50-55% fuel-economy improvement over the regular Escape, which has a V6 gasoline engine. In response to a comment that better fuel economy may not be a strong selling feature to U.S. consumers, Patil said, "If fuel economy translates into dollars, then [U.S.] consumers will be interested.... There is a growing [environmental] consciousness...where as long as [consumers] don't have to give up performance and quality," they'll be willing to do a little more for the environment by purchasing a hybrid vehicle.

Patil also believes that in North America, HEVs will be more successful than diesels because getting diesels to SULEV levels will be too costly. Conversely, Takimoto said that Toyota is currently developing clean diesel technologies and believes there may be a case for clean diesels over hybrid-gasoline vehicles in the future. He also brought up the possibility of a vehicle

incorporating diesel-electric technology.

Hybrid-electric technologies are key building blocks applicable to hydrogen fuel-cell vehicles, said Robert Kirk, Director, Office of Advanced Automotive Technologies, U.S. Dept. of Energy. Ford's Patil agreed, saying, "Hybrids are not contrary to fuel-cell development...and are a necessary precondition for fuel-cell advancements. They (hybrids and fuel cells) are on converging paths." Jason Mark, Director of the Clean Vehicles Program, Union of Concerned Scientists, noted that HEVs are also enhancing conventional vehicles; hybrids are becoming technological leaders since some of their advanced technologies, including packaging and weight-savings advancements, are being applied to IC-engine vehicles.

As might be expected, the panelists mentioned cost reduction as the key issue to be solved to ensure mass-market penetration. Toyota's Takimoto, for one, believes time will allow cost to be driven down with an eventual increase in mass production and competition.

John Wallace, Executive Director of Ford's The Th!nk Group, organized and moderated the panel session.  
Ryan Gehm

## 42-V global standardization panel

A group of automotive experts convened Wednesday to discuss the global harmonization of 42-V standards. The panel was moderated by Norman Traub, Director of SAE 42-V Initiatives. Panelists included Tatsuo Teratani, 42-V Project Manager for Toyota and Chairman of the newly formed 42-V Working Group in JSAE; Wolfgang Bremer from Robert Bosch GmbH; and Anson Lee from DaimlerChrysler, current Chairman of the United States Council for Automotive Research (USCAR) 42-V Working Group.

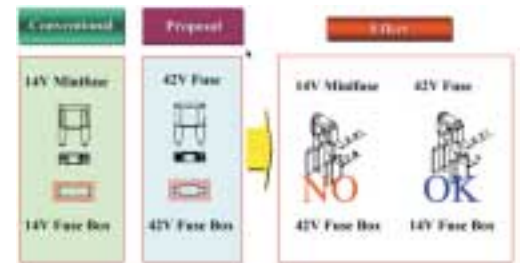
Vehicle manufacturers are faced with the challenge of providing more electrical power to offer more fuel-efficient and safer vehicles with additional customer features. A higher voltage system has been the focus of a MIT/Industry Consortium, as well as the Forum Bordnetz in Europe. All are in agreement that global cooperation and standardization will be needed.

Teratani led off the discussion with a short preview of the Crown, a THS-M 42-V mild-hybrid vehicle that is now in production in Japan. Toyota's third hybrid car features a 42-V power system consisting of about 20 different components, including compressor, engine, starter, electromagnetic clutch, motor/generator, inverter, dc/dc converter, electronic control unit, 12-V battery, and 36-V valve-regulated lead-acid battery.

Bremer continued the discussion with an overview of the International Standards Organization (ISO) 21848 standard development. Part 2 of the standard applies to electric/electronic systems/components for an automotive 42-V network and describes the potential stress requirements as well as the necessary testing. The committee's draft of the standard is due to be completed by the end of 2002, with a draft of an international standard finished by the middle of 2003 and development of the final version expected by the end of 2003.

Also involved in 42-V standard activities is USCAR. The group is charged with furthering current efforts to address the fundamental challenges and conversion priorities regarding the transition to 42-V systems. The organization is also looking to get the automotive industry to agree on common interfaces and performance standards to reduce cost, improve quality, and optimize the conversion to 42-V architectures. Four subgroups—battery terminal, jump-start, arcing, and regulations—have been formed to achieve this mission.

Traub concluded standardization discussions with an overview of SAE's activities regarding 42-V systems, including a 42-V advisory committee, a 42-V interior and exterior lighting cooperative research project, a U.S. technical advisory group, a 42-V professional development program, and a 42-V battery connection task force. SAE is hosting a 42-V professional development seminar via an interactive telephone/Webcast on March 22. For further information regarding SAE's 42-V activities, visit [www.sae.org/42volt](http://www.sae.org/42volt).  
Frank Bokulich



Japan has proposed a new 42-V minifuse standard that employs a polyamide material in place of standard polyethyl sulfur material as well as a cording with side ribless structure.

## NASCAR driver ...continued from page 1

are involved in remote discussions about product designs. The Windchill portion of Sim3D demonstrates how team members in various locations can collaborate on the design process via an online project management tool. The Pro-E segment highlights the capabilities for designing 3-D simulations that enable stakeholders to interact with virtual prototypes in order to test form and function.

E.M.P.'s display features its electric air pump integrated into a racecar helmet to keep the driver cool. The pump also pushes air through a vehicle's braking system to cool hot brakes. This technology also could work well in a soldier's helmet and on the braking system of a military vehicle, especially for desert missions. E.M.P. is developing robust products for automotive racing that could easily be used in the military environment. Brian Vickers, the driver of E.M.P.'s racecar, will be on hand today to talk about the helmet technology.

At the NAC's other display (Booth 926) in the Test Group area, three technologies have been brought together that make the military environment safer and more efficient: Ford IMPACT, BRTW5, and Automation Alley. The IMPACT program focuses on applying efficient, high-strength lightweight technologies to a high-volume truck platform—resulting in cost and time savings for the military and a stronger, safer vehicle for the soldier. BRTW5's design system of screws supports a lighter, faster, and more efficient fighting force. The Uni-Screw allows a single drive to be used for all sizes of screws, from 2 to 12 mm (0.08 to 0.5 in), avoiding tool changes and cutting tool costs and assembly/maintenance time. Automation Alley is a dynamic consortium of business, educational institutions, and government leaders dedicated to attracting world-class employment talent and strengthening the economic base in Southeast Michigan.  
Kevin Jost



SAE 2002 attendees are forming long lines at the U.S. Army TACOM National Automotive Center (NAC) exhibit to see a 3-D movie called Sim3D—A Virtual Army Adventure.

## Editorial staff

Automotive Engineering International editorial staff for the Show Daily can be reached during show hours at Booth 1000 or by calling (313) 393-4324.

Kevin Jost,  
Editor  
[kevin@sae.org](mailto:kevin@sae.org)

Frank Bokulich,  
Associate Editor  
[bokulich@sae.org](mailto:bokulich@sae.org)

Jean L. Broge,  
Associate Editor  
[jbroge@sae.org](mailto:jbroge@sae.org)

Patrick Ponticel,  
Assistant Editor  
[ponticel@sae.org](mailto:ponticel@sae.org)

Jenny R. Hessler,  
Assistant Editor  
[jhessler@sae.org](mailto:jhessler@sae.org)

Ryan Gehm,  
Assistant Editor  
[rgehms@sae.org](mailto:rgehms@sae.org)

Kami Buchholz,  
Detroit Editor

Linda Trego,  
Correspondent

Wayne Silvonik,  
Production Manager

Christian Bonicky  
Katie Korol  
Bill Schall  
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*SAE and MIA ...continued from page 1*

## Trends in mobility technology

An emerging trends report covering three distinct mobility industries—passenger car, air transportation, and heavy-duty vehicles—reveals that information technologies, wireless communications, materials, flexible manufacturing, and virtual reality tools will play vital roles for each industry in the next few years.

The report, which summarizes challenges and technology options, focused on three themes: global design and build, eco- and user-friendly products, and personalization. Information gleaned from participants involved in Wednesday's fifth Mobility Technology Planning Forum (MTPF) will be passed to a number of entities, including the SAE Board of Directors.

A comprehensive written report is expected in March. Oral presentations like the one given on Wednesday also will occur at the International Truck & Bus Meeting and Exhibition at Cobo Center in November.

Kami Buchholz

SAE President Neil Schilke acknowledged the role of motorsports within the engineering community. "Along with the excitement that it provides, motorsports is a proving ground and candy store for vehicle engineering," he said. "This affiliation between MIA and SAE greatly expands our opportunities in bringing together the engineering community."

The two organizations are set to coordinate activities at the Performance Industry Show, which will be held in Indianapolis in December 2002.

Frank Bokulich



**For the first time, attendees of the SAE 2002 World Congress were asked to vote for their favorite exhibit in four categories based on size. Ballots and ballot boxes were available at the entrances to the exhibition, and votes were collected from Monday at 10:00 a.m. through Tuesday at noon. Winners were Olin Brass, Booth 2950 (200 ft<sup>2</sup> and under); dSPACE, Booth 2601 (300-1050 ft<sup>2</sup>); Denso, Booth 2101 (1100-2550 ft<sup>2</sup>); and American Axle & Manufacturing, Booth 1801 (2600 ft<sup>2</sup> and greater).**

*New SAE President ...continued from page 1*

Award-winning SAE paper and current use in diesel engine emissions control).

Following his stretch at Cummins, Shahed spent the next seven years at the **Southwest Research Institute** (SwRI) in San Antonio, TX, doing contract research and development for all major engine/vehicle OEMs on diesel and gasoline engine emissions control technology development. His position brought him as a consultant to all of the main automotive OEMs and suppliers in the U.S., Europe, and Asia and provided him with worldwide industry perspective.

Shahed began his current stint six years ago at Garrett Engine Boosting Systems, a business unit of **Honeywell, Inc.** in Southern California. There his responsibilities include the development of advanced air management systems for boosting diesel and gasoline engine performance, fuel economy, and emissions control.

Every new SAE President comes to the job with specific goals in mind, and Shahed is no exception. He refers to his own focus for the organization in three parts. First, he wants other young engineers to gain from the society as he has by ensuring that SAE continues to provide learning opportunities and

experiences to younger and prospective members. Second, Shahed makes the point that mobility technology as well as the benefits and other side effects of that technology know no geographic boundaries, so therefore, SAE should not know any geographic boundaries. "SAE should be a global organization with a global impact, and at the same time provide member services locally," he said, so that will be a key focus of his term.

Finally, Shahed notes that mobility technology is changing very rapidly. Now, "because automobiles as well as other mobility devices have so much brain power," Shahed feels SAE must broaden its scope to attract electronics and software professionals. With so much fast-advancing technological innovation, "I want to make sure that SAE stays the first port of call for all mobility technology, covering all knowledge—software, electronics—as well as old-fashioned metal bending," he said.

Shahed admits that his presidential focus will extend well beyond these three items because this year, the entire Board membership is joining in and championing various focus areas. "We can expect a lot of progress in 2002," he said.

Jenny R. Hessler

# AEI Tech 2002 Awards

Each day, AEI Show Daily editors highlight some of the top products and technologies on display at the SAE 2002 World Congress.

## Emissions control

Emissions legislation calls for a dramatic decrease of the emissions of heavy-duty diesel engines, especially NOx. The SINOx system from **Siemens Ceramics** and **Hydraulik-Ring GmbH** (a Siemens company) represents the technology to reduce NOx and HC emissions by approximately 80%, and PM emissions by 20-40%, thereby fulfilling the expected European NOx emissions requirements of 2008 even with today's engine technology and calibration. The companies combine their expertise to provide the major components of the SINOx system: the SCR catalyst, catalyst housing, urea dosing control unit, and SCR system electronic unit with control logic software.



Booth 2929

## Optical sensor

The Correvit HS-CE optical sensor system from **Corrsys-Datron Sensor-systems, Inc.** simultaneously measures roll angle, pitch angle, longitudinal speed or vectoral velocity, transverse speed, and drift angle. The sensor is the first measurement device to incorporate the Correvit pupil-splitting technology that allows measurement of movement in three axes with a single optical path. This capability provides increased accuracy, a measurement field diameter of 30 mm (1.2 in), and a local resolution of up to 0.5 mm (0.02 in).



Booth 942

## Exhaust gas aftertreatment

**AVL List GmbH** has developed heavy-duty diesel engines complying with Euro 4 emissions legislation without the use of particulate traps or DeNOx catalysts. The technology builds on advanced fuel-injection equipment combined with AVL's combustion knowledge and holistic development approach. A dynamically controlled EGR system is applied. An Oxicat is added to compensate for production tolerances affecting the lube-oil control. Test results show a 20% margin to the legislated emissions limits. On-road fuel consumption is similar to current Euro 3 compliant engines. The technology is also applicable to off-road engines to meet Tier 3 requirements.



Booth 1001

## Pyrotechnic activator

To help prevent serious neck injuries during a typical rear impact, **Hirtenberger**



**Automotive Safety** has developed a pyrotechnic activator for crash-active headrests. In the case of a rear impact, the device moves the headrest toward the occupant's head in less than 20 ms. Due to the quick and reliable reaction achieved by using pyrotechnics and sensors, the system presents a significant improvement in comparison to conventional systems. The system also is easily reloadable and, therefore, cost competitive. By launching the system in the new BMW 7 Series, the company is the first supplier of a pyrotechnic anti-whiplash system.

Booth 2413



### Simulation table

A high-frequency multi-axial simulation table from **MTS Systems Corp.** features a hexapod with six extensible servo-hydraulic struts. It provides repeatable, high-frequency, six-degree-of-freedom simulation of the operating environment of automotive systems and components. Engineered to be stiff, the system delivers frequency content in excess of 250 Hz, giving it unique potential in both durability and noise and vibration testing. It offers sinusoidal testing, including sine sweep and sine dwell, and time history reproduction using MTS' Remote Parameter Control software. To ensure accuracy, controllability, and repeatability over a broad frequency range, the system uses displacement, velocity, and acceleration feedback in conjunction with a three variable control algorithm.

Booths 1011 and 1211



### Limited slip differential

The Super LSD (limited slip differential) from **Tochigi Fuji Sangyo KK** includes a core clutch developed to work well with the strut suspension found in front-wheel-drive vehicles. The unit also works well in the front axle of four-wheel-drive off-road vehicles. Compared to other torque-sensing LSDs, the super LSD has a lower torque bias ratio (1.5-2.0), which fits well with front suspension systems. Production costs are lower because of similarities to open differentials, and the device can be lubricated with standard differential fluid or ATF. The system can easily replace open differentials because it uses many of the same components and features identical installation points. The device provides good handling and control as well as a cost reduction.

Booth 1757



### Clutching a hybrid powertrain

The ever-increasing demand for higher fuel economy of cars and trucks continues to fuel research and development of hybrid propulsion systems. Several types of hybrid-electric vehicles have been developed at **Ford Research Laboratory**, some of which were presented yesterday during the Transmission & Driveline Systems Symposium.

Among the parallel hybrid systems with a single electric motor, two types were studied. In the first type, the electric motor was attached directly to the crankshaft (mild hybrid) to enable the engine start-stop and regeneration functions. In the second type (full hybrid), the electric motor was connected to the engine via a clutch to allow electric launch of the vehicle and pure electric driving at low speeds.

Researchers at Ford, **LuK Inc.**, and **Adapco, Ltd** developed a full hybrid powertrain that uses a more-powerful electric motor for enhanced regenerative braking and engine power assist. An engine-disconnecting clutch saves energy during both the electric propulsion and during vehicle braking. When the clutch is disengaged, the engine is shut off, eliminating the energy otherwise spent on motoring the engine during electric propulsion. Similarly, during vehicle braking, the energy that otherwise is

wasted on motoring the engine is collected in the battery.

The hybrid powertrain consists of a 2-L gasoline engine, a converterless transmission, and a SA/clutch assembly. The engine clutch (packaged inside the rotor) allows the engine to be disconnected from the rotor, thus enabling electric propulsion, regenerative braking, and other hybrid functions without wasting energy on motoring the engine.

The space available inside the transmission bell housing in the absence of the torque converter was not sufficient to package the electric motor, clutch, damper, and the clutch release mechanism. An additional length had to be added to the powertrain length to fit all of the components. A dry clutch mounted inside the rotor, powered by a **Valeo** auto-clutch hydraulic actuator, enabled disconnecting the engine from the rest of the driveline. The concentric slave cylinder was designed by the FTE Automotive Division of **Dana Corp.**

The engine torque is first transmitted from the end of the crankshaft to the clutch housing.



*According to researchers from Ford, LuK, and Adapco, an engine-disconnecting clutch saves energy during both electric propulsion and vehicle braking.*

The clutch housing drives three pressure plates through the splines cut at the inside diameter of the clutch housing and the outside diameter of the pressure plates. Two dry-friction discs, squeezed between three pressure plates, transfer torque through another splined connection to the drive plates of the damper. The drive plates are rigidly connected to the transmission-side bearing bracket, which is attached to the rotor. The damper springs are downstream of the rotor and between the drive plates and the damper hub. The damper hub drives the transmission input shaft through the splines. The driveline clutch is inside the automatic transmission.

Engineers performed a design analysis, which included a dynamic analysis of bearing loads for the crankshaft, starter-alternator, and transmission-input shaft. The rotor radial deflections, amplified by a "flywheel whirl" effect as well as clutch thermal loading, were also accounted for. Finite element models were used to analyze the dynamic variation of the rotor gap, as it is affected by the crankshaft bending and the clutch engagement heat.

When the rotor is supported by ball bearings on each side, the maximum deflection of the centerline of the rotor is only 4 μmm (157 μin). This variation is small enough to ensure absence of the rotor "whirl" and the durability of the crankshaft. However, a lower-cost non-bearing design may also be possible, if the number of splined connections and their tolerances are reduced.

The engine-disconnecting clutch has a much easier job of cranking the engine compared to a driveline clutch that pulls the vehicle. Thus, even when the clutch is located inside the rotor, the heat transfer for the chosen clutch design is insignificant.

Linda Trego

## What's New from the exhibitors



The SAE 2002 World Congress provides industry suppliers the opportunity to showcase their products, services, and technologies to the global automotive community. Show Daily editors review what some exhibiting companies are displaying this year.

### AMT systems

Hydraulik-Ring's hydraulic automated manual transmission (AMT) systems are appropriate for light trucks and cars and are used



in the 3.0-L Volkswagen Lupo and the Audi A2. The advantage of an electrohydraulic system is the high-performance capability in puncto power, space, and weight requirements of hydraulics. AMT systems increase vehicle lifetime through optimized gear changes, reduced fuel consumption and emissions, and greater driving comfort. Together with electronics and software, the firm offers its customers development of the entire system.

Booth 3138

### Strain testing

The VHS8800 Series of high-rate servohydraulic test systems from Instron Corp. encompasses a wide range of machines, high-performance actuator options, and test fixtures with dynamic load capacities ranging from 25 to 100 kN (5620 to 22,480 lb) and velocities up to 25 m/s (82 ft/s). They are combined with specialized measurement transducers and a high-speed data-acquisition package controlled by Instron's FastTrack 8800 controller and VHS software. Systems are contained by a protective enclosure and interlocked with the control system to ensure operator safety. The test systems can configure VHS8800 systems around specific test requirements, considering the specimens/components to be tested. Non-ambient tests can be conducted by combining specially configured environmental chambers with a range of test fixtures.

Booth 635

### Modeling and simulation

The **U.S. Army TACOM National Automotive Center (NAC)** features *Sim3D – A Virtual Army Adventure*, a 3-D movie that highlights improved modeling and simulation techniques employed by the U.S. Army for developing new weapons systems that will ultimately meet the challenges of the Objective Force. The challenges faced by future fighting forces include the need for reliable protection of soldiers on the field and state-of-the-art technologies that can effectively assist in the completion of missions and

confront advanced opposition forces. The movie shows how virtual prototyping can shorten the development lifecycle while ensuring that additional stakeholders have input in designing vehicles that will eventually be on the battlefield. The NAC will also highlight its partnerships with PTC and E.M.P., who were involved in the making of *Sim3D*.  
Booth 926

### Steering systems

**Koyo Seiko** has developed numerous types of steering systems for improved vehicle safety, driving stability and pleasure, and energy conservation. Its electric power steering systems



include the column-assist type with the power-assist unit, controller, and torque sensor attached to the steering column. The system is compact and easy to mount on the vehicle. The pinion-assist type has a power-assist unit attached to the steering gear's pinion shaft; the unit is outside the vehicle's passenger compartment, allowing assist torque to be increased without raising interior noise. Combined with a variable-ratio steering gear, the system can suffice with a compact motor and offers enhanced handling characteristics. The rack-assist type has the power-assist unit attached to the steering gear rack; the unit can be located freely on the rack, allowing flexibility in layout design. The company also offers hydraulic-electric power steering. Microcomputer control of the electric motor driving the pump allows the system to achieve energy savings. The motor, pump, reservoir, and controller comprise a single unit, making installation easy and nearly eliminating the need for tubing adjustments after attachment.  
Booth 2151

### Rubber lubricant

**International Products Corp.**'s P-80 temporary rubber lubricant has a second version, P-80 THIX, that extends its range of applications. The new lubricant is more viscous than the standard version, which allows it to remain where applied without dripping, puddling, or running. P-80 lubricants aid the attachment/insertion of rubber/soft-plastic parts where there is a tight fit. They provide a water-based emulsive film that temporarily makes rubber surfaces slippery. Once a part is installed, the film disappears, allowing the rubber surface to return to its normal non-slip condition. P-80 lubricants contain no silicones or petroleum distillates, and thus will not dry out or harm rubber, and leave no residue.  
Booth 1183

## Water-based coating

**Metal Coatings International's** Geomet water-based, chrome-free coating extends the life of steel automotive components such as fasteners, stampings, springs, rotors, brake components,



and fuel-filler tubes. Extensive tests conducted on the coating include salt spray, cyclic tests (SAE J2334, GM 9540P, Ford APGE), and proving grounds, in addition to many assembly-plant trials. For fastener applications, GEOMET offers a thin film, consistent coefficient of friction, bimetallic compatibility, and solvent resistance, and is applied in a process that does not induce hydrogen embrittlement. Various lubricity levels and colors are available.

Booth 1363

## Air-quality sensor

**Paragon AG's** MK IV air-quality sensor reduces the amount of pollution carried into the vehicle cabin through the HVAC system,



providing health benefits to drivers and occupants of motor vehicles. The sensor, located near the outside air inlet, sends a signal to close the outside air door whenever the vehicle enters a high pollution area. Other versions are available with shortened reaction time, the ability to be adjusted on the air-conditioning control unit, a LIN interface, an automatic adjustment during several operating cycles and for city traffic, and the ability to recognize the smell of skunks and switch to circulating air.

Booth 3141

## Gasoline/diesel study

Despite public and private efforts to develop new sources of automotive power, advanced forms of fossil-fueled spark-ignition and diesel engines will continue to dominate the market through 2020, according to a joint study by consulting firm **Arthur D. Little** and industry consultants at **DRI•WEFA**. The forecast for the continued reliance on fossil-fuel power for automobiles considers advances in fuel-cell research such as the Bush administration's

announcement supporting the development of fuel cells through its Freedom CAR initiative. However, advances in gasoline and diesel engine technology will increase fuel efficiency and keep the powertrains competitive for 20 years or more. The study, "Future Powertrain Technologies: 2008 to 2020," was developed for major component suppliers, OEMs, and policy makers. Booth 1857

### Machine vision

#### M&R Automation

GmbH provides customer-specific, comprehensive solutions for assembly lines, production and test machines, and production logistics.

To improve industrial machine vision, the company collaborated with **Alicona Imaging**

GmbH, a competence

center for 3-D analysis, enabling solutions that combine special camera systems, software, component handling, and further data processing.

Benefits include integrated systems for handling of components, proven automation, and reliable data processing; project conception, realization, setup, and support; and up-to-date technologies such as digital cameras, special illuminations, and fast, robust algorithms.

Booth 2413



### Test stand drive

**Unico**, Inc.'s all-digital 2400 Performance Vector Drive incorporates software designed



for operating transmission, engine, and component test stands as well as engine, emissions, and chassis dynamometers. A velocity observer determines motor speed and acceleration with or without a motor transducer. A torque estimator eliminates the need for expensive and mechanically complicated torque-measuring devices. It uses motor torque, motor characteristics, and machine data that can be translated into the torque that would be measured by an inline torque transducer.

Booth 2828

### Test station

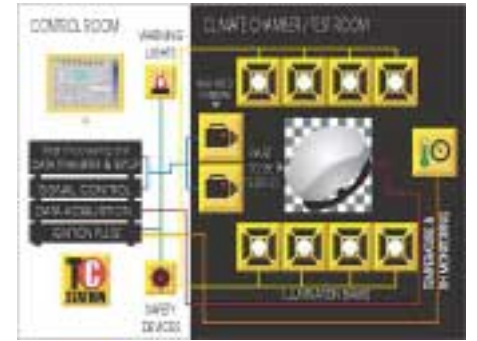
The TC Station Ensemble from **Soluciones**

**Tecnologicas SA de CV** is an all-in-one modular

solution for diverse testing of airbag, pretensioner, inflator, squib, and seating/interior systems. The system's dual-ignition pulse unit allows the user to select voltage (0-50 V) or current (0-10 A) pulse as

well as pulse duration from 0.1 to 100 ms in 0.1 ms increments. Besides its 12-bit test data acquisition, visual information is obtained by firing one or several high-speed digital cameras through user-programmed pulse types and pulse delay combinations for testing flexibility. The automatic control of the test environment ensures high safety for test personnel. The system also has powerful capabilities to satisfy long-term and high-volume archiving needs of measured data and imaging. Modular architecture allows for easy expandability for future needs.

Booth 1018



### Signal lighting

**Sound Off**, Inc.'s commercial-vehicle LED

lighting products use an innovative reflector cell technology to direct light to the desired location. Reflector cell LED lighting allows for greater 180° light displacement and output than other LED lights on the market, says Sound Off. The company manufactures a wide array of LED stop/tail/turn, warning, and interior lights.

Booth 1481



### Aluminum anodizing

The **Aluminum Anodizers Council** is a trade association of firms engaged in aluminum anodizing. Strong and lightweight, aluminum is a natural material for automotive applications because of its durability, recyclability, formability, and versatility obtained through surface treatment. Anodizing yields a deep, rich metallic luster and is available in a complete range of gloss and color alternatives. Typically, it is available at a lower initial cost than competing finishes and offers low maintenance costs as well as enhanced resistance to abrasion.

Booth 1672

### Measuring microphone

**A-DAT** introduces the 6.35-mm (0.25-in) Electret-Measuring Microphone M360 from Microtech Gefell, which has Class 1 performance and is suitable for single and array positioning typical of automotive acoustic analysis. It is designed to meet the standards of advanced multi-channel measuring. Key features include frequency range of 20 Hz-20 kHz free

field, sound pressure level of 35-130 dB, sensitivity of 12.5 mV/Pa, 2-10 mA current consumption, low mass, and wide operating temperature range.  
Booth 535



### Cold impact extrusion

**Piper Impact** applies the cold impact extrusion process to produce engineered metal components. The process uses mechanical or hydraulic presses



to overcome the compressive yield strength of the raw material and literally "flow" the material through an orifice or fill a cavity in a die. Directions of material flow can be forward (through a die cavity or orifice), backward (around the punch), and lateral (horizontal flow). High reductions in surface area and long extrusions are possible due to the compressive nature of the process vs. tensile forming found in deep drawing. High mechanical properties, close tolerances, and good surface finishes are possible due to deformation at room temperature. Materials commonly impacted include aluminum, steel, copper, brass, and magnesium; other alloys such as stainless steel and titanium are impactable under special circumstances. Common applications include automotive airbag canisters, cartridge cases, high-pressure cylinders, yokes, air-conditioner receiver/dryer cans, shock housings, fluid reservoirs, and pistons.

Booth 1381

### Wiring analysis

AutoSteve software from **FirstEarth** integrates with the SaberSketch design tool from the **Avant!** Corp. The Volkswagen Electronics Research Group is the first customer of the release. The tool enables interactive analysis of electrical wiring schematics and provides automated support for electrical design failure-mode and -effects analysis and sneak-circuit analysis. The software simulates all possible activity of electrical schematics in minutes and automatically generates textual FMEA and SCA reports.  
Booth 1379

## Digital controller

The FlexTest SE digital controller from **MTS Systems Corp.** can be used with or without computer supervision for automotive component testing applications. The unit can be used for running cyclic, block-cycle, and monotonic tests. Multiple controllers can be linked to run multi-channel tests, and controllers can be connected to a PC for simulation testing. The system has direct-access menu keys and a multi-color graphic display to support easy test setup and operation. A built-in scope with



multiple colors for signal traces enables observation of signals while setting up and running tests. Meters allow users to display real-time, calibrated measurements as digital readouts, in volts, or as engineering units of their choice.  
Booth 1011 and 1211

## Data-flow management

**Delmia's** Product, Process, and Resources Hub (DS-PPR Hub) provides a way to store and distribute data to process-engineering and systems-design teams. Linking the Hub to Product Data Management ensures that the manufacturing engineering team is always working with the latest data, without having to wait for data transfers or prints. Using the software, the team looks at the company's best practice process. Since the Hub is shared between central and plant engineering, the team knows that the database is current, and no in-plant studies are required. With the information, several manufacturing concepts can be studied.  
Booth 1837

## Motion capture

The Vicon 624 from **Vicon Motion Systems** is an accurate, robust optical motion capture system that supports up to 24 of the firm's million-pixel resolution MCam cameras. It can be set up and calibrated quickly and easily to



capture the motion data of a subject outfitted with unobtrusive, lightweight reflective markers. The data can be applied to digital humans through various interfaces to analyze human interaction factors. A capture subject can be fully immersed in a virtual environment when the unit is combined with a head-mounted display to enable interaction with a CAD model of a vehicle or environment to access safety, design, and ergonomic concerns in real time.  
Booth 1701

## Sealant recovery

**Ultraseal's** recycling sealant offers benefits including enhanced sealing as well as temperature and chemical resistance; good washability; reduced processing costs with



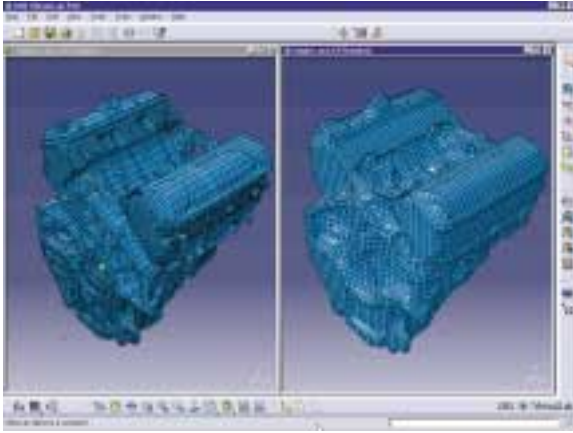
sealant consumption down as much as 90%; reduced water consumption; and reduced stock holding of consumables, transport, and storage. The recycling sealant and the sealant recovery system (SRS) work together to provide a fully automatic process that requires little or no attention. The sealant, being hydrophobic and having a specific gravity less than water, tends to migrate toward the water's surface. A weir box collects the water from the surface of the cold wash tank, and the sealant-rich solution is pumped to the SRS. The SRS receives the solution from the wash tank, filters it to remove any solid contaminants, and separates the sealant from the water. The recovered sealant is collected in a discharge pot that, when full, automatically returns the sealant back to the autoclave. The clean wash water from this process, now devoid of sealant, is then returned to the wash tank.  
Booth 439

### Virtual prototyping

LMS International's LMS

Virtual.Lab software suite for virtual prototyping is an integrated environment for the functional performance engineering of critical design attributes such as noise and vibration, ride and handling, comfort, safety, and durability. Fully associative, it automatically links to leading CAD and CAE tools, captures the process flow to better manage the analysis sequence, and enables engineers to refine their designs not only at the component level, but also at the subassembly and full system levels. By eliminating unnecessary file transfers as well as model and data redundancies, and by automating the analysis process, LMS Virtual.Lab increases value-added engineering time.

Booth 1241



### Virtual vehicle

A new system test simulator from dSPACE enables simultaneous testing of engine, transmission, and vehicle stability systems' electronic controllers. The Virtual Vehicle is a "hardware-in-the-loop" network for testing prototype or close-to-production electronic



control units (ECU), their functionality, and the interaction of several ECUs at the same time. Due to the increasing number and complexity of ECUs in today's vehicles, automated tests of interconnected ECUs are an important step in the development of automotive electronics. The Virtual Vehicle demonstrates how, for example, an engine simulator and a chassis simulator can run independently or be linked together, increasing flexibility and facilitating parallel development until the customer is ready to test the ECUs in a network.

Booth 2601

### Portable CMM

The Orbital 8-axis portable CMM from Axila Inc. can measure a 6-m (20-ft) part within 0.15 mm (0.0059 in) standard deviation, directly on the shop floor. Since the device uses the lightweight CMM Arm 100, it provides a local accuracy under 0.07 mm (0.0028



in) in a 2.4 m (7.9 ft) volume. Measurement applications include large assembly fixtures, large foundry parts, large sheet metal parts, and entire cars. The device can also measure small parts up to 2.5 m (8 ft) with a 0.07 standard deviation. G-Pad geometric software is included.

Booth 1853

### Sensors

INZI Controls develops and manufactures various automotive sensors, switches, and actuators for most automotive systems. Engine-



management-system components include fuel pressure regulators, fuel pulsation dampers, knock sensors, purge control valves, dual sensors, water-temperature sensors, and air-temperature sensors. Cooling system components include thermostats, thermo switches, radiator fan switches, and water-temperature sensors and controls. Engineering plastics applications include thermostat housings, cooling water tanks, fuel rails, air cleaner assemblies, cylinder head covers, and air cleaner integrated head covers.

Booth 2820

### Multi-channel temperature measurement

Through an agreement with AFT Atlas Fahrzeugtechnik GmbH, Corrsys-Datron Sensorsystems is introducing the DMes multi-channel CAN-bus temperature measurement system in the North American market. The system enables the decentralized preparation of elements to be tested, saving instrumentation time and resulting in longer testing periods for the vehicle. With the system, it is also possible to measure different elements in the same vehicle during a single test-drive, reducing testing costs. The same hardware can be used for mobile and test-bench operation, further reducing costs and cable



wastage. The system consists of the DMes networking module and individual DMes thermo-couple modules, which collect temperature measurements and forward the data to the DMes network module.

Booth 942

### Dynamic signal analyzer

Enhanced hardware for Dactron Inc.'s Photon Dynamic Signal Analyzer uses 24-bit inputs and provides sampling at rates up to 96,000 samples/s. The analyzer weighs less than 230 g (8 oz), is enclosed in a shock-resistant case, and is powered from a notebook computer's USB port. It comes with two input channels, a waveform source, and a built-in tachometer. Users can reduce test measurement time by expanding to four simultaneously sampled inputs. A built-in DSP processor powers a 21-kHz real-time rate for tri-spectrum measurements with four inputs active. The 32-bit floating-point computations in the DSP processor provide high accuracy for all spectral calculations.



Booth 2765

### Impact test evaluation

TNO Automotive R&D evaluated the 3-D kinematics of a Hybrid III dummy during oblique impact tests by using high-speed video cameras and the FalCon extra Mov3D analysis software. 3-D photogrammetric reconstruction requires that each target in the object space be recorded simultaneously by at least two cameras. Engineers installed the cameras at an angle of 25° looking in the direction of sled motion. Custom targets had to be developed, allowing large out-of-plane rotations and automatic tracking with high accuracy. For the 3-D analysis, the FalCon Mov3D could automatically track all unknown points in the stereoscopic views. 3-D point coordinates were calculated via resection in space. Despite the low video resolution and the motion in the line of view, the measurements are highly reproducible and very accurate.



Booth 729

### Music recognition

**Gracenote's** music-recognition service for consumer electronics has been incorporated into various car audio products, including those from manufacturers Pioneer and SONICblue. The CDDB Music Recognition Service automatically identifies CDs and allows car audio devices to name, store, and categorize their customers' music files intelligently. It can also provide a safety benefit: music identification combined with voice-recognition technology enables car audio manufacturers to create voice-controlled interfaces for hands-free music playback.  
Booth 5520

### Permeability analyzers

**GTR Tec Corp.** manufactures gas, vapor-transmission, and liquid-permeability analyzers based on gas chromatography. The permeated gas is separated by column to components and measured simultaneously. For the differential pressure method, the cell's supply side is pressed or kept at atmospheric pressure for the gas sample. To moisten the sample side, test gas is used for bubbling. A PV cell supplies liquid to produce a pressure difference for sensitive measurement. Measurements are performed for

single or mixed gases, water vapor permeation, H<sub>2</sub>/O<sub>2</sub> transmission in a moistened room, transmission of organic solvents or gasoline by PV cell, and VOC vapor transmission using a vapor-generating T cell. For the equal pressure measurement method, both cell rooms are moistened with vapor produced by bubbling. Test gas is used for the supply side, and carrier gas is used for the permeation side; the H<sub>2</sub> or O<sub>2</sub> permeated amount in the moistened room is then measured.  
Booth 2570

### Onboard dynamometer

**Land & Sea's** DYNOMite onboard (rotary torque transducer) dynamometers provide the ability to measure actual torque and horsepower on almost any rotating



shaft assembly. Equipping a driveline with the computerized wireless transducers allows on-the-road monitoring, recording, and printing of true engine output. The measurements flow directly from the output shaft mounted strain gauge for true engine crankshaft torque. It reports the same readings as an engine dynamometer cell. Built-in Smart Record allows collecting racetrack runs without needing a passenger to activate the unit manually. Combining the device with the DYNO-MAX 2000 enhances the testing capabilities to include exhaust back pressure losses, fuel starvation issues, ram-air efficiency, transmission drag, and traction.  
Booth 2429

### Wire harness system

The Capital Harness System (CHS) from **Mentor Graphics Corp.** aids in the design, engineering, and manufacture of electrical wire harnesses. The CHS family addresses the issues facing the automotive industry, providing a



complete flow of tools to handle the complexity more efficiently. Built on a component-based data model and electrical database, the CHS facilitates information-sharing through the entire supply chain. Capital Manufacture is a set of software tools that enables the design and engineering of wire harnesses for manufacture. It supports complex wire-harness configurations, including options, variants, and modules. Capital Factory facilitates the fabrication and production of complex wire harnesses. Capital Formboard, the first product in the suite, automates the creation of wire harness formboard drawings, onto which the wire harness is assembled.  
Booth 452

### Occupant sensing

**NEC Technologies Inc.** was awarded a GM contract for its Seat Sentry Occupant Sensing System, an advanced airbag static suppression system. The system measures a person's mass to determine whether a child, baby, or small adult is present in a seat. The information is used to appropriately deploy the airbag in case of a crash. The system meets NHTSA's recently mandated requirements for smarter airbag systems that will not harm



children. The technology was first introduced on Honda vehicles for side-airbag systems in MY2000; GM will introduce the system on some MY2004 vehicles.  
Booth 1229

### Tire reinforcement

Beltec fiber from **Honeywell** is a tire reinforcement designed to enhance the performance of tires with cap plies. Use of the fiber results in a high-performing tire that is more durable and secure, with better handling and less flat spotting. The reinforcement features new adhesion technology that provides advanced dimensional stability. The technology features high modulus and low shrinkage, as well as improved adhesion to rubber.  
Booth 2500

### Brazing paste

**Lucas-Milhaupt, Inc.** is approved as a certified supplier of brazing pastes to manufacturers using the CuproBraz process. By blending the



CuproBraz brazing alloy (Cu, P, Sn, Ni) with proprietary binder systems, the firm has developed several products designed for use with the CuproBraz process. The process facilitates the production of strong, efficient, and environmentally friendly copper and brass radiators. Under the name Cupro-Flo, the firm offers a proprietary series of materials suitable for all the joint configurations commonly found in heat transfer equipment. Formulations for tube-to-header and tube-to-fin joints are available using low melting alloys that produce high-strength, leak-free joints.  
Booth 2057

## Hygienic reel

**Nederman**, Inc.'s Series 886 stainless-steel hygienic reel was designed for industries with heavy demands for easy cleaning and corrosive resistance. Its design with stainless materials and smooth and sloping surfaces helps achieve those characteristics. The spring assembly has optimum balance for ease of use when pulling out or retracting the hose. Two ball bearings offer a minimum of friction during drum rotation. All vital moving parts are sealed off in the drum with fluids conducted through a stainless-steel swivel. Booth 501



## Lighting simulation

**Optis** develops and markets 3-D CAD-compatible SPEOS software for the simulation of head-, tail-, and sidelights, instrument clusters, mirrors, and LED-based switches. Photometric and colorimetric analysis are made easy due to the user-friendly man-machine interface; the user can export geometric files directly from CATIA, Solidworks, Pro-Engineer, Unigraphics, and other CAD tools. Capable of photo-realistic rendering, the software

shows the lit and unlit results of the simulated lighting part, including shadows and reflections. It also models the optical characteristics of each source, material, and surface used in the development of a product, and includes libraries of the most common. The Lighting Scenery module allows users to simulate automotive lighting in varying weather conditions: rain, fog, or bright sunlight. Booth 2075

## High-speed camera

**Photron**'s FASTCAM-X 1280 PCI is a mega-pixel high-speed camera system designed to operate inside a personal computer. Using a CMOS sensor with a 1280 x 1024 array, the unit provides high image



quality at speeds up to 16,000 frames/s from a single PCI card that easily fits in most PCs. The CMOS sensor technology eliminates the problem of blooming, where a bright light within the scene can "bleed" over to neighboring pixels, causing the image to look "torn" or obliterated. An electronic global shutter, with exposure rates as low as 7.8 ms, ensures sharp, crisp images, regardless of the speed of the event to record. Data can be exported to a spreadsheet to plot graphs showing the tracked point's velocity and displacement. Booth 718

## Gunn diodes

Gunn diodes are semiconductor frequency sources that are suited for adaptive cruise control systems. **Marconi Applied Technologies'** Gunn diodes are positioned in the radar sensor oscillator to transmit the 77-GHz signal to detect objects ahead of the vehicle. A graded gap structure is used for enhanced performance. Features of the diodes include 50 mW of power at 77 GHz, good frequency stability against temperature, low phase noise, low AM and FM noise characteristics, and operability across a wide range of temperatures including cold start turn-on. Benefits include high reliability, high efficiency, and consistent manufacturing process. Booth 1838

## DI diesel piston

The high ignition pressure and specific output of modern direct-injection (DI) diesel engines create a combination of mechanical and thermal loads where pistons with a conventional cooling duct may easily reach their limits. **Mahle** has developed a new piston concept with the cooling duct in an optimized position. On pistons with a cooled ring carrier, the cooling duct is formed by a steel plate welded directly onto the carrier. Cooling of the piston areas subject to a high thermal load (the first groove and the perimeter around the cavity) helps to increase the acceptable load limits and give pistons a longer running life. Comparative finite-element calculations on passenger-car DI diesel pistons with cooled ring carriers and salt core cooling ducts have shown that the technology reduces the temperature at the bottom of the first groove by about 50°C (122°F). Booth 2113

## Hydrophobic membrane

Versapor R membrane from **Pall OEM Specialty Materials** provides practical economic solutions for various automotive applications. It is a modified acrylic copolymer cast on a



nonwoven nylon support. The membrane is FluoRepel treated for enhanced oleophobic/hydrophobic properties. Applications for the media include antilock brake systems, fuel tank pressure sensors, transducer protectors, electronic black boxes, electronic motors, and lighting assemblies. The membrane is compatible with a wide range of chemical solvents and sealing methods. It has good handling properties and can be sterilized by gamma irradiation or EtO, and it passes all USP class VI testing for bio-safety. Booth 2713

## Electron beam processing

**IBA Advanced Materials** Div. performs electron beam (EB) processing of polymer materials for automotive applications. EB processing has typically been used to enhance the properties of wire and cable, heat-shrinkable tubing and connectors, heat-shrinkable films, hot water piping, tire components, and PTFE micropowders. With the increasing use of plastics in automobiles and the increase in property requirements, EB processing is solving automotive materials problems such as high-temperature wiring, formed polymer components, tire components, interior panels, seals and gaskets, fuel-system components, adhesive-bonded parts, and composite filament/tape-wound parts, RTM components, and body panels. Booth 2472

## Next generation pursuits

Two future products—one relying on an optical device and the other relying on radio frequency-based technology—highlight the wares on display by Novi, MI-based electronics supplier **Omron Automotive Electronics, Inc.** (Booth 2801). Omron's passive entry system, a next-generation version of remote keyless entry that Omron has produced since the 1980s, allows

vehicle entry without actually depressing a key fob or putting a key in a door lock.

As the driver carrying the transponder approaches the vehicle, a two-way radio signal prepares the door to open. "When the driver touches the door handle, the car door automatically unlocks. The key part of the technology is how the door handle 'senses' it's being

touched," said Jerry Bricker, Vice President & General Sales Manager for Omron.

At the Omron exhibit, show-goers can experience passive entry by using a key fob to unlock a door. The system is also illustrated by a graphical display.

The company will also feature new cruise control technology at its booth. Omron's laser radar-based adaptive cruise control, targeted for a 2005 MY vehicle application, is a next-generation iteration of a current co-developed product serving as optional equipment on select 2002 MY vehicles. "It's less than half the size of the current product, so it's easier to package.



**Omron's passive entry uses a radio frequency-based key fob to unlock a vehicle's door.**

This next generation product will be self-aiming technology," said Bricker. A key enabler for the product is the system's internal optics. Kami Buchholz

## Hybrid front-end systems

Engineers at **Dow Automotive** have developed a new manufacturing approach to hybrid front-end systems, which will be presented by Padraig Naughton, Jan Roettger, and Bill Bowser at a technical session being held today at 3:00 p.m. in Room D2-08. Front-end carriers are the part of a vehicle that supports most of the cooling package, headlights, latch, and other minor components. It also ties the upper and lower longitudinal rails together, playing a role in the structural stiffness of the car.



**Engineers at Dow Automotive have developed a new manufacturing approach to hybrid front-end systems.**

Traditional front-end carriers are assembled from steel, bolted or welded to the body-in-white. In recent years, however, there has been a trend toward mounting the complete front-end system, as a module, to the body-in-white with an open structure. The carrier assembly then connects the longitudinal rails. This modular assembly technique allows for reductions in cost, moves part of the assembly away from the vehicle assembly plant, and often improves overall quality.

The move to modular systems opened the door to the use of plastics. Use of molded carriers allows integration of parts and functions, weight reductions, and cost advantages. However, in most cases, a hybrid structure of metal and plastic still is required to resist the high loads exerted on the carrier.

The approach to building a hybrid system started with the use of glass-mat technology carriers that contained metal parts riveted to the plastic structure. Technical advances have improved the plastic carrier economics and the options for integration and weight reduction. Development of the overmolding process allowed even better coupling of the plastic and metal, while introducing added challenges.

Dow Automotive's new manufacturing approach involves bonding the metal parts to the plastic. Through resourceful design of the plastic and metal parts, a continuous joint between the plastic and metal has been achieved, including a closed box section not possible with overmolding. Where stiffness and strength are critical, this continuous joint and closed box section deliver a flexible, efficient approach to achieving maximum benefit from the hybrid system.

For this concept system, stiffness is increased by 30-100%, depending on temperature, from the addition of the closed box section. The proposed system can meet or exceed common vehicle manufacturer requirements for vibration, hood slam, and latch pull at various temperature and environmental conditions. Mass was reduced by almost 20%.

John Fobian

## The future for diesel engines

The diesel engine has been a hot topic this week. On Monday it served as the theme of the Blue Ribbon Panel, "Environmental & Regulatory Policy: The Role of the Modern Diesel." It continues to be discussed today at 9:00 a.m. during the Diesel Engine of Tomorrow Executive Panel in Room O2-33, organized by Kevin F. Brown, **Engine Control Systems, Ltd.**, and moderated by Rodney J. Tabaczynski, **Ford Motor Co.**

Diesel engines have been developed to new levels of sophistication, resulting in higher power levels, improved durability, and expanded use in automotive applications, though for a variety of reasons, a diesel-engine passenger car is much more likely to be driven by someone in Europe than by someone in the U.S. In fact, more than 30% of passenger cars in Europe are diesel, while diesels count for less than 1% in the U.S. Two major reasons for the discrepancy include less expensive diesel fuel in Europe (from \$1-2 /gal compared to gasoline) and stricter emissions standards in the U.S.

The executive panel today will touch on some of the easy issues as well as tackle some of the harder ones, such as how the diesel engine will address the future needs of the automotive industry, environmental regulations, and a more demanding consumer. During the panel, industry experts will summarize the current state of diesel engine development and the possible advances needed to meet these challenges.

Panelists scheduled to discuss the diesel engine's attributes, regulations, technologies, and competition include Wolfgang Groth, Director, Environmental & Engineering Office, **Volkswagen** of America; Bernd Bohr, Member, Board of Directors, **Bosch** GmbH; Tim Johnson, Manager, Emerging Technologies & Regulations, **Corning Inc.**; David Foster, Director, Engine Research Center, **University of Wisconsin-Madison**; and Consultant Michael Walsh.

Jean L. Broge

## Shipping Available

United Parcel Service will be available to ship bookstore purchases and other materials from the SAE 2002 World Congress. Ground service, air, and international service is offered. UPS is located across from the SAE Bookstore.

## Company Modulation of EGR for DI diesels

As researchers from **Valeo Engine Cooling Spain** and **Universidad Politecnica de Valencia** will emphasize today beginning at 9:30 a.m. in Room W2-68, exhaust gas recirculation (EGR) systems are widely used in automotive direct-injection automotive diesel engines. Thermal efficiency of these systems has been carefully chosen for optimum emissions levels in European test cycles. Cooled EGR effectively reduces the raw emissions of NOx without a specific consumption penalty.



**Tests have proved that an EGR cooler installed on an engine can reduce HC and CO emissions.**

However, other emissions may be increased with cooled EGR since ignition time increases, leading to more premixed combustion and combustion noise.

EGR cooler efficiency is chosen to counterbalance NOx with hydrocarbon (HC) and carbon monoxide (CO) emissions during the whole emissions certification cycle. Therefore, this total optimization leads to overcooling or undercooling of the EGR flow at certain periods compared with point-by-point optimum values. A modulated EGR cooler permits optimum EGR temperature during individual cycle modes. Temperature-modulated EGR also accelerates engine warm-up, reduces catalyst light-off time, and improves particulate trap regeneration.

The researchers report on a prototype dual-efficiency EGR cooler with the same external dimensions as a previous passive EGR cooler, while modulating recirculated gas temperature through integrated high- and low-efficiency circuits. This prototype has been tested for pressure losses, thermal efficiency, and on-engine behavior.

The information obtained in the steady flow test rig was used to modify the EGR cooler model. Predicted and measured data in different engine operation points were then compared, showing good correlation.

The EGR cooler prototype was tested in four steady operating points in the critical EGR control zone of load and speed of a 2.2-L direct-injection diesel engine. At high engine speed, benefits in HC and CO emissions were achieved when undercooling and counterbalanced by an increase in NOx. At low

load and engine speed and resultant low engine temperatures, HC and CO were reduced, keeping NOx emissions nearly constant.

In warm-up tests, useful reductions in HC and CO emissions can be achieved if EGR flow is not cooled. In addition, when the engine temperature is still low, NOx formation is not critical. Warm-up time also decreases when the low-efficiency cooling circuit is used.

The proposed EGR cooler prototype with the appropriate efficiency circuit at each mode can reduce HC and CO emissions in the certification test. With faster warm-up, catalyst light-off time and regeneration of the particulate filter improve.

John Fobian

## Simulating diffuse interior light

In a modern luxury vehicle, the driver expects an ergonomic and attractive interior. In daylight conditions, attractive styling, high-quality materials, and excellent fit and finish are predominant, while at night the illumination of the interior becomes significant to the appeal of the vehicle. Therefore, Andreas Reich and Mathias Hahn of **Audi AG** have begun investigating new methods for the development of interior lighting schemes. Highlights of their study were presented yesterday.

The diffuse illumination of the interior usually provides the driver with the necessary orientation. However, it should not distract from attention needed to control the vehicle. Essential features of interior lighting require that the size, location, and orientation of lamps be determined for direct illumination of primary surfaces and only indirect lighting of the remaining areas. The objective is to eliminate unwanted, distracting scattered light. Intensity of the indirect illumination is strongly influenced by the quality of the reflecting surfaces, and these characteristics must be considered in the design.

The lighting details cannot be completed early in the interior design process because the evolution of interior hardware and surface continues to change. Therefore, interior lighting design becomes an iterative process as the overall interior development approaches completion.



**Diffuse lighting simulation is being used by Audi to enable early lighting studies to be performed in the absence of a physical mockup.**

An optimal procedure calculates light distribution on the various surfaces in the interior while also simulating it for night driving. After immediate analysis, the results can be refined as the design evolves.

The radiosity method of analyzing light distribution can handle large amounts of data, which is common in the investigation of vehicle interiors. Emphasis is given to the influence of modifications on the quality of the results. Finally, the simulation results will be used in a virtual reality scene.

The radiosity method enables a qualitative study of interior lighting in an early phase of the development process without building up a physical mockup. The better defined the details of the geometry, lamps, and materials, the better the results will be of a radiosity

simulation. However, lighting in the car interior usually is assessed in a subjective way since a completely technical presentation of radiosity results generates no benefit in the development process.

By using virtual reality with its excellent man-machine interface, engineers can experience the results of changes in the interior of the car. Moving independently in the car, they can examine the light effects and the impressions created from them.

Since modifications in geometry, material, or lighting can be integrated quickly in the computation model, many iterations can be performed while remaining within time and cost constraints.

John Fobian

## World's largest automotive bookstore

The SAE Bookstore at the SAE 2002 World Congress continues to grow and expand its topic selection to better meet the needs of automotive engineers and professionals. With nearly 11,000 ft<sup>2</sup> of space, the SAE Bookstore is packed with automotive engineering-related products, including new books, technical papers, and CD-ROMs.

The SAE Bookstore features over 300 titles onsite, covering all automotive areas. More than 1300 technical papers are available for purchase. In addition, 50 new Special Publication (SP) books, four of which are available for the first time on CD-ROM, are being featured.

Located in the Cobo Lobby across from Macomb Hall, the SAE Bookstore is open from 8 a.m. to 6 p.m.

## Controlling 4-wheel steering for an SUV

As sport utility vehicles (SUVs) and light-duty trucks have gained in popularity, demand for more car-like behavior has increased. Two areas for potential improvement are vehicle stability and maneuverability. According to **General Motors**, four-wheel steering (4WS) can be an effective solution to stability and low-speed maneuverability. GM engineers Tokihiko Akita, Katsuhiko Satoh, Aisin Seiki, and Michael Gaunt will provide a brief glimpse of this solution today at 2:00 p.m. in Room D0-03C/D.

Vehicle stability of SUVs is more difficult to achieve than for passenger cars due to higher center of gravity, vehicle weight, and higher payload capacity. Trailer towing also can affect stability. Rear-wheel steering systems, particularly 4WS with vehicle motion state feedback control, are effective countermeasures for high disturbances, such as vehicle weight transfer and cross winds.

SUVs are less maneuverable when parking because of their long wheelbase. Therefore, 4WS can be an effective solution for maneuverability by reducing turning circle of the vehicle. However, when the rear tires are steered at large angles in negative phase relative to the front tires, the vehicle's rear edge is largely overhung compared with a normal vehicle. To resolve this concern, a swing-out reduction control algorithm that bases the rear



**A GMC Yukon XL is equipped with 4WS.**

steering angle on the front edge trajectory has been developed.

To avoid introducing the driver to a significantly different vehicle dynamics characteristic than that of a conventional vehicle, a control design method that can theoretically calculate the control algorithm based on preferable vehicle dynamics was selected.

The fundamental functions of the 4WS system are vehicle stability, control, and maneuverability improvement at low speeds. Vehicle velocity, yaw rate, lateral acceleration, and steering-wheel angle are detected at the vehicle state from which the rear-tire angle is controlled. To improve vehicle stability at medium and high speeds, a feedback control loop is applied, which uses the steering ratio calculated from steering-wheel angle and the difference between the preferable

vehicle state and the measured values. At low speed, the rear tire is controlled in negative phase based on the preset steering ratio to improve maneuverability.

The 4WS with the feedback control of vehicle motion state is more effective in improving handling and stability of the vehicle compared with 4WS without feedback control, especially for a vehicle towing a trailer.

With the swing-out reduction control, swing-out overhang of the vehicle body rear corner can be reduced while keeping the turning diameter equivalent to that of a regular 4WS vehicle, which allows the driver to operate a 4WS vehicle as easily as a 2WS vehicle without special attention during parking maneuvers.

John Fobian

## Pressure sensors for common-rail injection systems

The direct-injection diesel engine system was developed to solve such problems of conventional diesel engine systems as emissions of particulate matter (PM) and high emissions of NOx. The common-rail pressure sensor, which requires high-pressure resistance to 160 MPa (23,000 psi) and an accuracy of  $\pm 1\%$ , is a key part of the system. Researchers from **Denso** will discuss how a new generation of common-rail, high-pressure sensors are structurally simpler to conventional sensors while still meeting the needed performance requirements during today's 1:00 p.m. Vehicle Sensors and Actuators technical session in Room D3-24/25.

Diesel engines have CO<sub>2</sub> emissions of about 67% those of the gasoline engine because the diesel engine offers greater thermal efficiency and lower fuel consumption than other internal-combustion

engines. In the direct-injection diesel engine, the common-rail injection system's high-pressure sensor monitors fuel pressure so it can be kept at an optimal value determined by engine speed and load.

The improved sensor features a hermetically sealed structure, a diaphragm for receiving fuel pressure, and a single-crystal silicon, piezoresistive sensor element for converting the pressure into an electrical signal.

A single-crystal silicon piezoresistive element has three times as many gage factors as a thin-film polycrystalline silicon piezoresistive element. The element therefore can be made with three times the sensitivity, an advantage in improving sensor accuracy that led to the selection of a single-crystal to achieve an accuracy level of 1% over the operating temperature range of -30 to +120°C (-2 to +248°F).

**The common-rail pressure sensor is a key component in the development of direct-injection diesel engines.**



During development, stress generated on the metal diaphragm was found to be caused by diaphragm thickness and corner curvature. As a result, a diaphragm thickness of 1.4 mm (0.055 in) and corner radius of 0.9 mm (0.035 in) were chosen to ensure diaphragm stress lower than that of the adhesive layer or low-melting glass, yet higher than the minimum required by the silicon piezoresistive element.

John Fobian

## SAE Foundation Contributor Lounge

All Foundation contributors wearing a Foundation VIP ribbon are invited to visit the SAE Foundation Contributor Lounge located at Congress Central

adjacent to the SAE Member Lounge and open daily from 8:00 a.m to 5:00 p.m.

All SAE 2002 World Congress attendees are invited to take part

in the *A World In Motion (AWIM)* demonstration that will be held in the Foundation Lounge on Thursday from 1:00-2:00 p.m. The *AWIM* hands-on educational



programs for elementary and middle school students provide engineers with volunteering opportunities at schools in their communities.

For additional information about the SAE Foundation or the *AWIM* program, call 724-776-4841 or visit [www.sae.org/foundation](http://www.sae.org/foundation).

## SAE introduces new FMEA product

SAE has teamed with **Dyadem International** Ltd. to offer members a risk analysis software product backed with engineering support. Designed and built for the automotive, aerospace, and manufacturing industries, FMEA-Pro 5 allows suppliers to fulfill the new demands of FMEA 3rd Edition to standardize FMEA procedures, reporting formats, and technical language. The product provides guidance for design, service, process, application, and machinery FMEA technical standards, including SAE J1739, QS-9000, ISO/TS 16949, SAE ARP 5580, and MIL-STD-1629.

The full version of the latest release of FMEA-Pro 5 is now available for download and a 15-day trial at <http://www.sae.org>. SAE members who purchase the software save at least \$500 off the price of stand-alone, LAN, and WAN license configurations. For a free online demo, visit the SAE Booth in Cobo Lobby. For more information, e-mail [profdev@sae.org](mailto:profdev@sae.org) or call 724-772-8528.

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## Interactivity big part of Digital Car

In a clever nod to high-tech communications, people attending the Digital Car Conference technology sessions channeled instant comments to presenters via a Web link.

"It's a pretty neat setup," said Tom Creech, an electrical engineer with **General Motors Corp.** as he scanned the 250-laptop computers adorning rows of tables in a dedicated area within Cobo Center's Michigan Hall.

With a mouse click and a few keyboard taps, audience members conveyed non-verbal comments during a presenter's speech. "There is interactive polling, and questions can be asked of the presenters in real time," said Bob Leon, President of **Colortone Staging & Rentals**, which provided the Compaq computers. "At the same time, we're streaming this to the Web (via digitalcar.org), so there are people all over the country who are in the same loop."

Regarded as the first interactive "webstream" of this magnitude and context, the high-tech two-way communication format was intended "to show we're on the cutting edge," said Greg Muha, Exhibition Sales Manager for **SAE International**, who added, "It creates the e-factor: energy, enthusiasm, and excitement."

August Burgett, Chief of the Advanced Safety Systems Research Division for the U.S. Department of Transportation's **National Highway**



**Early attendees receive interactive training at the start of Wednesday's Digital Car Conference.**

**Traffic Safety Administration**, tailored his Wednesday morning presentation to match the theme participants said they preferred among three choices—in this case, assessing crash prevention technologies that affect driving performance.

"I would like to see this interactive aspect again for large groups," said Richard Darienzo, a mechanical engineer in the sales and marketing group of **Peugeot Citroen Engines** in New Jersey.

Digital Car technical session attendees also were encouraged to complete a five-point survey that included telematics-related queries respective to the average price increase per vehicle people will accept

based on the improved benefits of navigation, communications, and entertainment—as well as an opinion as to whether automakers, service providers, or consumer electronics suppliers should be responsible for addressing/determining customers' telematics requirements.

This year's Digital Car Conference and Exhibition—co-located with the SAE 2002 World Congress—is presented by SAE in partnership with the **Consumer Electronics Association**. Sponsors of the Digital Car show are **Accenture, IBM, Sun Microsystems, Philips,** and **Microsoft Windows CE** for Automotive.

Kami Buchholz

## SAE offers Global Technology Briefings service

In response to industry's quest for competitive technology information, SAE has announced the availability of an intelligence service designed to help business strategists and R&D managers track technology developments and trends from around the world.

The Global Technology Briefings (GTB) service provides weekly summarizations on new product developments, model launches, technology applications, joint product ventures, and regulatory announcements that have been reported from trade journals, newspapers, and online services. Using a unique automotive engineering filter, coverage also includes business news such as mergers, plant openings, and supplier exchanges that may impact decisions in product planning or development.

The Web-based service includes an advanced search engine, optional archival content, and e-mail alert system. Available by annual subscription, SAE's GTB serves the individual or integrates to a corporate intranet. Trial subscriptions are available at no cost at 724-772-7144 or [elecpubs@sae.org](mailto:elecpubs@sae.org).

## Dymola used for hybrid developments

In presentations to be delivered at 12:30 in Salon C on the exhibit floor, **Dynasim** CEO Hilding Elmqvist and **Ford Motor Co.** Technical Specialist Mike Tiller will detail how Dynasim's Dymola software was used in the development of control systems for the Hybrid 2003 Ford Escape. The software is being demonstrated at Booth 2157.

Dymola software had previously been used by **Toyota Motor Corp.** in the development of its Prius hybrid car. Hybrid vehicles, which use a combination of an internal-combustion engine and an electric motor, posed many new challenges when Toyota began its Prius program about four years ago. Since torque is delivered from two sources, a completely new coordinated controller needed to be developed and tested.

Dymola is a rapid-modeling tool that can be used for debugging electronic control units, determining hardware specifications, and devising a system development strategy. "Dymola 5.0 allows simulation of detailed models of complete vehicles including engine, transmission, and chassis prior to committing to prototypes and full production," said Elmqvist. "Dymola is unique in allowing modeling and simulating the multiple engineering disciplines of mechanics, electronics, thermodynamics, chemistry, hydraulics, and control systems utilized in a car. This enables analysis of vehicle acceleration, shift quality, fuel economy, emissions, noise, and even new technologies like fuel cells and hybrid-electric car systems."

Equipped with Dymola, Toyota engineers created a gearbox model of the hybrid system and a 3-D multi-body systems model of the gearbox suspension. Those models were used to simulate hybrid torque control of the engine and electric motor, including reduction of gearbox oscillation caused by engine torque pulsation.

Frank Bokulich

## Exhibitor Directory Addendum

The following is a listing of new exhibitors as of March 6, 2002.

**Sagient**  
313 N. First St.  
Ann Arbor MI 48103  
**Booth 2602**