

## Continental demos active safety

When working together, sensors, controllers, and actuators enable cars to think and act much faster than humans can. At a demonstration earlier this summer in Germany, **Continental** showed that, when it comes to safety, the gap between human and technological capability is growing, thanks mainly to digital control.

The demo also showed that with better technology, the time gap between the car's recognition of a possible accident and the actual outcome is growing as well. Continental is putting so much safety technology into that growing time gap that, in many cases, accidents can be averted. And when they cannot be avoided, the injury and damage they cause can be minimized.

Continental places special emphasis on early detection of accident potential, said the company's R&D chief Peter Rieth, noting that the greatest gains in stopping distance come when the vehicle is traveling the fastest—at the outset of

a possible accident. The company will talk about its technologies for stopping distance reduction at the Convergence conference, October 18-20, in Detroit's Cobo Center.

A self-described "safety company," Continental is refining its safety philosophy/initiative called APIA (active passive integration approach). APIA is an integration of active- and passive-safety technologies—active safety referring to technologies designed to prevent crashes, and passive safety referring to technologies that protect car occupants when a crash occurs. In addition to improving safety, the goals of APIA are, according to Continental APIA Project Manager Jurgen Diebold, adding value for the car owner and the carmaker via systems integration and multifunctional use of existing sensors; reducing the number of components needed; and providing an open interface so multiple companies can provide components.

At the heart of Continental's multiple active-safety technologies is a "danger control module," an onboard computer that determines what, if any, crash-prevention measures a car should take in any given situation. The computer's evaluation is based on inputs from the driver and from onboard sensors, the number of which varies depending on OEM specifications.

Continental is refining this now common safety system approach by linking passive- with active-safety systems. The two generally have been treated as separate, according to the company. Integrating the systems not only provides a greater level of safety but also allows for elimination of redundant sensors: The yaw sensor for electronic stability controls systems, for example, can provide the signal for adaptive cruise control as well.

For the demonstration held at a vacant air strip near Frankfurt, Continental showcased its capability to increase the level of safety in cases when one car closes quickly on another ahead of it. Drivers of the trailing car experienced the full panoply of visual



*Continental's demo involved drivers speeding up on a "leading" vehicle and experiencing the car's automatic responses.*



*Peter Rieth, head of R&D at Continental, holds an upgraded electronic brake system module, the MK60E5, which uses analog valve and pressure control and has five sensors for individual control of pressure at each wheel.*

**Briefs**

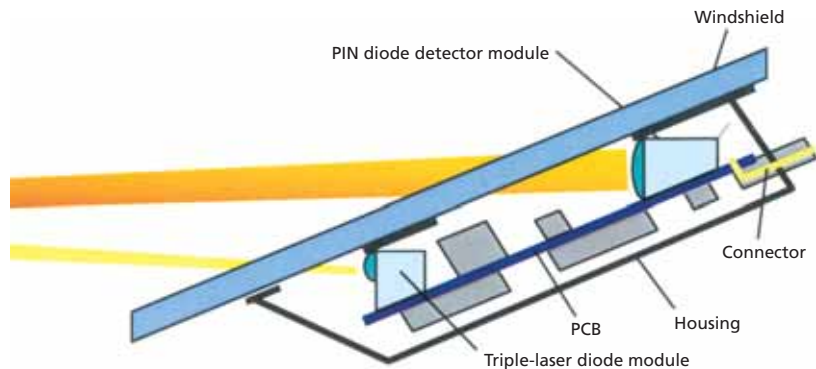
**SmarTire Systems** has successfully completed the initial test phase of its tire-pressure monitoring technology that does not rely on batteries. A passive sensor is located inside each tire, energized by an antenna located within each wheel arch. Elimination of the battery in the sensor reduces its mass, size, and cost, reliability is improved, and battery disposal issues are eliminated. SmarTire expects to take at least a year to commercialize the technology.

**Koito Manufacturing, Denso Corp.**, and Royal **Philips Electronics** have developed the first mercury-free high-intensity discharge (HID) headlamp. Koito and Philips developed the mercury-free discharge bulb using a mercury substitute. Koito and Denso developed the ballast for lighting the bulb, which achieves increased initial operating wattage and current with 50% reduction in volume and 25% reduction in mass. The new HID system is installed on the Japanese-market **Toyota Porte**.

**Alcan** has developed an aluminum front bumper beam for the new **Opel Astra** that features a special aluminum extrusion attached to the vehicle body via high-strength crash boxes. A unique bending method used in the automated production line process permits the shaping of high-strength materials to exact tolerances.

**TRW Vehicle Safety Systems** will manufacture the next-generation environmentally friendly passenger airbag inflator at its Mesa Operations beginning in 2005. The Heated Gas Inflator will use a simple high-pressure hydrogen fuel/air mixture, and contains no solid propellant or moving parts.

**BorgWarner** will provide its Interactive Torque Management I (ITM-I) on-demand four-wheel-drive technology for a North American OEM's sport wagon beginning in 2006. The patented technology uses electronic sensors and microcomputer controls to sense slippage at a vehicle's front wheels, and can work with antilock brakes and electronic stability programs to enhance traction and stability. The BorgWarner ITM system was first seen on the 2002 **Hyundai Santa Fe**.



*Continental's closing-velocity sensor uses pulsed laser light for short-range obstacle detection. The image on right shows the sensor attached to a windshield behind the rearview mirror.*



and haptic alerts within milliseconds after the danger control module detected an unsafe condition, and then dynamic countermeasures when the crash threat increased. Using a special rig for the leading car (i.e., a rear-end mockup) that flipped up and out of the way when contact was imminent, the demo allowed drivers to exceed the limits of the APIA system.

Continental's APIA system fires automatic vehicle responses in one to five stages, beginning with a visual alert on the instrument panel and haptic warning via a vibrating accelerator pedal in cases when the leading vehicle brakes gently and a preprogrammed trailing distance limit is exceeded. Like state one, the remaining stages are calibrated to probability and severity of the potential accident, with each actuating one or more dynamic responses in addition to those fired in any previous stage of a given accident scenario.

Stage two automatic responses kick in when the leading vehicle brakes hard. They include:

- Boosting of the brake system so clearance between brake pads and discs is reduced to zero
- Pretensioning of seatbelts
- Closing of side windows and sunroof

Stage three kicks in when the leading vehicle brakes rapidly and the driver of the trailing vehicle takes his foot off the

accelerator. Automatic vehicle responses in this situation include:

- Braking up to a deceleration of 3 g (the maximum allowed by law for automatic braking, according to Continental)
- Activation of seatbelt pretensioners
- Adjustment of the passenger seat position and seat squabs for the driver's seat.

Stage four responses—initiated when the leading vehicle makes an emergency stop and the trailing car applies the brakes—include:

- Activation of the extended brake assist function. Maximum pressure is reached more rapidly than normally because pressure had been built up in previous stages. If the driver fails to generate the required braking pressure to avoid a collision, the system acts on the information provided by sensors and builds up extra brake pressure automatically.
- Activation of seatbelt pretensioners to the maximum level.

The responses in stage five are based on the assumption that a collision will occur, in which case the airbags deploy.

The full range of responses is available only if the vehicle is fitted with a brake system designed to accept external control signals and is equipped with electronic stability control and the appropriate sensors.



When a driver exceeds braking limits, the "leading car" flips up and out of the way in Continental's in-line driving maneuver demo.

Continental has developed what it calls a precrash closing velocity sensor with a wide short-distance detection range. The windshield-mounted sensor emits pulsed laser light in three beams (15° wide, 10° high) at a wavelength of 910 nm (35.8 μm). Range is 10 m (33 ft) or less, accuracy is within 100 mm (3.9 in), and the velocity range is 5-200

km/h (3-124 mph). The company says the unit can also be used for pedestrian protection systems if coupled with additional contact sensors.

For longer-range object detection Continental uses near-infrared technology. Its LIDAR (light detection and radar) sensor uses 15-20 beams to detect multiple objects and determine their

width and distance to within 0.2 m (0.7 ft) over a range of 0.5-170 m (1.6-558 ft). The horizontal field of view is 24-30° and the vertical field is 5°.

Under development by Continental is a headlamp infrared sensor that would detect objects at all distances.

Patrick Ponticel

## Redesigning a future truck

Students from 15 North American universities recently participated in the FutureTruck competition to further refine and optimize 2002 model year **Ford Explorers** that they previously had re-engineered to achieve 25% improved fuel economy as well as lowered emissions without compromising the vehicle's performance, utility, and safety. The U.S. **Department of Energy (DOE)** and Ford Motor Co. served as headline sponsors for the 2004 competition, which marked the final stage of a three-year event focused on the Explorer. Industry, government, and academic judges evaluated teams in more than 12 events, including dynamic testing of towing ability, acceleration, vehicle design inspection, and oral presentations.

Advanced techniques—such as employing series- or parallel-hybrid designs, using alternative fuels, and/or operating hydrogen internal combustion engines—were at the heart of the teams' vehicle alterations. Ford assisted by providing each team with an engineering mentor, a 2002 Explorer, and competition facilities, as well as prize and seed money. The DOE provided technical and logistical support via its **Argonne National Laboratory** research and development facility.

FutureTruck had several major corporate sponsors, including **Delphi**, which donated \$30,000 to the competition. "Sponsoring events such



Fifteen teams competed in the 2004 FutureTruck competition with headline sponsorship by Ford and DOE.



Overall FutureTruck competition winner University of Wisconsin is shown on the trailer tow event.



Canada's University of Alberta, shown on the off-road event, was voted the most-improved team.

as FutureTruck help provide hands-on experience in science and engineering for tomorrow's workforce," said Delphi's Chairman, CEO, and President J.T. Battenberg III.

By staying with the same vehicle for three years, students were able to concentrate on systems integration. "The kids have figured out how to do the technologies and make those

**FutureTruck Teams**

- California Polytechnic State University-San Luis Obispo
- Cornell University
- Georgia Institute of Technology
- Michigan Technological University
- Ohio State University
- Pennsylvania State University
- Texas Tech University
- University of Alberta
- University of California - Davis
- University of Idaho
- University of Maryland
- University of Tennessee
- University of Wisconsin - Madison
- Virginia Tech
- West Virginia University

technologies last throughout the competition," said Al Kammerer, Executive Director of North American Product Development for Ford. Learning what it takes to achieve overall vehicle reliability represents a real-world lesson. "It's a key piece of learning to know what it takes to get to [a given] level of refinement," he said.

With the 2004 competition marking Jim Garrison's second year of

participation, the electrical engineering student at **Georgia Institute of Technology** was better able to grasp how product development proceeds to a final destination. "We made several large changes between year one and two. From year two to three, the emphasis was on refinement and optimization of the vehicle, and that wouldn't have been possible if this were only a two year duration with this Explorer," said Garrison.

Paul Smith, Managing Consultant for **The MathWorks**, agreed that having the same vehicle for three years gave students a more comprehensive learning experience. According to Smith, in the first year of competition, teams typically used software tools to define the vehicle architecture and confirm those proposals with simulations. In the second year, teams were more focused on the mechanical issues of the vehicle.

"The third year is really icing on the cake. They've learned all these hard, practical lessons from the two previous years," said Smith, "It's exciting to see the progress that's been made, especially in the past year. The level of refinement is

starting to approach what car companies do over a three-year cycle in terms of the optimizations they're making to powertrain calibrations as well as the powertrain control strategies that they're developing."

For **Visteon**, a first year event sponsor, the company's varied portfolio enabled some teams to fill a void. "Even with most vehicles already defined, Visteon was able to provide some of our new technologies, and the teams were able to integrate them," said Biljana Stewart, Customer Business Group Manager at Visteon for Ford trucks and SUVs.

With the conclusion of the FutureTruck competition, a new three-year advanced-technology program is in motion with host sponsor General Motors—Challenge X: Crossover to Sustainability. Each competing team will modify a 2005 **Chevrolet** Equinox to minimize energy consumption, emissions, and greenhouse gases, while maintaining or exceeding the current vehicle's utility and performance.

*Kami Buchholz*

## Learning behind the wheel

Vehicle dynamics is a subject that's getting a lot of attention from the automotive industry at the moment. With the focus on safety moving from passive (airbags, structural crash performance, etc.) to active (stability control, rollover avoidance, etc.), vehicle handling is becoming one of the key areas where expertise is of increasing value to automotive companies. Getting an understanding of the theory and principles of vehicle dynamics, and then experiencing how it feels in practice, is the goal of a new seminar from **SAE International**.

SAE Professional Development is launching its first vehicle dynamics seminar that will include substantial real-world, hands-on driving experience. The Applied Vehicle Dynamics Clinic will debut October 11-13 at the **BeaveRun** MotorSports Complex in Western Pennsylvania. The course fee includes all instruction and driving time with qualified instructors, as well as all required safety equipment. Lunch and refreshments will also be provided.



*The first Applied Vehicle Dynamics Clinic from SAE International will be held October 11-13 at BeaveRun MotorSports Complex in Western Pennsylvania, and will feature classroom theory combined with experience driving both front- and rear-wheel-drive vehicles on a test track.*

The three-day fundamentals course features eight hours of traditional classroom time to provide the principles associated with longitudinal and lateral

vehicle dynamics, including weight transfer, braking, cornering, and steering. Each of the principles studied are then illustrated and practiced through a total

of nearly 15 hours of supervised time behind the wheel of both front- and rear-wheel-drive vehicles. Attendees will learn to feel and anticipate the effects of longitudinal and lateral inputs, as well as understand the physics and engineering involved. Day three is devoted entirely to practice and repetition of critical vehicle maneuvers.

"While a variety of engineering tools are available to assist in creating optimal vehicle designs, subjective evaluation of vehicle behavior is still a vital tool to ensure desired ride, handling, and other dynamic characteristics," said principal clinic instructor, James Walker, who is also Vehicle Performance Development Manager for brake control systems at **Delphi Energy and Chassis Systems**. Richard Lundstrom, **Kettering University** professor and instructor of SAE's fundamental and advanced seminars on vehicle dynamics, is also involved with course conceptualization and development.

The clinic is targeted at both newly hired as well as experienced engineers in career transition who quickly need to acquire a fundamental theoretical foundation but also understand how vehicles feel and behave in response to certain inputs.

Unlike many driving schools, this course is not designed to train performance drivers. Rather, it builds the bridge between vehicle dynamics theory and practical application by providing a detailed academic understanding and then reinforcing it with highly focused, relevant driving exercises. Individuals can then further refine their driving skills back on the job.

To deliver a quality driving component of the seminar, SAE is partnering with the newly constructed BeaveRun MotorSports Complex in Western Pennsylvania, located approximately 20 minutes from SAE World Headquarters. According to Kevin Perry, Manager of SAE's

Professional Development business unit, BeaveRun offers the right infrastructure, including a professionally designed racetrack for longitudinal maneuvers, a six-acre vehicle dynamics area for lateral activities, and a new conference/classroom building. Plus, the proximity to SAE headquarters enables close planning and communication with BeaveRun driving instructors.

Initially, the Applied Vehicle Dynamics Clinic will be offered once each fall and spring, but, depending on demand, could be more frequent. SAE also routinely offers a variety of other vehicle dynamics classroom-based seminars. For more information or to register, visit [www.sae.org/events/seminars](http://www.sae.org/events/seminars) or contact Kevin Perry at [kperry@sae.org](mailto:kperry@sae.org)

*David Alexander*

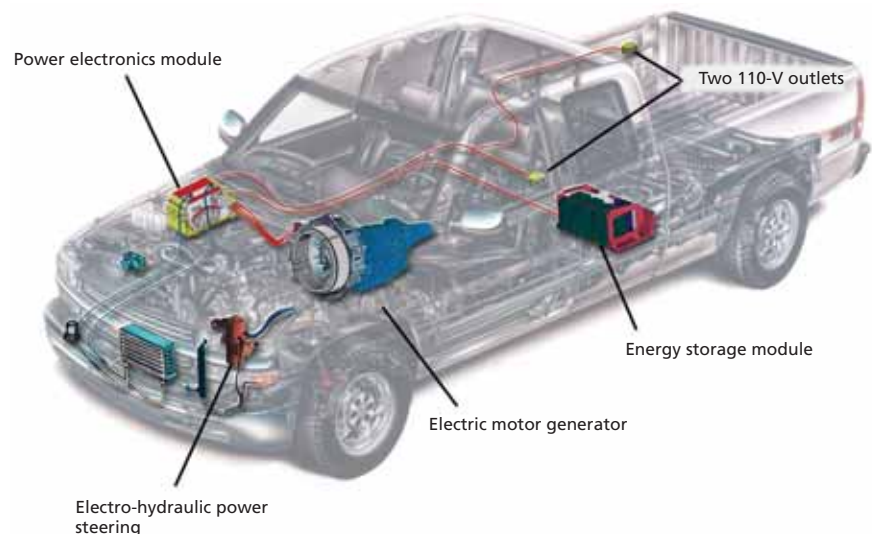
## Controlling a hybrid

UK engine controls specialist, **Zytek Systems**, has taken an important role in the development of **GM's Hybrid Pickup**. The company became involved at the project's inception when it conducted a control systems architecture study.

Criteria for the vehicle included the need to retain the performance and driving characteristics expected of a regular vehicle of this type, including towing capability. Zytek worked with GM to help implement changes to the vehicle's base engine (the 5.3-L Vortec V8) and transmission control system, including the definition and application of hybrid control algorithms, to maximize the effective use of the electric machine (motor and alternator) and energy storage capability.

The vehicle uses a **Continental Integrated Starter-Alternator-Damper (ISAD)**. The energy storage pack and battery management electronics are positioned beneath the rear seat.

The biggest challenge for Zytek was that the Hybrid Pickup's driveability would need to be comparable to that of its conventionally powered equivalent, despite the extra complexity in the



*A new Hybrid Control Module (HCM) was developed by Zytek for the GM Hybrid Pickup. It links the V8 engine, automatic gearbox, and hybrid-electric motor alternator.*

drivetrain hardware and controls. "We had to be very careful that the vehicle did not recover too much energy during coast. U.S. drivers will not accept pronounced engine braking," said Zytek Program Manager, Neil Heslington. Hybrid functionality is controlled by the

Zytek-designed Hybrid Control Module, which evaluates the vehicle's state and issues instructions to the Powertrain Control Module, which controls the gasoline engine and transmission, and Continental's Starter-Generator Control Module that in turn controls

the ISAD and power conversion tasks. A Continental Energy Storage Control Module looks after battery management

Heslington underlined the importance of systems integration in a hybrid concept and said that energy management strategies that work effectively in all environmental conditions together with "transparent driver interfaces" are challenging to develop. "For example, lead-acid batteries do not always accept the desired levels of power, so systems have to work to create the optimum conditions. Also, engine start needs

to occur as the driver's foot is lifted from the brake pedal before touching the accelerator pedal." He added that the power and flexibility of the ISAD was used by GM with ZyteK's help to overcome many of the driveability and NVH issues associated with the hybrid powertrain.

"Inevitably, operation of a hybrid vehicle involves many additional driveline torque reversals as the electric motor switches from driving to generating as the vehicle's acceleration changes. The ISAD and ICE were used intelligently during these reversals to improve the

overall smoothness of the powertrain system." The Hybrid Pickup has a regular 12-V electrical system, but its 42-V energy-storage system supports an electro-hydraulic power-steering pump and an inverter providing power for four 120-V ac power points.

ZyteK has 10 years' experience with hybrid systems and electric vehicles. The company engineered the Panoz Q9 hybrid-electric racecar that competed in the U.S. in 1998.

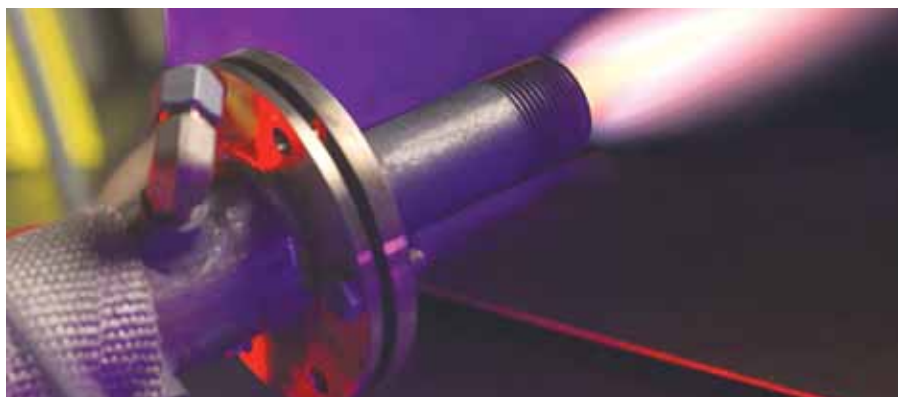
*Stuart Birch*

## Creating an emissions weapon

A device is being developed that will provide on-board, on-demand production of hydrogen-rich gas, and that enriched gas will spark a process to fight the release of unwanted exhaust emissions. For nearly three years, **ArvinMeritor** engineers have been working to take technology that originated within the Plasma Science and Fusion Center at the **Massachusetts Institute of Technology** to a production-ready state. Hydrogen that is produced by the Plasma Fuel Reformer (PFR) device will be used as a fast-starting regenerator for a nitrogen oxide (NOx) trap.

"The device takes a stream of air and a stream of fuel, mixes them, then passes the mixture through an electrical plasma arc to spark the reaction that generates hydrogen and carbon monoxide—and that combination of gases is useful for regenerating NOx adsorbers used in an after-treatment emissions system," said William Taylor, Director of Engineering for Commercial Vehicle Exhaust for ArvinMeritor's Commercial Vehicle Systems in Columbus, IN.

In a conventional approach, diesel fuel is used as the regenerator in the NOx trap, but regeneration can be difficult to accomplish at low temperatures. The traditional process consumes more diesel fuel than the PFR approach, and the atmospheric release of unburned diesel fuel is possible. Ongoing PFR laboratory and field tests (including a **Gillig** Phantom transit bus



*ArvinMeritor's new Plasma Fuel Reformer creates hydrogen-rich gas onboard the vehicle from gasoline or diesel fuel. The hydrogen-rich gas is the catalyst for a process that reduces vehicle emissions.*

application) show that hydrogen-rich gas regeneration requires, on average, about half the diesel fuel, operates at a much broader temperature range, and has shown the ability to remove sulfur from the NOx adsorber at temperatures below 500°C (932°F), which can translate to a longer catalyst lifespan.

Commercial diesel vehicles are expected to be the first production application of the PFR device. The technology eventually will migrate to passenger diesel vehicles as well as passenger gasoline vehicles. In a diesel application, the PFR device is likely to be exhaust-coupled, while a gasoline engine application means the PFR device is likely to be engine integrated.

"The Plasma Fuel Reformer is a piece of technology that generates hydrogen, and that's core to diesel and gasoline

applications. PFR is a component of our under-development Hydrogen-Enabled Combustion Engine (HECE) system. To hydrogen-enhance an engine, you need a hydrogen source and that's where the Plasma Fuel Reformer comes in," said Taylor.

HECE development work on a **Porsche** Cayenne sport utility vehicle enables engineers to better understand the underlying issues. "There are a lot of control issues that need to be taken care of as well as making sure that you integrate those systems correctly," said Rudy Smaling, Chief Engineer of Commercial Vehicle Exhaust for ArvinMeritor's Commercial Vehicle Systems in Bedford, MA.

The system will work with any homogenous-charged gasoline engine, but it will not work with a gasoline-

direct injected engine or with a set-up employing stratified combustion. According to ArvinMeritor engineers, HECE can impact emissions and fuel efficiency. "With a hydrogen presence, you can extend the lean burning limit. You can run the engine with much more excess air—reducing the engine-out NO<sub>x</sub>—essentially to the point that you don't require any after-treatment for NO<sub>x</sub>. So a very simple oxidation catalyst will allow you to meet the emissions

requirement, and at the same time you get fuel-efficiency benefits," said Smaling.

Work on the PFR and the HECE includes input from Ingenieurgesellschaft Auto und Verkehr (IAV), based in Chemnitz, Germany. According to Pedro Ferro, Vice President and General Manager of ArvinMeritor Commercial Vehicle Emissions, "We've confirmed that our hydrogen-rich gas has real promise to achieve ultra-lean turbocharged

operation of gasoline engines with improved fuel economy and dramatically reduced exhaust emissions."

The next step for PFR development puts the technology closer to its target-ready date of 2010. "We are now developing the next-generation of prototype. It will be more compact and more streamlined in terms of the way we get air, fuel, and electrical power to the device," said Taylor.

Kami Buchholz

## Two into four may go

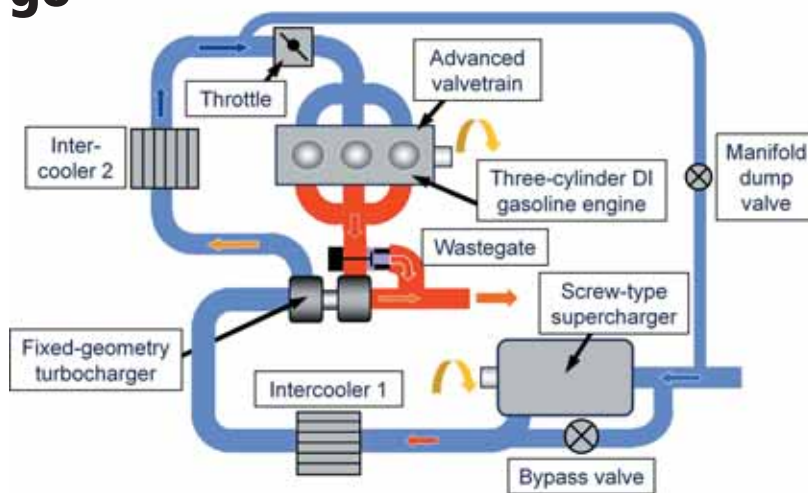
A UK research project under the Foresight Vehicle Program called 2/4SIGHT has investigated the feasibility of creating a gasoline engine with the capability to switch automatically between two- and four-stroke operation. More than 400 UK companies and universities have been participating in the industry-backed Foresight Vehicle initiative led by the **Society of Motor Manufacturers and Traders**.

The team involved in the 2/4SIGHT project was led by **Ricardo**, and included **Ford, Ma 2T4, the University of Birmingham, and Brunel University**.

"It is well known that significant improvements in fuel consumption and CO<sub>2</sub> emissions can be achieved via smaller, more highly rated engines," said a team spokesperson. "To date, the extent to which this can be achieved has been limited by the ability to maintain acceptable driveability at low engine speeds."

Ricardo defined engine operating strategies and used its WAVE and V-SIM software to perform engine simulations, while the universities carried out detailed combustion system analyses. Ford was responsible for full-vehicle system modeling. Ma 2T4 investigated the technology needed for a valvetrain mechanism to switch between two- and four-stroke modes.

The three-cylinder gasoline concept engine created is of 1.0-L capacity, said to generate the equivalent peak power of a naturally aspirated four-stroke 1.8-L gasoline engine, but with 50% more bottom-end torque. Predicted fuel economy and CO<sub>2</sub> emissions are better



The 2/4SIGHT powertrain program has demonstrated the feasibility of two-/four-stroke switching based on advanced valvetrain, fuel injection, and control technologies.

than those of a typical current diesel engine, and manufacturing costs are projected to be slightly lower.

Key elements of the design include direct-injection technology to improve fuel economy and avoid the risk of unburned fuel passing into the exhaust—a problem with conventional two-strokes. The engine design also has an advanced mechanical valvetrain or a camless electrohydraulic system to allow the valvetrain to double in speed when operating in two-stroke mode.

The engine designers specified an air-handling system featuring a combination of fixed-geometry turbocharger, intercooler, and supercharger to deliver the necessary airflow to the engine—essential to achieve the required level of low-speed torque.

Finally, there is what the team describes as "careful" electronic control to coordinate these systems and ensure negligible impact on driveability when switching between operating modes.

"The project has demonstrated that the switchable two-/four-stroke concept is highly feasible," said Dave Greenwood, Ricardo's Chief Engineer, Advanced Technology. "Further development will be required in some areas such as the valvetrain, air handling, and control systems, but the technology offers a great combination of high performance, excellent fuel economy, and low CO<sub>2</sub> emissions."

With work continuing on the concept engine, a physical prototype that could be installed in a vehicle is being considered.

Stuart Birch

## New image for mirrors

Plastic has been used to house the external rearview mirrors of cars for many years but the mirrors themselves are of glass. The downside to using glass is weight and liability to damage (both physical and chemical), but the upside is low cost and ease of manufacture—and it is cost that is invariably the major criterion. But that is set to change.

Later this year, a European car manufacturer is expected to fit plastic mirrors to a production model following development work by the optical specialist company, **VTEC Technologies**, which has its headquarters in Boston, USA, and a technology presence at the **University of Warwick's** Science Park in the UK. The mirrors are to be manufactured in China. Although VTEC mirrors are now offered on some off-highway vehicles, Daryl Wiseman, the company's Technical Sales Director, Europe, believes this year will see a "first" for cars.

Wiseman, who joined the company in 2001, was formerly a mirror specialist working for **Land Rover** and **MG Rover** and was fully aware of the problems of replacing glass with plastic for external mirrors. "In 1998, I had discussions



*VTEC Technologies has developed a mirror reflective surface made from plastic material that is lower mass and more robust than glass.*

with VTEC and realized that they had the potential to make plastic mirrors a production reality by processing plastic to make a mirror that had all the beneficial properties of glass without its inherent flaws," he said. "It would need to be simple to manufacture and less prone to damage.

"For the past 15 years, many companies have considered plastic rearview mirrors and rejected them because of concerns about likely service life, image distortion, the effect of heat

and moisture—but most of all because of cost," said Wiseman. Now, development work by VTEC Technologies has overcome these issues, using special molding techniques and optical-grade plastic materials combined with an advanced hard coating and mirror coating process. VTEC holds several patents covering the use of its technology.

Stuart Birch

## Dana lightens the load

**Dana Corp.** has developed a lightweight, robust cylinder-head-cover module for the **Chrysler** Group's high-volume 3.7-L V6 engine, which is featured on the 2004 and 2005 **Jeep** Liberty sport-utility vehicle, **Dodge** Dakota, and Dodge Ram light trucks, and the Dodge Durango full-size SUV.

Following the launch of Dana's 4.7-L module just over a year ago, the 3.7-L module is comparable in structure and shares common components with the 4.7-L. "Dana worked closely with Chrysler engineers during design and development to ensure this product delivered outstanding results and value," said Michael Burns, Dana Chairman and CEO.

Dana provided in-depth product design, prototyping, and validation support during the module development



*Dana's cylinder-head-cover module for the Chrysler Group's high-volume 3.7-L V6 engine has a mass savings of 4 lb (1.8 kg) per engine compared with the previously fitted steel system. It is made from a hybrid thermoset material Premix TMC (thick molding compound).*

process, making it possible to launch the product in just nine months.

The module is produced at Dana's Paris, TN, sealing facility using an advanced two-cavity straight injection-molding process. Manufactured from a hybrid thermoset material, **Premix TMC** (thick

molding compound), the Dana module has a mass of 4 lb (1.8 kg) less per engine compared with the previously fitted steel system with a plastic carrier gasket.

The specially formulated material provides reliable long-term strength, even when exposed to extremes of heat and

engine oil. TMC is reinforced with 22% intermediate-length glass fibers, produced by a unique process in slab, heavy sheet, or rolled form. The material can be molded by the injection, transfer, or compression process. It combines the flow properties of bulk molding compound and the mechanical properties of sheet molding compound. The hybrid material is typically used for heavy-duty electrical breakers, under-the-hood automotive components, and large corrosion-resistant pieces.

Improved NVH characteristics and sealing performance are achieved due to the application of an integrated press-in-place gasket along with a built-in grommet system. The gasket material is Vamac ethylene/acrylic elastomer from **DuPont**. The material was chosen for its resistance to hot lubricants, and its good vibration damping characteristics that remain constant over broad ranges of temperature, frequency, and amplitude.

"The new module eliminates a costly and time-consuming preparation and

painting process, is more robust for shipping and handling, and reduces cost due to the press-in-place gasket over the previous plastic carrier-style gasket," said Mike Laisure, President of Dana's Automotive Systems Group. "With fuel economy becoming increasingly important, the module also contributes to overall engine-weight reduction."

A similar product was developed by Dana for the **Ford** 4.0-L V6 engine in Germany.

David Alexander

## Chrysler shifts up a gear

**Chrysler** Group is growing its six-speed manual transmission offerings beyond specialty vehicles such as Chrysler Crossfire and **Dodge** Viper, to include its **Jeep** sport-utility and Dodge truck vehicles.

"A six-speed manual transmission will now be standard equipment, improving performance and driving pleasure in Jeep vehicles and Dodge Trucks where manual transmissions are offered," said Bob Lee, Vice President – Powertrain Product Team, Chrysler Group.

For 2005, Jeep Liberty and Jeep Wrangler will feature the NSG 370 six-speed manual transmission, replacing two five-speed manual transmissions previously used in these applications. Sharing transmissions will help the company reduce cost and complexity.

The new transmission is a member of the six-speed NSG 370 family, similar to the one used in the Chrysler Crossfire, which was the first six-speed for the Chrysler Brand. The NSG six-speed manual transmission provides a 4.46:1 first-gear ratio, versus the 3.85: and 4.04:1 ratios of the five-speed transmissions it replaces. The higher ratio will provide improved launch and traction.

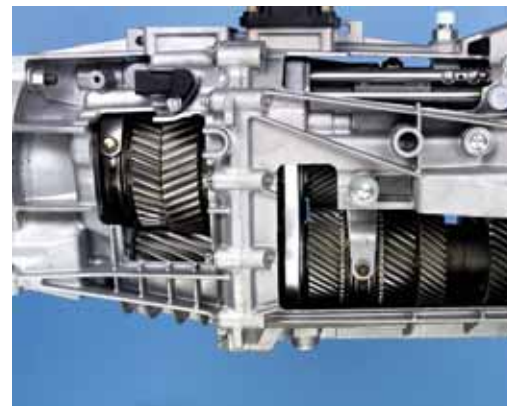
"Because Jeep vehicles are designed to perform in a variety of challenging off-road conditions, the NSG 370 six-speed manual transmission has a unique gear case and direct-shift system specifically designed for the Jeep application," said Frank Frederick, Director – Manual and Rear-Wheel-Drive



The 2005 Jeep Liberty and Wrangler get a version of the six-speed NSG 370 manual transmission first seen in the Chrysler Crossfire.

Transmissions and Driveline Engineering, Chrysler Group.

The NSG 370 six-speed manual transmission was developed to give improved shift quality and quietness. A new dual-ratio transmission shift-tower system allows packaging of the six-speed shift pattern within the existing Jeep vehicles. For smooth operation the first and second gears have triple-cone synchronization, the third and fourth gears feature double-cone, and



The Getrag 238 six-speed manual transmission is featured as standard equipment on the all-new 2005 Dodge Dakota and 2005 Dodge Ram 1500.



The G56 six-speed manual transmission will be available with the 5.7-L HEMI V8, in addition to the High Output Cummins Turbo Diesel, on 2005 Dodge Ram Heavy Duty pickups.

the fifth and sixth gears single-cone synchronization.

The multi-rail, steel-construction shift system is designed for high strength and precision, and hard-finished gears deliver quiet operation. The two-piece aluminum case with integrated clutch housing gives good powertrain stiffness and low mass. The new first-gear ratio combined with the six-speed spread allows engineers to optimize the axle ratios for fuel economy and performance.

Joining Chrysler Group's six-speed manual transmission family is the **Getrag** 238 six-speed manual featured as standard equipment on the all-new 2005 Dodge Dakota and 2005 Dodge Ram 1500. Replacing the NV3500 five-speed manual transmission, this six-speed offers smooth shifting with triple-cone synchronizers in the first and second gears, and double-cones for third and fourth gears. As in the NSG transmission, NVH is minimized

with hard-finished gears. Shift rails are supported with ball bearings and Teflon bushings to provide precise shift feel. Torque capacity and efficiency are optimized through the use of an intermediate plate, speed gears supported by needle bearings, and clean-sealed ball bearings on shafts. A two-piece, die-cast aluminum housing keeps mass low while providing good stiffness.

Six-speed manual transmission performance will be available with the 5.7-L HEMI V8, in addition to the High Output Cummins Turbo Diesel, on 2005 Dodge Ram Heavy Duty pickups. The G56 six-speed manual transmission replaces the NV4500 five-speed and NV5600 six-speed manual transmissions.

The new six-speed truck transmission features a dual-trunnion shift tower, which provides a compact shift pattern with optimal mechanical advantage for shifting. Double-cone synchronizers in first through fourth and reverse

gears provide high-capacity and long-term durability. A two-piece, die-cast aluminum case with integral clutch housing provides good stiffness and reduces NVH. The multi-rail, all-steel shift system provides precise shift feel. The 6.29:1 first-gear ratio provides better launch performance for an improved experience under heavily loaded and trailer-tow conditions. Power take off access covers are available on both sides of the transmission.

Chrysler Group will continue to offer a six-speed manual transmission on both Dodge Viper and Chrysler Crossfire. The Dodge Viper **TREMEC** T-56 transmission is synchronized in all gears, with electronic 1-4 skip shift and reverse lockout mechanisms. The Chrysler Crossfire features a version of the NSG 370 six-speed transmission.

*David Alexander*

## Plugging in with BERU

Diesel engine technology advances steadily, and the German company **BERU**, which invests some 8% of its annual turnover in research and development, has announced a new smart pressure-sensor glow plug (PSG) which is slated for production.

BERU states that a "European automobile manufacturer" has placed a major order. According to the company, the new PSG is uniquely positioned right in the middle of the combustion chamber in the cylinder to accommodate other components. Working together with **Texas Instruments**, BERU has integrated a piezoresistant pressure sensor into the plug.

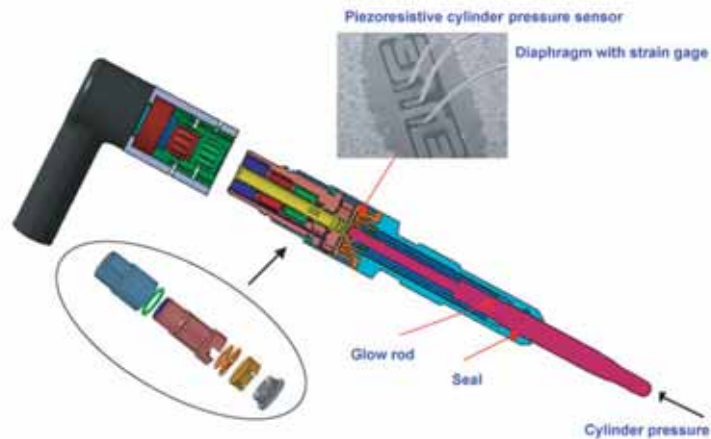
"In view of the extremely high temperatures, vibrations, and pressure ratios in the cylinder head, the mechanical design of the glow plug is a major issue," said a spokesman for the company. "The heating element is not incorporated into the body of the glow plug but is instead mounted on flexible bearings as a moving part, transmitting the pressure to a membrane. The actual pressure sensor is nowhere near the

combustion chamber but is located in more favorable conditions. Using a heating element from the BERU Instant Start System, which only glows at the tip, means that the thermal load can be controlled."

Marco van Maltzan, Chairman of BERU's Executive Board, said the new glow plug development has the potential

to reduce diesel engine emissions. Last year some 55% of **Mercedes-Benz** passenger car registrations were for diesel-engined models, and diesel's share of the passenger car market across Western Europe is now approaching 44%. It looks certain to top 50% in the short term.

*Stuart Birch*



*BERU's new smart pressure-sensor glow plug has the potential to reduce diesel engine emissions.*