

# AEI Tech 2003 Awards

**Automotive Engineering International** highlights the top products and technologies (submitted as of February 18) from the SAE 2003 World Congress.

## Exhaust measurement

**AVL North America's** DVE-150 direct vehicle exhaust measurement device completes an AVL-developed system for the collection and analysis of exhaust emissions, particularly in ultra-low- and super ultra-low-emitting vehicles. Along with the AVL BMD-150 Bag Mini Diluter and the GEM-150 control software, the unit provides an accurate analysis of the mass flow rate of exhaust emissions. This compact device can be seamlessly integrated into the BMD system, in a footprint 70-80% smaller than a traditional CVS (constant volume sampler) system. The U.S. EPA and the CARB have recommended the use of BMD sampling systems for future low-emissions measurements.



*For more information, circle 31*

## Refrigerant circuit

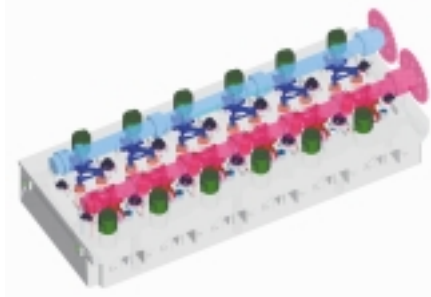
The Mobile R744 (CO<sub>2</sub>) refrigerant circuit from **Imtech Deutschland's** Environmental Simulation/Test Bed Engineering Division is equipped with safety measures for high-pressure systems. The compact system is built as a mobile, low-noise unit for comfortable operation in

laboratory environments. A separate stand-alone brine supply module supplies the gas cooler. The following control loops are integrated: R744 (CO<sub>2</sub>) compressor speed control, gas cooler outlet temperature, suction temperature, suction pressure, and expansion valve intake pressure.

*For more information, circle 32*

## Variable valve actuation

Version 2.2 variable valve actuation from **Jacobs Vehicle Systems** is an integrated design using parts contained in the cylinder head instead of a separate housing. By electro-hydraulically using lost motion to modify valve lift, timing, and rate of opening and/or closing, engines will realize many benefits including increased fuel economy, lower emissions, and higher performance. Just as fuel



injection systems have evolved from mechanical to electronic controls, engine valvetrains will follow this trend over the next 5 to 10 years.

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## LEDs

The Luxeon LED from **Lumileds Lighting** is available in all colors and in three different radiation patterns. It is claimed to offer the highest flux per LED family in the world. It is a reliable, life-of-vehicle light source that is suitable for any automotive lighting application, including forward lighting. The firm's Luxeon V LED offers up to 120 lumens per LED and up to 60 times the output of competitive devices.



A white Luxeon 5-W produces 120 lumens; green, cyan, blue, and royal blue Luxeon 5-W packages deliver luminous output ranging from 30 lumens for blue to 120 lumens for green and cyan.

*For more information, circle 34*

## Engine design and optimization

Automated Design with Virtual Engines from **Optimum Power Technology** takes the established engine simulation technology of Virtual Engines and combines it with advanced optimization methods and parallel processing to create an expert system for engine design. OEMs, Tier 1s, and motorsports teams using the product will achieve better engine designs faster and increase their competitive advantage, according to the firm. The process begins as a base engine model is created. Then, an engineer selects which parts of the engine can be changed in the search for improved performance. Running simulations in parallel, Automated Design creates new engines and compares the solutions. It uses built-in intelligence to assess which direction to move within the design space to create a better engine. Many engines can be evaluated automatically using the system.

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## Metal extrusion

**Textron Fastening Systems'** metal extrusion system combines stamping, deep drawing, and cold forming to produce complex, fully integrated, and durable automotive components. The system integrates all parts into one engineered system that increases joint



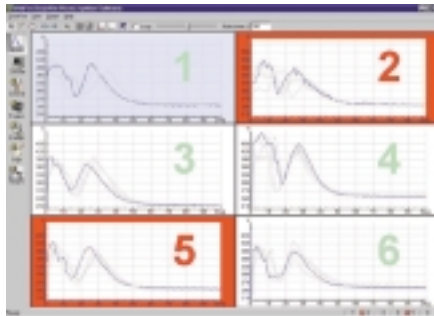
strength and process efficiency. Fasteners become part of a single component, eliminating the need for weld nuts, stamp-in nuts, and self-piercing nuts. The system more than doubles the thickness of walls of base metals, allowing applications with high stress loads such as suspension systems, drivetrains, and seatbelt anchors. No heat treatments are required to strengthen the metal. A 2000-ton stamping press is equipped with

computerized controls that adjust instantly to 100 different component designs. One component is complete with each stroke of the machine, which has a capacity of five million parts per year.

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## Ignition system

**Adrenaline Research Inc.'s** SmartFire Ignition System has knock calibration capability. According to the company, it is the only ionization-based dynamometer instrumentation tool commercially available today. The system provides direct knock calibration without the time and expense of modifying the cylinder for pressure sensors. Cylinder pressure sensing requires water-cooled sensors that are



expensive and require intricate machining to install. Using ordinary spark plugs and specially designed pencil coils, the system can detect knock directly from the combustion process. The individual cylinder timing control, accessible through the WinFire PC interface, means that the dyno operator can complete a knock calibration accurately in a matter of hours. The WinFire PC interface allows for easy setup on any engine from 1 to 12 cylinders. SmartFire's individual cylinder approach allows engineers to better understand the variability and sensitivity to knock-limited timing, thus allowing for power increases while ensuring engine reliability and durability.

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## Optical sensing

**Automotive Technologies International Inc.'s** optical occupant-sensing system, shown here, has numerous motor vehicle applications. For "smart" airbag applications, optical sensing, in combination with neural-network pattern-recognition technology, can estimate occupant height and size and adjust the amount of gas fed into the

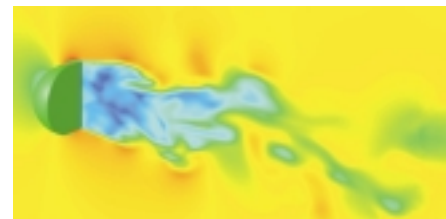


airbag and/or the size of the vents, which control the outflow of gas from the airbag. In the event of an accident, it can provide emergency service personnel information about accident severity. The distribution of heat and air-conditioning can be controlled automatically if seat occupancy is known, and acoustic engineers can use seat-occupancy information to improve sound quality from the entertainment system. Other applications include mirror adjustment, selective darkening of mirrors and windshield, drowsy-driver or driver-distraction detection, and driver identity.

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## CFD simulation

**Fluent Inc.'s** Fluent 6.1 computational fluid dynamics software expands the automotive applications for CFD simulation. It offers dynamic mesh technology, bringing new modeling capabilities for an array of applications including fuel injectors, IC engine modeling, and valves. Other enhancements include efficiency gains in the surface-to-surface radiation

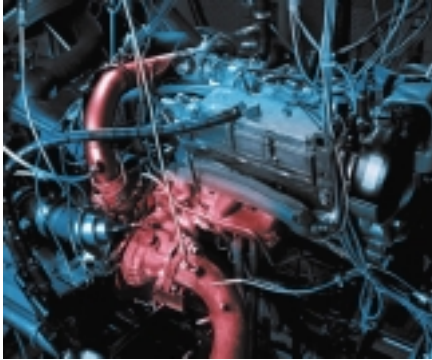


model and inclusion of a volumetric macro-based heat exchanger model, expanding the applicability of CFD for underhood thermal management analysis. It offers dynamic coupling with WAVE—in addition to GT-Power—a crevice model and a spray-wall interaction model for IC engine simulations, and a built-in capability to compute discrete Fourier transforms of time series data.

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## Engine downsizing

Downsizing is a major way to improve the fuel-consumption levels of spark-ignited engines while maintaining the advantage of low-emissions capability of the three-way catalytic system. The **IFP** downsizing approach with turbocharged applications is mainly fuel-economy oriented due to innovative dedicated solutions. For example, IFP has realized a



prototype engine on a 1.8-L, turbo-charged, 4-cylinder, direct-injection gasoline engine concept. The engine allowed engineers to take advantage of the high knocking limit of this approach to replace a 3.0-L naturally aspirated engine and thus to have a fuel consumption benefit of more than 15% with at least the same acceleration performance. At full load, the specific fuel consumption is less than 300 g/kW·h (0.5 lb/hp·h) over the entire engine speed range with a BMEP of 20 bar (2000 kPa) below 1500 rpm and a power density of 82.5 kW/L (110 hp/L) with a fixed compression ratio over 10.

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## Electric thermostat

**INZI Controls'** Adjustable Electric Thermostat (AET) provides new ways of optimizing vehicle coolant temperature control systems in all engine operating conditions, reducing engine friction pressures and improving the reaction kinetics in the combustion chambers. The results are seen in benefits including a reduction in fuel consumption of 2-3% based on FTP 75; a reduction of emissions (HC by 15% and CO by 4%, also based on FTP 75); increased engine power by 8%; improved interior heater performance; and improved engine durability. The AET operation is based on an increase in coolant temperature and the use of an integral electric motor in the thermostat, controlled by the engine

control unit. By controlling the electric motor, volume of the wax element is changed, achieving new dilatation functions. In the unit, the wax element is fixed in the thermo-

stat housing. Consequently, the AET does not move and the same thermal dynamic and flow dynamic exist in all engine conditions. This characteristic is important for coolant temperature control accuracy and functional safety. The device needs the same package area as conventional thermostats, can be used in both inlet and outlet temperature control systems, and is suitable for both gasoline and diesel engines.

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## Auxiliary power unit

The U.S. Army TACOM **National Automotive Center** will showcase an auxiliary power unit (APU) that uses fuel cells to generate power for a class 8 truck, in addition to 42-V electrical systems and an omni-directional inspection system (ODIS) robot for homeland security. The NAC, with partners **Ballard** Power Systems, **Freightliner**, and the **University of Alabama**, has developed a prototype heavy-duty truck APU with a Ballard fuel-cell stack to generate power for onboard electronics and appliances. The APU produces 5 kW of electricity with an onboard power-management system that delivers electricity to the truck's system, and can export electricity off the vehicle as standard household power. The current APU requires a mixture of methanol and water as fuel; future systems will run on common commercial or military fuels such as diesel or JP-8.

For more information, circle 42

## Interior acoustics

**Owens Corning** is enhancing its portfolio of interior acoustics offerings with an increased focus on the VersaMat thermal and acoustic insulating material product line. The firm plans to provide composite solutions using the technology in applications such as headliners, door panels, under-the-hood applications,

trunk storage systems, and under-carpet heat shields. During the molding process, the thermal and acoustic insulating material forms a semi-structural system that allows it to carry its own weight along with the electronics and ductwork of an overhead system. In addition to acoustic control, it withstands hot and damp conditions. VersaMat can be molded into complex shapes and use different amounts and blends of fibers to meet specific performance requirements. The capability to mold complex components with thicker density in some areas for strength or specific noise control will give automakers more opportunity for functional integration into a single part.

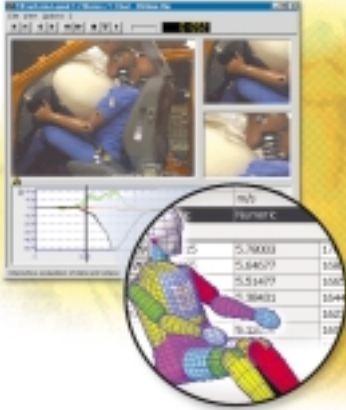
For more information, circle 43

## High-speed cameras

**Photron's** ultima 512 and ultima APX high-speed cameras use two new and totally different CMOS sensors to answer different issues currently being experienced in sled and barrier testing. Both cameras are tested to withstand 100 g for 10 ms and use a remote head configuration with the 16-ft (5-m) cable, permitting the lightweight compact camera head easy access to remote locations. Camera systems can be easily upgraded to incorporate new or different communication cards such as FireWire or Ethernet, as well as other functionality unique to the individual companies using them. Both the 512 and APX incorporate enhanced functionality with features such as over-exposure protection that enables users to set exposure limits for all pixels; dual-speed recording, allowing the change of a recording speed during image capture; 10 "GoTo" event markers for immediate access to key points of interest; and partitionable memory to enable multiple (up to 64) recordings to be made before needing to download stored images. The system provides live video output (color or monochrome) at all times, multiple record modes, and rugged and reliable design and engineering. The ultima 512 offers 512 x 512 pixel operation to 2000 frames/s and reduced resolution operation up to 32,000 frames/s. The ultima APX uses a 1024 x 1024 pixel sensor at full resolution up to 2000 frames/s, and as fast as 120,000 frames/s by reducing the resolution.

For more information, circle 44

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## Body inspection

The ABIS Interactive (Automatic Body Inspection System) from **Steinbichler** uses fringe projection technology to identify, quantify, and classify surface defects such as bumps, dings, dents, and surface waviness in sheet-metal



components and panels. With a data acquisition time of 1 ms, producing 430,000 points in a field of view of 210 x 265 mm<sup>2</sup> (0.33 x 0.41 in<sup>2</sup>), ABIS can detect defects with depths of up to 30 μm (1.2 mil). It is highly portable with no accuracy trade-offs and does not require surface preparation such as highlighting. The system consists of a camera, fringe projection unit, sensor-handling system, and PC with an image-analysis system and software. The system's insensitivity to vibration and motion allow for integration of an inline version of ABIS into a production line. It can inspect the complete surface of a car body within 90 s.

For more information, circle 45

## Vehicle component simulator

**Southwest Research Institute (SwRI)** engineers have developed a test apparatus capable of simulating vehicle powertrain operations in the laboratory. The apparatus uses hardware-in-the-loop



technology and a software-controlled simulator to determine how a powertrain or related component would perform if it were integrated into a vehicle. The engineers designed and constructed a test system that simulates the operation of a transmission under a wide range of real-world conditions. (The image shows a portable cold box being used to test a transmission under low-temperature conditions and varying grade angles.) Similar test systems can be developed to test engines, electric motors, hybrid-vehicle battery packs, and other equipment under a variety of road and environmental conditions. Using the RAPTOR VSM powertrain simulation software, researchers can perform numerous driving cycles to simulate driving conditions and eliminate some fleet testing. The apparatus can simulate stop-and-go traffic, roll and grade angle, heat rejection, aerodynamic drag, varying temperatures, and other parameters.

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## 42-V auxiliary power unit

**Aria Power Products** presents the experimental installation of its AAPU system in a 2003MY Lincoln Navigator. The system incorporates the compact Sytec two-cylinder 500-cc<sup>3</sup> engine, harnessed to a 5-kW high-efficiency permanent magnet generator with combined AC starter. APP has commissioned **Prodrive UK** to perform the design and assembly of the installation. The installation displays the feasibility of mounting the engine as an under-slung unit, cross-member located rearwards of the rear axle in its own enclosure. The generator is located in an environmentally separated compartment of this enclosure. The fuel and coolant systems of the AAPU are integrated into the

main vehicle systems. The prototype Power Management System—which controls the AAPU start-stop system relative to power demand, battery condition, output rectification, and control—is installed in its own cabinet on the

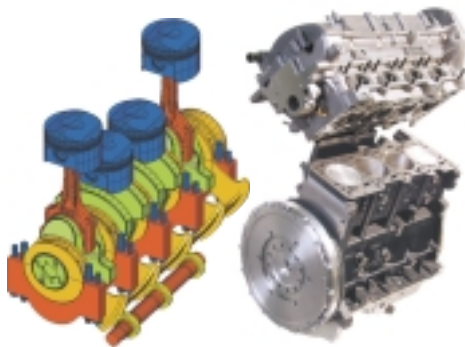


Navigator's rear load deck. This housing also incorporates a 36-V battery in a separately vented, 12-V fan-cooled compartment. The dual-voltage electrical system specification showcases three 42-V features representative of future applications of the technology, including drive motors for the rear HVAC compressor and power-assisted steering pump, and the main vehicle power unit cooling fan. All other onboard electrical applications are powered via a dc/dc converter at 12 V while a rear-bumper-mounted connection socket allows the connection of either a 110-V or 220-V inverter for powering satellite electrical appliances.

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### Engine technology

FEV's Variable Compression Ratio (VCR) technology helps avoid the compromise that is necessary with fixed compression ratio in supercharged engines that feature extended load ranges. It is

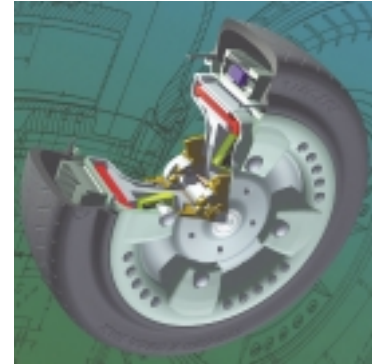


based on the concept of an eccentric crankshaft bearing. Rotation of the eccentric bearing leads to a vertical position change of the crank-train relative to the cylinder head and thus a continuous change in the compression ratio. The company has developed a demonstration vehicle that features the VCR concept. A highly boosted, four-cylinder turbocharged SI engine was redesigned for the eccentric positioning of the crankshaft. The vehicle has undergone several thousand kilometers of test driving and has exhibited neither damage nor unusual wear. As a result of careful combustion tuning, the compression ratio can be adjusted to its maximum/retaining position. Even during continuous driving at 140 km/h (87 mph), the compression ratio can remain at a relatively high value of 14. FEV has subcontracted to the EPA to help develop an in-cylinder NOx control methodology that simplifies after-treatment technologies while meeting 2007/2010 emissions standards. This Ultimate Clean Diesel Engine technology opens the door for cost-effective diesel powertrains that meet the federal Tier 2 standards.

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### Motors and generators

The traction characteristics of **Technologies M4** (TM4) drive systems, which include electrically actuated ABS and traction control, make them especially suitable for launch and wheel assist applications. The distributed control system and direct drive features provide independent wheel control in both acceleration and braking.



The firm's integral electric motor and gearbox/differential units are suitable for most EV, HEV, or FCEV applications. Paired with power converters and electronic controls, the units are efficient and contribute to a system overall efficiency over 96%. The company produces a range extender for EVs or generator for series hybrid vehicles. The generator can also be used to assist as a starter for an ICE. In addition, TM4 develops power converters and electronic control systems for generators and motors, including power inverters, vehicle control devices, and energy flow management systems.

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