Mercedes-Benz heavy-duty developments

As the largest truck manufacturer in the world, **DaimlerChrysler** took some 18.4% of the global medium- and heavy-duty truck market in 2003 with 312,900 new vehicle registrations. Truck brands include **Mercedes-Benz**, **Freightliner**, **Fuso**, **Sterling Trucks**, **Western Star Trucks**, and **American LaFrance**, as well as the **Detroit Diesel** and **MTU** engine businesses.

Many of DaimlerChrysler's truck research programs are focused on safety developments, and the company recently gave an insight into future developments in Germany. As Gerald Weber, head of the Truck Product Creation Unit told *SAE Off-Highway Engineering*, "Our vision of accident-free driving is primarily directed toward active safety or driver support systems."

But with a customer take-up of some 7-8% globally for safety technology in commercial vehicles, manufacturers still have a job to convince customers that the additional cost is worth it. At present, no series production commercial vehicle is equipped with any system that removes control from the driver, but there are circumstances where this may be desirable, such as when a driver has failed to react to a hazard ahead, reducing both the safe braking distance and room for maneuver.

A Mercedes-Benz equipped with ESP (electronic stability program) with steering intervention on a wet split-μ surface demonstrated a shorter braking distance and better control than a vehicle without it.

Torque applied from a servomotor can help drivers of commercial vehicles hold position in highway lanes.

Although electronic stability programs (ESP) offers great control benefits for heavy trucks, reducing the potential for jack-knifing and rollover accidents for truck/trailer combinations, ESP reaches its limitations where full-power emergency braking is needed. Since ESP tries to restore control by braking individual wheels, stopping distances are inevitably extended. But if ESP could intervene in steering movements, it could overcome the problem.

DaimlerChrysler demonstrated the point using two Mercedes-Benz Actros tractor units on a water-logged split-μ surface, with differing coefficients of friction under the left- and right-side wheels. The first vehicle was equipped with ESP and a conventional hydraulic power-assisted steering system. Under full braking, it eventually turned and slid away to the right. For a driver to apply the series of steering corrections in the short time needed to bring the vehicle back under control would be extremely difficult and demand great skill.

The second truck was equipped with an electrohydraulic steer-by-wire system programmed to intervene and prevent oversteer by automatically applying the necessary steering corrections. The system works by comparing the current braking forces for each wheel and the yaw rate with the steering wheel movement from the driver. It then calculates the required braking and steering correction to keep the vehicle stable. With no feedback through the steering wheel, the driver is not directly aware of the steering corrections applied. Under the same braking conditions, the vehicle maintained a more or less straight course.

DaimlerChrysler provided test results that showed a reduction in braking distance from 51.26 to 47.43 m (168 to 156 ft) from the same unspecified speed. Measurements of steering angle also showed a reduction of driver input from a maximum of 126 to 44° for the truck equipped with steering intervention.

Since steer-by-wire presents legislative difficulties, DaimlerChrysler does not currently foresee a production start date for such technology. Even so, it is not necessary to remove the mechanical linkage between the steering wheel and steer axles or remove control from the driver to offer other safety enhancements.

DaimlerChrysler already offers Lane Assistant, a system using a camera mounted behind the windshield to sense vehicle positioning between painted highway lane lines. The vehicle's position relative to the lines is shown on a visual display in the instrument panel. If the vehicle starts to drift into a neighboring traffic lane, a rumbling sound is generated in the audio system speaker on that side—drivers automatically respond by steering in the opposite direction.

Automatic brake activation can help drivers avoid rear-end impacts in traffic.

An extension of the system could apply corrective steering torque to a conventional steering system before the audible warning is given, using a servomotor fitted to the steering column beneath the steering wheel. The driver feels a pull on the steering wheel in the appropriate direction but always maintains complete steering control.

The most dramatic demonstration of the day was delivered by another development of existing technology. DaimlerChrysler's Distronic active cruise-control system has been available on the Mercedes-Benz S-Class sedan and on DaimlerChrysler trucks for the past few years. Using three radar sensors, the system can automatically apply the brakes, or accelerate the vehicle, to maintain a pre-set distance from the vehicle in front.

But Distronic cannot bring the vehicle to a standstill—it can only apply 20% of the maximum braking power and only senses moving obstacles ahead. The radar sensors are active 7 to 150 m (23 to 492 ft) in front of the vehicle in a narrow 3° arc.

In some respects it is easier to trigger full power braking in a commercial vehicle with a compressed air braking system. Pressing the brake pedal opens valves in the system and air pressure applies the brakes. Opening the valves electronically to trigger emergency braking does not therefore require too much energy.

During the demonstration, a Mercedes-Benz Actros truck/trailer combination loaded to 40-t (44-ton) gross approached a slow moving Mercedes-Benz B-Class sedan in the lane ahead. As it approached to a point well inside the safe braking distance, the truck first triggered a flashing red triangle warning on the instrument panel to alert the driver, then, when the driver failed to respond, it sounded the horn, and again, without further response, automatically applied full braking, without loss of control. The system first applied 30% braking force, followed by full power, once the driver failed to react.

The system will be available starting next spring on Mercedes-Benz Actros models, without the sounding horn, and DaimlerChrysler claims that even if the system fails to prevent an impact, it can reduce the impact energy significantly. Using the example of a vehicle traveling at 30 mph (48 km/h), even if emergency braking is not triggered until 15 m (49 ft) before the obstacle, impact energy can be reduced by 95%.

An enhanced version is already under development. Using a microphone to monitor tire noise, a computer then determines the level of surface grip from the noise. The system can determine up to five levels of grip from dry to wet surfaces, taking in snow and black ice. This system is also designed to work when approaching stationary obstacles. Since the system also scans through a wider 15° arc, it can also operate on curves, provided that line of sight is maintained.

John Kendall

Two-stage turbocharging

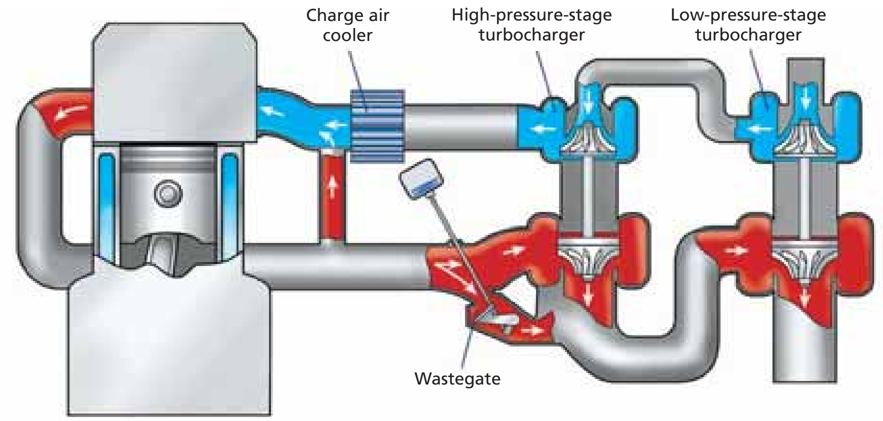
Some of the benefits cited for BorgWarner Turbo Systems' new R2S regulated two-stage turbocharger are an improvement in non-steady-state behavior, reduced NOx emissions, and improvements in boost pressure characteristics.

Regulated two-stage turbocharger technology from **BorgWarner Turbo Systems** (BWTS) that initially debuted in the passenger car market on a **BMW** 535d is now also serving the commercial vehicle market. Developed in cooperation with **MAN** Nutzfahrzeuge AG, the company's R2S allows an infinitely variable adaptation of the turbine and compressor side to any engine operating point. It is currently being used in the new MAN TGL for the 151-kW (206-hp) four-cylinder D0834 LFL 42 common-rail engine.

Diesel engines for passenger cars, and to some extent commercial vehicles, have benefited for some time from the addition of single-stage variable turbine geometry (VTG) turbochargers, though BWTS says that its two-stage R2S is designed specifically to meet the increasing demands for more power output and emissions control in heavy-duty applications.

In regulated two-stage turbocharging, a large low-pressure turbocharger and a small high-pressure turbocharger are arranged in series. Unlike the system used in passenger car applications, regulated two-stage turbocharging for commercial vehicles has only one bypass valve as an actuator on the high-pressure turbocharger. In this arrangement, the turbochargers are tuned in such a way that both of them are active at all engine operating points.

At low engine speeds, and thus low exhaust flow rates, the low-pressure turbocharger performs only a small part of the turbocharging. The bypass on the high-pressure turbine is completely closed. As a result, all the energy from the exhaust gas is used to compress the fresh air in the high-pressure compressor. In the medium- and high-engine speed range, part of the exhaust gas is diverted through the bypass on the turbine side.



As engine speed rises, the high-pressure turbocharger in the R2S system is supported by the larger low-pressure turbocharger, initially as a pre-compressor, providing a constant increase in power and providing a more spontaneous response, particularly when pulling away, accelerating, and on hills.

During this process, the exhaust energy is not wasted but is fully available to the low-pressure turbine.

The boost pressure is regulated by the external bypass, allowing continuous control without any drop in boost pressure, such as with register turbochargers. As the engine speed rises, more and more of the exhaust energy bypasses the high-pressure stage and is fed directly to the low-pressure stage. As an alternative to a turbocharger with a turbine bypass valve, a turbocharger with VTG can be used in the high-pressure stage to control the boost pressure. The VTG can also by adjusted by a pneumatic or electronic actuator.

Jean L. Broge

A victory for bug-free software

Five autonomous vehicles successfully completed the 2005 **DARPA** Grand Challenge in October, led by "Stanley," the **Stanford University** team's entry that finished the course of just over 131 mi (210 km) through the Mojave Desert in 6 h, 53 min, and 58 s (6:53:58). The winning team of faculty and students from Stanford's School of Engineering in Palo Alto, CA, modified a stock diesel-powered **Volkswagen** Touareg SUV with full-body skid plates, a reinforced front bumper, and a drive-by-wire system. For their efforts, the team won a $2 million prize.

Two robotic vehicles entered by teams from **Carnegie-Mellon University** (CMU)—Red Team's "Sandstorm" and Red Team Too's "H1ghlander"—followed closely behind. The modified **Hummer** vehicles finished the course at 7:04:50 and 7:14:00, respectively. "KAT-5," a vehicle sponsored by **Gray Insurance** in Metarie, LA, and named after Hurricane Katrina, completed the course in 7:30:16.

Stanley averaged 19.1 mph (31 km/h) over the course; Sandstorm, 18.6 mph (30 km/h); H1ghlander, 18.2 mph (29 km/h); and KAT-5, 17.5 mph (28 km/h). Another vehicle, the **Oshkosh Trucks** 16-ton (14.5-t) robot, "TerraMax," did finish the course, but exceeded the 10-h time limit with an unofficial time of 12:51:00.

The DARPA Grand Challenge was a race in which autonomous ground vehicles used nothing but onboard sensors and navigation equipment to steer themselves along a desert course. And unlike traditional vehicle races that include mostly straights and curves, this race included tunnels, mountain switchbacks, lake beds, and on- and off-highway stretches—similar to routes driven by military convoys.

The race was the second Grand Challenge for DARPA. None of the competitors was successful during the first race in March 2004, when the best performance was by the CMU Red Team that managed to cover 7.4 mi (12 km) of the 142-mi (228-km) course.

Alex Aiken of Stanford's racing team suggested that software bugs were a major reason for failures in the 2004 DARPA. The team wanted to make sure that did not happen in 2005,

The Stanford University Racing Team won the 2005 DARPA Grand Challenge with its modified VW Touareg, Stanley. Coverity tools were used to analyze the software for errors.

so Aiken brought in code analysis firm **Coverity** to check the software for bugs.

"We were able to identify and subsequently address software issues using Coverity's technology that we were unable to find through manual testing," said Aiken.

Coverity's Prevent and Extend source code analysis products were used to find and eliminate software defects in six custom software modules designed by the Stanford team: computer vision, inertial navigation, LIDAR (similar to radar but using lasers), planning and optimization, control, and reliability. Of the 68 defects detected, approximately half were in the custom software developed at Stanford Artificial Intelligence Lab and half were software libraries that other engineers created.

In addition to a five-cylinder turbocharged diesel engine, Stanley was powered by a cluster of six onboard **Intel** Pentium M computers that processed information for five laser range finders, radar, monocular vision, GPS, and an inertial measurement system.

David Alexander

A smooth ride marks the beginning

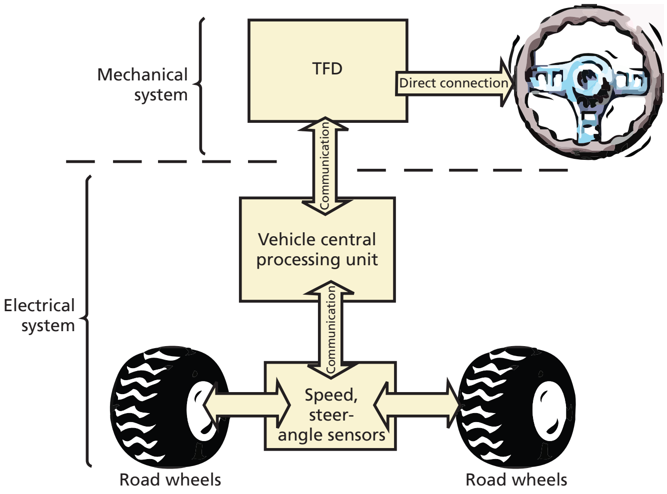
Real-time controlled damping is just one of the applications for magneto-rheological (MR) technology. Sold as MagneRide by **Delphi**, MR fluid technology will be standard or optional on six **General Motors**' vehicles in the 2006 model year for the U.S. market. Additional production vehicles—for Europe and other markets—will use the high-performance, semi-active suspension control system by 2007.

Delphi's MagneRide uses input from body and wheel motion sensors to make damping control adjustments up to 1000 times a second. Delphi holds many device and suspension application patents on MR fluid technology, while **Lord** has several device patents as well as patents on the fluid's composition.

"The fluid is optimized for each specific application," said Kristopher Burson, Market Manager for Lord's MR Solutions Group.

Magneto-rheological fluids have micron-sized, magnetically sensitive particles in a liquid. The application of a magnetic field changes the fluid from a liquid to a semi-solid state that is proportional to the strength of the magnetic field applied.

"This change occurs because the particles form a network of 'chains' when exposed to a magnetic field. These chains cause the fluid to behave more like a semi-solid or plastic. This change in apparent viscosity is instantly reversible and infinitely variable," said Andy Kintz, Manager of MR Fluid Technology at Lord.



The diagram shows a drive-by-wire system that employs Lord's MR-enabled Tactile Feedback Device (TFD) to simulate the resistive torque of steering.

Fenwick Linde, based in France, offers magneto-rheological (MR) technology on its all-electric lift trucks.

Fan clutches, engine mounts, and driveline clutches represent a few applications of interest. "Our internal work on mount applications has focused on developing fluids that provide the required performance and still meet the rigorous temperature demands of the device," said Kintz.

A fan clutch application using MR fluid could be an alternative to using silicone fluid. The device consists of an input shaft connected to an inner rotor, surrounded by MR fluid and an outer housing that attaches to the fan. When the MR fluid is exposed to a magnetic field and becomes semi-solid, that translates to more input shaft torque being transferred to the outer housing and fan.

"The fact that MR fluid is continuously variable allows precise control of the fan speed, allowing for optimal cooling of the engine. Also, when the fluid is not energized, almost no torque is transferred to the fan—unlike a silicone clutch that stays partially engaged and drains power from the engine," said Kintz, adding that MR clutches could improve fuel economy by 2.5 to 5% when compared to a conventional viscous clutch.

Several steer-by-wire applications have used MR technology. For instance, **Linde** uses Lord's Tactile Feedback Device to simulate the resistive wheel torque in its all-electric forklifts, while **Volvo Penta** uses MR technology as part of a new propulsion system for select marine pleasure crafts launched in 2005.

Agreement among OEMs, government, and standards bodies on a system specification is the major hurdle to having steer-by-wire for production applications. "Once resolved, the remaining technology elements exist today. There are no performance or durability issues with using MR technology in a [production] steer-by-wire application," said Kintz.

Kami Buchholz

EBM process comes to America

With the direct manufacturing sector growing, **Synergeering** Group has imported a technology from Sweden to broaden its filled nylon plastics LS prototype-making capabilities to include titanium alloy metal. The EBM S12-T machine from **Arcam** was installed at Synergeering's facility in Farmington Hills, MI, late last year.

"This expansion of our capabilities helps us to further develop, and continue to serve, focused niches in fully functional prototyping [prototypes that are also functioning components] and direct manufacturing," said Tom Gogoe, President of Synergeering.

A service bureau (a company that provides rapid prototyping, rapid manufacturing, and peripheral services to customers who do not have these capabilities in-house), Synergeering uses electron beam melting (EBM) technology in titanium as well as laser sintering in nylon plastic to serve its clients. Three-dimensional objects are created layer by layer from powdered titanium alloy (Ti-6A14V) in the EBM process. An electron gun is used to melt the powder within a precisely controlled vacuum chamber. It is different from

Among the engine parts produced by Synergeering via Arcam's EBM process are valves, valve rockers, pistons, connecting rods, gears, and bearing races. A number of chassis parts also are produced.

Circle 211

laser sintering in that, among other things, the finished material is fully melted, yielding material properties equivalent to those of billet titanium alloy.

The Arcam product is a cross between a layer deposition rapid prototyping machine, an electron beam welder, and a cathode ray tube. CAD models from the customer are "sliced" to provide data to the machine. Magnets "steer" the electron beam to melt the titanium in the shape of each layer's cross section, simultaneously melting it into the layer below. After each layer is complete, the build table moves down, a new layer of powder is spread across the build area, and the melting of the next layer begins. When melting is complete, the part is removed from the build chamber and cleaned, yielding a surface finish similar to that of a sand-casting. Further post-processing (*e.g.*, chemical milling, machining, drilling) can be performed to provide necessary surface finish or features.

Use of a vacuum chamber allows the electron gun to function properly and provides a contaminant-free environment for melting the titanium. Because the powder is fully melted, the parts have 100% density and billet material properties in a near net shape. This combination of performance attributes cannot be achieved with other manufacturing methods, according to Synergeering. When compared with machining an entire part from stock, EBM has much less engineered scrap and equivalent material properties. Any finish machining required on the EBM part will have to remove much less material than starting with bar or plate. Compared with casting, EBM has no tooling, no porosity, and is also suitable for low-volume runs/prototyping.

Patrick Ponticel

Ford adds LCF to commercial fleet

The tilt-cab market, which is expected to grow from 24,000 units/year currently to 40,000 by the end of the decade, recently received a new competitor as **Ford** introduced its 2006 LCF (Low Cab Forward).

Designed with maneuverability as a top consideration, the LCF has what Ford claims to be the tightest turning radius and diameter in the segment. The LCF's wheels cut 53°.

"The reason that maneuverability and turning radius are so important on this is the majority of these vehicles are sold and maneuvered in inner-city areas where you need to have the opportunity to get in and out of traffic," said Joe Castelli, Ford Division Commercial Truck Director.

The over-engine cab features a large windshield, which helps aid visibility needed for maneuvering in tight situations. Various second-unit bodies are attached to the vehicle to fit different applications, including landscaping, construction, and towing.

The LCF was developed as part of the **Blue Diamond** joint venture (JV) established in 2001 by Ford and **Navistar International**. This project took on increased complexity, as it was a global endeavor. The cab was engineered and built in Japan by **Mazda** and shipped to the JV's Escobedo, Mexico, facility, where the vehicles are being assembled.

The project was also an exercise in coordination as Ford and International shared design responsibilities.

"The engineering is done through International. We add our differentiation, like the grille and other features of the vehicle, but the way we did the venture is very efficient for both companies because we supply a parts bin to try to keep the investment down on that vehicle," said Frank Davis, Vehicle Program Director for Trucks and Commercial Vehicles at Ford.

The Ford LCF was built as part of the Blue Diamond joint venture with Navistar International. It is being assembled at Blue Diamond's facility in Escobedo, Mexico.

Tilt cabs offer advantages in visibility and maneuverability over conventional cabs. The cab is lifted easily through the use of a latch system.

"If you look at the total market, one manufacturer dominates, and that's **Isuzu** and its peripherals," said Davis. "We want to go after that market and own a little bit of market share."

International supplied the LCF with its PowerStroke 4.5-L V6 diesel engine. The unit produces 200 hp (149 kW) at 3000 rpm and 440 lb·ft (597 N·m) at 1850 rpm.

Ford provided its TorqShift five-speed electronic automatic transmission with tow/haul mode, which automatically adjusts shift points for hauling loads up and down steep grades. The transmission was built at Ford's Sharonville, OH, plant.

The LCF's 34-in (864-mm) wide frame is based on the Ford Super Duty chassis. Crossmembers joined by **Huck** bolts help give the LCF what Ford claims to be the segment's strongest standard frame.

The LCF has four axle-to-frame choices, five cab-to-axle options, and five wheelbase lengths, ranging from 113 to 185 in (2870 to 4700 mm).

Customers also have a choice in fuel capacity, with capacities ranging from 35 to 70 gal (132 to 265 L). A 40-gal (151-L) tank is standard.

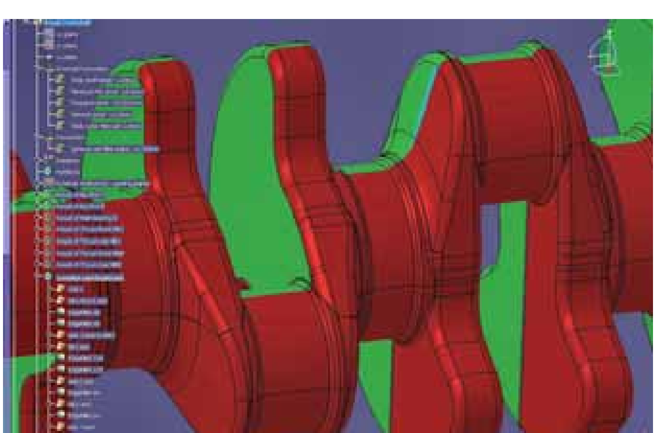
Matt Monaghan

New AID to speed engine design

The need to automate design, modeling, and engine optimization to cut lead times has led UK engineering consultancy **Integral Powertrain** to develop new rules that govern the way the company's Catia CAD system creates models of engine parts and assemblies. Called Automated Intelligent Design (AID), it is claimed to be capable of reducing the time needed for the creation of a crankshaft design from three weeks to half a day.

The 5000 rules in the Catia database control hundreds of aspects of the engine's design, from the detailed shape of bolt holes to the positioning of oil jets. "Engineers make use of rules every day during the design process," explained Luke Barker, Technical Director at Integral Powertrain. "They might be driven by material characteristics, company standards, or their own design experience. What we have done is capture the best practice and embed these traditionally manual calculations and decisions directly into the CAD system, so anything that can be automated, has been."

The resulting "templates"—CAD models of engine components with rules attached—can then modify themselves according to the requirements of each design task. The company's



Integral Powertrain's Automated Intelligent Design tools facilitate design of a crankshaft in half a day.

LOOK AT WHAT YOU CAN SEE!!

ACTIA introduces the endoscope Endomotor designed to see inaccessible and hidden vehicle parts.

- Allows you to see inside of the engine or dashboard without heavy dismantling
- Check belts, hidden part numbers or fluid leaks
- Check for carbon & sludge build up inside of the engine
- Flexible cable with CCD camera displays images real-time onto your computer
- Images can be stored or emailed to your customer for authorization and verification of repair
- 3 optical nozzles-Wide Angle, Axial, or 90 degree
- EndoMotor only needs one USB port. "Plug & Play" and no external power reguired

Thinking Globally....Acting Locally!

www.actia.com
info@actia.com
734-266-2083

ACTIA®

Circle 213

piston template is a single model that can be adapted from a gasoline to a diesel design by changing certain key input parameters. "Instead of worrying about the details of geometry creation, our engineers can control the model by entering higher-level parameters such as bearing size, cylinder pressure, and rotational speed," explained Barker. "From the resulting models, we learn very quickly whether a particular engine concept is going to meet our requirements."

Many more options can be considered during the concept design stage, and Integral Powertrain has created what Barker terms "sophisticated digital mockup and analysis tools" to verify concepts. "This enables us to move forward with a more competitive solution that we know isn't going to throw up costly problems further down the line."

Some 3700 labor-hours have been invested in the creation of the rule base, but Barker is confident that productivity benefits achieved in use have far outweighed the cost of the time taken to create AID. "When we started using this system on customer projects, we were able to complete one engine design iteration in 10 weeks—significantly faster than with traditional methods. In one of our most recent projects—also lasting 10 weeks—we were able to investigate and optimize engine architecture to enable a single engine family covering three engine configurations to fit three vehicle platforms. Some key components were iterated 50 times to deliver the solution," said Barker.

Integral Powertrain is now extending the AID system to automatically generate machining data for prototype part production.

Stuart Birch

Applying technology to the combat zone

The ULTRA AP concept vehicle was developed by Georgia Tech Research Institute to illustrate potential technology options for improving survivability and mobility in future military combat vehicles.

A concept vehicle known as the ULTRA AP (armored patrol) has been designed to help illustrate potential technologies that could benefit future military vehicle design in terms of improving survivability and mobility. R&D development for the ULTRA was led by the **Georgia Tech Research Institute** (GTRI) and included a team of research engineers from **Chrysler** and **General Motors**, as well as the **U.S. Army TACOM** (Tank-automotive and Armaments Command).

The research initiative was sponsored by the **Office of Naval Research** (ONR) to investigate and assess new technologies for military use for the **U.S. Marine Corps** and **U.S. Army**.

In terms of survivability, the diesel-powered ULTRA AP will feature novel design concepts and research advances in lightweight and cost-effective armor to maximize capability and protection. The new armor was designed at GTRI in partnership with the Georgia Tech School of Materials Science and Engineering. The vehicle also incorporates a "blast bucket" designed to provide ballistic, blast, and enhanced rollover protection. Current real-world events have provided proof that new vehicle designs must incorporate dramatically increased resistance to explosions caused by mines and improvised explosive devices.

The ULTRA design also explores the use of onboard computers to integrate steering, suspension, and brakes for increased levels of mobility and safety. The ULTRA project is linked directly to "e-safety," an emerging concept that combines computers and advanced technologies to make driving safer. In e-safety, night driving systems and stability control add security, while radar systems—already available in Europe—actually slow vehicles automatically under certain conditions.

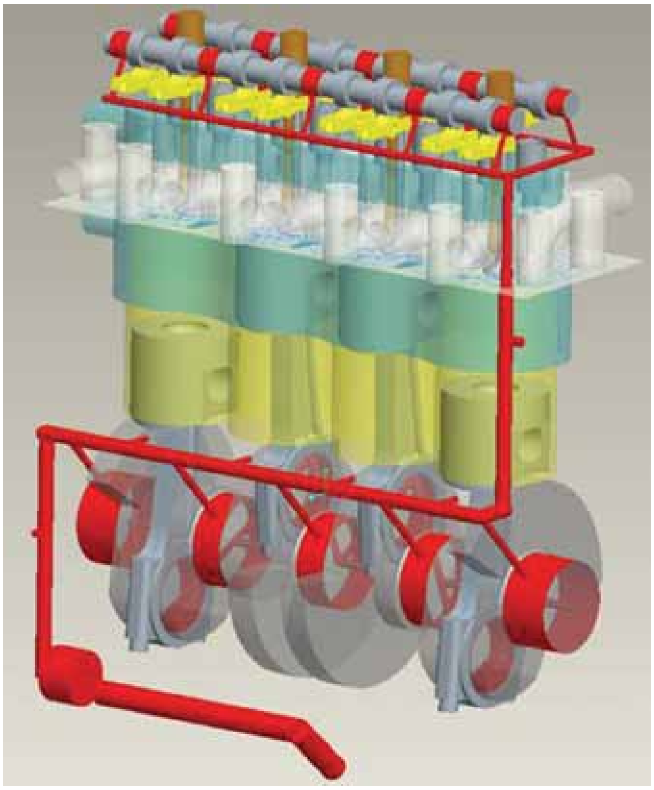
Jean L. Broge

Developing engine engineers

The idea for a new type of engine engineering qualification came from a meeting on campus at the **University of Wisconsin-Madison** (U of W-M) in 2000 between the academic staff and industry customers. The meeting was called to evaluate demand for short courses for the engine industry, but it became apparent that all the participants had a greater need to fill. Feedback came from executive engineers at companies such as **DaimlerChrysler**, **Caterpillar**, **Cummins**, **International**, and **Harley Davidson**.

"All were experiencing similar challenges in their organizations," said Kevin Hoag, Director of the Master of Engineering in Engine Systems (MEES) program at the University of Wisconsin-Madison. "Career progress for engineers tended to be down either a thermal/combustion or structural/vibration path. Few get technical expertise in both disciplines. A new engine program at any company would like to have a chief engineer with significant technical background in both, in addition to electronics, controls, and manufacturing." All companies have the same challenge—a breadth of technical background is needed to be able to integrate the different disciplines into a successful program.

The first MEES class started in 2003. Wayne Pferdehirt, Program Director for Engineering Distance Degree Programs, had already developed a Web-based master's course that won awards for excellence in distance education. The new model is Web-based—all specially designed course modules with no classroom—which makes it very compatible with the engine research approach.



A recent Master of Engineering in Engine Systems (MEES) design class project was to develop a lubrication system for a four-cylinder engine.

Award Winner.

dSPACE is Company of the Year

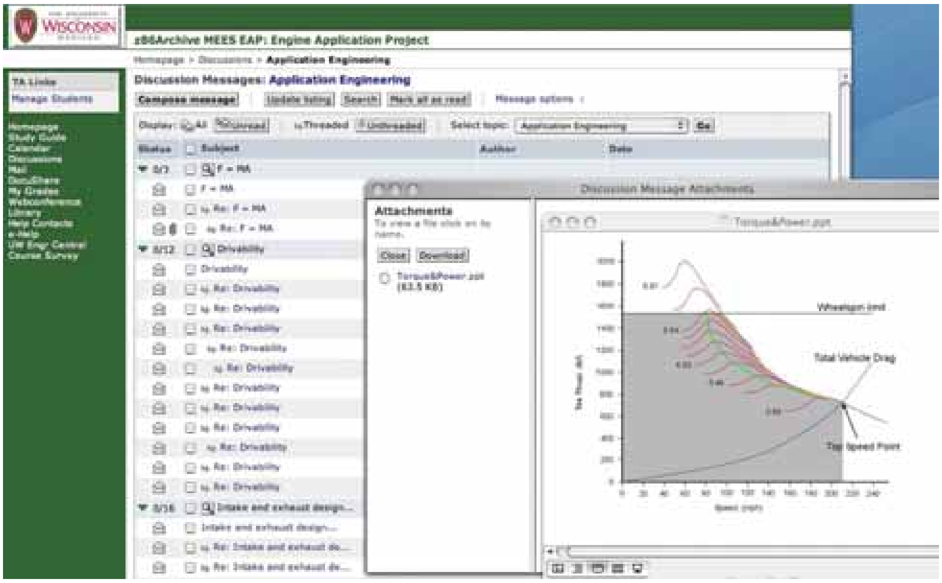
- Complete solutions for closed-loop testing of embedded controller software in real-time
- More than 1100 dSPACE hardware-in-the-loop simulators implemented world-wide
- Unmatched in engine, powertrain and vehicle dynamics applications

2005 FROST & SULLIVAN
Company of the Year Award

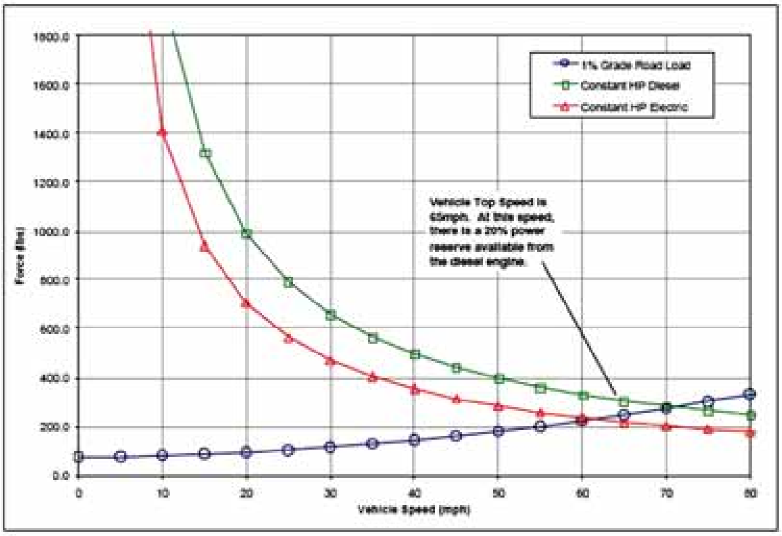
dSPACE Inc.
Phone: 248 567-1300
info@dspaceinc.com
www.dspaceinc.com

dSPACE

Circle 215



The MEES program at the University of Wisconsin-Madison relies on distance-learning tools such as threaded online discussions.



MEES students undertake detailed engine design projects in small groups, with output such as this analysis of a hybrid powertrain for a postal delivery truck.

Key to establishing the MEES was the existing large engine research facility at U of W-M, with 50 graduate students focusing on engines, plus six full-time faculty staff. The graduate school had already generated a master of engineering option.

"An advantage of distance learning is that it can focus on a particular industry regardless of geography," said Hoag. "The potential audience is anyone working on engine development. Our objective is to produce people with a breadth of technical skills who know enough to be able to understand the experts."

Student teams take on a major project that extends over several semesters. Each team consists of three or four engineers who help to define their responsibilities. Each member is employed in the industry, and takes responsibility for learning the general methodology and working on how it is applied in his or her own company's products. The project is an in-depth engine design, and each individual does a "deep dive" on one aspect.

"I feel that the distance-learning approach encourages more student-to-student interaction with online study than through the traditional classroom learning environment," said Hoag. "The class has progressed as a group, and cross-learning has been critical."

One key tool used is the threaded online discussion. Students can post questions and experiences and share answers and results. Being online means it is available 24/7. At the start of each semester a ring binder is supplied containing a study guide with a CD. Lectures are developed using Camtasia software from **TechSmith**, which allows the presenter to include sound and video. Students can work ahead if they want to.

Ricardo was involved early on, volunteering student licenses of WAVE. During the course on engine fluid dynamics, WAVE models were built by each student. Other software companies are also involved. **ReliaSoft** has provided Wiebull++ for reliability prediction. Student licenses of Matlab and Simulink from **The MathWorks** are used for engine control development.

The scope of the degree course is deliberately kept as broad as possible, with a focus on fundamentals. Students come from many industries, with backgrounds in small and large engines, marine and automotive, two- and four-stroke, diesel and spark ignition. Understanding the governing equations and fundamental physics is the goal, and how these principles are applied across industries is the contribution from the students themselves. Because of its ubiquitous popularity, the internal-combustion piston engine does get most of the focus.

Instructors are drawn from the university faculty and from industry. Harley Davidson, **GE**, **Southwest Research Institute**, **Toyota**, and **GM** have all provided instructors, who are hired as adjunct faculty. Guest lecturers from **Ford** and **Honeywell** have also been featured, and others are always welcome.

Bill Hancock is the President of **Arrow Racing Engines** in Auburn Hills, MI. His shop does many of the aftermarket parts for the **Mopar** performance catalogue, and all of the warranty work on the **Dodge** Viper V10 engines, and his background includes being factory engineer for Richard Petty's **NASCAR** team. Hancock has been involved with MEES from the very beginning and has done several guest lectures on engine design considerations for racing.

David Alexander