

Bi-fuel, fuel-cell power gen

A fuel cell that can operate on either natural gas or methanol, or both, went into service at a **Vattenfall** plant in Berlin last fall. The bi-fuel properties of **MTU CFC Solutions'** HotModule are being tested in everyday operation as part of field trials at **BeWAG**, a subsidiary of Vattenfall, a Swedish-owned utility company whose main markets include Sweden, Finland, Germany, and Poland. The test run is also intended to demonstrate that the system is not reliant on the existence of supply networks because the liquid fuel used in the system is derived from wastes generated in the city of Berlin.

The HotModule was built by MTU CFC, a **DaimlerChrysler** AG company, as a decentralized miniature power plant. The current testing program is the result of more than 10 years of development work. MTU CFC's parent company, **MTU**

Friedrichshafen, is better known for its diesel engines and drive systems for ships, trains, heavy-duty vehicles, and decentralized power supply systems, however, "For our parent company, fuel cells represent a long-term addition to the present-day range of products, particularly in the field of power supply systems," said Michael Bode, CEO of MTU CFC.

The HotModule system consists of three separate components: a central steel container with the fuel-cell stack, which is how the HotModule got its name; upstream gas treatment; and an electric part in which generated dc is converted into ac and the system control is housed. The HotModule is a carbonate fuel cell, inside which the temperature is 650°C (1200°F). Such high temperatures eliminate the need for expensive catalytic converters made of precious metal. Nickel is sufficient to initiate the fuel-cell reaction.

At 650°C (1200°F), natural gas and water can be combined within the fuel cell to result in dehydrogenation. Hydrogen is required to run fuel cells, and it is expensive to obtain from low-temperature fuel cells in bulky reformation systems.

With virtually no emissions, the HotModule is said by MTU CFC to require significantly less fuel than comparable conventional power plants to produce the same amount of electricity. The HotModule generates not only electricity, but also high-temperature heat. The waste air emitted by the HotModule is heated to 400°C (750°F), with which high-pressure steam can be produced for a variety of industrial processes, for example at **Michelin** for producing process steam for the vulcanization of tires.

To date, 12 field-trial plants have been erected, of which eight are currently undergoing practical testing and four have finished the testing phase. "With every new system we gain valuable experience, which we incorporate during further development, above all with regard to preparation for series production," said Bode, adding that the preliminary target for the start-up of series production is 2006.

So far, the HotModules have achieved electrical efficiencies of almost 50%, a value that MTU CFC claims is not attained by any conventional technology in the 250-kW class. For comparison, modern gas engines in the same size class have a mechanical efficiency of about 41%, which does not include the conversion of the mechanical energy into electrical power.

Two MTU CFC HotModules are currently in service in the U.S. for the automotive and power supply industries courtesy of Danbury, CT-based **Fuel Cell Energy** (FCE). FCE is a U.S. cooperation partner that has MTU as its largest single shareholder. The cells of the HotModule, the key components of the plant, are supplied by FCE. The actual nucleus of the system includes some 350 individual cells installed in sequence and held together by anchor bars, thus



The first MTU CFC bi-fuel fuel cell went into service at Vattenfall Europe AG in Berlin last year. It is fueled with natural gas or methanol or any mixture of the two. The methanol used is derived from waste generated locally.



The HotModule fuel-cell power plant is the result of 10 years of development work and, according to MTU CFC, should be ready for series production in 2006. It generates electricity as well as process steam from manufacturing facilities.

creating the cell stack.

Along with methanol and natural gas, the HotModule can be run with other hydrocarbon-based fuels including biogas, sewage gas, landfill gas, and industrial residue gases. "Currently, much of this gas in industry and agriculture goes completely to waste or at best is used in thermal applications," said Bode. "The HotModule offers a highly efficient possibility to use these gases to produce power."

MTU CFC believes that fuel-cell technology has not become sufficiently established in the mass market for power generation because efficient fuel cells are still too expensive, either because they require complex installations with costly peripherals or because they are dependent on high-grade materials such as platinum.

"The bar in the market is set high," said Bode. "The pace at present is being set by gas engine plants, which cost less than €1000 per kilowatt even though they achieve significantly lower efficiencies than our HotModule."

MTU CFC intends to lower the costs of its fuel cell to between €1100 to 1500 per kilowatt by implementing technical simplifications to make the system peripherals—such as the fuel gas treatment—significantly cheaper to manufacture in

A sense of force

Swiss company **Kistler** specializes in meeting force, pressure, and acceleration measuring requirements using piezoelectric, piezoresistive, and capacitive techniques. Now it has come up with the RoaDyn System 2000 automotive static and dynamic wheel-force measurement and analysis system using what it terms the "latest data-processing and RF transmission technology." It has been designed to meet all types of on-road and laboratory test applications to provide a precise method of wheel-force measurement, from passenger cars to construction equipment.

Kistler explains that integrated digital processing and RF telemetry transmission of data from the force sensors in the moving wheel to the signal-conditioning module in the vehicle eliminate the need for "noisy, difficult-to-set-up-and-maintain, slip-ring transmission." One compact stator that can be fitted inside a wheel arch determines wheel rotation angle, provides inductive power for the rotating electronics, and receives the transmitted data. According to the company, the elimination of complicated fixing arms and cables on the exterior of the vehicle allows testing to be carried out safely on public roads.

Only six components are required for the system, which registers the three forces and three moments acting on the wheel. Received data is digitized by in-built electronics, thus avoiding any potential errors caused by electrical/electronic interference, temperature variations, and transmission noise. By using light-

the future. They are also taking another close look at the fuel cell itself. The plan is to simplify its construction further, to economize on materials, to increase the power output of the cell, and to reduce the number of steps required for production of the cell. However, the greatest savings potential lies in series production.

"Today, every HotModule is still a one-off handmade product whose costs cannot be compared with those of series-manufactured products such as engines," said Bode. "When the HotModule reaches the stage at which it is ready for series production, cost savings of a further 50% will become possible, enabling us to achieve our cost target."

Like other types of fuel cells, the development of the HotModule is not yet complete. MTU technicians are working on increasing the energy density of the cell and extending its service life. Individual cells currently produce 0.7 kW, but are expected to generate 1 kW in the future. MTU engineers are also in the process of making the HotModule even more flexible so that it could continue to generate power independently in the event of problems with the power-supply system, even in the event of total power failure.

Jean L. Broge



The RoaDyn wheel-force measuring system does not affect performance, braking, or steering.

weight equipment, the RoaDyn wheel is said to have weight and inertial characteristics similar to those of a standard wheel.

According to Kistler, vehicle performance, braking, and steering are unaffected. The RoaDyn wheel can cope with dust and splash water. The system has a Windows-based interface run on a laptop PC. Data interfaces are available for all standard data-acquisition systems.

Stuart Birch

Crushing design challenges

In 1979, **British Rail** introduced its Advanced Passenger Train project to design and build a high-speed train that could use existing track. A prototype train went into service briefly in the early 1980s, but for various reasons—some of them political—the government scrapped the project.

High-speed rail service has now returned to the UK. **Alstom** is providing 44 trains featuring **Fiat's** Pendolino tilt-train technology, and **Virgin Rail** is funding the venture.

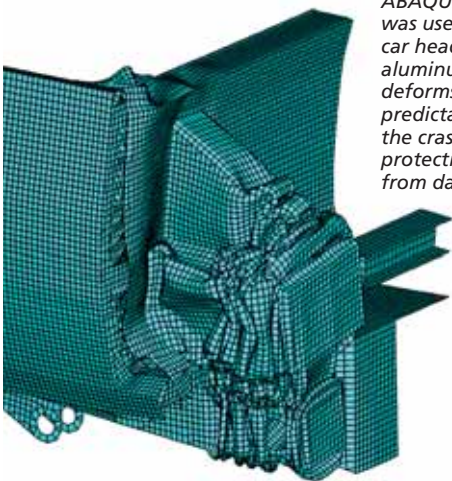
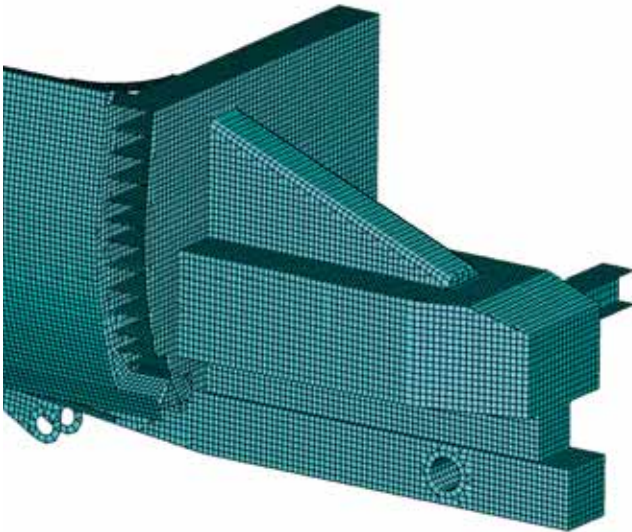
Alstom turned to **Alcan Mass Transportation Systems** (Alcan MTS), based in Zurich, Switzerland, for the design and

testing of a crash zone at the front and rear of the rail cars to protect the occupants in the event of an impact. "Each metal feature of the crash zone has to absorb as much energy as possible before failing," said Alois Starlinger, head of structural analysis and testing at Alcan MTS. "In that way, it passes less of an impact to the passenger zone of the car."

Speed and reliability are important to train design, but safety is paramount. "The safety requirements for high-speed trains are stringent," Starlinger said. Vehicle requirements for the Class 390 Pendolino trains stipulate that rail cars be built so



Crashworthiness is a vital safety requirement for the Pendolino high-speed trains built for the UK. (Image courtesy Alcan Mass Transportation Systems)



ABAQUS FEA software was used to simulate a rail car head-on impact. The aluminum crash module deforms in a controlled and predictable way, absorbing the crash energy and protecting the survival zone from damage.

that the passenger zone of the car can withstand a 60 km/h (37 mph) closing-speed collision between two trains.

The crash zone of a rail car faces challenging design requirements. The zone must be strong enough to withstand the day-to-day forces of use and maintenance, but must also be significantly weaker than the passenger zone or it will not fail first and properly absorb the impact of a crash.

Making the crash zone heavier (for strength) or longer (for energy absorption) are not options. Customer design requirements specify that the crash zone be no more than 1.2 m (4 ft) long and as light as possible. "The maximum axle loads of high-speed rail cars are set by the track they run on," Starlinger



Alcan MTS built a full-scale prototype of the crash zone, upon which quasi-static physical testing verified the analytical predictions from ABAQUS.

said. "The main mass of the car is reserved for the propulsion units and the air conditioners."

The aluminum alloy selected to build the rail car helps meet these design challenges. AA 6008 is lightweight and strong in its extruded form. It is also highly ductile, making it suitable for absorbing the energy of a crash. Alcan materials engineers subject the finished parts to a heat-treating and quenching cycle that increases the ductility more.

Safety regulations stipulate that the crash zone of a rail car must absorb as much as 3 MJ of energy. As a basis for comparison, studies have shown that roughly 0.11 MJ is absorbed by a small automobile running into a wall at 35 mph (56 km/h). Compliance with safety guidelines is proven through analysis and testing. A new European rail standard in preparation specifies the use of FEA software to verify structural and crashworthiness designs.

The Alcan MTS designers and engineers began by modeling a cross section of the rail car crash zone in **Dassault Systemes'** CATIA software. Structural and crash engineers were part of the design team at the earliest stages, and they made suggestions based on analytical rules, design equations, and experience.

"We were very familiar with the aluminum alloy and its properties," Starlinger said. "And from previous projects, we had a good idea of what the crash structure would look like and how it would behave." For maximum energy absorption, the structure has numerous internal walls with enough space between them to allow buckling on impact.

Once the cross-section design was complete, the team used it to create a 3-D model of the crash zone, complete with joints and welds. Using **Altair Engineering's** HyperMesh software as a pre-processor, the engineers exported the model to ABAQUS/Standard, an FEA software package for advanced linear and nonlinear analysis from **ABAQUS**. They then performed a quasi-static analysis that simulated the forces the structure would undergo during normal operation and maintenance.

"A number of the static structural analyses were nonlinear and even involved plastic yield," Starlinger said, "but nothing outside of safety standards." The European structural standard for railway vehicles allows for local stress peaks, small zones of stress beyond the yield stress of the structure, as long as these spots are small and do not cause significant residual damage or deformation.

The team decided that quasi-static analysis was sufficient to prove out the structural design under regular operation and maintenance loads. "If we had been working with steel or composites, we might have needed dynamic testing," Starlinger said. "But for AA 6008, the effects of strain rate—the speed at which an impact deforms the structure—are minimal: below 10%." The completed crash-zone design was engineered to bear a force of 4500 kN (1010 lb) of longitudinal compression and withstand all other operating and maintenance loads.

At this point, the analysis entered the nonlinear FEA phase in which the behavior of the structure under impact was simulated. The engineers transferred the digital model directly from ABAQUS/Standard into ABAQUS/Explicit. The automated transfer saved a great deal of time, considering that the meshed model of the crush zone was large—approximately 120,000 elements.

The engineers used a buckling-analysis tool in ABAQUS/Explicit to investigate how the aluminum would fold on impact. The goal of the analysis was to verify that the final design would undergo plastic buckling at a fairly constant, predetermined force level. Over the course of the analysis, the team at Alcan MTS varied wall thicknesses, tried different cutouts, added curvature, and changed welds to ensure that the crash structure would deform at a controlled and steady rate, front to back.

Modeling the transfer of forces inside the structure involved using the general contact feature in ABAQUS/Explicit. General

contact allows the engineer to easily define complex contact scenarios—for example, the multiple walls of an "egg-crate" structure crumpling under impact.

"The general contact feature automates what is otherwise a time-consuming, surface-by-surface process," Starlinger said. "It saved us a great deal of time." When the analysis was complete, the engineers used ABAQUS/Viewer to review the results of the simulations.

Once the results of the FEA analysis met the safety requirements, Alcan MTS built and heat-treated a full-scale prototype of the crash zone. At a testing facility, they placed the prototype in a large hydraulic press and physically applied quasi-static forces equivalent to those in a crash. Readings from the press provided data that determined the load-deflection curve of the structure under compression.

The data from the ABAQUS/Explicit analysis and the physical test are remarkably close. "Whenever I show these results to people, I feel I have to say, 'We did not cheat; we performed the FEA analysis before the testing,'" Starlinger said. The crash zone met all design requirements. In fact, it was well under its target mass.

Alcan MTS, a subdivision of **Alcan Aluminum**, has used ABAQUS to analyze several other crash modules, including on the **Stadler** GTW trains for **New Jersey Transport** and for the Swiss Federal Railway **SBB**.

David Alexander

Defensive software solutions

Windchill Aerospace & Defense Module is a software add-on module for **PTC's** Windchill PDMLink. It was developed for the global aerospace and defense (A&D) industry's need for the traceability of highly complex product and program informa-

tion across a program life cycle. In this new module, PTC fuses both experience and best practices development with market-leading A&D companies into a single solution.

A&D companies are commonly faced with information that is disconnected and spread across many organizations, often making configuration management of their products laborious, error-prone, and time-intensive. The combination of Windchill PDMLink and the new Windchill module allows A&D manufacturers and government program offices to efficiently manage and securely share digital product and program information internally and externally with customers and suppliers, from a single net-centric environment. To support the rapid and low-risk implementation of the Integrated Digital Environments frequently mandated by A&D contracts, PTC offers a fixed-price, quick-start service package as well as specialized training.

With Windchill Aerospace & Defense Module, Windchill PDMLink now offers contract deliverables management, advanced serialized parts management, advanced effectiveness management, as-built / as-maintained configuration management, and advanced change management processes.

Customers are expected to be able to reduce time and effort to meet contract requirements for defense programs; improve quality of execution; reduce risk of delays in program milestones and deliverables, avoiding potential payment penalties; and achieve enhanced compliance with configuration management standards.

David Alexander



PTC has developed a new module to help companies such as General Dynamics work with the government on defense contracts. Shown is the company's Stryker brigade vehicle, which can travel on highways at speeds up to 62 mph (100 km/h) with a range of 312 mi (502 km).

Uplifting lift-truck technology

Raymond has been making material-handling equipment for more than 82 years, and with its commitment to emerging technologies, it should not be hard for the company to at least double that time.

"Raymond focuses on developing and incorporating new technologies that will help its users improve material-handling operations in terms of truck reliability, performance, and cost of ownership," said Jim Malvaso, President of Raymond. "We are working with developers of emerging technologies to ensure that our trucks will be compatible with or incorporate these innovations as they become practical and commercially available."

Claiming to be the company that introduced the first hydraulic hand pallet truck in 1930 and the first narrow-aisle lift truck in 1951, the company has moved to the incorporation of microprocessor control technology and beyond. It is currently involved in the development of emerging technologies with



Raymond is currently involved in several technology areas such as RFID, fuel cells, and vision systems that it believes will improve material-handling operation in terms of reliability, performance, and cost of ownership.



The company is looking into fuel cells to replace the batteries that power its lift trucks. The fuel cells would eliminate battery change-out and a battery-changing infrastructure while enabling longer run times.



The vision system envisioned by Raymond would use cameras and/or lasers mounted on the fork carriage to make it easier for operators to position the forks for put-away and retrieval of loads.

advanced research and collaboration in RFID (radio frequency identification), fuel-cell power, and vision systems for lift trucks.

Raymond trucks are currently being used in a working RFID warehouse, or what it describes as a "living lab," in Alberta, Canada. This joint venture with three other North American companies is assessing the value, productivity, and return on investment of RFID in the material-handling trade.

RFID requires no physical contact between the pallet or case and the scanning device. This feature means lift truck operators do not have to dismount or otherwise expend effort and time to record the receipt, movement, or placement of loads. RFID codes also have the advantages of being highly secure, accurate, and flexible.

Over the past two years, Raymond has been working with several fuel-cell technology companies to explore the viability of hydrogen fuel-cell power for lift trucks. The fuel cells for Raymond vehicles would replace batteries and generate savings by eliminating battery change-out, enabling longer run times, and eliminating battery-charging infrastructure.

Raymond is also involved in the development of a vision system for lift trucks. These systems will use cameras and/or lasers mounted on the fork carriage to make it easier for operators to position the forks for put-away and retrieval of loads. The operators will be able to watch the forks interface with the rack from a screen in the compartment, thus increasing accuracy and efficiency. The current system uses a point of light to indicate the position of the forks relative to the rack.

Jean L. Broge

Shuttling off with hydrogen

Ford is introducing two hydrogen-fueled internal-combustion engines for the airline ground-support market. The engines will also have an application in the power-generation market, according to Ford.

The first commercial application of the hydrogen V10 will be the company's 2006 E-450 shuttle bus, which first saw duty in January shuttling attendees at the 2005 North American



The Ford 6.8-L V10 (shown) is one of two hydrogen engines currently prototyped for use in the industrial market. It has a rated power of 188 hp (140 kW) at 2600 to 3600 rpm. The smaller 4.2-L V6 engine will offer 80 hp (60 kW) at 3600 rpm.



Ford's 2006 E-450 shuttle bus for airline ground support will be powered by the company's hydrogen-powered V10 internal-combustion engine, which is a modified version of the company's Triton engine.

Accelerating armor

Department of Defense (DOD) engineering and technical support services contractor **Radian** of Warren, MI, had already been tasked to develop an armor kit for the **U.S. Army's** Family of Medium Tactical Vehicles when roadside bombs, guerrilla attacks, and increasing casualties in Iraq brought about an aggressively accelerated schedule for the company.

"We had time to make just one physical prototype for testing," said Hugh "Sandy" McLeod, Director, Land Systems Division, Radian. "It had to pass the first time, as the margin for failure would be measured in casualties. The only way we could achieve the design objectives and still meet the schedule was by using virtual prototyping tools."

The overall design objective was to achieve DOD-specified ballistic and blast protection without degrading payload capac-

ity, maneuverability, reliability, or durability. Losses in any of these characteristics would directly impact driver and passenger safety, potentially negating the protection of armor. The ballistic materials added approximately 4200 lb (1900 kg) to the mass of the vehicles. Fortunately, the original design characteristics of the vehicles were such that the extra mass of the armor had minimal impact on payload capacity.

The DOD-specified ballistic materials—steel and glass—had to be securely mounted. Laying armor on the floor of a vehicle without securing it would allow the plate to fly up into the cabin if a roadside bomb exploded. One of the most difficult issues was determining how to attach armor plate to the truck cab without crushing it.

"We had to know the stresses—where and how much they

International Auto show in Detroit. A pilot lease program has been established to place pre-production E-450 buses in target markets. The 12-passenger vehicle is equipped with a 26-gal (98-L) equivalent, 5000-psi (34.5-MPa) hydrogen fuel tank with an expected range of about 150 mi (240 km).

A modified version of the 6.8-L Triton gasoline engine that powers the 2005 F-Series Super Duty, the E-450's V10 is supercharged and inner-cooled. It will also be able to operate on natural gas (NG) and liquefied petroleum gas (LPG). Compared to a current gasoline-fueled internal-combustion engine, Ford says the modified hydrogen engine delivers up to a 99.7% reduction in CO₂ with many of the benefits of a hydrogen fuel cell but at a fraction of the cost.

The 6.8-L hydrogen engine has also been prototyped in a genset application via Waukesha, WI-based **Generac Power Systems**. According to John Andreas, Director of Programs and Engineering for **Ford Power Products**, the engine creates "minimal vibration, making it highly durable, with little wear on the engine or genset components."

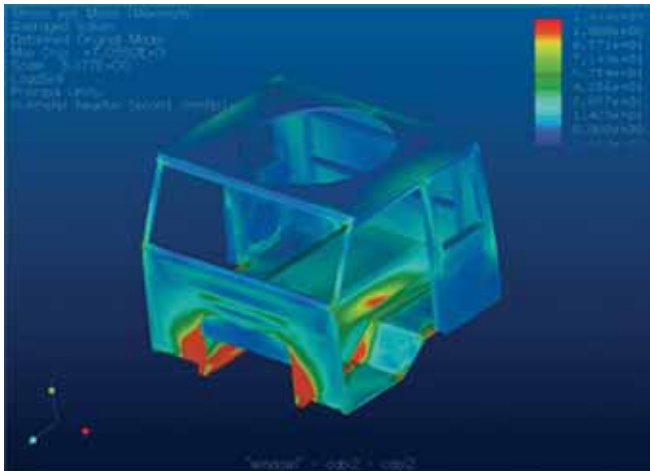
In addition, a Ford 4.2-L V6 industrial engine has been modified to run on hydrogen. This engine has previously been a key power source to the ground-support-equipment market in gasoline, NG, and LPG configurations and is currently being prototyped in smaller airline ground-support equipment.

Marietta, GA-based **TUG Technologies** is using the engine in its model M1A airport tow tractor. The hydrogen internal-combustion engine is a helpful power solution within the airport environment, where emissions levels are strictly regulated.

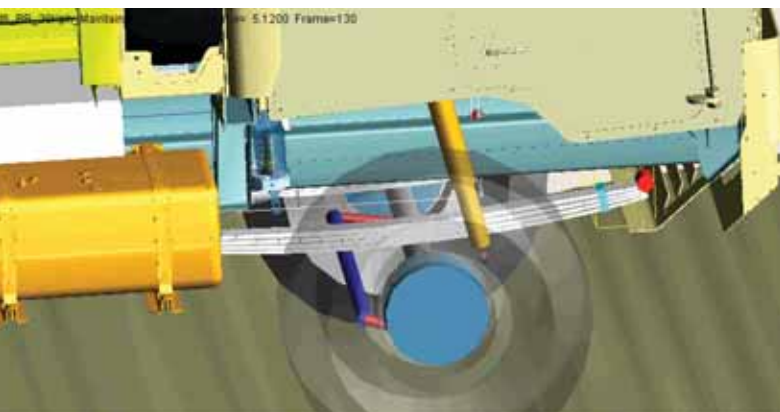
Ford says it is advancing hydrogen fuel technologies as a way of reducing mobile and stationary emissions and reducing the U.S.'s energy dependence on fossil fuels, and claims to be the only OEM actively involved in all four alternative fuel technologies: gasoline-electric hybrids, clean diesels, hydrogen-powered internal-combustion engines, and fuel cells.

The company is working with **BP** to build a network of hydrogen fueling stations in demonstration fleet markets to support further development in hydrogen- and fuel-cell-powered vehicles. Some BP hydrogen refueling stations will evaluate technologies that have near-term commercial feasibility, such as reformation of natural gas, while others will explore more long-term technology options and assess the potential to produce renewable-based hydrogen that achieves **Department of Energy** hydrogen fuel cost targets.

Jean L. Broge



Radian used stress analysis on the truck cab to identify how and where to attach the armor.



Dynamic suspension analysis of the armored vehicle was run with MSC.ADAMS to determine the effect of the extra mass on handling.



The crew walked away from this truck fitted with a Radian Armored Cab Kit after it was hit by a suicide car bomb.

were without physically putting armor on a truck," said McLeod. "The FEA analysis provided the data to find out how and where to attach the armor to the cab."

Another crucial issue was a requirement that the armor be removable and the cab restorable to its original configuration. In peacetime, the army cannot afford the increased cost of

fuel, maintenance, and shorter life from driving a heavily armored truck. The Radian Armored Cab Kit (RACK) envelops the original cab with a protective armor cocoon designed to be bolted on. RACKs can be installed on the production line or shipped to any location for field installation.

The doors and windshield are removed from the original cab and the RACK is mounted to the cab by locating a portal (a structural member) inside the door frame. The attaching point for the armor is the attaching points of the original doors plus four new bolt holes. This portal becomes the anchor for the entire armor system. The only other attachment location is where the rear armor is bolted to the frame, because the cab is a tilt-forward design. The integrity of the cab is ensured by clearances between the armor and the cab.

"MSC.Nastran and MSC.Marc [from **MSC.Software**] indicated where the stresses were so we could minimize or redistribute them," said McLeod. The use of the software ensured 90° corners were maintained and prevented the hood and sides from bending or twisting from the weight. "MSC.Nastran provided more robust analytical capability than what we had before. Also, MSC.Marc has a ballistic component that helped analyze the integrity of the attachment points."

Tactics adopted by U.S. convoys in Iraq rarely include casual drives down smooth roads. Vehicles must often leave the highways, encountering harsh off-highway conditions while still needing to maintain speed. This type of driving requires powerful brakes and good handling. The extra mass of the armor changes a vehicle's center of gravity, and therefore affects its driveability and handling characteristics.

"We used MSC.ADAMS to replicate the Army Test Center Mobility Courses at Aberdeen Proving Ground in Maryland," said McLeod. "We modeled the full vehicle and various components, including the suspension system, allowing us to test mobility, braking, lane changes, and cornering without a physical prototype. With simulation, we were able to determine the impacts on the vehicle, as well as the forces on the driver and passengers."

Simulation tools helped Radian's engineering team determine that changes to the frame were unnecessary. Although the added mass would cause them to wear out sooner, the brakes still stopped the vehicle. In fact, the mass of the armor over the front axle actually reduced the stopping distance.

"Dynamic simulation allowed our design team to anticipate changes to springs, suspension, and latch-down beams," said McLeod. "We did not go through the traditional design processes of build, break, redesign, and retest. Instead, we used design, simulation, and physical test for validation, which cut development time dramatically. When the government acceptance tests were completed, we went straight into production and began building the kits."

Durability and reliability are continuing issues. Although the engine was designed for hauling heavy cargo, the weight of the armor created an extra load. The long-term effects will be a shorter life.

"We have some ongoing work that we hope will help us discover lighter-weight armor so army vehicles will always be armored," said McLeod. "We're also doing some redesign work to increase the speed with which RACKs can be installed, and speed is more important than reducing labor costs in the current situation."

David Alexander

No vibrations are good vibrations

The main difference between a diesel engine and electric motor is not as much about power as it is about vibration.

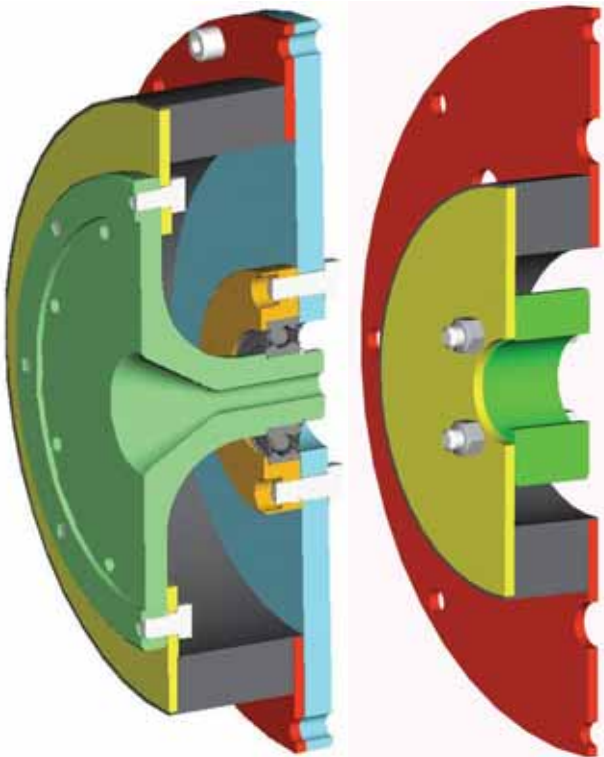
Lovejoy cites one example in which a California farm switched from electric motors to diesel engines to power irrigation pumps. It was not long before constant vibrations began damaging connected equipment.

A coupling was found that helped damp the vibrations, but it had been designed specifically for marine applications and proved to be cost-prohibitive for long-term use in an agricultural application.

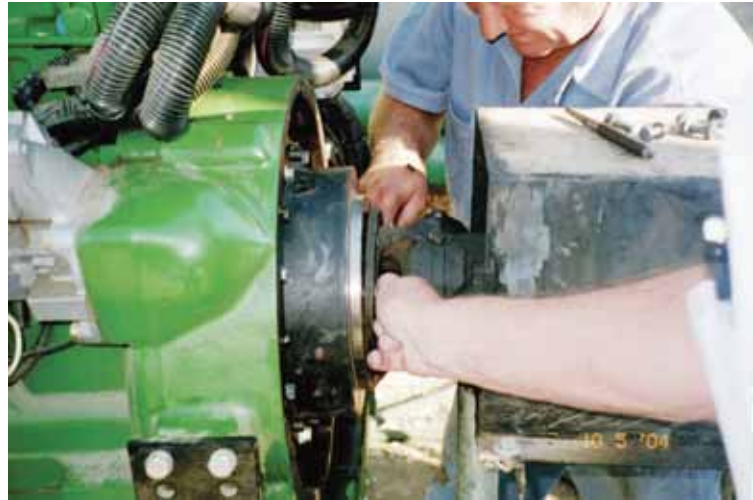
To address such issues, Lovejoy designed and built the LV-Torsional coupling for u-joint drive systems and the LV-C for direct-drive systems as economical alternatives for both the agricultural and construction equipment industry. Agricultural users can attach the coupling to diesel engines driving deep-well and centrifugal pumps, while the construction industry could use the coupling on engines that run diesel-powered portable compressors.

This type of coupling also takes advantage of the strength, durability, and economical manufacturing qualities of sintered technology. Lovejoy claims to own and operate the most technologically advanced powdered-metal processing press in the country. According to Jim Mahan, Director of Engineering at Lovejoy who helped create the new couplings, "We were able to use our new sintered technology to achieve a balance of performance and price. We planned the available sizes and power range to cover any potential use or pumping application in these industries."

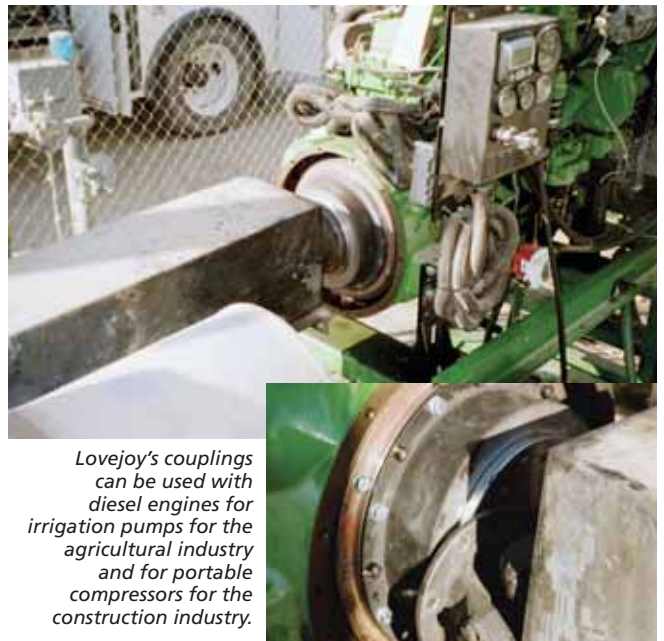
Lovejoy says that this type of coupling lends automatic torsional tuning to smaller diesel engine systems. By providing



Lovejoy's LV coupling (left) is offered in five sizes from 150 to 625 hp (112 to 466 kW) at 1800 rpm, and the LV-C type in six sizes ranging from 50 to 425 hp (37 to 317 kW) at 1800 rpm.



An LV coupling being installed on a diesel engine used for an agricultural application. Most of Lovejoy's coupling manufacturing and assembly is done in the U.S.



Lovejoy's couplings can be used with diesel engines for irrigation pumps for the agricultural industry and for portable compressors for the construction industry.

relief from vibration, the coupling helps extend the life of the machinery connected to the engine and pump, thus saving on expensive parts and labor due to breakdowns. "The agricultural market doesn't have a lot of extra money to spend on additional equipment," said Mahan. "And the construction industry is highly competitive. Both require economical parts with a long lifespan."

A current application of the coupling is in almond groves in California. Almond growers use pumps to flood the ground at night, allowing water to seep into the ground. Grape orchards and other fruit and vegetable growers use similar irrigation methods and therefore a lot of diesel-driven pumps. In the construction industry, the most common application for the Lovejoy LV-type torsional coupling would be portable compressors on-site that power jackhammers or other equipment.

Jean L. Broge