

## Casting iron for a role in suspension components

Engineers are often hesitant to design suspension components made of nodular cast-iron materials because local material properties are thought to be more brittle, especially under the extreme loads of heavy-duty vehicles, compared to forged materials with equal strength properties. Recent developments in cast-iron materials, produced via enhanced casting processes, allow component properties to catch up with properties of forged component, say researchers from **MAN Nutzfahrzeug, Claas Guss**, and the

**Fraunhofer Institute** for Structural Durability and System Reliability.

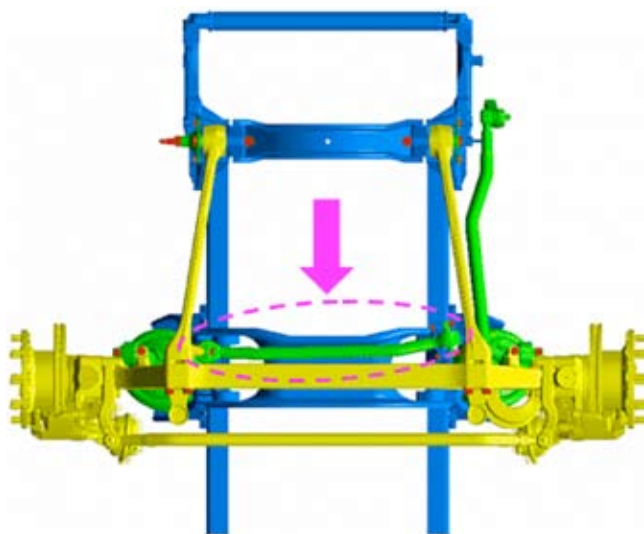
Nodular cast-iron materials allow for the production of near-net-shape components and are characterized by good fatigue performance and ductility. In contrast to flake graphite cast iron, nodular cast-iron materials show energy absorption and fatigue properties that can compete with the properties of forged materials.

The fatigue performance and the impact behavior of two variants of a heavy-duty suspension arm were compared by experimental and computational tests. The first variant was made of EN-GJS-400-15, a cast iron with a tensile strength over 400 MPa (58 ksi) and a ferritic microstructure. The other variant was austempered EN-GJS-800-8, a cast iron with a tensile strength over 800 MPa (116 ksi) and an austenitic-ferritic microstructure.

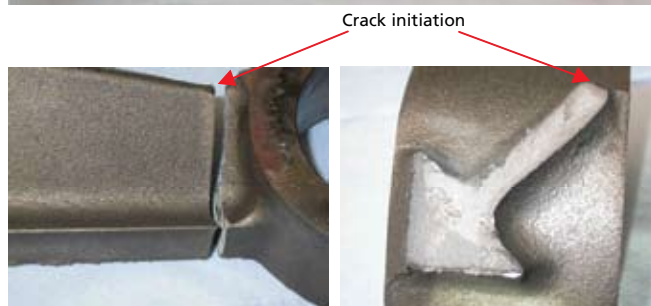
Researchers found that the high-strength cast iron with an austenitic-ferritic microstructure showed better fatigue properties than ductile cast iron with a ferritic microstructure in specimen and component tests. The high-strength cast iron was superior especially in the component tests under variable amplitude loading. In those tests the cyclic load capacity of the suspension arm was about two times greater, although the area of first cracks was notched.

However, the occurrence of microstructure imperfections—e.g. porosity and micro-shrinkages—led to a reduction of the fatigue life in a single specimen of a high-strength cast-iron suspension arm, proving that the material quality is obviously decisive when it comes to fatigue life. The application of high-strength materials in suspension components requires a low scatter of final strength properties in the component and a high level of quality in the production process. The quality of cast components can be increased by using enhanced feeding systems, quality control loops, and nondestructive testing. Without such measures, the advantages of high-strength materials cannot be exploited.

A pre-loading of suspension arms made of high-strength cast iron that led to a local plastic strain of 0.02% did not influence the fatigue life of the arms significantly under variable amplitude loading. The upper limit of plastic pre-strains that do not influence the fatigue life of high-strength cast iron could not be determined in the project because of test rig restrictions. Therefore, 0.02% plastic pre-strain has to be understood as a minimum value. The fatigue life of the arms made of ductile cast iron was not influenced up to a local plastic strain of 1%. Micro-structure imperfections significantly reduced the fatigue life of pre-loaded suspension arms made of high-strength cast iron.



Researchers conducted constant and variable amplitude fatigue tests on suspension arms made from high-strength and ductile cast iron. The fatigue tests were performed on both un-preloaded and preloaded arms.



During un-preloaded tests, cracks in both materials always occurred at the radius close to one of the lugs. The average fatigue life to crack initiation was about 70% of the average cycle number to rupture for the EN-GJS-400-15 arms and 80% for the EN-GJS-800-8 arms.

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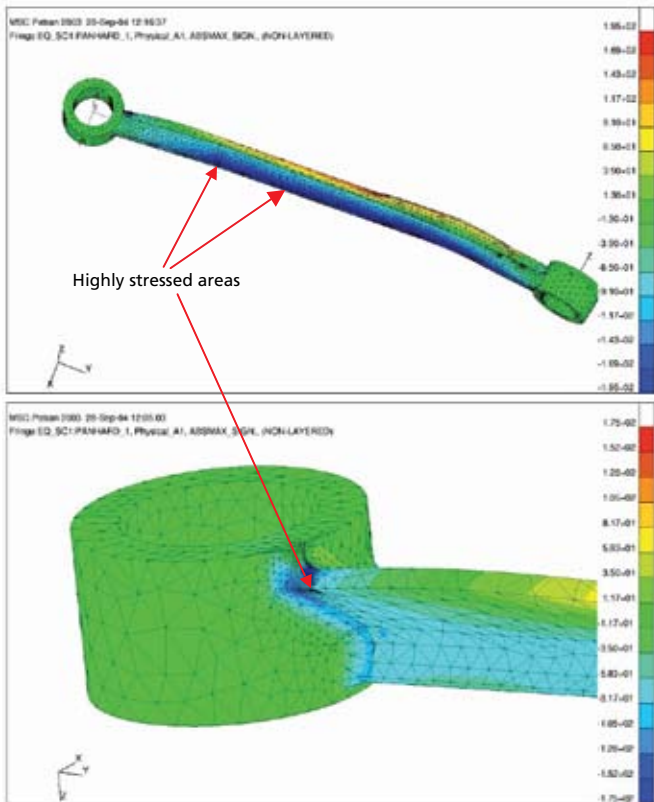
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To evaluate the components, strain gages were applied on the suspension arm and measurements were conducted in the test rig, with additional stress calculations also being performed.



There were two areas where cracks initiated first in the fatigue tests with preloaded high-strength cast-iron suspension arms.

tested impact speed of 6.5 m/s (21 ft/s). In the drop hammer test rig, ruptures occurred only when microstructure imperfection were found.

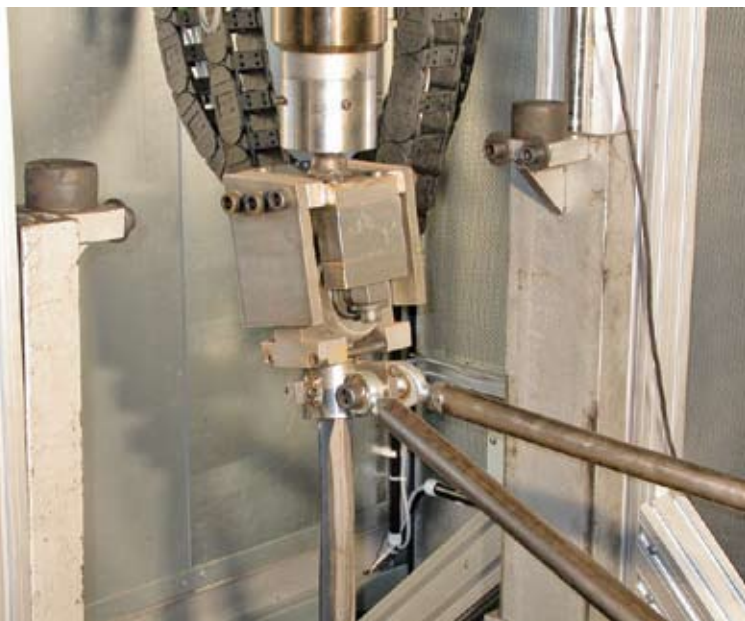
For the component's design, the deformation properties of the high-strength materials had to be taken into account to achieve a load-deflection property of the component similar to components made of more ductile materials. This lower component stiffness allows a driver to differ between a misuse event, which can lead to the necessity of repair, and an extreme load, which the suspension can bear without an influence on the vehicle's aimed service life. A soft load-deflection property also led to lower loads in the adjacent components, and thus lower damage when an exceptional load occurred.

A simple substitution of lower-strength materials by high-strength materials in suspension components could lead to hazardous accidents if the modified impact properties of the component are not taken into account in the design phase. Hence, the substitution of the materials of suspension components without changing their shape is generally not recommended.

Finite element (FE) simulations can be used to optimize components that are mounted in complex assemblies and loaded by different load types. Simulations are recommended to achieve better solutions in component design when various requirements have to be fulfilled. Simplifications in FE models are allowed only as long as the simplified load and displacement boundary conditions generate local results in the relevant areas close to reality. The total and local behavior of the component simulated needs to be meaningful compared to the physical tests.

The application of experimental and numerical methods can produce optimized solutions for suspension components that are designed with respect to a wide range of operation loads in customer service, including cyclic and impact loads. To maximize the benefit of modern high-strength materials, the application of the FE method is vital.

Information for this article was provided by **André Heinrietz** and **Rüdiger Zinke**, Fraunhofer Institute; **Manfred Streicher**, MAN Nutzfahrzeug; and **Christine Bartels**, Claas Guss.



To achieve an impact characteristic of the realistic load in the lugs of the arms, the arms were tested with the rubber bearings mounted in a drop hammer test rig.

Fatigue tests on suspension arms showed the potential of austempered high-strength cast iron as design material to reduce mass of suspension components, while impact tests showed high energy absorption of the components up to the

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# Company spinning its wheels, but in a good way

Glenn Metalcraft (GMI) expects to be a bigger and better supplier of oversized metal spinnings to the off-highway industry once “the most powerful machine in its configuration ever built for a company in the United States” is up and running.

The Minnesota-based company will use the machine custom-built by **MJC Engineering and Technology** of Huntington Beach, CA, to make wheels for tracked vehicles and wheel centers (*i.e.*, the bore and bolt pattern portion to which the rim is attached) for Tier 1 suppliers to ground-mobility industries, as well as heavy-gauge metal spinnings for other industries.



Glenn Metalcraft's new lathe features a 200-hp (150-kW) spindle, 100-hp (75-kW) hydraulic system and a three-station automatic turret.



A part is removed after being spun during the machine's testing period.

GMI was wrapping up the testing phase for the machine as of September, anticipating the start of production work soon after—“adding shields, finishing the installation of a crane erected over it, and doing various other things,” said company President Joe Glenn.

“With the size of the tools and blanks for the new work

that will be running through it, we are forced to tackle a new set of paradigms not yet faced,” said Glenn, elaborating on the larger issues surrounding installation of the new machine. “Above all, we are determining what things need to be modified and adjusted so that we can be successful with the new projects slated to run through this new work center. We are taking it slow to make sure that we do it correctly and safely.”

Prior to commissioning the MJC Model SP-78200-3, the company was limited to spin-forming materials no more than 0.50 in (12.7 mm) thick in many configurations. Additionally, the software tools provided with its expensive, foreign-made equipment failed to keep up with the company's demands for rapid changeover; repeat production orders frequently needed to be reprogrammed every time they were set up.

Faced with the limitations of standard PNC (playback numerically controlled) machines, GMI began to consider a custom solution—a machine that could quickly, accurately, and consistently form and machine a mild-steel blank of diameter up to 80 in (2032 mm) and of thickness up to 1.375 in (34.93 mm). An increasing number of customers requesting spinnings in grades as hard as 80,000 ksi (551,580 MPa) tensile yield was another reason for considering a custom solution.

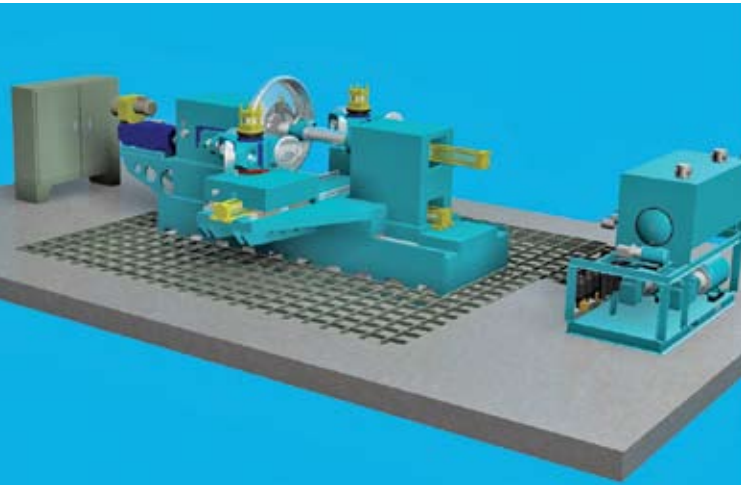
“We have used PNC playback controllers for nearly two decades,” said Glenn. “These machines are set up manually by highly skilled operators using a joystick to guide the spin rollers. The joystick motions are recorded by the PNC control and then ‘played back’ to produce parts. In theory, the PNC recording should be reusable *ad infinitum* with the occasional minor programming change.

“In practice, however, the machine tool bed does not have a permanent, fixed position; the beds are moved to accommodate different types of parts. To effectively repeat a program, the bed has to be pinned precisely in the same spot in which the original program was created. Machine rollers, cutting tools, and spin mandrels also need to be exact from setup to setup along with material thickness. If any one of these variables changes, the recalled PNC program is useless because current controls do not incorporate a home reference position. The machine doesn't know where it is and we have no effective way of telling it through the existing control.”

Working with close-toleranced and heavy-gauged materials— $\pm 0.005$  in ( $\pm 0.127$  mm) and 0.375 to 0.750 in (9.525 to 19.05 mm) thick, respectively—GMI has had to develop a lot of proprietary manual processes along with specialized tooling and equipment to overcome the limitations of the PNC-type control and movable bed system. Despite these efforts, it has managed to achieve a recall success rate of only about 80% for most PNC playback recordings. “Operating 24/5, this has been an enormous issue for us,” said Glenn. “We need to have 100% recall capability for our off shifts to function effectively.”

With MJC's SpinCAD CNC programming software, a **Microsoft** Windows-based operator interface program allows the machine programmer to generate spin passes on a computer screen with point-and-click technology. These are tools that are not standard with PNC controllers. To prove to its employees that MJC's software would work in its environment, GMI upgraded one of its machines this year to the SpinCad controller. “With a minimum amount of training we were spinning production parts,” said Glenn.

“MJC's software allows an easy ‘home bed’ position,” he added. “It eliminates the joystick and allows true PC-based



*Solid Edge 3-D design software from UGS allowed MJC engineers to model every part of the new machine.*

CNC programming. To date, we are experiencing about a 98% success rate of retrieval of programmed parts. As an added bonus, the SpinCAD CNC control provides for smoother, more consistent product finishes than the PNC playback machines have historically produced.

“Our final consideration is product servicing. Our current PNC machines are foreign-made. Domestic on-site service is difficult to get and expensive if we need it. Replacement parts can be difficult to find or almost prohibitively expensive; the LCD monitors fitted to two of our machines are proprietarily programmed /altered by the manufacturer with replacement units costing upwards of \$5000 each. We have a video card for one of these units sitting on the shelf. The card cost \$5000. It did not fix the problem and it cannot be returned.”

The MJC software will be the brain behind the new machine. Integrated control solutions of this type result in advantages when it comes to maintenance, parts stocking, and training of operators.

Having a mass of nearly 50 ton (45 t), MJC’s Model SP-

78200-3 spin machine features a 200-hp (150-kW) spindle and 100-hp (75-kW) hydraulic system. Each topslide features a three-station automatic turret designed to handle the massive thrust forces generated by the hydraulic system. In addition to cold-forming mild steel up to 1.375 in (34.93 mm) thick, the SP-78200-3 also will be able to machine the profile and edges of the part.

“While our focus is engineering and technology, our solutions are based upon the customer,” said David Grupenhagen, Vice President of Sales and Marketing for MJC. “Each new component we incorporate into the design of a machine must offer our customer a feature that makes the machine more reliable, safer, and less expensive to own and operate. Wherever possible, we use parts that are made in the U.S. so that service, support, and availability remain the standard.”

“The new machine is an enormous step for Glenn Metalcraft,” said Glenn. “MJC’s business model has allowed them to research and design a piece of equipment that exactly meets our needs and thus the needs of our customers.”

GMI worked with MJC to find the solution for completing a variety of operations in one setup with the double-roller, three-axis system. It was a blank-sheet-of-paper effort. “Many parts of the design—headstock, slides, bearings—are actually over-built based on detailed FEA analysis to be worry-free,” said Glenn. He added that the company likely will upgrade more of its equipment to MJC’s control system.

“We have positioned ourselves to be very appealing for low- to medium-volume production runs, as our tooling is a fraction of what stamp tooling costs,” said Glenn. “We have the ability to start with a value-added laser blank, form the wheel center, and machine certain diameters and heights all in the same operation. The significance of this can be better understood when you begin to tackle the handling involved with a part that can weigh 200 lb to upwards of 1200 lb each.”

Glenn estimates that the company will be able to turn roughly 3000 ton (2700 t) of value-added steel through the machine per year.

*Patrick Ponticel*

## DuPont resin helps marine engines shift smoothly

The Flo-Torq IV propeller hub isolator, developed by **Mercury Marine**, is said to deliver quieter and smoother gear shifting for marine engines. “The hub isolator virtually eliminates the noise, vibration, and harshness effects perceived as ‘shift clunk’ when shifting from neutral into gear,” said Scott Olig, Materials Engineer, Research and Development, Mercury Marine.

The component consists of two ring-shaped plastic parts joined by eight titanium rods. The plastic parts, made of **DuPont Delrin 150** acetal resin, are over-molded onto the rods. The isolator is mounted on a sleeve that mates with the propeller shaft. When the engine is shifted into gear, the isolator functions as a torque spring, absorbing the difference in rotational energy between the shaft of the propeller, which is turning “lazily” in the water, and the engine’s drive gears, which are spinning at 264 rpm.

According to DuPont, the titanium rods are deformed by up to 15° of arc as the acetal part nearest the drive gears turns faster than the acetal part at the propeller end. The rods act like springs, damping transient vibration and high shock loads.

The parts made of Delrin serve as rotational direction lead-



*Mercury Marine’s propeller hub isolator assists in smooth, quiet gear shifting. The component consists of DuPont Delrin acetal over-molded on titanium rods.*

ers for the titanium rods, provide corrosion isolation of the rods from other metal elements of the drive system, and also help to damp energy, says DuPont.

Another important function for the plastic parts is to protect

the drivetrain against damage in the case of a severe propeller impact. Both parts have molded-in races that are designed to shear under severe loads, helping to prevent the transfer of impact forces to pinion gears, drive gears, or other drivetrain components, according to Olig. After such an impact, the boater can “easily and quickly” install a spare isolator hub.

“By combining Delrin acetal resin with titanium rods, we were able to design a part that performs functions neither the plastic nor metal could do alone,” said Olig, noting that DuPont assisted in the development process. “A key element of assistance was computer-aided finite element analysis,” he

said. “It gave us crucial data for designing the molded parts and for simulating the nonlinear force deflection curves of their interaction with the titanium rods during operation.”

Mercury Marine manufactures the Flo-Torq IV isolator at its plant in St. Cloud, FL. It is currently used on production models of supercharged four-cylinder, four-stroke outboard engines up to 200 hp (150 kW). In the future, the company plans to adopt it for all of its four-stroke engines, including six-cylinder models with up to 275 hp (205 kW).

Ryan Gehm

## Industrial robots get a bit more human-like

Robot makers are striving to make hardware that performs more like humans, using two arms to perform related tasks such as assembly. The new focus comes despite a slump in the auto industry, which is the largest consumer of robots in North America.

**Motoman** is leading the move to develop industrial robots that more closely mimic human actions, unveiling a dual-armed robot at September’s International Manufacturing Technology Show in Chicago. The closely linked arms improve efficiency in both movement and floor space.

“The key advantage to having one robot in a workspace is that you get a 50% floor space savings,” said Craig Jennings, President of Motoman.



Motoman unveiled a dual-armed robot at September’s International Manufacturing Technology Show in Chicago.

The robot also offers a minimum of seven axes of motion, going up to 13. That represents substantially more flexibility than conventional robots, which typically go up to five axes. The additional motion gives the robot more flexibility and helps it operate in areas where space is limited. The company’s dual-arm unit currently has a 20-kg (44-lb) payload at this point, leading to its DA 20 name.

“Our first DA 20 sale was to **General Motors**,” Jennings said. “They see a chance to automate assembly, which is the last frontier for jobs that are not yet automated.” That robot is being used in a research facility to determine how it can be applied, he added.

Jennings explained that half of the manual tasks now performed by OEMS involve bolts and screws, with parts installation consuming another 20%. The dual-arm robot’s close interactions make it possible to pick up a part, position it, and attach a bolt or screw.

The Motoman robot also marks a change in technology,



Two Fanuc robots can be deployed with a single controller.

incorporating an actuator that integrates the motor, encoder, and the reducer. “That gives you fewer moving parts and a smaller footprint,” Jennings said.

Other suppliers are taking a slightly different approach. Instead of using one robot, some vendors control two robots with a single controller, linking them tightly together.

“We perform robot-to-robot calibration using a pointer on one robot and a hole on the other,” said Virgil Wilson, Senior Engineer at **Fanuc** Robotics America. “You run it through a calibration sequence when the work cell is set up, then you don’t have to do it again.”

He noted that there are tradeoffs that can make it more practical to have separate robots, since they can be dedicated to different tasks or even be moved to other areas. Jennings said the arms of the DA 20 can be programmed to operate independently, although they cannot be located apart for obvious reasons.

The automotive industry is the largest customer for robotics, accounting for more than 60% of all robot purchases in North America, according to the **Robotic Industries Association** (RIA). During the first six months of this year, the travails of U.S. automakers have prompted a 52% year-over-year sales decline. North American robot shipments are down 38%.

The RIA believes the sharp decline in overall robot orders may continue for a while as the automotive industry digests its large purchases made in the last few years. It says many industries make major acquisitions, then slow purchases for a while as they fully deploy the robots and determine what other tasks can be automated.

Terry Costlow

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# SAE standard elevates model-based design

Model-based design is a methodology that is increasingly being used to overcome some of the difficulties in the traditional approach to embedded systems and software development. Software tools that incorporate the approach use graphical models to define and simulate algorithms and can even automatically generate executable code. This saves costs by reducing the time needed to understand, test, and implement algorithms.

However, its current state in the mobility world may not be good enough, according to the author of the Architecture Analysis and Design Language (AADL) standard. "Current practice for model-based design is to focus on the functionality of the specific components of the [vehicle]," said the **Software Engineering Institute's** Peter Feiler, author of the **SAE AADL Standard AS-5506**. "However, many of the problems that will appear, if they haven't already, will be due to unforeseen network and system interactions."



Peter Feiler of the Software Engineering Institute, who authored SAE AADL Standard AS-5506, advocates the standard's use in mobility for embedded system control applications.

Another key point is that the distinction between purely hardware design and software design is not as clear as it once was, reasons Jorgen Hansson, also of the Software Engineering Institute. He believes it is now possible to push more of the application logic into hardware, resulting in performance gains. This means that a model system design is best when it can adequately capture both hardware and software behavior, which AADL does.

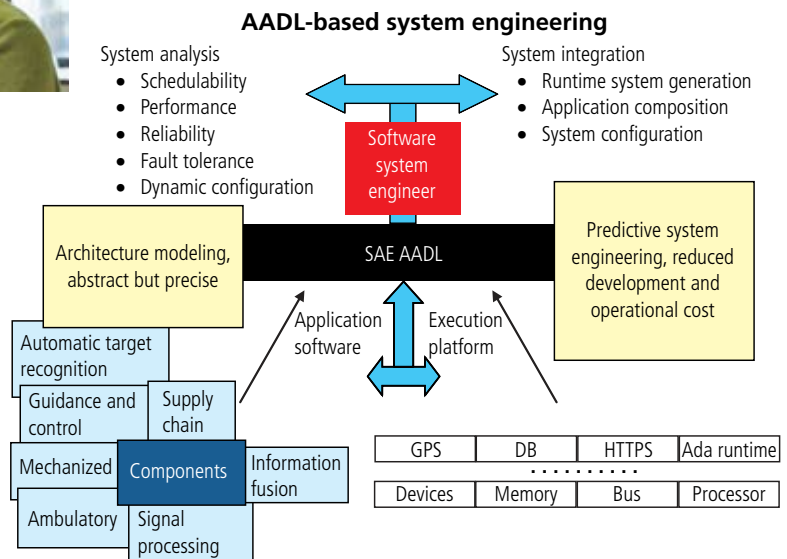
Feiler believes the same issues of network interactions that led to AADL as a solution for the avionics world will be needed in the ground-vehicle world. The avionics world simply found them first.

Maturity of software tools that implement the AADL standard is expected. The AADL standard supports interchange of models and information by using the Extensible Markup Language (XML), the XML Metadata Interchange (XMI), and Unified Modeling Language v2.0 (UML 2.0). This allows for interfacing to commercial tools that support these widely used commercial standards for data interchange and modeling.

Currently, a number of companies are implementing AADL toolsets in-house, according to Feiler and Hansson. A graphical editor for AADL is becoming available through the open-source TOPCASED effort led by **Airbus**.

**ElliDiss Software** has enhanced its STOOD tool environment to support AADL. There is also an Eclipse-based extensible OSATE (Open Source AADL Tool Environment) available under a no-cost common public license agreement through

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The SAE AADL standard addresses the challenge of precisely modeling the relevant system properties by providing precisely defined semantics for embedded real-time systems, suppressing unnecessary detail.

This means that systems as different as a radio and window controls may have unforeseen interactions, such as the windows being made inoperable because of the radio being turned on, if they operate on the same network but were not analyzed together as a system.

Nonfunctional system behaviors, such as responsiveness and availability, can be modeled and evaluated using AADL, says Feiler. The timing characteristics and reliability of the network are just as important as the algorithms for the individual application.

the AADL website.

A complementary SAE AADL document, AS-5506/1, includes an XML interchange format for AADL models. According to Feiler, this allows tool vendors and users to build tool chains against the standardized AADL interface. A UML profile for AADL is being pursued, which would allow the UML community to use the AADL system and design.

Bruce Morey

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# Heavy-duty urea-free system

Eaton engineers have put a unique diesel exhaust aftertreatment system on a 2007 heavy-duty truck engine that it expects will meet 2010 U.S. EPA emissions requirements. Unlike competitor systems that use urea to generate the ammonia needed to reduce NOx from diesel emissions, Eaton's under-development system is urea-free.

"Our system intentionally eliminates the need for urea and the dependency on the urea infrastructure," said Vishal Singh,

and engineer who holds the position of Marketing and Business Development Manager for Eaton. For more than three years, the company's researchers have been working on an aftertreatment system that employs a fuel-dosing unit, fuel reformer catalyst, lean NOx trap (LNT) catalyst, diesel particulate filter (DPF), and a selective catalytic reduction (SCR) catalyst to reduce NOx and particulate matter.

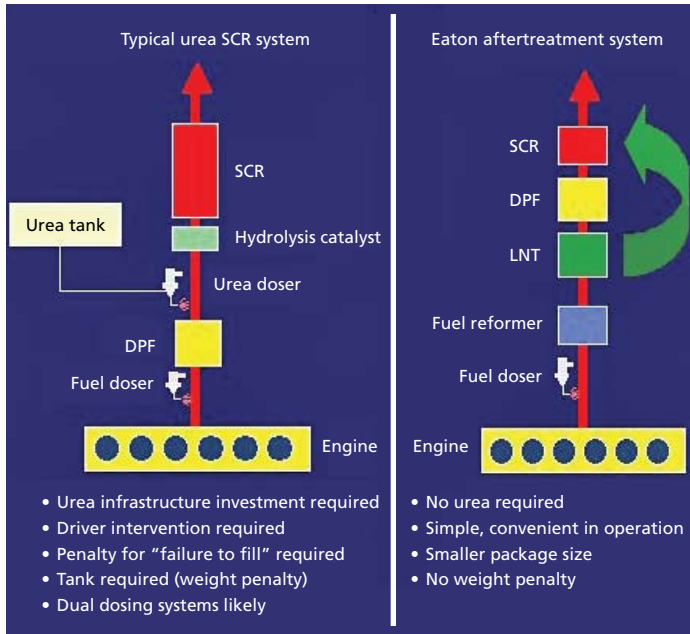
Eaton's solution—aimed at heavy-duty diesel-fueled vehicles, but expected to be appropriate for light-duty diesels—produces ammonia on board via a chemical process. In a typical SCR system that is urea-dependent, the system includes a urea-dosing unit, a urea tank, and a hydrolysis catalyst.

There are associated costs—namely, a urea delivery infrastructure and an onboard urea tank—with an aftertreatment system requiring urea. "Eaton has combined two NOx-reduction technologies—the lean NOx trap catalyst and the SCR catalyst—and created an environment that also takes advantage of a naturally occurring chemical reaction to eliminate the cost and logistic issues of urea-based systems," said Singh.

Eaton's aftertreatment system uses the fuel reformer to generate an optimum mixture of gases that, in turn, improves lean NOx trap regeneration. Essentially, NOx reduction takes place in two stages. During rich-exhaust conditions, the lean NOx trap converts the stored NOx to nitrogen while producing ammonia. The ammonia is stored by the SCR catalyst and is used to convert the remaining NOx that slips beyond the lean NOx trap.

"So far our tests have shown promising results," said Singh. Eaton offered more information on its proprietary aftertreatment system at the recent SAE Commercial Vehicle Engineering Congress & Exhibition in Chicago. "Our intention is to stay with this diesel emissions aftertreatment system and make it a success," said Singh. "We're very confident about our approach."

Kami Buchholz



Eaton says the exhaust cleansing system it is currently exploring compares favorably to a typical urea selective catalytic reduction system.

# New materials spur manufacturing concerns

OEMs have offset the weight ramifications of safety regulations with ever-higher levels of standard equipment via various light metals and new alloys. But the introduction of new materials has brought manufacturing considerations.

"To reap the full financial benefits of this production solution, manufacturers need to ensure that their tools and metalworking fluids are able to cope with the pressures of machining tougher metals," said Charsten Wienbreyer, metalworking specialist with Shell Lubricants. "If not, they risk facing long periods of unscheduled stoppages and high levels of compo-

nent and equipment damage."

One significant method of protecting against these risks is by using a high-performance, fit-for-purpose metalworking fluid, he said. Metalworking fluids play an important role in the smooth and efficient running of all automotive component manufacturing equipment as well as the successful formation of the finished part. The extreme temperatures, high level of chipping, and long, continuous operational hours of metalworking processes such as deep hole drilling, turning, and broaching place multiple demands on the fluid.

"It must provide lubrication, flushing, and cooling properties not only to protect the tool part from accelerated wear, but also the finished part from surface damage and deformation," said Wienbreyer.

For decades, many fluids were formulated using chlorine because it provided required performance, even in low temperatures, protecting the tool and part against wear and damage. But with the banning of chlorine for such applications in the early 1990s, fluids are now developed using different Extreme Pressure (EP) additives.

"These allow them to meet specific operational requirements, providing operators with greater performance," said Wienbreyer. "Increasing the strength of the metal that is being machined will in turn lead to an increase in cutting duration, temperature, and chipping.



"Manufacturers need to ensure that their tools and metalworking fluids are able to cope with the pressures of machining tougher metals," said Charsten Wienbreyer, metalworking specialist at Shell Lubricants.

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In general terms, there are four types of fluid used in metalworking: neat oils and soluble oils, each in synthetic and semi-synthetic form. Selection of the appropriate fluid depends on a number of variables specific to the cutting process and type of metal being machined. These include the size of metal chips, cutting speed, duration, and tolerance.

"A high-wetting, anti-weld and anti-corrosion, water-miscible metalworking fluid such as Shell Adrana A 2859 is required during deep hole drilling to flush chips from the cutting area and stop them from welding to the drill tool or part being

drilled. A specialty product, such as Shell Sitala B 5801, with high resistance to water hardness and increases in pH levels, is required to meet the challenges of machining magnesium alloys," said Wienbreyer.

Wienbreyer and his team advise automotive OEMs and suppliers in auditing the cutting process and identifying fluid demands: "This helps to determine the required EP rating, wetting, cooling, anti-corrosion, and flushing performance of the fluid."

Stuart Birch

## Michigan firm tests for toxicity of nanomaterial

Over the next several years, nanotechnology is sure to have a tremendous impact on the automotive industry. Nanoparticles are being explored for use in materials, tires, coatings, and combustion. What is not as certain, however, is the effect these new man-made substances will have on health and the environment.

One firm, **Innovative Cell Technologies** (ICT) of Oakland County, MI, has been testing the toxicity of nanomaterials in the pharmaceutical/nanomedicine industry for the past five years and is looking to expand its vision to the automotive field.

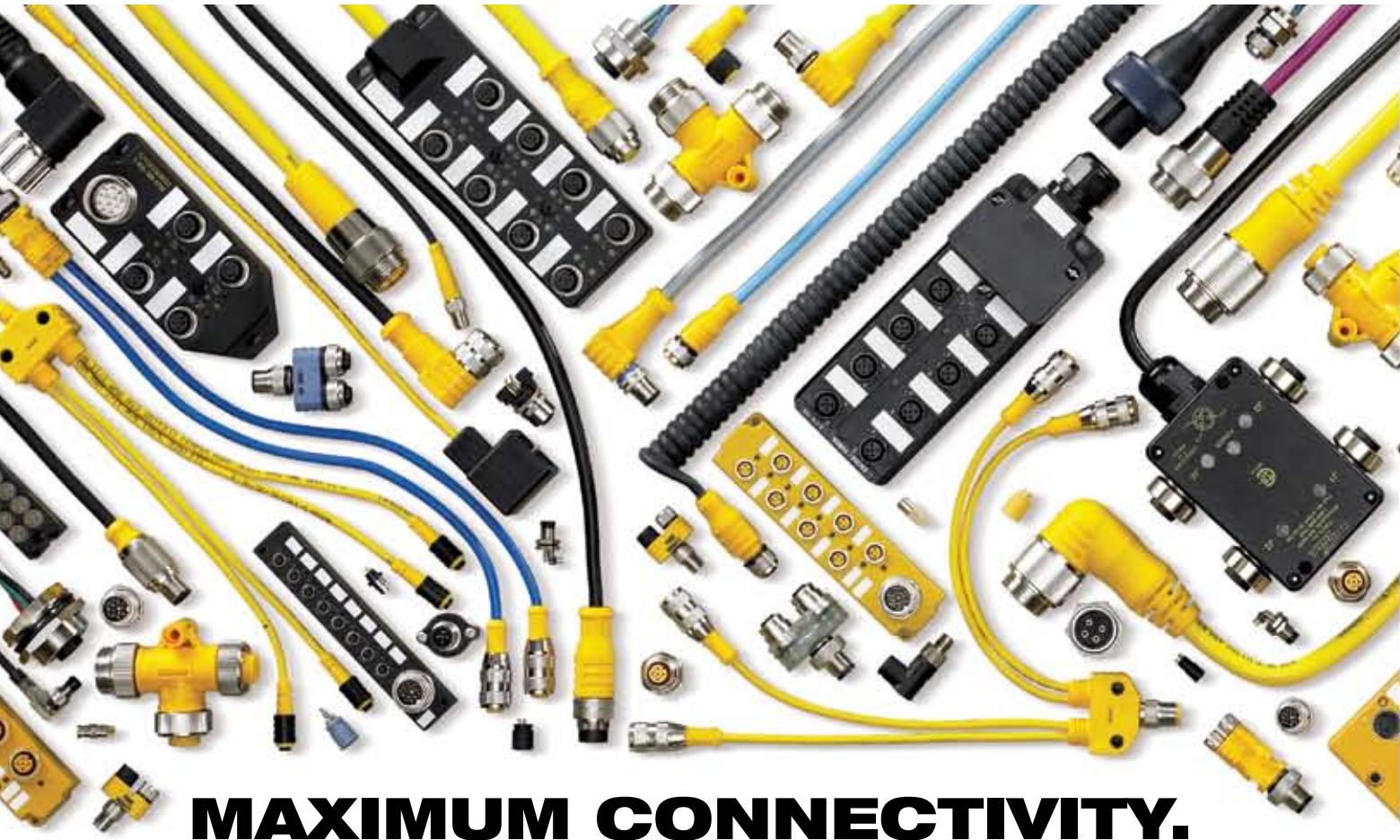
"The material that is released from the automotive industry is very similar in characteristics and properties to the material that we are using in the medical field," said Joseph Kassab, ICT's Chief Scientific Officer. "The principle is not going to

change, no matter which field you work in."

ICT uses *in vitro* hematopoietic stem cell technology to test the cytotoxicity levels of nanomaterials. Hematopoietic stem cells, found in either human or animal bone marrow, are exposed to nanomaterials to see if they affect the cells' growth and division.

The large surface to mass ratio of nanoparticles allows them to absorb and carry other compounds, which makes them attractive across many industries, most notably the medical field. It has been discovered that nanoparticles are able to penetrate the brain cortex, which was previously thought impossible. This has its advantages in drug delivery in the medical industry; however, uncertainty surrounds what happens to the nanoparticles after they serve their intended purpose.

"Do they stay there? Do they leave? And if they do stay,



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what do they cause? Most of these nano-engineered particles are chemically highly reactive, so they might react with something else that we are not aware of. Therefore, it is important that we test this material and make sure that it is safe," said Kassab.

That same uncertainty surrounds automotive industry applications as well. ICT scientists are trying to determine what will happen to the material after a vehicle has completed its service. Since nanomaterials do not decay, it is possible that as the vehicle erodes the material will become airborne, leading to possible inhalation.

Inhalation is one of four ways that nanomaterial can enter the body, joining ingestion, skin contact, and injection.

"What we worry about the most is inhalation because it goes straight to the lungs, and the lung is the most sensitive part of the body in receiving foreign materials," said Kassab. "If this is a highly reactive material, it might cause inflammation in the lung, and that may lead to cancer."

In addition to components such as paint, nanomaterial is used in combustion in the form of oil or other liquid and also the catalytic converter process.

ICT offers consulting services to automotive manufacturers, suggesting alternative materials or providing information on how to make the nanomaterial nontoxic.

Kassab noted that organizations such as the U.S. **EPA, Food and Drug Administration, and Occupational Safety and Health Administration** are lagging in controlling the release of nanomaterial manufactured in the U.S. into the environment.



*Innovative Cell Technologies Chief Scientific Officer Joseph Kassab uses in vitro hematopoietic stem cell technology to determine the toxicity levels of nanomaterials across many industries, including automotive.*

Another issue Kassab noted is that there is no standard technology or nomenclature for chemicals listed as safe by the Toxic Substance Control Act.

"Before you convert a material to nanomaterial, it is listed as nontoxic," explained Kassab. "When you convert it to nanomaterial, it becomes sometimes toxic, but it has the very same name and chemical compound. Therefore, in the listing with the government, it is considered nontoxic. There is some confusion there. This is something we are looking at very carefully."

*Matt Monaghan*



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