

Salting away for the future

Off-highway vehicles and tough working conditions invariably go together, but sometimes the toughness gets very difficult indeed. The 800-m (2625-ft) deep **K+S Herfa-Neurode** salt mine near Hesse, Germany, puts huge operating demands on vehicles in terms of consistently high temperatures, restricted space, and steep, rugged surfaces.

Among the vehicles that endure such conditions are two articulated **Mercedes-Benz Econic 1828** trucks equipped with **Allison 3060** fully automatic transmissions. The trucks are used to transport industrial waste with recycling potential to long-term storage in the mine's labyrinth of empty tunnels and chambers. With crucial criteria for mine vehicles including maneuverability, productivity, safe operation, and reliability, transmissions need to be robust, and those fitted to the Econic are capable of handling up to 1085 N·m (800 lb·ft) of torque for a gross vehicle mass of 36 t (40 ton).

Getting large off-highway vehicles into a mine is always a challenge. Although the lift at Herfa-

Neurode takes only 45 s to descend 800 m (2625 ft), substantial dismantling of the Econics plus the use of a crane was needed to load them. Once reassembled and tested, they faced a working life in an all-year-round temperature of 28°C (82°F), with a humidity of only 20 to 24%.

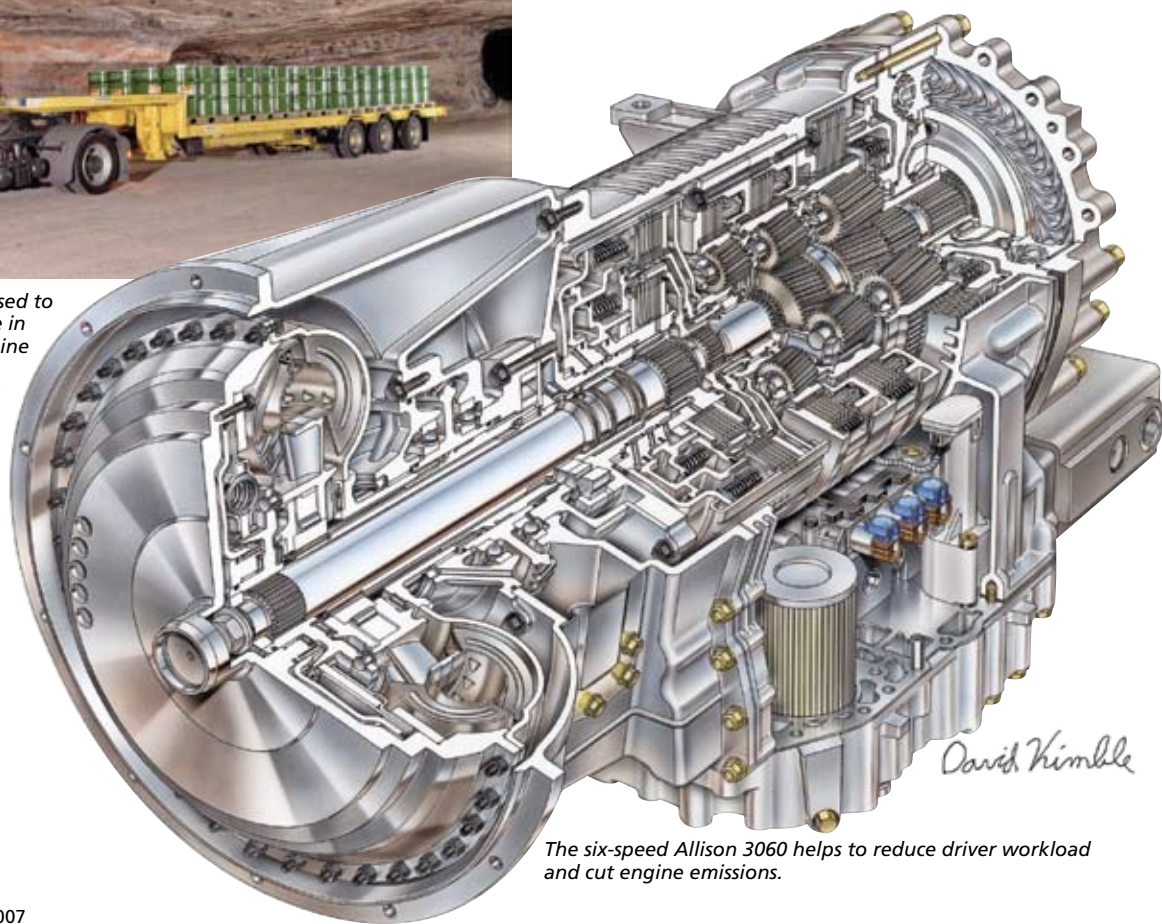
During a two-shift operation per day, each Econic, powered by a 6.3-L, six-cylinder 280PS diesel engine, covers a distance of about 100 km (62 mi). Transporting waste in barrels and "big-bags," the working conditions are harsh for both man and machine. The truck's relatively compact dimensions—7 x 2.49 x 2.38 m (23 x 8 x 7.8 ft)—and maneuverability with a 16.1-m (52.8-ft) turning circle make it suitable for the application. With the tunnel and chamber height of the mine between 2.5 to 2.9 m (8.2 to 9.5 ft), the low cab height provides sufficient clearance even in the tightest passages.

The salt roads in the 300-m (980-ft) long excavation area are hard and uneven with steep gradients of up to 15%. Narrow and difficult conditions dictate a speed restriction of 50 km/h (31 mph).

"For working the mines, fully automatic transmission is highly practical," said Gerhard Voigt, Allison's **DaimlerChrysler** Account Manager. "Safety is critical in the partially lit, narrow passages, and drivers



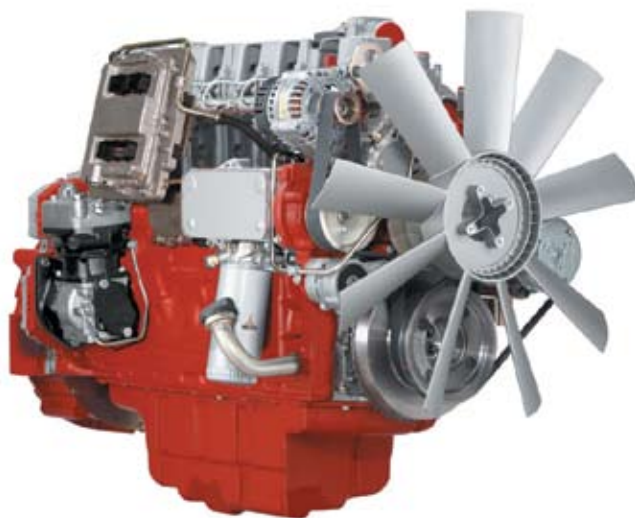
Mercedes-Benz' Econic, used to transport industrial waste in the Herfa-Neurode salt mine in Germany, is equipped with an Allison 3060 fully automatic transmission.



David Kimble

The six-speed Allison 3060 helps to reduce driver workload and cut engine emissions.

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Tractor unit of the Mercedes-Benz Econic 1828 before being partially dismantled to be lowered into the Herfa-Neurode salt mine.

need to remain vigilant at all times." By using a fully automatic transmission, the mine's drivers can keep both hands on the steering wheel, reducing operator workload, fatigue, and stress, and enhancing safety.

The transmission's smooth change ability offers a further safety benefit by protecting potentially dangerous or hazardous loads from damage. Vehicle reliability is essential. The Allison six-speed torque converter transmission provides constant power and maximum traction to reduce shock on the drivetrain, said Voigt, which "is especially important in the mine where the vehicles are starting and stopping frequently. The adoption of fully automatic transmission instead of a manual gearbox does away with clutch wear, improving reliability and maintenance time, so allowing the trucks to operate for longer periods."

To further tailor the transmission to operating requirements in the mine, the transmission offers closed-loop adaptive controls, the electronics consistently adapting to duty-cycle and

variations in driving conditions caused by load, terrain, or driver operation. With an unusual and difficult environment to contend with, making the driving operation simpler is a significant plus. So are built-in diagnostics, covering low oil level, assessment of clutch wear, and service requirements. The system also monitors performance during the Econic's operation to prevent secondary damage if a problem occurs. The transmission used for the salt-mine vehicles offers more than 200 codes to pinpoint the source of any abnormality. If a fault is detected, a "limp home" mode is available so the vehicle can be moved to a safe area.

For their underground role at Herfa-Neurode, the vehicles' emissions need to be tightly controlled. Allison has achieved this via selection of the most appropriate gear ratios for the duty cycle and, using the electronic control unit, defining specific shift points for the engine to achieve optimum fuel economy. The transmission's early lock-up feature eliminates slip in the torque converter to maintain mechanical efficiency via its closely spaced ratios, facilitating progressive shifting with reduced engine speeds.

A further benefit of engine speed control is the low level of noise generated. The Econic's transmission also uses helical gears, which contribute to quieter operation both inside and outside the cabin, particularly important because of the acoustic effects created in the mine's tunnel.

The K+S Group's disposal and recycling division uses hollow spaces and the infrastructure of nearly 30 pits across Europe. The Herfa-Neurode mine offers a waste depository for combustion residue, chemical waste, electrical waste, metal waste, and aluminum smelting waste. Other items include fluorescent tubes, capacitors, and solidified metal-hydride sludge. The mine is able to store materials that are deemed worthless at present but that may become of value in the future as resources become scarcer.

Stuart Birch

Getting a visual on operator interfaces

To address the fact that bad or limited view is one of the most frequent causes for accidents at construction sites, **TTControl** has designed a camera vision system that allows machine operators to better keep their work environment in view, thereby increasing safety and productivity. TTControl is a subsidiary of **TTTech Computertechnik** that specializes in off-highway vehicle control.

The visual operator interface consists of a digital LCD module, a visualization unit, and up to three analog phase-alternating line (PAL) cameras. The cameras are designed for outdoor

use, have an internal heater, and are supplied by the video adapter card. The LCD module provides adaptable illumination for changing light conditions and comes with a 6.5-, 7-, or 10-in color display. Other LCD models are supported at customer request.

At the heart of TTControl's camera vision system is TTC Vision, which was designed specifically for use in vehicles and machines that run in harsh environments and at extreme operating temperatures. This visualization unit controls the views of the cameras and displays the machine parameters. Integrating the camera vision system with the vehicle application in a single LCD leads to reduced production costs and increased operating safety, says the company.

Its robust injection-molded aluminum housing protects against electromagnetic disturbance and mechanical stress. TTC Vision can connect with both CAN and TTP (Time-Triggered Protocol) networks. The system provides both a low-voltage differential signaling interface and a PAL/NTSC (National Television Systems Committee) interface. The user can interact with the control unit by keyboard, encoder, or touch panel. In addition to the interfaces for display control, TTC Vision has 26 digital inputs, and 24 digital outputs for controlling switches and lamps in cockpits.

Jean L. Broge



TTControl's camera vision system was designed to avoid dangerous situations on a job site that are caused by bad or limited view for the operator.

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Garmin expands marine lineup

State-of-the-art satellite photo-generated cartography and a streamlined user interface and design are what **Garmin** says it is offering in its 2007 lineup of chartplotters, sonar, and charting devices. The redesigned interface enables boaters to intuitively see and select the information they want, while eliminating the clutter they don't, with fewer buttons to push.

All of the chartplotters are equipped with a worldwide satellite imagery basemap to enhance the standard vector chart format. For even higher-resolution photomapping capabilities, Garmin offers BlueChart g2 Vision technology, which is available on a pre-programmed SD card. In addition to high-resolution satellite imagery, g2 Vision features true "mariner's eye view" above water or a "fish eye" underwater perspective—both in 3-D. The g2 Vision data card also enables auto guidance technology on compatible units, searching all of the chart attributes to suggest the best navigational course. For help in navigating tricky harbors and channels—or locating marinas and resorts—g2 Vision cards offer a growing database of aerial reference photos.

GPSMAP 4012 and GPSMAP 4008 are Garmin's new flagship multifunction displays (MFDs) for its ethernet-based Marine Network. The GPSMAP 4012 sports a 12.1-in diagonal XGA display with an alphanumeric keypad. When helm space is at a premium, the smaller GPSMAP 4008 features an 8.4-in VGA screen without the keypad. Both units have eight vertically placed "soft keys" for navigating the network. Both MFDs can be accessed by an optional wireless mouse and remote control.

The 4000 series has all of the same networking capabilities of other MFDs within the proprietary Marine Network, a system that combines GPS, radar, **XM** WX Satellite Weather, sonar, and other data for improved situational awareness. All 4000 series units are **NMEA 2000** compliant.

With a new, sunlight-readable 5-in VGA display, the GPSMAP 5x5 series includes the GPSMAP 555 UK, which is available pre-loaded with detailed offshore chart coverage of the UK and Ireland as well as portions of France, Belgium, and the Netherlands. The GPSMAP 555 AUS has detailed Australian and New Zealand offshore charts, while the GPSMAP 545 in-



All of Garmin's 2007 line of marine units come with a flat-screen multifunction display, one of which, the GPSMAP 4012, features a 12.1-in display and a keypad.

cludes detailed charts of U.S. coastal waters and Explorer Charts of the Bahamas. The GPSMAP 535 contains pre-loaded maps of thousands of inland U.S. lakes and rivers.

Each unit in the GPSMAP 5x5 series is also available with sonar capability (designated by an "s" after the model number). Sonar models have a digital sonar receiver for enhanced target definition and boast 1-kW/500-W rms (depending on transducer used) with a dual frequency transducer for offshore and 400-W rms with a dual beam transducer for inland use. All 5x5 units enable users to share sonar pictures on other compatible plotter displays around the boat.

All of the units come with an internal GPS patch antenna. For flush-mounting, the unit can connect to an optional external GPS antenna. In addition, all North American versions of the GPSMAP 500 series are capable of displaying XM WX Weather, allowing boaters to see directly on their chartplotter's display weather data such as storms, wind currents, temperatures, etc.

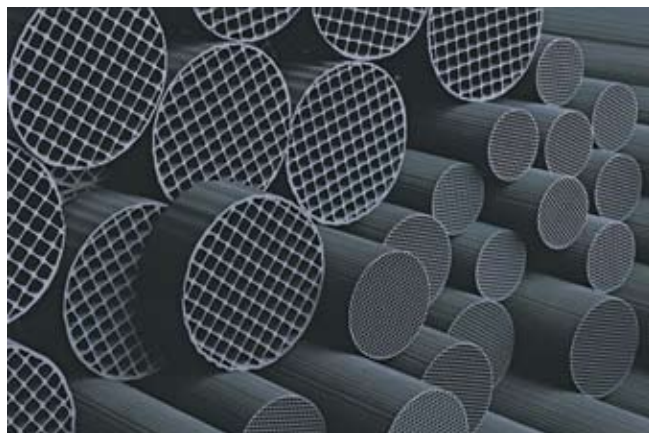
Jean L. Broge

What's the buzz about honeycombs?

Activated carbon has been used for centuries to purify liquids and gases by means of the adsorptive properties of the large surface area density of the material. Over the last 40 years, **MeadWestvaco Specialty Chemicals** has worked to improve and customize the porosity and surface characteristics of activated carbon, allowing for specialized and selective adsorptive capabilities and high capacities.

Advancements in producing large-diameter pelletized activated carbons have reduced the pressure drop that occurs at relatively high fluid velocities and expanded the utilization of the product. This lowered pressure drop has occurred at the sacrifice of adsorption capacity, because mass transfer kinetics are inhibited by the slow rate at which the adsorbate diffuses through the 1- to 5-mm (0.04- to 0.2-in) pellets.

Technology has also progressed, however, to allow for the production of very small and uniform activated carbon powders that allow adsorption and desorption processes to occur very rapidly. These powders are of limited use, unfortunately, because of the high pressure drop associated with powders



The open structure and small carbon particle size of the new activated carbon honeycomb increases adsorption performance and reduces the pressure drop (see graph) associated with traditional granular or pelletized carbons used in emissions-control, industrial, and chemisorption applications.

Can your transducer survive a really rough ride?



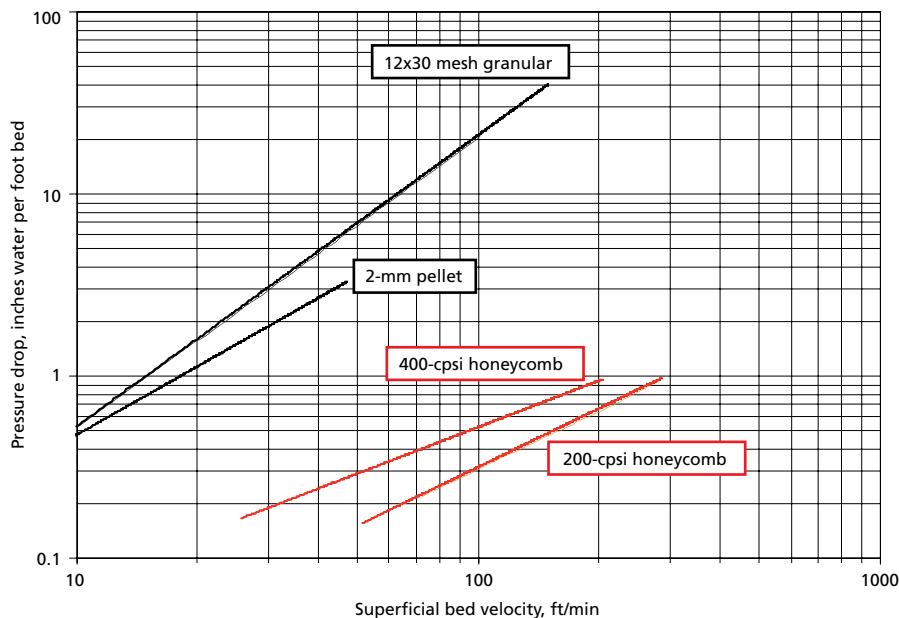
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and the difficulties with handling and filtering them from fluids. Many adsorptive systems could be refined and optimized by realizing the performance characteristics of a finely powdered activated carbon in a low-pressure drop and functional form without the need to filter the powdered carbon from the fluid. The utility of activated carbon could be further expanded in much the same way as it has by advancements in pelletization and control of porosity.

MeadWestvaco has responded to this commercial need by developing the activated carbon honeycomb. The honeycomb is an extrusion-formed, dustless ceramic device that contains 30 to 50% of micron-sized activated carbon powder with a plurality of cell densities ranging from 16 to 600 cells per square inch (cps). The open structure of the honeycomb results in a product with pressure drops many times lower than granular and pelletized carbons.

The cell wall thickness of the honeycombs can be made as thin as 0.13 mm (0.005 in), resulting in rapid adsorption and desorption plus full utilization of adsorption capacity at very high fluid velocities. The honeycombs may be made with diameters more than 20 cm (8 in) and in any extrudable shape, able to fit in a wide range of vessels and beds. Direct heating allows the honeycomb to be regenerated by thermal swing processes, requiring little to no purge gas. Moreover, the strength of the honeycomb structure permits it to be used in rapid pressure swing adsorption applications and high velocity environments with little to no product attrition.

The open structure of the honeycomb and the thermal conductivity properties of the ceramic backbone prevent hotspots and reduce temperature swings resulting from adsorption and desorption, so the honeycomb allows for rapid, high adsorption rates and the complete utilization of the regenerative adsorption capacity. Honeycombs containing zeolites and aluminas are also available to allow optimization of gas concentrators and catalyst support with temperature capabilities in excess of 800°C (1472°F) in air.

Opportunities to use activated carbon honeycombs include

any application where high mass transfer rates are advantageous and low pressure drop is critical. The MeadWestvaco activated carbon honeycomb is standard equipment on California partial zero-emission vehicles to achieve regulatory standards for diurnal evaporative emissions control from the carbon canister. They are able to fully regenerate with limited purge air and capture practically all the diurnal bleed emissions from the primary carbon canister with little effect on the canister system pressure drop.

The carbon honeycombs are now finding application on hybrid and GDI (gasoline direct injection) engine vehicles to meet U.S. LEV (Low-Emission Vehicle) II/Tier II

standards. The carbon canister systems on these vehicles have a very limited volume of available purge air, yet the honeycomb is able to completely regenerate and repeatedly adsorb a large quantity of canister bleed.

It is the unique combination of fine carbon particles, thin cell walls, and extremely low pressure drop of the carbon honeycomb that sets it apart from granular and pelletized carbons. When adsorbing 22% gasoline vapor in air at a load velocity of 29 m/min (95 ft/min), the activated carbon honeycomb has a working capacity six times greater than an 11 BWC (butane working capacity) carbon per kPa of pressure drop. Moreover, under the same load conditions the mass transfer zone is only two-thirds as long, so greater bed utilization is possible when using the honeycomb.

The positive effect is even greater when compared to pelletized carbons, where the adsorptive capacity in the center of pellets may not be used when superficial load velocities are high. Honeycombs are currently being designed for systems used to separate and concentrate solvents from large-volume airstreams, such as paint booth applications.

The carbon honeycombs may be impregnated for highly efficient chemisorption processes. Impregnated honeycombs are rapidly displacing impregnated carbon pellets in systems made to remove corrosive gases from air. Honeycomb systems may be designed to handle superficial air velocities of 150 m/min (492 ft/min) vs. 30 m/min (98 ft/min) for pellets, yet the total system has a lower pressure drop. The equipment footprint is reduced as is the energy consumed to power the blowers. In addition, the honeycombs resist attrition and generating dust, eliminating both the need for costly particulate filters and the possibility of entraining dust in the exhaust airstream.

As the industry looks at the shape of things to come, OEMs can take advantage of new opportunities to apply the many properties of activated carbon to applications that until recently were limited to a few types of delivery systems.

Michael F. Tschantz, Product Development Manager, Carbon Technologies, MeadWestvaco Specialty Chemicals, wrote this article for *SOHE*.



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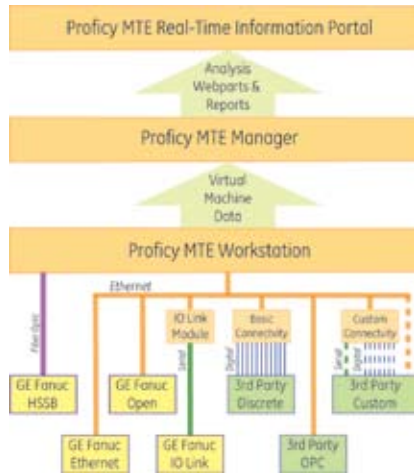
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Driveline and Chassis Technology

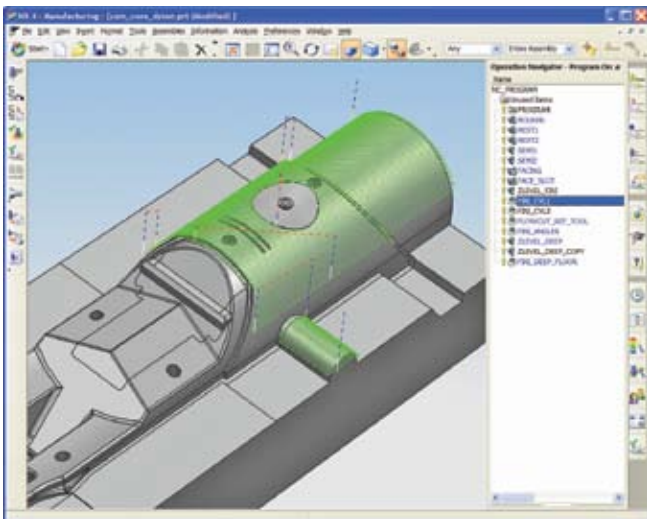


Software focuses on data management

Design and manufacturing software providers are rolling out new tools that make it easier for manufacturers to track changes as products move from design to manufacturing. These tools also make it simpler to distribute changes made throughout the production lifetime, making sure that updates get to all the people who need to know about them.



GE Fanuc's Proficy Machine Tool Efficiency helps ease communication across many levels.



UGS tools link both product and manufacturing data management.

A number of factors are making it simpler for automakers and their suppliers to manage data throughout the manufacturing cycle. While product life-cycle management tools address the bigger picture over longer periods, continuing advances in tools are focusing on data management in the factory.

Though some manufacturers have relied on e-mail and phone calls to inform people about changes, that is becoming more difficult as manufacturing cycles get smaller and extend to global operations with a growing number of contract manufacturers. Many tool providers say that it is no longer viable to rely on personnel to update every operation every time there is a change.

"Data management is a non-optional aspect of running an engineering department. It's a necessary evil," said Bob Merlo, Marketing Vice President at **Autodesk**.

He added that the move to 3-D files plays a big role in the need for data management. "You have seven times the num-

ber of files when you go from 2-D to 3-D," he said.

Autodesk recently upgraded its Vault technology, which handles changes during design and the transfer to manufacturing, as well as its ProductStream manufacturing software.

At the recent International Manufacturing Technology Show in Chicago, **GE Fanuc Automation** touted Version 4 of Proficy Machine Tool Efficiency. The monitoring and analysis tool digitizes the information generated throughout factories. This so-called virtual plant facilitates data sharing, so it is easier to transfer files and communicate between design and manufacturing teams, whose changes often impact many related aspects of production.

One segment of the tool, Proficy MTE Connections, uses a variety of hardware and software protocols to collect the most comprehensive data, integrating on-line data systems from other GE Fanuc, third-party, and internal legacy systems.

Along with simplifying the job of updating changes, the software also makes it simpler to track problems—for example, determining which vehicles are equipped with faulty parts. That could give OEMs a way to reduce the cost of recalls.

"If you know where the bad parts are, you can do a focused recall. That can represent a huge savings," said Rich Breuning, Director of Automotive Solutions at GE Fanuc Automation.

Another major tool supplier, **UGS**, recently unveiled its Teamcenter Express V2, which lets manufacturers maintain their manufacturing data and easily access the right data for a given task. As part of the company's product life-cycle management offerings, the latest version of the Teamcenter software provides both product data management and manufacturing data management. That is an industry first, the company said. It will offer extensions for manufacturing process planning as well as tool, fixture, and standard resource libraries, interfacing directly with the firm's NX CAM Express.

The new Teamcenter program will also integrate closely with Manufacturing Process Management software that was added last year with the acquisition of **Tecnomatix Technologies**. Tecnomatix links design and manufacturing software, simplifying the job of updating each side when changes are made.

While suppliers roll out new software, market watchers note that these tools have to be deployed with changes in the enterprise. Management must devise plans for data sharing to make sure the right people get all the necessary messages without overloading everyone with messages they do not need.

Both of these factors must be addressed to get the biggest improvements in productivity. "People say that the software is not there, but in my estimation it is there. The bigger challenge is the organizational processes are not where they need to be so everyone gets the word when changes are made," said Joel Orr, Vice President at **Cyon Research**, which tracks software tools.

Though earlier generations of data management tools have been available for a while, he noted that OEMs and their largest suppliers may find it more difficult to implement them and set up management processes than smaller organizations.

"Smaller companies like medical device manufacturers tend to move faster because there are fewer people involved. When you've got thousands of people in the loop like most automakers do, it's a major challenge," said Orr.

Terry Costlow

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Surface roughness testing made easy

Mechanical components are created and finished using a wide variety of processes, including machining, grinding, polishing, etching, and shot peening. A component's finish can have a large effect on tribology and wear, impacting everything from efficiency and emissions levels to engine reliability and life expectancy. As a result, both manufacturers and R&D engineers need a tool to provide comprehensive surface topography data.

Ideally, the tool should work with a wide range of surface treatments and materials, as well as on both flat and highly contoured parts. Component manufacturers are increasingly adopting optical profiling to meet this need because high-speed optical profilers now enable noncontact surface mapping over a broad range of roughness and surface types, including metals, polymers, and sensors.

An optical profiler relies on a technique known as white light interferometry, which uses light waves themselves as a high-resolution ruler, or depth gauge. An optical profiler looks

similar to a conventional optical microscope, and the test part is placed on the sample stage. Light from a filtered halogen lamp passes into the objective and is then split into two paths by a beam splitter (a partially reflective mirror). One of the paths is focused on the sample surface and the other is deflected to an extremely flat reference surface located internally. The two reflections are recombined by the microscope imaging optics. When the microscope is focused on the test surface, the combined reflected image contains intensity striations called interference fringes. These dark and light bands are a direct function of the profile of the test surface; they are analogous to elevation contours on a topographic map.

In operation, the instrument's computer steps the microscope through a full range of focus positions and captures these fringes on a digital camera. Onboard software then calculates a full 3-D surface map over a field of view as large as 8.5 mm (0.33 in). This technique delivers high dynamic range; that is, it provides vertical resolution of better than 0.1 nm (0.004 μin) over steps and heights of up to 8 mm (0.31 in). In addition to surface mapping, the instrument software can also compute common statistical parameters such as Ra roughness.

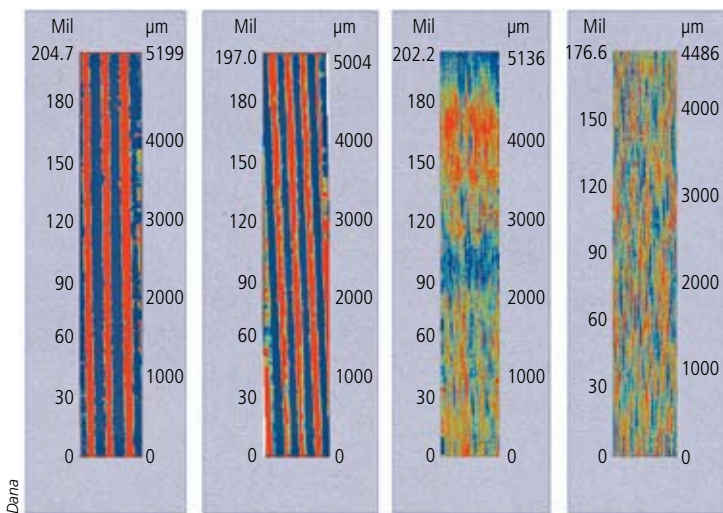
One R&D application for this technology involves profiling steel shafts in a study to improve shaft-to-seal performance. When a shaft is turned on a lathe, there is always a residual threading on the surface called lead, which can cause significant lubricant leakage if untreated. Manufacturers address this issue by inexpensive techniques such as plunge grinding. However, process variations can cause quality problems, particularly between different manufacturers. **Dana** has shown that the large field of view of the optical profiler is good for characterizing and tolerancing lead, which is hard to discern using traditional spot or transect testing tools.

A process development application at **GM Powertrain** addresses methods for creating the final surface in engine cylinder bores. This surface quality can have a major impact on tribology, impacting frictional mechanical losses as well as oil consumption and overall emissions. Traditionally, stylus profilometry has been used to characterize bore surfaces, but tiny voids and high-aspect-ratio grooves can be missed because of the width of the stylus tip. Moreover, stylus profilometers are very slow if an area view is needed because they collect data line-by-line.

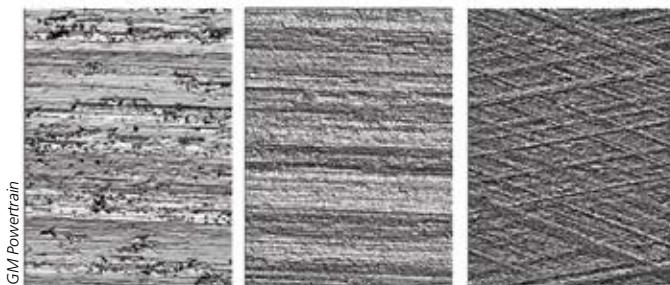
Shot peening can yield significant increases in fatigue life when applied to components such as gears, axle shafts, crankshafts, and connecting rods, in addition to numerous kinds of springs. Optical profiling is now being used for quality control purposes to ensure consistent results. For example, peening intensity is traditionally quantified by measuring the curvature of a strip of spring steel used as a witness sample. Work at **Advanced Material Process** has shown that optical profiling data enables rigorous process control of peening. The optical data correlates with both key process parameters: peening energy and intensity.

Optical profilers can be used by semi-skilled operators in pass/fail tests as well as for sophisticated research studies.

Geoff Anderson, Senior Product Manager, Profilers, Veeco Instruments, wrote this article for *SOHE*.



Optical profiler images show the progressive effectiveness of different types of surface treatments on a steel shaft. The treatments shown are (left to right) rough turning, fine turning, plunge grinding with a roll-dressed abrasive wheel, and plunge grinding with a single diamond-sharpened wheel. Surface height is represented in false color for this set of images.



The optical profiler image at left shows smearing in a cylinder bore due to use of a dull tool. The other images of the same bore show the effects of roughening with a water jet treatment (center), and final mechanical honing (right) with polishing lines typical of the process.

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