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OCTOBER 2014

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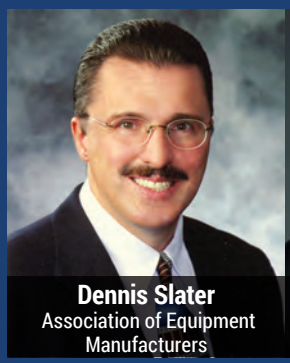
AC BUSINESS MEDIA

STATE OF THE INDUSTRY

Find out how global economies, political legislation, industry consolidation, climate change, and the future potential of technology development are shaping the heavy-duty vehicle industry in 2015.

Q&As start on Page 48

WE ASK THE EXPERTS



Dennis Slater
Association of Equipment Manufacturers

Martin Richenhagen
AGCO Corp.

Walter Koellner
Siemens

Anders P. Larsson
Volvo Construction Equipment

Peter Lauwers
Atlas Copco

Eric Lanke
National Fluid Power Association

Jim Hasler
CASE Construction Equipment

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COVER STORY

WE ASK THE EXPERTS

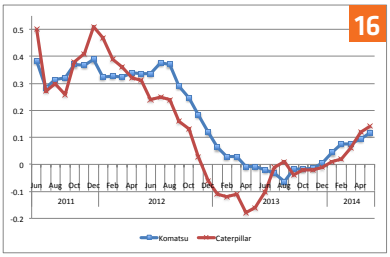
SEARCH EACH Q&A'S UNIQUE 8-DIGIT ID FOR THE FULL INTERVIEW ONLINE!

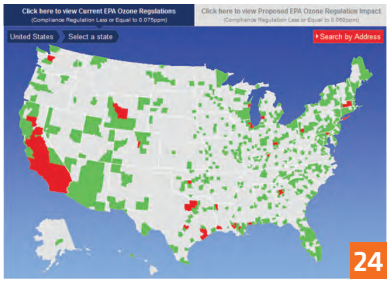
State of the Industry starts on page 48

The right time and the right place for growth and development is here. A slow and steady growth trajectory for select U.S. markets coupled with continued consistency in emerging economies and global market expectations means OEMs are prepared and ready for 2015 and beyond.

STATE OF THE INDUSTRY

FEATURES





Features continued on page 6

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Farm tractor market forecast: A tale of two or more markets, not one

Farm tractor sales expected to be up and down for the rest of 2014 and into 2015.

Search: 12007563

Market Forecast: Fluid Power

The NFPA's most recent analysis of the fluid power industry's shipments and orders for hydraulic and pneumatic components for the month of September.

Search: 12007451

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A little too soon

Throughout the process of compiling the State of the Industry interview responses this year, it became quite clear that I was a little ahead of myself with the questions, and I think I know why. Much like other industries outside of heavy-duty equipment manufacturing, the economic downturn created a near-sighted effect on many companies. You couldn't look too far down the road because there was too much to worry about in the short-term. So, when I asked our participants about what was yet to come in 2015 and beyond, the "beyond" was hard to come by in any concreteness.

You can still hear that tone of cautious optimism in people's responses, and I suppose I was a bit naive or hopeful that the veil of cautiousness would have been lifted. But, as I noticed, it's just too soon.

Even looking beyond Tier 4 Final—which launched at the beginning of the year—is too soon, as many OEMs are waiting until purchasers are ready to buy expensive new equipment. The rental market looks promising for that very reason.

The BRIC economies (Brazil, Russia, India and China) are still viewed as the strongest emerging economies to invest in for global expansion, and while a few mentioned concern over Russia's current socio-politicial situation, none seemed too threatened by the ordeal in regards to business development potential. Mexico is starting to make a strong name for itself as a North American alternative to China for affordable labor costs and production capabilities.

Frank Manfredi, our market forecaster, summarizes the off-road industries of construction and mining on page 16 and delves deeper into the agricultural industry online at www.oemoffhighway.com/12007563.

Two perspectives are presented on the global emissions reduction industry: The first from the Diesel Technology Forum on the evolution of emissions tracking systems and people's involvement in cleaner air on page 24. The second is from Integer Research, a UK-based provider of research, data and analysis with a look at Stage 5 emissions regulations coming from Europe on page 30.

CNG fuel and its storage is investigated by REL Inc. on page 36, and finally, the reemerged industry of 3D printing is explored for manufacturing opportunities on page 42.

Don't forget to check out the full interviews from all of our State of the Industry participants online at www.oemoffhighway.com or in our digital edition (subscribe for free at www.oemoffhighway.com/subscribe).

Michelle

IN THE NEXT ISSUE

NOVEMBER/DECEMBER

- Mining engine trends
- Track and tire development
- Smart braking systems
- Engineering and research centers
- Top Ten New Products of 2014!
- **New Column:** The Big Picture

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PO Box 803, 1233 Janesville Ave., Fort Atkinson, WI 53538-0803
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PRINT AND DIGITAL STAFF

Publisher Sean Dunphy
sdunphy@ACBusinessMedia.com

Associate Publisher/Editor Michelle EauClaire-Kopier
Editor@ACBusinessMedia.com

Associate Editor Sara Jensen
sjensen@ACBusinessMedia.com

Senior Field Editor Curt Bennink
cbennink@ACBusinessMedia.com

Contributing Writers Thomas Berry

Ad Production Manager Cindy Rusch
crusch@ACBusinessMedia.com

Art Director Dave Haglund
Senior Audience Dev Manager Wendy Chady
Audience Dev Manager Tammy Steller

ADVERTISING SALES (800) 547-7377

Stacy Roberts.....sroberts@ACBusinessMedia.com
Jill Draeger.....jdraeger@ACBusinessMedia.com
Sean Dunphy.....sdunphy@ACBusinessMedia.com
Erica Finger.....efinger@ACBusinessMedia.com

Change of Address & Subscriptions — PO Box 3605 Northbrook, IL 60065-3605, Phone: (847) 559-7598 Fax: (800) 543-5055 • circ.OEMOff-Highway@omeda.com

List Rental — Elizabeth Jackson, Account Executive, Merit Direct LLC, Phone: (847) 492-1350 ext. 18 Fax: (847) 492-0085 • ejackson@meritdirect.com

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Volume 32, NO. 7, October 2014

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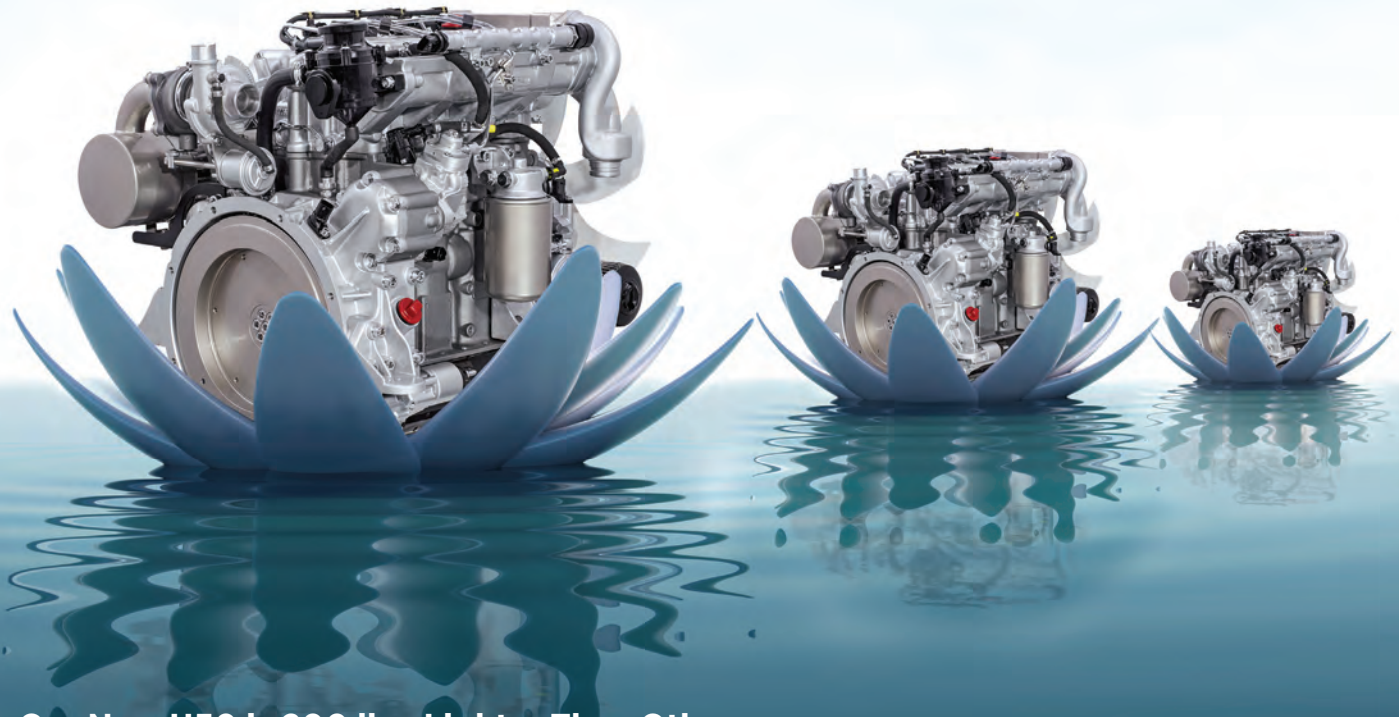
The Real Beauty Of Our New Water-Cooled Engine, Its Amazing Lightness.



Our New H50 is 200 lbs. Lighter Than Others.

At just 381 pounds (173kg), the new 74 hp H50 is so light and compact, it sits on top of its class in the water-cooled world. But it's no lightweight when it comes to power. This 4-cylinder, turbocharged 2-liter engine is the first industrial diesel to have a Bosch Off-Highway common rail fuel injection system for unbelievable power and fuel efficiency. And it falls significantly below the emissions limits without the use of a particulate filter. So don't let your equipment be waterlogged with a heavy hunk when things can go swimmingly with the all-new water-cooled H50.

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Healthy, steady growth ahead

The long slow climb back from the "great recession" continues. This, in itself, is not news. After all, we are now five years into the current expansion. More newsworthy is that after all this time some of the major imbalances are getting close to being worked out. This is setting the stage for healthier and more typical growth over the next several years.

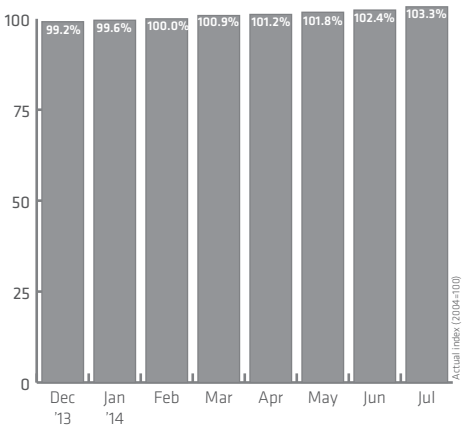
The big news from Europe is the ECB's new stimulus effort. In addition to cutting short-term interest rates to zero, the ECB announced its first ever effort at "quantitative easing." This is a major new initiative in the battle against economic stagnation in Europe.

Go to **oemoffhighway.com** to sign up for our monthly **ECONOMIC NEWSLETTER!**

QUESTIONS?
Contact Steven Crane, Senior Economist at C3 Statistical Solutions, at scrane@c3stats.com.

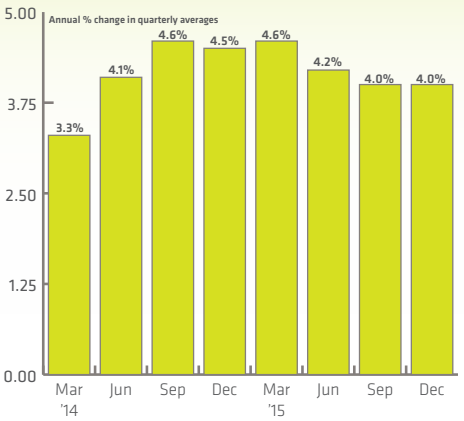
U.S. Leading Indicator:

- The leading indicator recorded a big gain during July.
- The index was up 0.9 points on top of an upwardly revised June estimate.
- The strong performance in recent months is a very encouraging signal regarding the remainder of 2014.



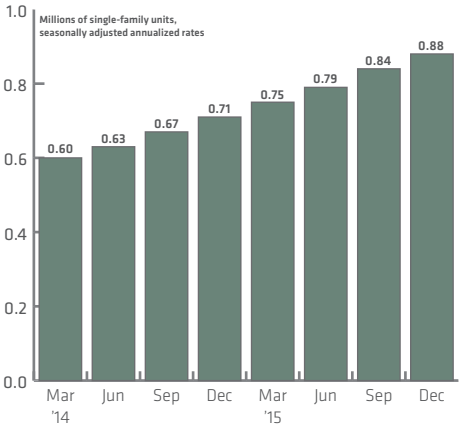
U.S. Total Industrial Production:

- Overall production rose 0.4% in July; this was the sixth consecutive monthly gain.
- Manufacturing did even better; it rose 1.0%.
- A 10.1% spurt in automotive sector production drove the manufacturing gain.



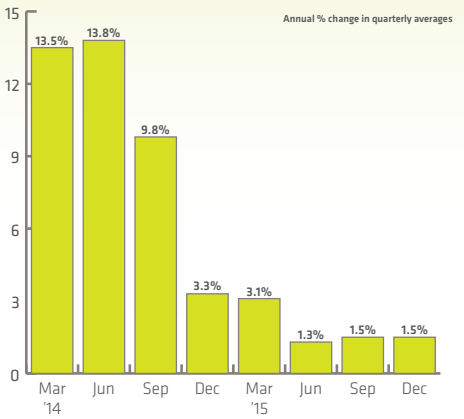
Housing Starts:

- Single-family housing construction bounced back during July housing construction.
- An 8.3% spurt more than offset the losses experienced during May and June.
- Starts are up 12.5% since January, but remain a bit below the year-end 2013 level.



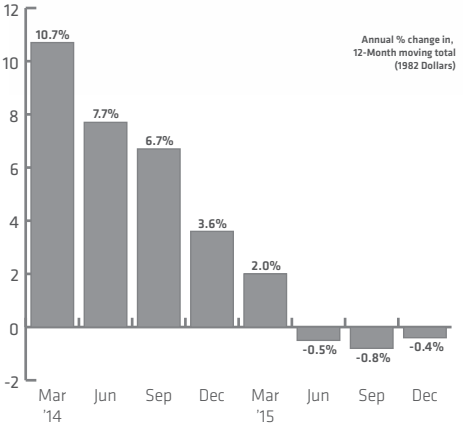
Private Nonresidential New Construction:

- The latest report on nonresidential construction was quite positive.
- July construction was up 2.1% over a June estimate that was substantially upwardly revised.
- Manufacturing and Power each saw major gains; many of the other sub-sectors lost ground.



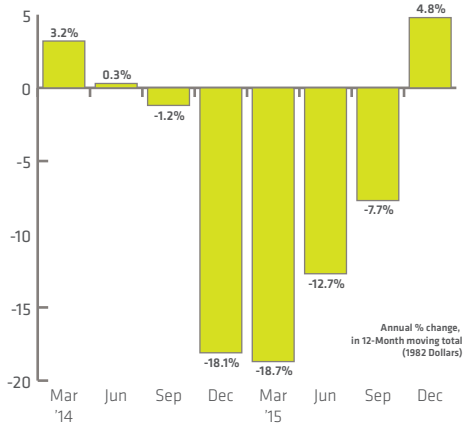
Construction Machinery, New Orders:

- The softness in orders that emerged during the second quarter extended into the early third quarter.
- Real orders were down 9.3% in July; this was the second consecutive monthly decline.
- There have been three declines over the course of the four months since March.



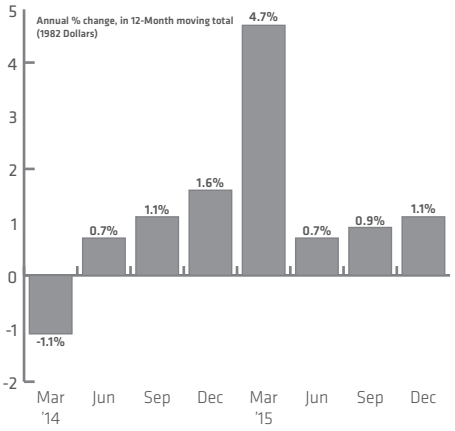
Farm Machinery & Equipment Shipments:

- Real shipments fell again in July.
- July's 4.5% decline was at least smaller than the revised 7.1% decline in June.
- Shipment volume has not been this low since 2001.



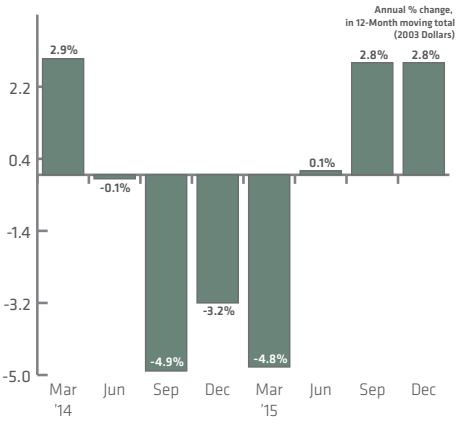
Total Public New Construction:

- The latest report on public construction was also very encouraging.
- June's decline was trimmed by the revision process, and July posted a 3.0% gain.
- A nearly 7% rebound in highway and street construction was a major contributing factor.



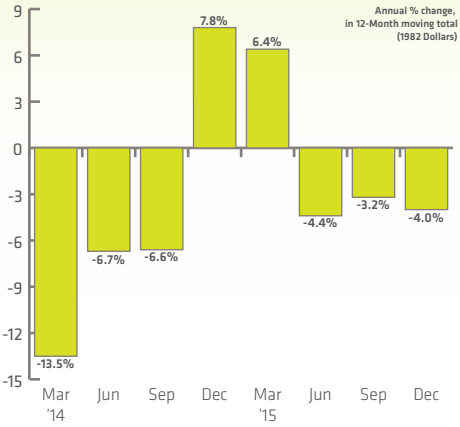
Mining, Oil & Gas Field Machinery New Orders:

- Orders jumped 8.6% during July.
- This was the best monthly performance since the beginning of the year.
- Order volume remains below the norm for recent years.



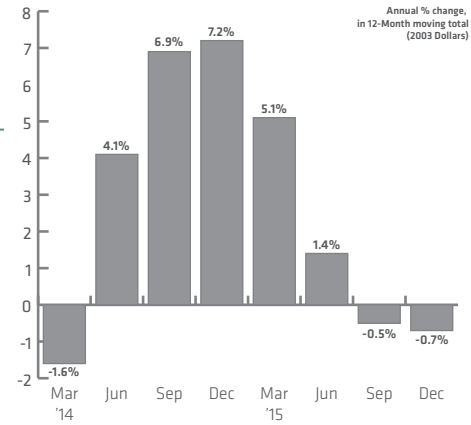
Defense Industry, New Orders:

- Defense industry market conditions have been far from ideal.
- Both the general trend in volume and order volatility have represented challenges.
- A nearly 18% decline in orders during July illustrated both of these issues.



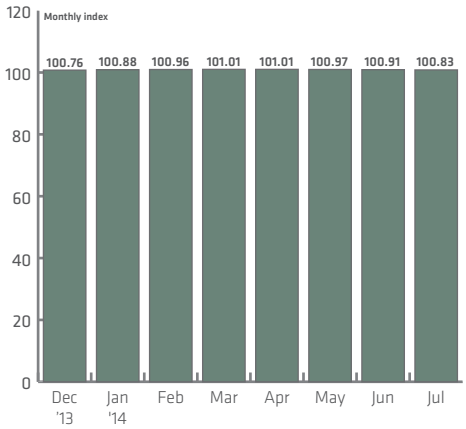
Heavy-Duty Truck Shipments:

- The recent boom in trucking shipments continued into July.
- The 3.3% advance pushed real shipments to their highest level since 2007.
- Volume is up a bit over 22% so far in 2014.

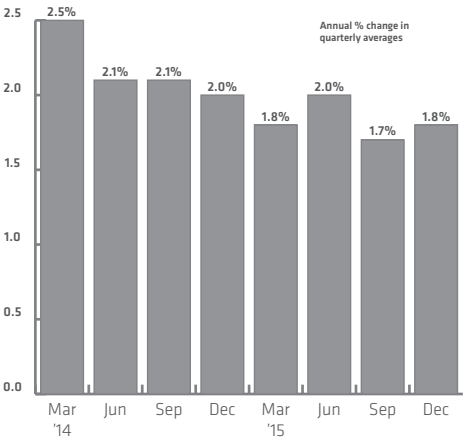


Euro Area Leading Indicator:

- Some additional softening occurred during July.
- The leading index declined slightly.
- This indicator is down three consecutive months and hasn't gained in four months.



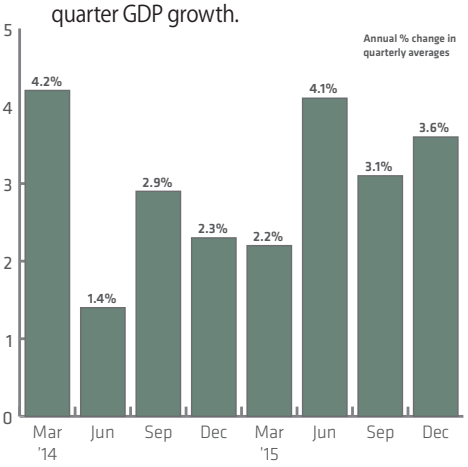
Industrial Production, United Kingdom:



- There was generally good news from the British Industrial Sector.
- Total production rose 0.5% and manufacturing gained 0.3%.
- Both were a bit better than expected and offer counterpoint to survey data suggesting industrial sector slowing.

Industrial Production, Germany:

- Overall production rose 1.9% in July and manufacturing output jumped 2.6%.
- New factory orders also soared 4.6%.
- These industrial sector results were a nice counterbalance to -0.2% second quarter GDP growth.



New Vanguard 810cc EFI Engine Line Sets New Standard of Engine Performance, Fuel Efficiency

Engines to be on display at GIE+EXPO in October

Briggs & Stratton Commercial Power is setting a new standard of engine power, performance and fuel efficiency for commercial cutters with its Vanguard 810cc EFI engine lineup. Scheduled to be revealed at GIE-EXPO in October, the new engine line combines the increased fuel efficiency of a closed-loop electronic fuel injection system with the increased capability of an 810cc engine.

Simply put, the Vanguard 810cc EFI engine gives landscape contractors an optimum level of power and fuel efficiency for commercial mowers.

"Landscape contractors expect two things out of their commercial mower engines: peak performance and fuel economy," said Dan Roche, marketing manager for Briggs & Stratton Commercial Power. "The Vanguard 810cc EFI engine excels at both by offering better fuel efficiency and operating at the 810cc displacement sweet spot that research shows is best to maximize productivity."

Available in 24, 26 or 28 gross horsepower[1], the Vanguard EFI engines have an automotive-based closed-loop EFI system for up to 25 percent better fuel economy compared to the already efficient 810cc Vanguard carbureted engine.[2] EFI engines use less fuel than carbureted engines because fuel in an EFI system is delivered precisely where and when needed, so fuel flow is less under typical conditions.

Built from the same engine platform as its 810cc carbureted counterpart released in the fall of 2013, the Vanguard EFI engines also have 810cc of displacement for higher torque to take on the heavy workloads common in commercial settings. This meets a growing landscape industry demand for higher-displacement engines and higher-productivity mowers.

Additionally, the Vanguard 810cc EFI engines offer unique diagnostic features to arm fleet or dealer technicians with an abundance of information to eliminate downtime and optimize engine performance. Three diagnostics options enable easy identification of issues in the field, and provide technicians unmatched ability to test, update, save and share engine data.

The 810cc EFI engines will be produced at the Vanguard Certified Production Center located in Briggs & Stratton's Auburn, Ala., plant.[3] The engines will be hand-assembled exclusively by certified Briggs & Stratton Master Service Technicians using Direct Current (DC) electric hand tools for superior quality control.

For more information, visit www.vanguardengines.com/efi.

[1] All power levels are stated gross horsepower at 3600 RPM per SAE J1940 as rated by Briggs & Stratton.

[2] Savings will vary based on cutting conditions and operator usage.

[3] The Vanguard 810cc engines are made in the US of US and global parts.

VANGUARD™
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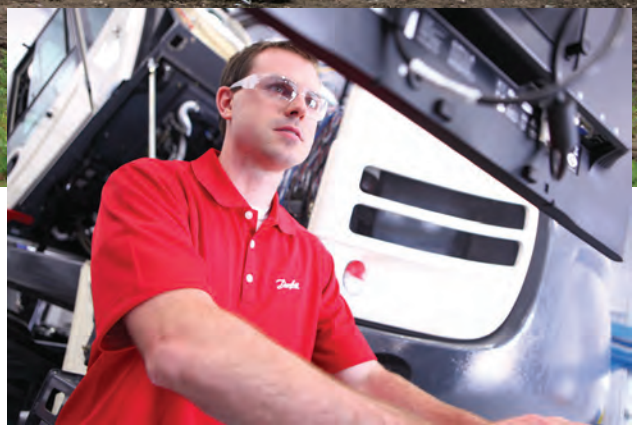
On the test track — where seeing is believing



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To learn more about the Global Application Development Centers, visit the Danfoss Power Solutions website: http://bit.ly/1nYB7UT

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Market expectations in 2015 a mixed bag

Second quarter 2014 industry revenues down 4%, profits down 14.5%; however, U.S. retail sales of Caterpillar and Komatsu are encouraging for construction and mining. **by Frank Manfedi of Manfredi & Associates, Inc.**

Manfredi & Associates has compiled the financial results of many publicly traded companies associated with construction and mining equipment to get a gauge on how the market fared in the second quarter of 2014. Overall, revenues were down 4% and profits were down 14.5%.

The industry was divided into three groups: manufacturers, distributors and rental companies. There were major performance differences among the three groups. Manufacturers reported second quarter 2014 revenues down 5.3% with profits down 15.6%. Distributors reported second quarter revenues up 6.8% but profits were down 1.6%. Rental companies are outperforming the other segments with second quarter revenues up 13.8% and profits up 16.4%. It appears that organizations closest to their customers perform better than others involved in the industry *(see Figure 1).*

Companies deeply involved in agriculture such as AGCO and Deere reported down revenues: -9.8% and -8.9%, respectively. Their performance is not surprising given the fact that year-to-date U.S. sales of agricultural tractors 100 hp or more are down 8.7%, four-wheel drive agricultural tractor sales are down 11% and combine sales are down 15.2%. *(Read more about the agricultural industry outlook specifically online,* **12007563***. Individual company results can be found online,* **12004091***.)*

The mining equipment sector has been particularly hard hit. Joy Global reported its second quarter revenues were down 31.7%. The drop in mining also affected Caterpillar. It managed to eek out a profit gain of 4.1% despite a revenue decline of 3.2%, which was largely caused by a 28.5% drop in the revenues of its resource industries segment that supplies equipment to the mining industry. AB Volvo also reported second quarter revenues were down 8.7%. The Volvo revenue figure is for all of their operations, including trucks and engines. The company's construction equipment segment reported a second quarter 2014 revenue decline of 7.4% that was largely due to a 29.7% decline in the company's Asia market region.

The equipment distributor segment fared somewhat better than the manufacturers with revenues up 6.8%, but profits down by 1.6%. It should be noted that with the exception of Titan, all of the distributors in the analysis are based in Canada because most U.S. distributors are not public companies and data is not available. The Canadian companies are benefiting from a good economy, especially in the oil sands region in Alberta.

It should also be noted that, Finning, based in Vancouver, British Columbia (BC), with Canadian operations in BC and Alberta, is the largest Caterpillar dealer in the world and has operations in the U.K. and Ireland, as well as the southern cone of South America. Finning benefitted from the robust Canadian economy as well as renewed economic growth in the U.K. Gains in both regions have been tempered by declines in the company's South American region that is almost entirely mining related.

The equipment rental segment is once again the star

Figure 1: Financial Results for Selected Publicly-Traded Companies (millions of dollars, percent)

	2nd Quarter						6 Months					
	2014	2013	% change	2014	2013	% Change	2014	2013	% change	2014	2013	% Change
	Revenues		14 vs 13	Profit		14 vs 13	Revenues		14 vs 13	Profit		14 vs 13
Manufacturers	$52,721.3	$55,657.0	-5.3%	$3,450.3	$4,086.8	-15.6%	$98,619.3	$100,324.4	-1.7%	$6,337.6	$6,707.1	-5.5%
Distributors	$3,607.6	$3,378.0	6.8%	$132.4	$134.6	-1.6%	$6,292.0	$5,935.9	6.0%	$232.1	$240.6	-3.5%
Rental Companies	$2,128.0	$1,869.9	13.8%	$107.0	$91.9	16.4%	$4,962.8	$4,355.8	13.9%	$171.2	$115.4	48.4%
Total	$58,456.9	$60,904.9	-4.0%	$3,689.7	$4,313.3	-14.5%	$109,874.1	$110,616.1	-0.7%	$6,740.9	$7,063.1	-4.6%

ALL CHARTS: MANFREDI & ASSOICATES

Figure 2: Komatsu Ltd. Retail Sales of 7 Major Construction and Mining Equipment Categories
(monthly percent change year-over-year)

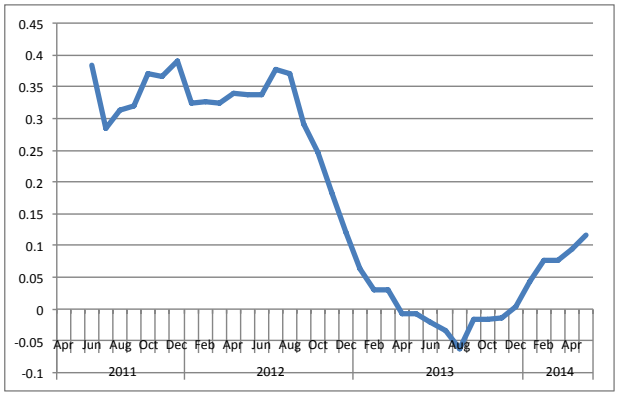


Figure 3: Caterpillar Monthly Dealer Retail Sales
(monthly percent change)

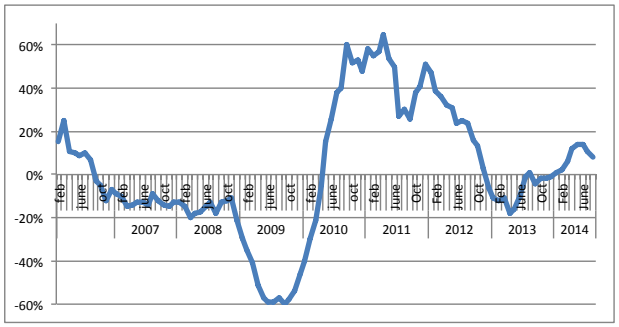
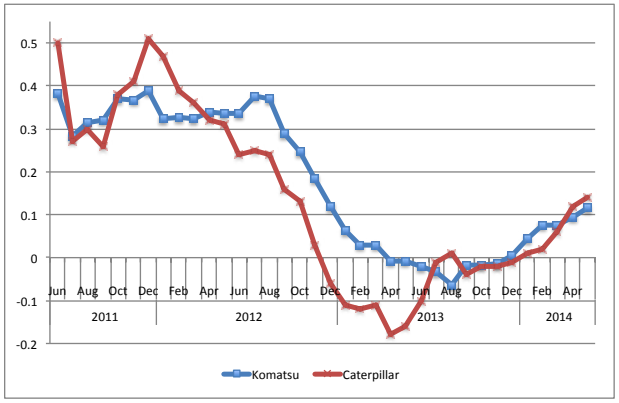


Figure 4: Caterpillar and Komatsu Retail Sales
(percent change, 3 month moving average)



performer with a second quarter 2014 revenue gain of 13.8% and a profit improvement of 16.4%. This group is benefitting from the industry trend toward renting more and owning less. The performance metrics of this group are extremely positive. Hertz has not yet reported its second quarter 2014 results and is in the process of restating its results for the past several years. There is no word yet on when the restated results are expected.

Manfredi & Associates believes that the 2014 market will yield considerable improvements. Growth will be back-loaded to the second half.

The company expects the mining sector bloodletting to slow in the second half of 2014 on the theory that it can't get much worse. Mineral commodity prices are still at levels that should encourage equipment investments. The U.S. coal industry is still under siege from the EPA that is issuing increasingly restrictive generating plant regulations, making upgrading and investing in coal-fired plants very risky. The U.S. housing market is well on its way to exceed one million housing starts, a recent milestone for this important construction segment. Housing construction drives a great deal of other construction activities and will benefit equipment sales.

The extension of the Federal Highway Trust Fund will allow for the continuation of projects underway and pending. Non-residential construction is on track to grow between 10 and 15% this year, which means the second half of the year will be very robust. Energy related projects such as fracking and wind farm construction will be strong for the balance of the year.

There is no better source for tracking retail sales of construction equipment than the manufacturers themselves. Both Caterpillar and Komatsu publish data that tracks retails. Caterpillar's is based on a survey of its dealers. The data is a three month moving average of the percent change year-over-year for its regions. That means the data has been smoothed. Komatsu publishes the monthly percent change in its retails for each of its regions ***(see Figures 2 and 3)***.

To make the two data series comparable, the Komatsu data has been converted into a three month moving average in order to compare the retail results with Caterpillar's results. They are remarkably similar. Together they portray a picture of a North American retail trend that is encouraging. The percent change in retail sales of construction equipment turned up for both companies in August 2013 and has continued on a mostly positive track since then ***(see Figure 4)***.

Manfredi & Associates believes there will continue to be an improving sales pattern for the balance of 2014 and probably well into 2015, and is sticking with the forecast made last year that predicted 2014 U.S. retails would be up between 5 and 10% compared with 2013.

2015 Forecast

The U.S. economy has been limping along for several years. U.S. GDP, the broadest measure of economic activity, has

Figure 5: U.S. GDP, Quarterly at Annual Rates

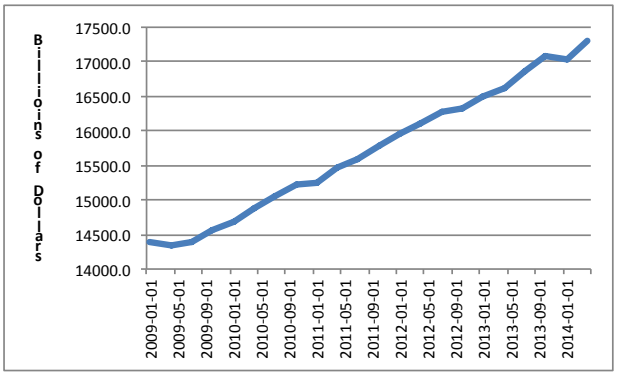


Figure 6: U.S. GDP, Quarter-Over-Quarter Percent Change

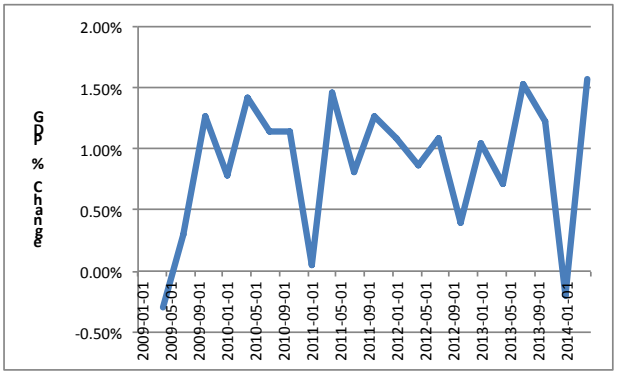


Figure 7: Total Put-In-Place Construction

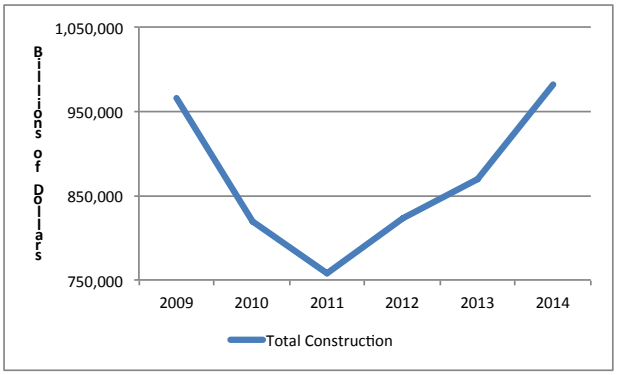


Figure 8: Put-In-Place Construction Funding Sources

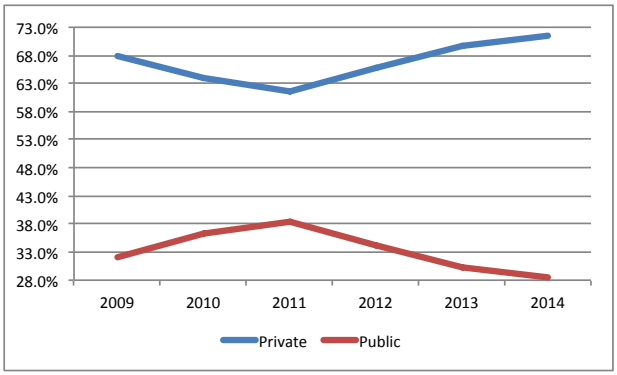


Figure 9: U.S. Put-In-Place Construction of Highways & Streets

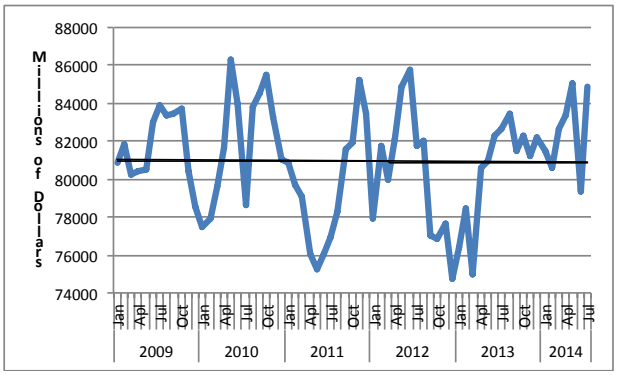
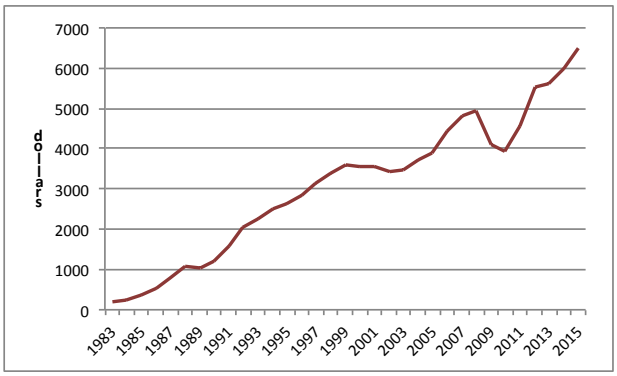


Figure 10: U.S. Rental Spending Per Construction Employee



been growing since 2009, but just barely. The table in **Figure 5** illustrates that the $17 trillion economy has been steadily growing.

However, examining the percent change from quarter to quarter the pattern is not a steady upward trend. This recent up and down economic pattern with no strong surge forward is one reason the Federal Reserve is keeping interest rates low and continues to express concern about the future ***(see Figure 6)***.

Total construction as measured by the U.S. Department of Commerce has finally recovered. The number of dollars put-in-place reached bottom in 2011 and has been increasing since then. Total construction will reach $1 trillion in 2015, or approximately 6% of the total economy. In the early 2000s the construction industry represented nearly 10% of the total economy ***(see Figure 7)***.

The source of funding has changed over this time period. In past downturns Federal and State governments

have jumped in and funded construction projects in order to bolster economic activity. This time around the major spending has been from the private sector not the public sector. The percent of construction funded by the private sector is expected to climb to more than 70% in 2014 and will probably be slightly less than 75% in 2015 ***(see Figure 8)***.

The improving sales pattern, at least for the first half of 2015, will be advanced by increases in housing starts. Housing is the engine that propels the economy in general and construction machinery sales in particular. Single family starts dropped dramatically when the great recession began and has been very slow to return to normal levels.

In the 1990s and early 2000s, starts were averaging 1.5 million units per year. One and a half million units was considered adequate by most economists to house new immigrants, provide for new family formations and replace dilapidated housing. The figures are annualized data plotted monthly. Monthly annualized starts have been trending slightly below one million annual units for several years, which is an unacceptable level.

At the end of the recession multi-family starts exceeded single family starts, which is very unusual, as people displaced from their homes because of financial trouble struggled to find adequate housing. Total starts were underperforming compared with previous historic periods because of a shift to multifamily and because so many people, especially young people who were unable to find jobs, moved back home with their parents.

Single family housing is an important driver of demand for construction machinery. Building single family structures is much more equipment-intensive than multi-family construction.

Road building is the mainstay of the construction equipment industry. For one thing the activity is noticeable to everyone. A person can't drive anywhere in the country without encountering men working or work zone notices. Funding for this activity is largely from government sources—state, local and of course Federal. Most people believe that Federal funding has been inadequate to keep up with the country's neglected infrastructure. Spending for roads has been erratic, as seen in **Figure 9**. The horizontal line represents the spending trend over the past five and a half years: almost exactly horizontal, which means

Figure 11: Estimated U.S. Construction Machinery Market (units)

Product	2010	2011	2012	2013	Estimated 2014	% Change 14 vs 13	Forecast 2015	% Change 15 vs 14
Asphalt Pavers	1,051	1,167	1,285	1,275	1,340	5.1%	1,400	4.5%
Compactors	3,945	3,900	4,115	4,315	4,530	5.0%	4,700	3.8%
Cranes	632	1,255	1,660	1,830	1,900	3.8%	1,700	-10.5%
Crawler Tractors	4,400	5,010	5,440	5,700	6,100	7.0%	6,700	9.8%
Hydraulic Excavators	21,285	32,120	38,175	39,000	42,300	8.5%	46,500	9.9%
Loader Backhoes	12,050	14,435	15,025	16,000	15,200	-5.0%	17,500	15.1%
Motor Graders	1,800	2,100	2,495	2,695	2,800	3.9%	2,900	3.6%
Haulers - Rigid	775	780	910	895	850	-5.0%	760	-10.6%
Haulers - Articulated	850	1,800	2,000	1,300	1,500	15.4%	1,650	10.0%
RT Forklifts	3,748	9,400	14,110	15,090	15,800	4.7%	17,700	12.0%
Rubber Tracked Loader	11,300	19,000	21,000	23,200	25,500	9.9%	29,000	13.7%
Skid Steer Loaders	30,030	35,006	40,019	41,027	45,000	9.7%	52,000	15.6%
Wheel Loaders	10,880	16,265	18,500	19,000	21,000	10.5%	23,100	10.0%
Total	102,746	142,238	164,734	171,327	183,820	7.3%	205,610	11.9%

there has been no change during the entire period. Annual spending is approximately $82 billion per year.

Energy production, especially shale gas, has gotten a lot of attention in the past few years. It is proving to be a boon to the U.S. economy and has the potential to allow the U.S. to become energy independent. Production development is unusual because it affects areas of the country where equipment demand is traditionally slow, or almost non-existent. Currently, the most active areas are in North Dakota, the Bakken deposit, and in western New York and Pennsylvania in the Marcellus and Utica deposits. Demand for equipment in these areas is at an all time high. Overall, shale gas production is up more than 500%.

Construction employment is a strong indicator of equipment demand. Employment is expected to reach six million people in 2014 and expected to reach 6.5 million people in 2015. The 2015 level is still far below the slightly less than 8 million people who where employed in construction in the 2006/2007 period. The lower level compared with 2006/2007 is due to shortages of skilled workers. The Associated General Contractors (AGC) has been complaining for the past year about the lack of skilled workers and the constraint that shortage is putting on construction activity.

The labor shortage is helping to grow the equipment rental business more rapidly than overall construction. Contractors will be spending more on renting equipment as they attempt to take on more and more work with fewer people while keeping their capital costs to a minimum. Jobsite automation is propelling the rental business to new highs. Manfredi & Associates forecasts that in 2015 equipment rentals per employee will reach $6,500. It also predicts that construction employment will reach 6.5 million people. Do the math and that implies that total U.S. rental revenues will reach more than $40 billion in 2015. High rental revenue growth is also good for equipment demand because rental companies have become the single largest purchaser of equipment in the U.S *(see Figure 10)*.

2015 construction equipment forecast

Manfredi & Associates' total 2014 forecast turned out to be spot on. Overall the year will end with retail sales up 7.3%. There were big gains in sales of wheel loaders, up 10.5%. Track and skid steer loader sales were up slightly less than 10%. Articulated truck sales were up 15.4% due to rental companies replenishing their fleets. The big miss was the crane market which was originally forecasted to be up 12%, but will actually be up 4%, or perhaps less. Rigid hauler retail sales continue to suffer from the slowdown in coal mining particularly in the East *(see Figure 11)*.

The 2015 market will grow at slightly less than 12% overall with the largest gain in the skid steer loader market and the tractor loader backhoe market. Both of those markets will benefit from the continued growth of housing starts. Most product markets will end 2015 on a positive note. Exceptions are the crane market and the rigid hauler market, both will decline about 10%.

Head to the web

Read Manfredi & Associates' forecast on the farm tractor market at **www.oemoffhighway.com/12007563.**

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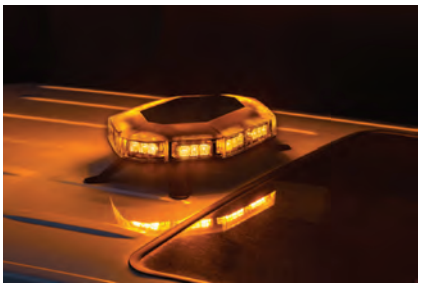

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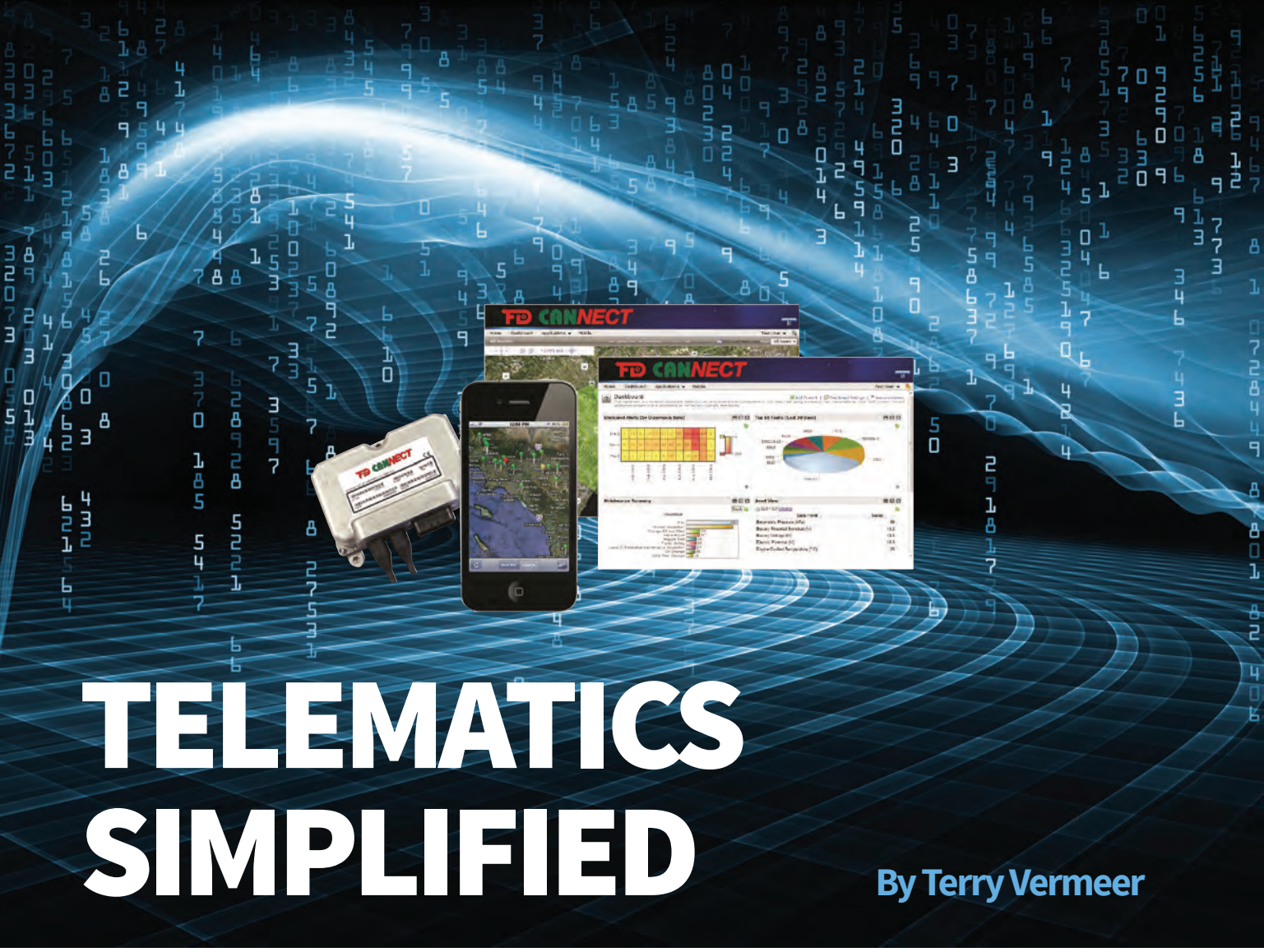

TELEMATICS SIMPLIFIED

By Terry Vermeer

For many OEM equipment and fleet management companies, one of the biggest 'time and money wasters' lies in the inability to know what is happening with their equipment without being on-site. In fact, many man hours are lost every year sending maintenance personnel out to make a service call, only to find that they have the wrong part or the wrong tools to do the job.

The Flodraulic Group has developed a remote monitoring telematics solution called FD CANnect, which transmits location and status, and can be configured to transmit logistics, service, utilization and other information vital to the successful operation of OEM equipment. This real-time system allows end users, fleet managers, and OEM distributors the ability to make relevant business decisions based on the information that is remotely acquired.

Flodraulic has devised the FD CANnect system as a complete end-to-end telematics solution, developed to provide the hardware, web and mobile interfaces, pushed data reports, alert call outs – even all carrier business (contracts, SIM purchase and assembly, activation, billing) necessary to effectively deliver the telematics program. The system includes multiple methods of data delivery, including mobile apps, making data collection completely accessible and easy to use for all types of end users.

This time efficient and cost effective system for streamlining data creates opportunities for owners and managers to make better business decisions regarding equipment health, compliance, integration, location, utilization, security and rental contracts. The online and mobile applications are designed to provide the power to make smart decisions from real time equipment information, and the user-friendly system provides all the required data in one operational view. In addition, FD CANnect uses CANbus to connect with the equipment and provides ten times more data points than an average asset tracking system.

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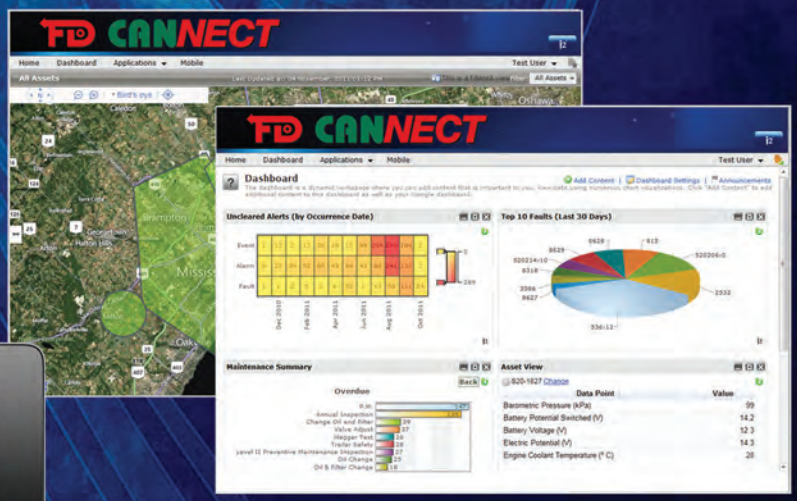

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CLEANER THAN CLEAN

As air monitoring technology becomes more portable and accessible, and clean air requirements continue to get stricter, the industry of clean air continues to be top of mind to equipment manufacturers and contractors alike.

by Allen Schaeffer, Executive Director, Diesel Technology Forum

I'm seeing more yellows, reds, oranges and some nice shades of green along the interstate this time of year. But I'm not talking about the leaves changing, I'm talking about the construction equipment and farm machines I see being shipped along the interstate coming and going from the Port of Baltimore and other reaches on flat-beds bound for somewhere. There's even more of those fall-like colors in the highway construction projects, and with extra time in traffic backups, a lot can be learned.

There seems to be one of every kind of light tower, material handler, paving machine, articulated truck, excavator, sweeper and roller from every manufacturer. Some have a rather rusty look to them, others newer, maybe one or two that are really clean and look almost brand new and still others (newer looking) are ablaze with a rental company's logo.

The good news is that they are working as this economy and spending starts to inhale and exhale a little more deeply. That image of the jobsite with the mix of old and new, borrowed and sometimes blue, however, is instructive about the state of the economy and the equipment industry.

Tier 4 out the door but there's more . . .

The party is still not over on the Tier 4 technology. While milestones have been met by manufacturers, and machines now available, the slow-moving economic recovery has slowed investments in these new and near-zero emission machines. Some OEMs have trimmed growth expectations for 2014 down to the 2 to 3% range. Contrast this with heavy-duty commercial trucks with sales expected to break 250,000 units this year and you can only envy the optimism and increased demand for trucking services which also means the need to replace older equipment.

For equipment OEMs and contractors, the situation is more complex, with housing still depressed and commercial starts minimal, the construction fleet is aging. Tier 4

technology was a must-do to meet EPA requirements, but not necessarily the primary motivator for contractor investment. That motivator is and has to be benefits – in the form of greater efficiency on the jobsite, less fuel consumed, lower operating costs, more capabilities, uptime and reliability than the equipment it replaces. The new generation of technology offers all of that and more.

Air needs to get cleaner

Another ratcheting down of national clean air standards is on the horizon and with it will come the air quality area re-designations, and new state implementation plans and potential control measures. EPA is required by court order to issue a proposed rule December 2014 that is widely expected to slash the levels of allowable ozone in the air by another 30%. More states, counties and regions will find themselves designated as "non-attainment" for ozone and begin looking for reductions from emissions source inventories, including on- and off-road diesel vehicles and equipment.

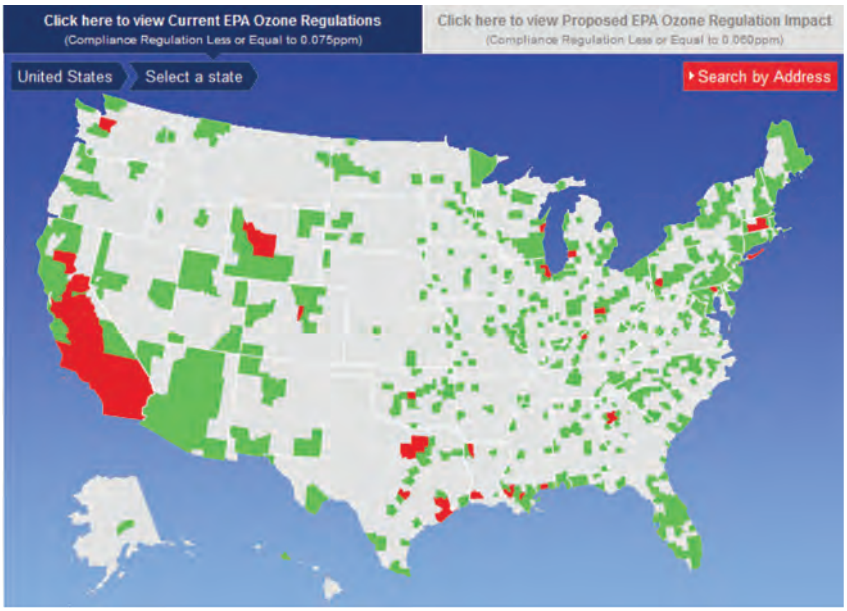
What is the fallout for engine and equipment makers and their customers?

While it is hard to imagine a further reduction in engine standards, as reported last year, California is leading the charge for further reductions in nitrogen oxide (NOx) emissions; a precursor to ozone formation in some areas. With a new optional low-NOx standard that is 50 to 70% lower than the current federal and California standard (0.2g/BHP-hr, on the books in California since December 2013), only time will tell how and whether manufacturers will produce trucks that can be certified under an optional standard, and of course whether customers will buy them.

Clean air requirements not just for manufacturers anymore

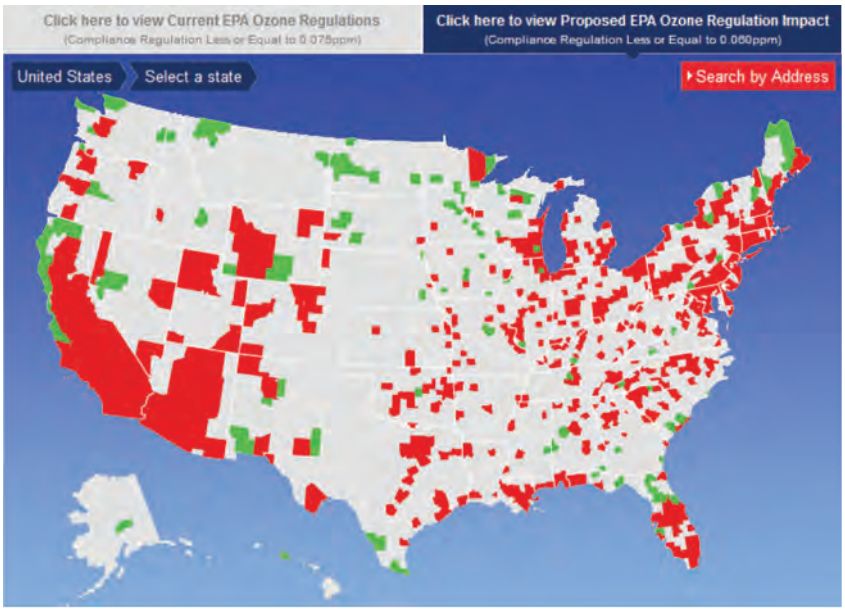
Tighter standards for manufacturers on new technology is one thing, but there are new forces that are likely to make clean air concerns in the future more relevant for contractors as well. Everyone is familiar with California's mandatory diesel retrofit regulations for off-road equipment, but that program only applies in California

Compliance Under Current Ozone Standard (0.075 ppm)



The EPA's current Ozone Regulations: Green indicates the county meets standards, red does not meet standards, and gray areas are not currently monitored.

Compliance Under Proposed Ozone Standard (0.060 ppm)



Using the same color-coding as above, this map demonstrates the compliance under the proposed EPA Ozone Standards.

(for the moment). Legal options for export of those California mandatory retrofit requirements to other states appear to be very cloudy or non-existent. But that doesn't mean that other non-regulatory forces can't have a near-regulatory kind of effect.

One example of the seriousness states are placing in emissions from existing engines and equipment can be found in New York at the New York State Energy Research and Development Authority (NYSERDA) who last year launched it's Clean Diesel Clearinghouse, a growing database, free and accessible to users to input data on diesel engine retrofit technology costs and special considerations and options for retrofitting their machine or equipment. Last year, the US Green Building Council, as part of it's Green building LEED certification, incorporated the potential for building owners and contractors to gain 1 pilot credit toward accreditation for meeting clean diesel construction requirements. These include minimum equipment performance standards (Tier 2) with the credit based in large part on increasing percentages of engines that use Tier 4 equipment in three horsepower ranges. Rebounds to road building activities or commercial construction are likely to consider green construction practices as threshold criteria, not regulations – but you've got to play along to have the chance to win the contract. That positions companies that have made investments in new clean diesel technology at a competitive advantage.

Citizen journalists and air pollution inspectors?

These days everyone is a reporter, thanks to the Internet, blogs and social media. Soon, just about anyone can also be an air pollution inspector, as well, which has implications for both manufacturers and equipment users.

Official EPA air quality monitors are typically hidden away on poles or in cabinets in out-of-the-way places, often at schools or government buildings. They are stationary, large boxy meters or cyclones along with measuring and recording equipment. But EPA is rethinking the locations and monitoring network with the states with a trend toward monitoring more near the at-risk populations.

More research funding has been directed toward emissions evaluations in hot-spot areas, areas of concern for environmental justice, and along roadways where some of the highest emissions seem to be occurring.

Only time will tell how and whether manufacturers will produce trucks that can be certified under an optional standard, and of course whether customers will buy them.

The revolution in monitoring technology has downsized monitors, made them more portable and accelerated more recently to personal monitors and soon to smartphone plug-ins. (Think of a square trade credit card reader device to measure emissions plugged into the smartphone.) Now anyone with a little technical savvy can measure levels of particulate matter and other emissions at their exact location, in their community, along a roadside, adjacent to a freight distribution center or construction project.

How will this new information be used and interpreted?

Consider the possibilities: social media sharing about pollution "hot spots," feeding data directly to regulators and to local reporters. But what this information means for compliance and ultimately determining non-attainment status, remains to be seen.

National clean air standards exist as either 8-hour averages or 1-hour maximums, which anticipates cyclical levels of emissions sources throughout a day; peak levels during afternoon rush hour, lower levels at night and morning are averaged out, and compliance determined.

Coming alongside this clean air emphasis are renewed concerns about real-world emissions performance from diesel engines, both on- and off-road. State and federal regulators are increasingly looking not just at new technology certification, but how it is performing in the field after 100 or 500 hours, or 50,000 miles. Some studies have suggested that emissions are higher than anticipated due to operational patterns of low load and lots of idle time which make it difficult to bring emissions control technology to optimum temperatures and performance.

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Virtual Test Drives for Everyone

Test driver assistance functions on your own PC

The challenge: Test scenarios not available

Validating ECU functions in realistic test scenarios during the early stages of development is becoming a more common practice. Simple unit tests do not provide enough coverage anymore, especially for safety-critical driver assistance functions which, by nature, are networked with many other systems. In cases like this, function developers must test the functions' interaction with other control algorithms closed-loop with complex environment models.

The idea: Virtual test drives

The pragmatic approach takes the environment simulation models that already exist for ECU testing and reuses them on the developer PC. dSPACE VEOS® is the bridge between these two worlds. It lets function developers perform virtual tests of functions whenever they want to so that they can easily test many different environment scenarios. This holds the number of real test drives at an affordable level. It also makes reproducing virtual test drives much easier, which is useful for checking a corrected function. VEOS also includes established error analysis methods such as debugging and code coverage, which are not possible in real test drives. If function developers do not have access to the environment models, they can use the dSPACE models that cover many ADAS areas.

The advantages: VEOS for virtual test drives

- Use your own PC for closed-loop tests of ADAS functions
- Reuse plant and environment models
- Use models and automated tests seamlessly throughout all development phases
- Support of Simulink®, TargetLink®, legacy C code, AUTOSAR, and FMI

One example: Developing complex intersection assistant functions

Performing automated tests of intersection assistance functions on a hardware-in-the-loop simulator involves constructing many test scenarios that describe the exact traffic situations (the course of the road, how many traffic participants there are there, what the roadside looks like, etc.) to test all the participating ECUs in detail. With VEOS, function developers can take the relevant function algorithms that were developed in Simulink or AUTOSAR and simulate them in interaction with these environment models. VEOS provides them the same features for visualization, simulation control, and automated tests as a HIL simulator.

Would you like to see how to virtualize your test drives? We are always glad to help: viva@dspace.com

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From HIL Simulator to PC and Back

Realistic hardware-in-the-loop tests need complex, real-time-capable models of the plant and its environment – and dSPACE Automotive Simulation Models lead the field. These same models can also be used to test virtual electronic control units on VEOS®, dSPACE's PC-based simulation platform. So you can simulate test drives at your desk without adapting a thing. It's total synergy! The result: earlier testing, higher-quality electronic control units, and more efficient use of HIL simulator time.

Just get in the car and drive off – with realistic simulations on your own PC.

For more examples of VEOS applications, visit www.dspace.com/viva_en

Embedded Success

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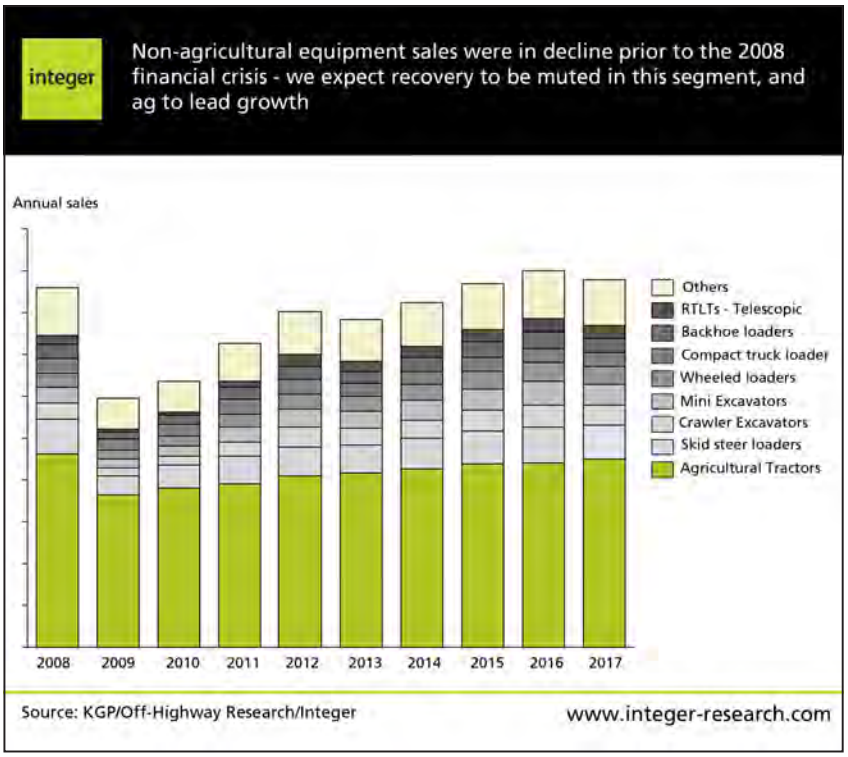
Emissions legislation gains traction: Are you prepared?

The off-highway sector must consider new emerging economies and their infrastructure needs when determining its technological course of action for tackling new emissions challenges and regulations. **by Dr. Niels Tholen, Integer Research**

The off-highway mobile machinery market can seem extremely complex, and, to a certain degree, it is. While commercial vehicles and passenger cars are broken down into weight classes as a basis for emissions regulation, the off-highway market is classified by application including construction, agricultural, mining and forestry equipment and subsequently into powerbands. To add to the complexity, emission standards can differ for each off-highway segment.

At the start of 2014, the U.S. Environmental Protection Agency's (EPA) Tier 4 Final and Europe's EU Stage IV advanced emission standards were enforced in North America and Europe, respectively, in an attempt to harmonize the two markets and allow OEMs to sell the same equipment in each region.

Harmonization was a key aim of both European and North American emissions policy makers, but the most recent developments are threatening this process and adding an extra layer of complexity to the market. Though the U.S. EPA does not have any announced plans to roll-out new legislation, on the other side of the Atlantic, European



discussions on the implementation of both particulate number and a new emissions standard named Stage V are ongoing. This new emissions standard could be rolled out between 2019 and 2021 and would put North America behind European emissions standards, side-tracking the harmonization process.

While Stage IV decreased NOx emissions levels by 90% compared to Stage IIIB, new Stage V legislation under discussion would further decrease NOx emissions by 37%, particulate matter by 40% and also include a particulate number standard. The new particulate number legislation would ensure the use of wall-flow diesel particulate filters (DPFs) as demonstrated by Euro VI configurations currently being rolled out in the truck segment in Europe where particle number limits now apply. Experience gained there will be built upon to ensure optimized aftertreatment system configurations in the off-highway sector. Stage V's equipment scope will be expanded to include small hand-held equipment as well as specialized vehicles such as snow scooters, providing a comprehensive emission ruling for a greater range of equipment, from very small units to large gensets. At Integer Research, we believe that Stage V would prompt increased application of selective catalytic reduction (SCR) equipment below 75 kW. SCR is already widely used above 56 kW and in almost all cases above 75 kW.

North America will most likely not stay behind for long and it is expected that European-like Stage V regulations will also be implemented in North America in the next 10 years.

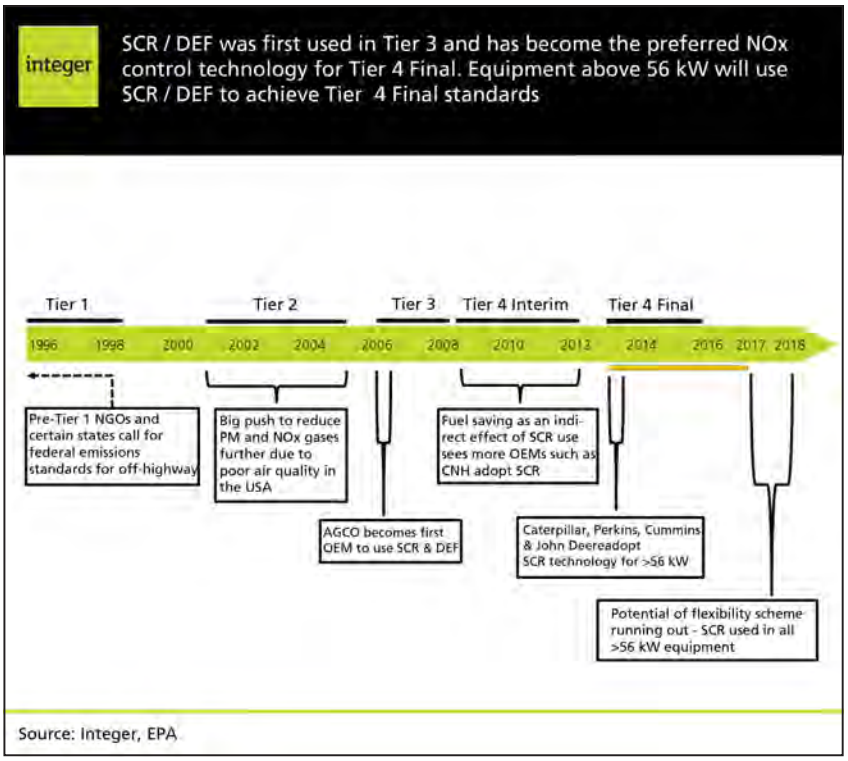
Economic influencers

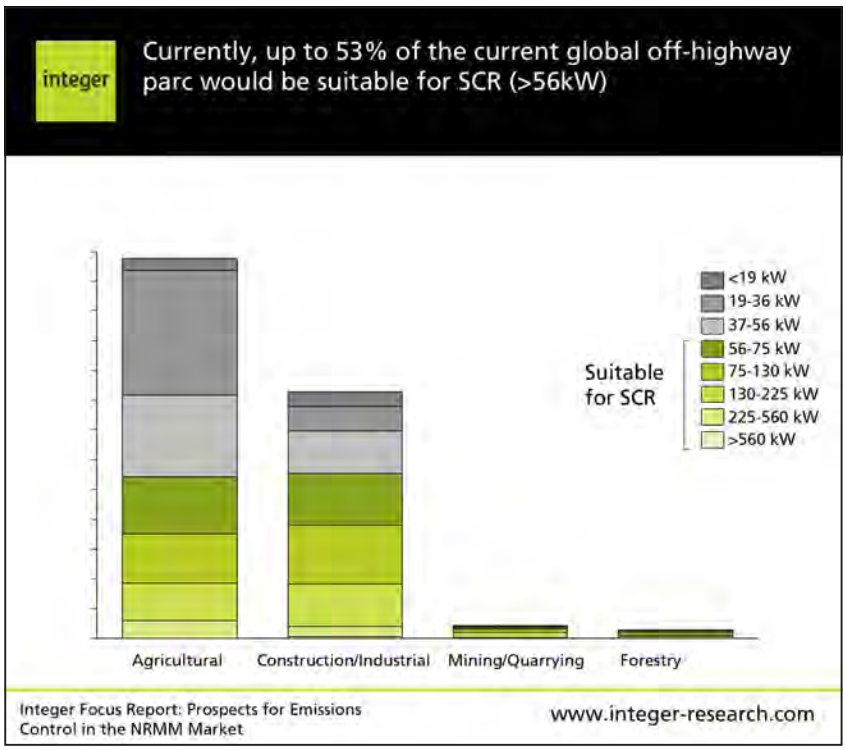
But while emissions standards drive the roll-out of ever more advanced machinery, economic conditions drive the overall market. From a total equipment fleet perspective, Integer Research forecasts the Indian and Chinese off-highway markets will both overtake Europe and North America by 2015. This rapid increase in demand for off-highway equipment in both China and India is driven by both countries' expanding economies, which will fuel the need for additional and more efficient machinery. India and China are set to expand towards 6.5 and 8.0 million units of off-highway machinery in use by 2023, while the equipment parc in Europe and North America will remain more stable at around 4.5 million units.

Even though the North American and European fleets might not expand much in size and may be overtaken by growing economies like India and China, equipment replacement schedules are shorter resulting in lower average equipment age and more advanced technology in use. Many of these advancements are driven by increasingly stringent emissions legislation.

Reduction technology options

In order to avoid the use of exhaust aftertreatment technology in their machinery, some OEMs are researching the applicability of alternative fuels such as natural gas, biofuel and electrification. Natural gas is one of the most discussed options for North America in light of recent fracking discoveries freeing up abundant and as yet untapped natural gas reserves. However, the scope for use of compressed natural gas (CNG) and liquefied natural gas (LNG) in off-highway equipment might be limited. This is because the fuel tank size as well as the additional weight added to the equipment would make it very heavy and cumbersome to operate. Similarly, LNG is mainly used in applications that run almost continuously, which makes it unsuitable for most off-highway machinery. As a result, in most cases we do not see diesel





technology being substituted by alternatives in the off-highway sector, although some applications such as forklift trucks are notable exceptions.

Far more promising are technological advances such as the use of GPS, enabling farmers to more accurately plot the most efficient harvesting route, lighter alloys to reduce overall weight and therefore fuel consumption, and more efficient catalysts used in aftertreatment systems.

With diesel here to stay, the off-highway sector has to employ aftertreatment technology to reduce toxic NOx gas emissions. Currently, almost all OEMs have opted to either use pure-SCR or exhaust gas recirculation (EGR)/SCR combination technologies in equipment above 56 kW adhering to Tier 4 Interim and Final regulations in North America.

It has to be noted that SCR technology is not the only technology available to reduce harmful emissions, yet out of all the NOx reduction technologies available, SCR has proven to be the most efficient and versatile and is used by almost all OEMs. EGR technology is used in combination with SCR, but for a time it was used as a stand-alone aftertreatment option.

However, as emissions levels were further restricted, EGR was combined with SCR and, in some applications, replaced by SCR given fuel economy savings to the customer compared to EGR, which incurs a fuel penalty instead. Other competing technologies with SCR include lean NOx-trap (LNT) and homogeneous charge compression ignition (HCCI), but these remain unpopular due to higher costs, potential for deactivation by sulphur in diesel, or limited operational application.

Challenges in lesser-regulated areas

Our recent investigation into the implementation and roll-out of Tier 4/Stage IV Interim and Final advanced aftertreatment equipment in North America and Europe has revealed several challenges for the secondary market for off-highway equipment. One issue focuses on the need for diesel exhaust fluid (DEF) when shipping Tier 4/Stage IV machinery outside North America to less regulated markets. DEF, also called AdBlue, is a colorless aqueous urea solution made up of ultra-pure urea and de-ionized water and provides the ammonia needed by the SCR system in order to reduce NOx to nitrogen and water vapor. DEF can be hard to come by in regions where there are no advanced emissions standards and as such do not have an existing infrastructure.

In these cases, some OEMs provide DEF from local OEM stores, but this depends heavily on the OEM in question. Several new countries such as Argentina, Colombia and Chile are slowly witnessing an increase in second-hand advanced-aftertreatment equipped machinery and therefore an increase in available DEF.

Another challenge presents itself in the availability of diesel fuel at the level of quality required to operate these complex aftertreatment systems. In this case, some OEMs have decided to remove the aftertreatment system and set their machines back to Tier 3, in which case there is no need for ultra-low sulphur diesel (ULSD) or DEF.

Global market expectations

As SCR expands to become the technology of choice, so does the market for DEF. Integer Research predicts that by 2023, there will be 5 million items of equipment globally using SCR technology. As a result, the DEF market will reach 3.2 billion liters (0.85 billion gallons) by 2023, of which North America will make up for 1.3 billion liters (0.35 billion gallons).

Consumption growth is seen accelerating from 2017 as flexibility

schemes come to an end. Europe and North America will continue to be the largest markets for DEF in this segment, with the BRIC countries slowly gaining traction, starting around 2020. North America and Europe are expected to account for 78% of the DEF market by 2023. The market for DEF could also be growing rapidly in China by 2023, depending on the implementation of Tier 4 equivalent legislation.

DEF is, however, not the only source of ammonia for SCR technology. Other ammonia sources do exist such as solid ammonia cartridges. Alternative technologies, however, have not yet been able to compete with DEF on a cost and safety basis. DEF has already been widely adopted in the diesel truck and passenger car industries across North America, and as such, an efficient infrastructure and supply chain already exist.

Integer Research sees the North American market gradually replacing older equipment in favor of Tier 4 machinery in time. DEF, which is already widely used in the region and widely available, will start gaining ground in the off-highway market as more advanced equipment comes online. This can bring about both opportunities and risks. The customer will need to be educated on the need for quality-certified DEF in order to prevent equipment damage.

While Europe and North America will see the gradual renewal of their off-highway fleets, countries such as Brazil and China are expected to have off-highway equipment markets growing at exponential rates. There are still plenty of opportunities and challenges in the off-highway market from both a complexity as well as sheer volume perspective.

This article is based on findings and forecasts from Integer Research's focus report: 'Emissions Control in Non-Road Mobile Machinery (NRMM) Markets.' This in-depth report delves into the off-highway market to provide essential insights into what drives diesel emissions control in off-highway equipment. It is the only report to provide such comprehensive analysis of the market, past, current and future, and includes a thorough analysis of Stage IV/Tier 4 strategies and emissions control technology forecasts. For more information about this report, please email ***publications@integer-research.com****.*

Integer Research is a specialist provider of research, data, analysis and consultancy services in the emissions control market, and runs six conferences each year around the world on related topics.

About the Author

Dr. Tholen is a consultant within Integer's Automotive/Emissions sector. Since joining Integer, he has led a number of emissions-related consultancy projects and contributed to several publications including 'Emissions Control in Non-Road Mobile Machinery (NRMM) Markets.' He manages Integer's discoverDEF.com website. Tholen has a Ph.D. in Chemistry from Imperial College, London.

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CNG for trucking, today and tomorrow

A look at the current CNG challenges being faced by on-highway vehicles and the solution providers working to make CNG a feasible and economical energy solution.

by Andrew Halonen,
REL Inc.

The trucking business has consistently been characterized by reliability, long life and small margins. Fleet managers track the smallest details looking for any opportunity to reduce costs. For those driving a lot of miles, fuel costs are a major concern and each political or weather event seems to increase the price. Unfortunately, the end customer doesn't see this as a good reason to pay more for product transportation, so the trucker needs to make up the difference. The new fuel on the block is natural gas, and with the onslaught of fracking technology, natural gas is abundant in the U.S. It burns cleaner than gasoline or diesel, and the economics are impressive.

The Agility Fuel Systems' behind-the-cab system, seen here installed on a Freightliner truck, requires as little as 22 inches of frame rail space and has a capacity from 30 to 155 DGE.
AGILITY FUEL SYSTEMS

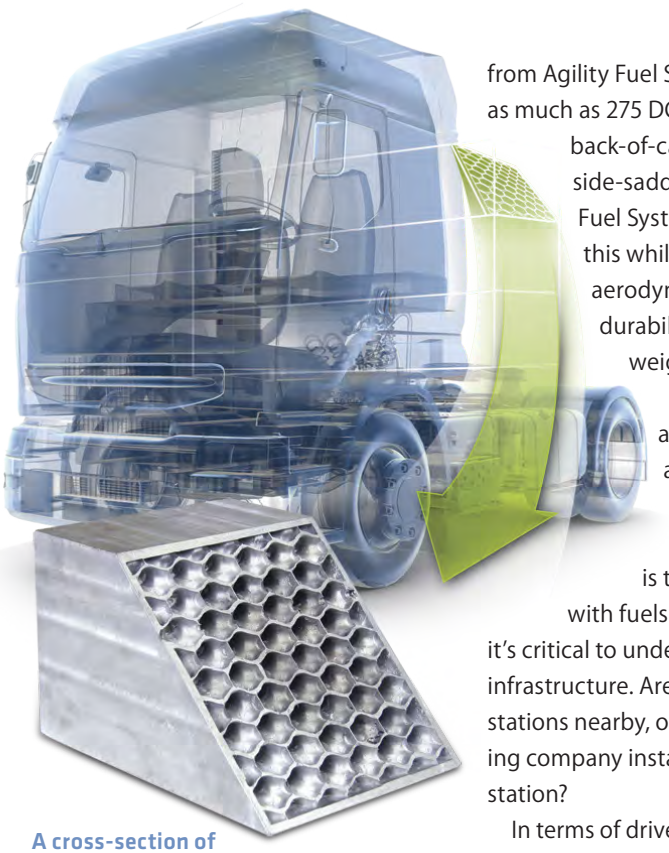
The cost of CNG is listed in gasoline gallon equivalent (GGE) or diesel gallon equivalent (DGE). The math is pretty simple. The delta in fuel costs multiplied by the number of gallons used per year is the savings. The upfront costs are needed to cover the conversion to a dedicated or a bi-fuel or a dual fuel system, and if there isn't convenient access to a station like Kwik Trip or Clean Energy, there is the additional cost of a compressor station.

Natural gas is not as volumetrically efficient as diesel, so it is compressed under high pressure to store more gas in a vessel. In Europe, the operational pressure is 3,000 psi, yet in the U.S., the operational pressure of compressed natural gas is 3,600 psi. Nature's shape for high-pressure storage is a sphere, yet that isn't practical for transportation vehicles, so the next closest shape is a cylinder. Cylinders come in many sizes and in many materials which are designated in the following categories:

- Type 1 – Metallic, steel or aluminum
- Type 2 – Metal with fiber hoop wrap
- Type 3 – Metal liner with complete fiber wrap
- Type 4 – Plastic liner with complete composite wrap

The worse the mileage, the better the payback with CNG. Type 1 is the lowest cost and by far the most produced worldwide. Type 4 cylinders are the lightest, and the highest cost. Type 1 cylinders are used in a number of applications where cost is the highest priority and/or weight is not a major factor. Fork trucks, which normally add weight for ballast, will use the heavier Type 1 tanks when powered by CNG.

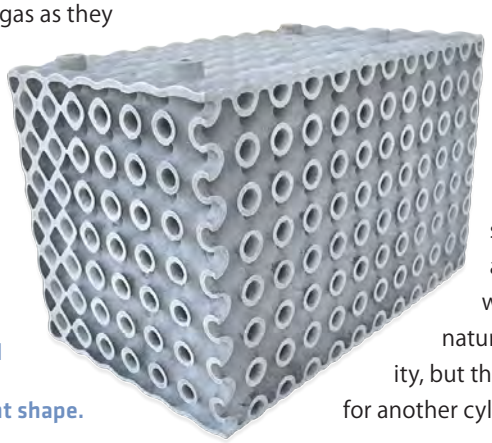
In countries like India, the tanks are largely metallic primarily due to cost, yet there is concern on safety of the Type 4 tanks. Type 4's are banned in India according to Prashant Banerjee of Tata Motors.



A cross-section of the REL conformable tank for back-of-cab mounting. REL INC.

In heavy trucks, like the Class 8 truck shown [on page 36], most tanks are Type 4, mounted 'back-of-cab' directly over the frame rails, yet hidden behind the cab to prevent aerodynamic inefficiencies.

As in any alternative fuel, there's a certain amount of range anxiety, and in CNG, this motivates truck owners to request as much gas as they can fit. Engineers are working to improve the packaging to maximize the volume of CNG; the premier system from Agility Fuel Systems can carry as much as 275 DGE, combining the back-of-cab storage with side-saddle tanks. Agility Fuel Systems accomplishes this while maintaining aerodynamics, aesthetics, durability and a lightweight design.



The REL conformable compressed natural gas tank features a structurally efficient shape. REL INC.

In consideration of an alternative fuel or alternative powertrain, the most important factor is the duty cycle, and with fuels like natural gas, it's critical to understand the fueling infrastructure. Are there public stations nearby, or must the trucking company install its own fueling station?

In terms of drive cycle or duty cycle, refuse trucks are particularly attractive because of the inefficient start-stop duty cycle. These trucks drive every day, and when they aren't hauling trash, the small owner/operator units are hauling construction site refuse. Refuse trucks are prime candidates to benefit from CNG considering their heavy weight, frequent usage and high fuel consumption. They represent the single largest growth area in CNG with 50 to 60% of the new refuse trucks coming off the line as dedicated CNG fuel engines. Much of the natural gas is stored either behind the cab, or on the rooftop mounted cylinders. There are instances where a customer wants more natural gas capacity, but there isn't room for another cylinder. This

McNeilus is a leader in the CNG refuse truck market with several different platforms and vehicles using CNG fuel.
MCNEILUS

situation has prompted additional natural gas storage vessel designs that can package CNG more efficiently than a cylinder.

The U.S. Department of Energy's (DOE) Advanced Research Project Agency (ARPA-e) recognized that there were two major hurdles preventing mass acceptance of CNG – access to fuel and the inconvenient storage of the fuel. To address the accessibility challenge, home fueling has been developed to take advantage of the fact that 60 million homes already use natural gas.

ARPA-e is funding teams to develop non-cylindrical vessels to store high pressure CNG to tackle the fuel storage issue. There are multiple metrics for success including the shape, the cost (lower than Type 4 composites), the energy density and the weight. A leading team is REL Inc. (*company information*, **10797192**), a technology development company who is developing an innovative cast aluminum tank. REL is trying to replicate the natural structural surface of a sea urchin, which is represented mathematically as the Schwarz P-surface. This is a volumetrically and structurally efficient shape, which makes it a great candidate for high-pressure gas storage. The cross section seen on page 37 shows the cast tank with the P-surface internal structure.

This technology disrupts the norms of CNG storage. A tank can be shaped much like today's gasoline tanks, yet still able to store a considerable amount of CNG. Integrating these tanks in a rectangular box on a large truck would store 20 to 35% more CNG than the cylinders used today. The non-cylindrical design also makes it easier to place tanks in more areas of the truck, such as between the frame rails. All of this results in more fuel on the truck. Truckers want more CNG to ensure they will reach their destination (due to the lack of fueling sites currently available), and so they spend less time at the pump.

More CNG on the vehicles in storage locations that don't hinder normal operation will lead to more consumer confidence and growth in natural gas in the U.S. Truckers will be able to reduce their fuel costs. The air quality will improve, and the U.S. will reduce its dependence on foreign oil. We all win.

Andrew Halonen is an OEM Off-Highway Editorial Advisory Board member and a regular contributor to the off-highway equipment manufacturer industry. Contact him directly with any questions or comments at ***andrew@relinc.net****.*

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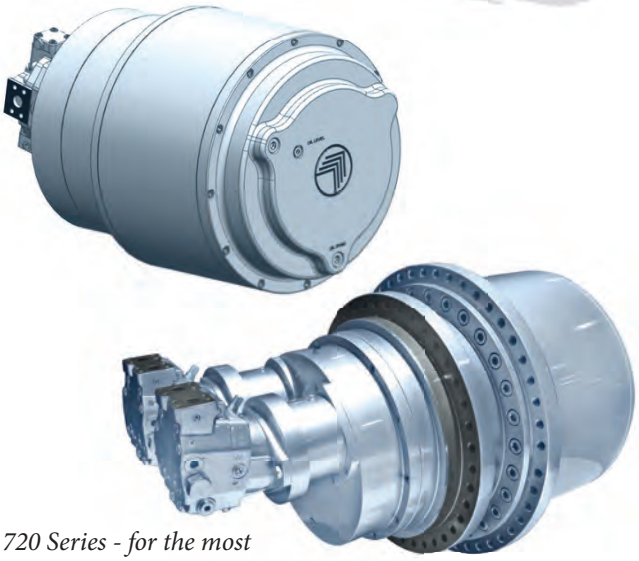

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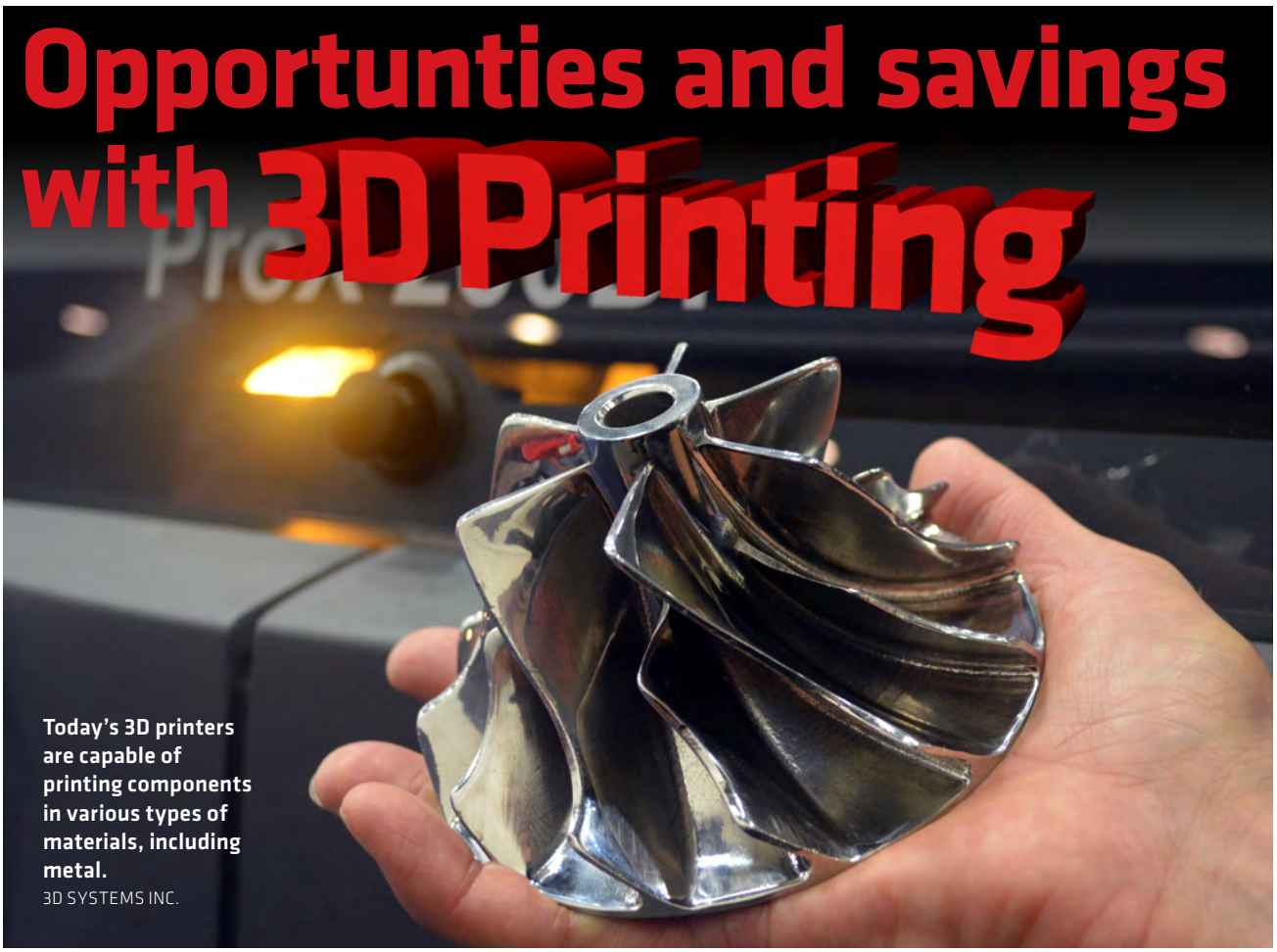


Today's 3D printers are capable of printing components in various types of materials, including metal.
3D SYSTEMS INC.

New technologies, materials and uses for 3D printers have expanded the technology's use in various manufacturing industries. **by Sara Jensen**

Though it may seem as if 3D printing is the "new kid on the block" in the manufacturing world, the technology has actually been around since the 1980s. Chuck Hull, founder of 3D Systems Inc. (*company information*, **12006241**), is credited with being one of the first to commercialize the technology after inventing a type of 3D printing known as Stereolithography in 1983.

Three-dimensional (3D) printing is a form of additive manufacturing which creates 3D objects by continuously layering material until the object is fully formed. The item being printed is typically first created in CAD software where the design can be easily manipulated and validated. Once a 3D model is created, the file is transferred to the computer controlling the printer and the printer goes to work building the object.

Use of 3D printers has continued to increase as manufacturers have seen the time and cost savings associated with 3D printing, as well as found new ways to utilize the technology. In addition, improvements to the printing technology and the materials it uses has helped bring down the cost, further expanding its use within various industries.

According to Tom Charron, Vice President of Product Marketing at 3D Systems, the industrial B2B side of the business makes up 90% of the company's revenue. "Last year printer revenue in these categories grew more than 50% and approximately half of the professional and production 3D printers go into outright manufacturing applications," he says, "and we expect that number to continue to grow."

Time and cost savings

One of the biggest benefits manufacturers have seen from using 3D printers has been a reduction in time

With 3D printers, even the most intricate details of a component such as this electronic connector can be accurately printed.
3D SYSTEMS INC.

and cost associated with prototyping. During a recent webinar hosted by 3D Systems, Daniel Copley, R&D Manager at Parker Hannifin, Racor Division (*company information*, **10055895**) explained how 3D printing has become a key part of the company's new product development process.

Copley said the company has invested in several in-house 3D printing technologies which enable it to create prototypes within one to two days versus weeks and has also put prototyping costs into the $100's, whereas outsourcing the printing of the prototype can cost into the $1,000's. "For a design engineer, it's fantastic to get your part in hand, be able to look at your concept idea and be able to experiment with it," stated Copley.

With the 3D printed model, engineers can test and validate their design, and make any necessary changes at a minimal cost. This helps ensure the most optimized design is reached before going into the production tooling phase of the design process, which Copley said can take anywhere from 4 to 6 months and cost $100,000's or more. Making even the simplest of changes at this stage could cost anywhere between $10,000 and $50,000, versus the $100's it costs to make another prototype in house. Copley estimated Racor has been able to save about $250,000 per year on prototypes due to its in-house 3D printing capabilities.

When Racor wanted to make changes to a new diesel engine blow-by filter for a customer on a tight deadline, Copley said 3D printeing allowed the company to create a prototype and validate its design within three weeks. For the project, Racor chose a 3D Systems Stereolithography apparatus (SLA). The printer enables Racor to print large filter designs, and use a high temperature material called Accura 48HT to create working prototypes that can actually be tested on systems such as an engine.

According to Copley, the Accura 48HT material has a temperature resistance of 130 C which allowed Racor to test the filter by using oil heated to actual engine operating temperatures. With this material Racor was also able to create a clear, see-through prototype filter assembly that allowed the engineers to observe oil flow through the filter and better predict the effect of potential design changes. In addition, the Accura 48HT features a high print resolution which Copley said enabled the creation of small, highly detailed components to provide Racor with a functional prototype very similar to that of a production tooled filter.

More than just prototyping

Charron says one of the biggest challenges currently facing 3D printing is raising awareness of its capabilities. "A large number of engineers and manufacturers still do not use 3D printing technology…this could be due to the lingering misconception that 3D printing is only useful for prototyping or concept models, and that's simply not the case."

Copley said during the webinar the industry is going through a re-branding of what additive manufacturing means to better encompass what can be done with 3D printers.

He went on to say that Racor has found many uses for the technology beyond creating a physical prototype. Depending on the type of material used with the printer, Racor has been able to test its prototypes both in the laboratory and directly on engines. This helps ensure the functionalities of the filter are verified and the company is creating the most optimized design.

Its use of 3D printers has also helped the company take the manufacturing process into consideration early on in filter design to make sure the component can only be assembled in one way and that it will be quick and easy to produce. Copley said this helps save time and money by ensuring the product is ready for manufacturing before purchasing costly production tool and manufacturing equipment.

Racor continues to find new uses for its 3D printers, said Copley, such as using them to print molds that are used for making urethane filter seals. Once a mold wears out, a new one

can easily be made at a price of about $300 or $400 each, whereas buying the molds costs between $3,000 and $4,000. The company has also been able to make custom designed fixtures to help make the assembly process easier during manufacturing.

Charron says 3D Systems' latest SLA machines are capable of creating casting patterns as large as an engine block in significantly less time than traditional pattern making. "And Selective Laser Sintering can also be used in applications for end-use parts, housings and robust test parts."

Growing use of materials

Plastic is one of the most typically used materials for 3D printing, though the use of ceramics, metals and recyclable materials have increased within recent years. For companies such as Directed Manufacturing—which makes prototypes and production parts using 3D printers—the more options of material types that can be used with 3D printers has enabled broader production capabilities and availability of products for customers.

Directed Manufacturing added a metal printer to its manufacturing facility in 2012, becoming the first U.S. commercial user of Renishaw Inc.'s (*company information*, **10056027**) AM250 laser melting additive manufacturing machine. With this system, Directed Manufacturing has been able to create parts in a variety of metals including aluminum, cobalt-chrome, stainless steel and titanium. If a customer requires a new material, the system's open architecture allows customization of machine parameters to print parts from the newly specified material. (*Visit **www.oemoffhighway.com/12006668** to learn more about how Directed Manufacturing is incorporating metal 3D printing into its business.)*

"Our direct metal 3D printing is a huge development that's allowing manufacturers to produce tool-free, highly complex, chemically pure metal parts in significantly less time," says 3D Systems' Charron. "Material advances also allow us to directly produce robust tooling for hydroforming, molds and more, in as little as a few hours, so manufacturers can skip the sometimes elongated process of traditional tooling and go straight to primary manufacturing."

Graphene is one of the next materials being investigated for use with 3D printers. Considered to be the strongest and thinnest material known to man, graphene is composed of a single lager of carbon atoms and has been found to conduct electricity 30 times faster than silicon. It is also a transparent and bendable material.

Because of its many advantageous properties, graphene has the potential to be used in various products

Printing an entire car

Local Motors' 3D printed car on display at the entrance to the 2014 IMTS Show.
LOCAL MOTORS

At the 2014 International Manufacturing Technology Show (IMTS), Local Motors produced its first 3D printed car, an electric vehicle called Strati.

The vehicle features less than 50 parts and was printed in 44 hours using carbon fiber-reinforced thermoplastic. Parts produced by the 3D printer included the car's body, chassis, dashboard and seats. Non-printable parts—the battery, tires, wheels, motor, wiring and glass windshield—were added onto the vehicle after it was printed. Once printed and fully assembled, Local Motors drove the car off of its exhibit stand to demonstrate it was in fact a working vehicle.

Local Motors collaborated on this project with Oak Ridge National Laboratory (ORNL), metal fabrication equipment maker Cincinnati and the Association for Manufacturing Technology (AMT). ORNL and Cincinnati developed the 3D printer that was used, called BAAM—Big Area Additive Manufacturing machine. The printer is capable of printing complex parts made from carbon fiber-reinforced plastic measuring 3 feet x 5 feet x 10 feet.

By printing an entire car, Local Motors and its project partners have shown 3D printing has capabilities beyond prototyping, and could make an even larger impact on the manufacturing world as the technology continues to progress in the coming years.

Find more images online at www.oemoffhighway.com/12006601

including electronics and supercapacitors. Many within the materials industry also believe graphene could be used in place of steel in the aerospace, defense and automotive industries to provide components with increased strength, reduced weight and better fuel efficiency.

Graphene 3D Lab Inc. and Graphene Technologies are currently developing graphene materials for use with 3D printers. In September, Graphene 3D announced a joint venture with Stony Brook University to test the functional and mechanical properties of 3D printed parts made with graphene-enhanced materials (*learn more*, **12006697**). Through this joint venture, Stony Brook University will review how the graphene material performs in 3D printing, as well as report on the optimal printing conditions necessary for the material.

Graphene Technologies is working with 3D printer manufacturer Stratasys Ltd. (*company information*, **12006043**) to develop advanced structural 3D printing ink that will be made using Graphene Technologies' graphene and nano-dielectric co-product magnesium oxide products. The Israel-U.S. Binational Industrial Research and Development Foundation recently provided the two companies with a development grant for this project (*learn more*, **12006660**).

Making graphene material available for 3D printing would be beneficial for manufacturers as they continue to focus their efforts on finding new methods for light weighting, and could help expand the use of 3D printing even further.

As the types of materials available for 3D printing continues to evolve, so will the technology. Charron says the technology will keep getting better in terms of increased build volumes and speed, as well as becoming even easier to use. "We're only at the tip of the iceberg," he says. "In the coming years and decades, we'll see designers and engineers get more accustomed to designing for 3D printing and embracing the unique geometry capabilities that the technology has to offer."

Read Online

Hewlett-Packard (HP) is reportedly set to enter the 3D printing world in October; unlike many of its other products, the printer will be geared towards businesses and not consumers.

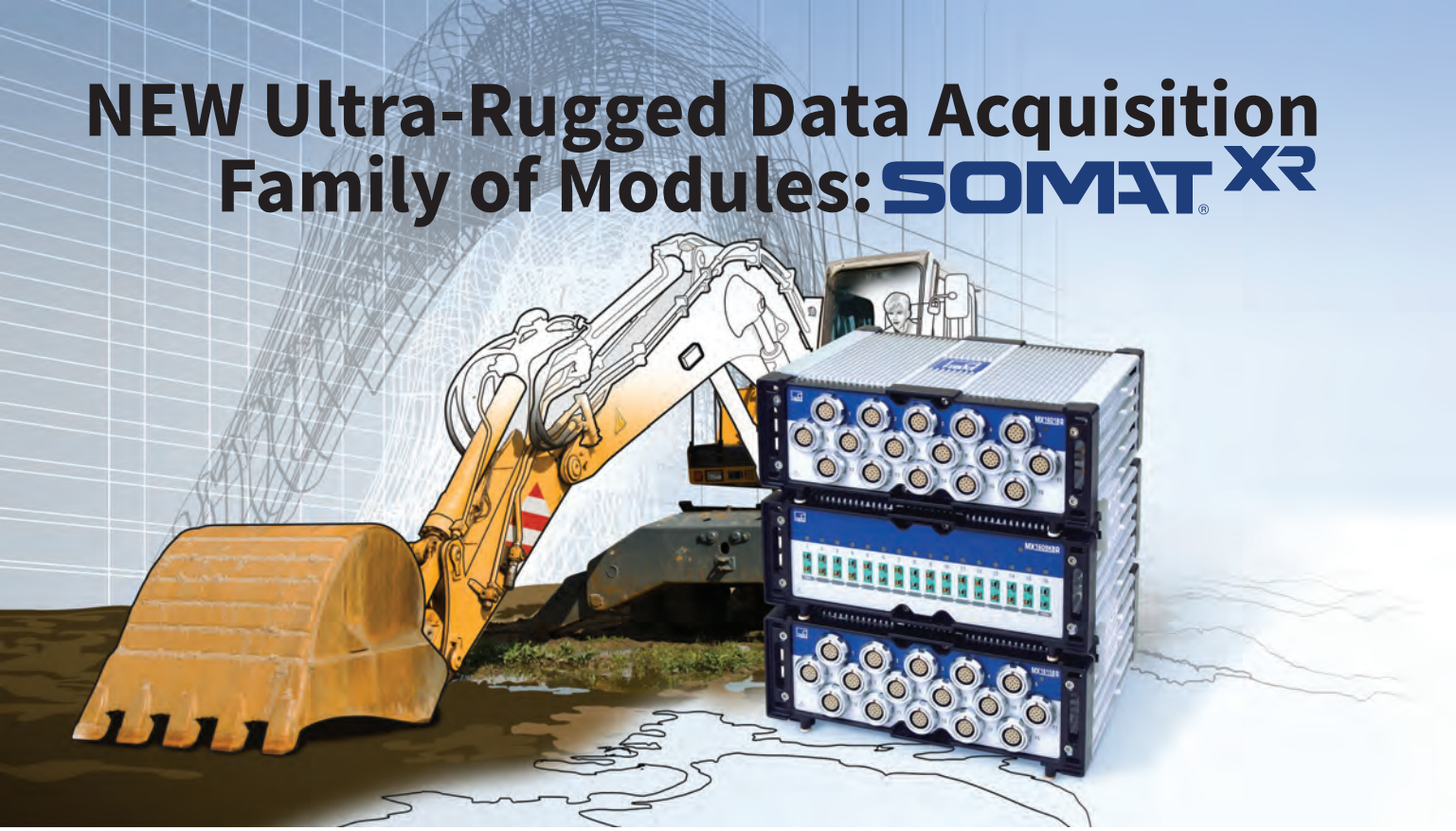
Read about HP's research on 3D glass printing in the whitepaper, 3D Printing of Transparent Glass, *at www.oemoffhighway.com/12006665.*

Watch Video Online

Renishaw Inc.'s AM250 laser melting machine creates dense metal parts using a high-powered fiber laser.

Visit www.oemoffhighway.com/12007257 to watch the video.

NEW Ultra-Rugged Data Acquisition Family of Modules: SOMAT XR



Measure Anything, Anywhere!

Built on proven technology and testing experience in harsh environments, HBM has developed the SomatXR family of data acquisition modules for use under extreme conditions. These modules are field-ready and can be used for an extremely diverse range of requirements and applications. Examples include off-highway vehicles used in construction, agriculture and forestry, civil engineering and energy for structural monitoring, and automotive and aerospace for field tests and mobile applications.

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The first three 24-bit amplifiers released include the:

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- MX1609B-R – K-Type thermocouple amplifier providing 16 individually configurable thermocouple channels.
- MX1615B-R – strain gauge bridge amplifier enabling up to 16 sensors or strain gauges in full, half or quarter-bridge configuration to be connected.
- Watch for additional members of the SomatXR family coming soon.

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SomatXR amplifiers were specially developed for measurements outside the laboratory, even under harsh ambient conditions. The modules are protected from water, dust, shock and vibration. All modules meet the IP65/67 degree of protection and can be used in the temperature range from -40 °C to +80 °C. Vibration resistance of 10g and impact resistance of 70g have also been confirmed through standardized tests.

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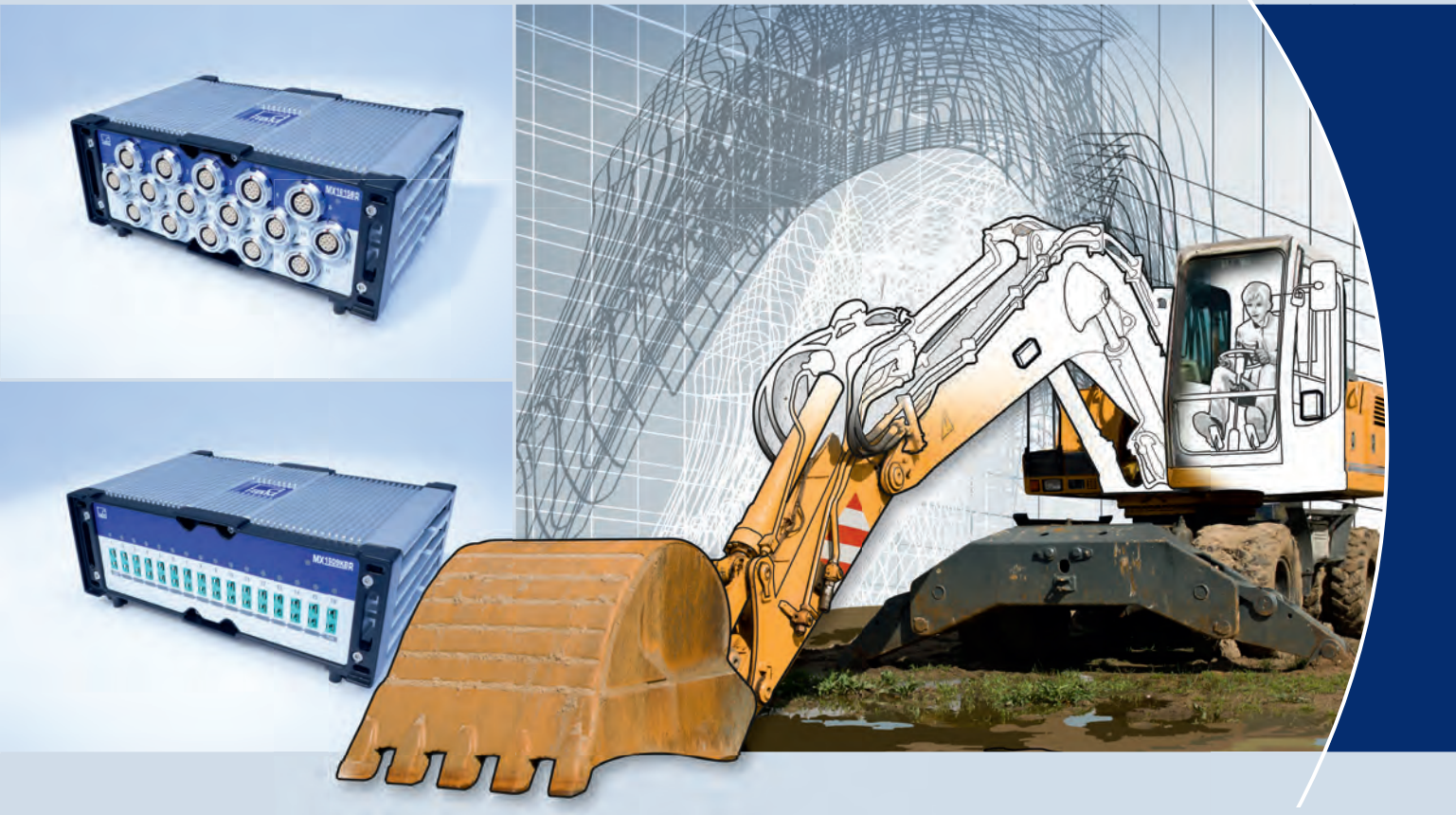

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More information: **hbm.com/oemsomatxr**

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WE ASK THE EXPERTS

ABOUT

Global Economies

Politics

Consolidation & Engineering Refocusing

Climate Change

Technology of the Future

Challenges

Every year, OEM Off-Highway interviews the top level executives of major equipment manufacturers, industry associations, and component and technology providers.

And, every year, we focus on several core topics for comment. We keep a few essentials like Global Economies, Technology of the Future, and Challenges so we can continue to compile insights into emerging regions around the world for potential expansion and investment, the direction of technological development, and new hurdles being faced along the way.

This year we added a few unique topics including Politics (think the Highway Bill, the Farm Bill and Emissions Regulations), Consolidation & Engineering Refocusing, and Climate Change (just for kicks).

The goal? To project into the coming years and hopefully find commonalities in the predictions to paint a "Big Picture" overview of the global marketplace.

What commonalities and trends do you see?

Global Economies | Politics

Responses by Dennis Slater,
President, Association of Equipment Manufacturers (AEM)

Fighting the good fight

AEM continues to engage with policy makers to implement long-term beneficial solutions for off-road equipment manufacturers, such as the Federal Highway Bill.

What economies hold the most potential?

Global markets continue to be volatile, as some expected. While the U.S., and especially its rental market, remain profitable. As always, these assessments depend on how demand will vary for different product lines.

Looking at an emerging region, the Middle East and North Africa (MENA) provide interesting opportunities, not only because of growth in the construction industry, but also because of the scale of the projects in the region. Projects coming online in the region seem to offer relatively good rewards for the risks. That cannot be said of all MENA countries (Iraq, Libya), but it is true for many of them. Looking at individual countries, there are opportunities in China, India, Indonesia, Colombia, Chile and others.

For construction, in the long term, the economic outlook for all of the above markets continues mostly positive. From a trade show perspective of reaching key customers, AEM members indicate continued interest in Africa, India and Latin America. In the next year AEM has construction shows on three continents: CONEXPO Latin America (2015), and BAUMA CONEXPO AFRICA (2015), and this December we have bC India.

In agriculture, the fundamentals are still very strong despite recent drops in equipment sales. People need to eat, and there are about 200,000 more people every day. One way to meet this need for increased food production is the mechanization of agriculture on a global basis. International markets should be positive for ag machinery sales for one simple reason; what the U.S. went through in the first half of the 20th century is now happening in countries like India and China at an unprecedented rate. As manufacturers, we will continue to provide the equipment necessary to meet the food needs of society.

What recent government legislation has significantly affected OEMs?

AEM has been consistently engaged in the battle in Congress to pass a long-term, sustainably funded federal highway bill. Fixing the Highway Trust Fund is of utmost importance to all of our members, whose equipment not only helps build our nation's highways but also depends on well-maintained roadways to do business. While we were disappointed in the short-term patch passed in July by Congress, we're continuing to fight for a long-term bill.

Reauthorizing the Export-Import Bank has also been a top priority for us. Many of our members depend on the bank's support to expand their business to foreign markets, and we were similarly disappointed in Congress' decision to reauthorize the bank only for a few short months. But AEM continues to work with our coalition partners to secure a long-term reauthorization as soon as possible.

We've also worked on Tier 4 engine emission regulations and various environmental and renewable fuels policies to ensure that manufacturers can fairly navigate the complex web of government regulations that threaten their ability to do business.

Read Online

Visit www.oemoffhighway.com/12006617 to read all of the responses from Dennis Slater, including AEM's constant engagement in government issues that will continue in the coming years.

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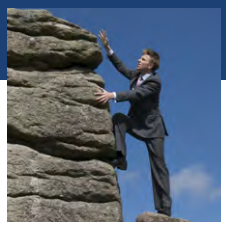

Challenges

Responses by Eric Lanke,
CEO, National Fluid Power Association

Workforce. Technology. Inclusiveness.

An increased demand for sophistication leads to an increased focus on innovation for fluid power system providers.

What are you seeing in the fluid power industry?

Our industry is challenged by an increasingly sophisticated and demanding customer base, that is ever more reliant on its suppliers to solve its engineering challenges, and which seeks to provide efficient, productive, reliable, compact and attractive machines to its customers.

As a result, we see NFPA members as increasingly focused on their capacity for innovation. Hiring the best talent, staying networked and educated, investing in R&D, keeping up with technology, increasing creativity, responsiveness and agility—these are all areas our members say they are focusing on to help them deliver more innovative products to the demanding marketplace.

What is the NFPA doing to address those challenges?

NFPA's mission is to strengthen the fluid power industry, and to fulfill that mission, we have been focused on three areas of strategic priority:

- **Workforce**: Building and connecting our members to an educated fluid power workforce.
- **Technology**: Promoting fluid power technology and fostering an innovative environment for the fluid power industry.
- **Inclusiveness**: Serving as a forum where all fluid power channel partners work together.

These priorities are well aligned with the needs our members have expressed.

Read Online

Visit www.oemoffhighway.com/12006363 to read the rest of Eric Lanke's interview on the NFPA's partnership with CCEFP.

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Grand Bending, a division of Morris Coupling, fabricates short and long radius bends for specialized exhaust systems for off-road vehicles including airport support and rail-mounted service equipment; heat exchangers; high performance automobiles; and other industrial applications. An extensive product offering is available in aluminized and galvanized carbon steel, carbon steel, aluminum and stainless steel. Our capabilities include compound bends, welded fabrications, expansion, swaging and beading.

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With the trend of electrification growing in the off-highway equipment market, OEMs are leveraging this to simplify their motion control design when the right application presents itself. Electric actuators have fewer components, require less assembly, are more energy-efficient, highly controllable and can be installed at a lower cost versus fluid powered systems. And they provide key benefits to the end user – no oil, no drips and no cleanup.

Fewer components and less assembly
As the design complexity of your product grows, so do the headaches of assembly and lean part counts.

Compared to hydraulics, LINAK electric actuators are simple to install and can significantly reduce your BOM. You can eliminate hoses, fittings, valves, pumps and reservoirs with a single IP rated LINAK electric actuator. Less parts and less assembly yields less headache, faster time to market and a lower installed cost.

More control
LINAK electric actuators are offered in 12, 24 and 36V. With speeds up to 160mm/second and forces up to 15,000N, they are finding their way into applications once reserved for hydraulics, as well as applications where hydraulics create environmental contamination issues.

LINAK provides more control and feedback options over fluid systems including "H" bridge, PWM, multi actuator parallel, BUS communications and analog or digital position feedback.

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The U.S. Department of Energy estimates the world's hydraulic systems are at best 25% efficient. Designers are continually looking for cost-effective energy saving solutions for their control needs. Parasitic hydraulic losses are the bane of remote, intermittent operated functions. LINAK actuators provide energy-saving results with manual or automated control of functions once out of reach. With LINAK application experience and our extensive energy-efficient product line, designers have another player in motion control.

No oil, no drips, no cleanup
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Global Economies

Responses from Martin Richenhagen,
Chairman, President & CEO, AGCO Corporation

The greatest potential for ag

Opportunities reside in emerging economies with rapidly increasing demand causing the need for exponential growth in productivity.

What economies hold the most potential for ag equipment?

Significant opportunity exists in emerging agricultural regions around the world such as Africa, Brazil, India and China. We're focused on getting the most relevant products and technologies to where they can make the most difference—regions that have rapidly increasing demand and a need to exponentially improve productivity.

We've been a market leader in Africa for many, many years. We're optimistic about growing our Africa market share because we have a good brand image, we have a long tradition—through our global tractor brand, Massey Ferguson, we have more than 60 years of experience in Africa—and we also have a good dealer and distribution network. There is great potential for farming in Africa, especially if the focus is on mechanization. In Africa, we have strengthened our position by establishing manufacturing capabilities in Algeria, investing in improved distribution and parts support, training local farmers on our model farm in Zambia and promoting international investment by sponsoring an annual Africa Summit in Berlin. Agriculture is the backbone of Africa's future development; with the projected world population to reach 9.6 billion people by 2050, gaining world food security is key. Africa plays an enormously significant role in solving some of the world's most pressing food supply challenges as a total of 15% of the world's arable land lies in Africa, of which more than 80% remains unused. Nowhere else in the world is there such an abundance of untapped resources.

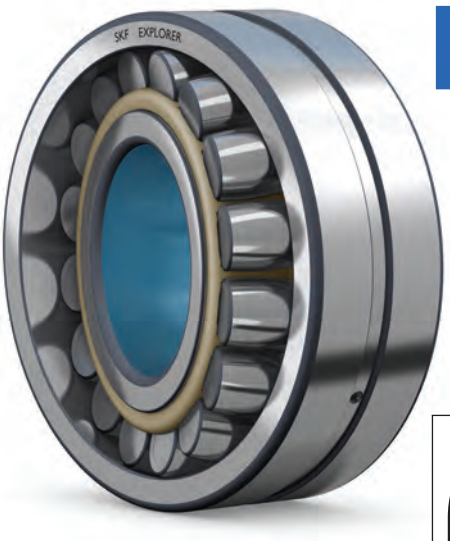
2013 was a record year for AGCO in South America; however, this year the market is more volatile. In Brazil, agriculture continues to be an important part of the economy and a source of future growth, and Brazil will benefit from the world's growing demand for both food and fuel. AGCO intends to expand the existing GSI production capacities by investing into a brand new factory in Passo Fundo (State of Rio Grande do Sul). The new factory is due to open in 2016. The record crops of 2013 and 2014, and the continuous increase of grain production have shown that there is a need to develop the necessary infrastructure for grain storage. AGCO's grain storage business GSI (equipment for grain storage and production of animal protein) will help to meet this demand in the future.

India represents an important agricultural equipment market for us too. Our global tractor brand, Massey Ferguson, has been in India since the 1960s. We have a long-standing and strong partnership with TAFE who is our Massey Ferguson licensee in India.

China is one of the world's largest farm equipment markets—it's a large and growing market for small and medium sized agricultural equipment. China also has a large, growing market for low/mid-horsepower tractors and its farm consolidation and government policies drive growth in high horsepower tractors and combines. AGCO's strategy in China is focused on growing our import business, establishing domestic production and localization of tractors and combines, and leveraging China as a global sourcing and manufacturing base.

Read Online

Visit www.oemoffhighway.com/12006239 to read more on how politics, consolidation and climate are affecting ag equipment and its technology needs.



Better bearings for vibratory applications

Applications such as vibratory compactors are challenging for rolling bearings, as the direction of load is alternating, inducing very high forces on the cage. Bearings designed for general machinery often fail in these applications due to cage fracture or operate with high friction due to improper guidance of the rollers.

SKF Explorer spherical roller bearings for vibratory applications are specifically engineered for rugged vibratory applications. They are manufactured with surface-hardened cages and guide rings, optimized internal clearance and tolerances. And to improve performance for end-users still further, SKF has recently upgraded the SKF Explorer performance class with a unique heat treatment, offering improved wear and contamination resistance.

The bearings provide a powerful solution in tough vibratory applications, especially compared to alternative bearings without a guide ring. The guide ring guides the rollers, so that they enter the loaded zone with a minimum of skew, reducing friction and heat generation to a minimum and contributing to extended bearing service life.

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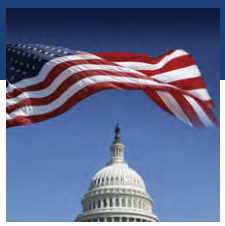


Politics

Responses by Jim Hasler, Vice President – North America, CASE Construction Equipment

New transportation funding methods needed

Funding shortages make maintaining current transportation system standards difficult.

What government legislation was passed that most affects off-road OEMs?

The expiration of MAP-21, and the temporary legislation enacted that will fund the Highway Trust Fund through May of 2015, is the most significant public policy issue we face as an industry. We fully support efforts to enact long-term federal funding for transportation and infrastructure projects. We also believe that there are great opportunities for state and local governments to enact new funding mechanisms. Most states have shortfalls when it comes to funding, and this problem will not be solved with federal dollars alone. A good example of forward thinking is Pennsylvania, a state that passed legislation in November 2013 that has provided new money for highway and bridge projects.

Another important piece of legislation passed in 2014 was The Water Resources Reform and Development Act (WRRDA), which will fund major water infrastructure projects throughout the country.

Were you able to get involved in the conversation on behalf of off-road OEMs?

CASE launched Dire States last year to raise awareness of our ailing infrastructure system and the impact it has on our customers and our lives. The team travelled around the country with an infrastructure author and his 1949 Hudson—a metaphor of the condition of our interstate system—to chronicle the state of our infrastructure. Along the way, they met with contractors, dealers, universities, local business groups and public officials to build support for infrastructure investment at the state and local level.

Awareness quickly transitioned to advocacy, as CASE now supports initiatives that advance local infrastructure development. We have been actively involved with the push for Proposition 1 on the Nov. 4 ballot in Texas—an amendment that will bolster that state's highway fund by an additional $1.7 billion annually. And we recently hosted an event with elected officials in support of policies to grow manufacturing in the U.S., as well as a constitutional amendment in Wisconsin that will guarantee that money generated by transportation-related resources (fuel taxes, vehicle registration fees) is only used for maintaining and building transportation systems.

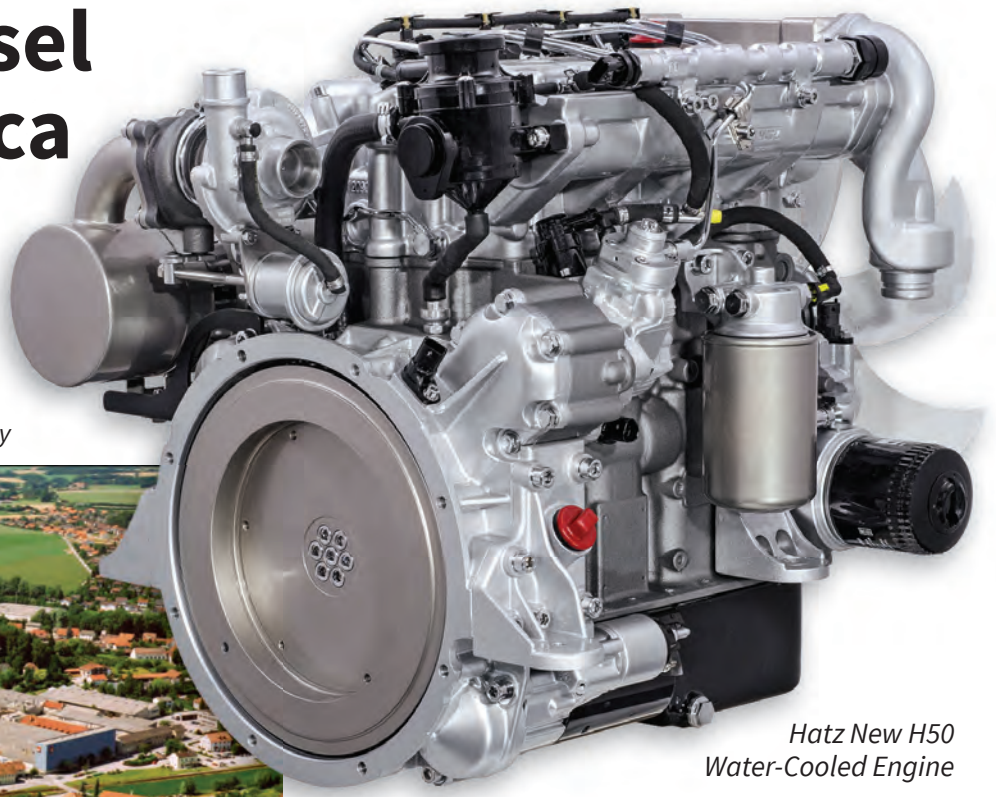
What effects do you foresee with the lack of infrastructure funding support continuing into the upcoming years?

Current funding levels make it hard for state and local governments to maintain existing levels of traffic and maintenance on our transportation systems. A long-term federal funding solution will help, but we're also encouraging local governments to find new ways to build and maintain these systems. As a nation, we require a robust infrastructure to keep us competitive in the global marketplace. As individuals, infrastructure impacts everything from our commute to our livelihood and well-being. We will need to continue to advance new and innovative methods of funding these systems.

Read Online

Visit www.oemoffhighway.com/12006495 to read all of the responses from Jim Hasler.

Hatz Diesel of America



Hatz New H50 Water-Cooled Engine

Hatz Bavarian Manufacturing Operations in Ruhstrof, Germany

Hatz Diesel of America is the US operation of Motorenfabrik Hatz GmbH & Co of Ruhstorf, Germany in the Bavaria region where many of the world's premier automobile makers are located. During its 130-year history the company has developed into a global engine manufacturing leader, yet it has remained a family-owned company.

Hatz specializes in the manufacture of high quality 1 to 4-cylinder diesel engines that are used in several applications such as construction equipment, compressors, commercial vehicles, agricultural machinery, generator sets, trucks and ships. In addition to manufacturing diesel engines, Hatz develops and sells complete system solutions and also produces prototype and production components for the automotive industry.

The company is divided into three divisions: Hatz Diesel (engines), Hatz Systems (complete system construction) and Hatz Components (automotive components). The company's global service network includes more than 500 service centers, 13 branch offices and 94 Hatz representative offices in over 110 countries. Through this large network, the company is able to provide quick response to customer needs for information, spare parts and replacement equipment.

Hatz Diesel engines

Hatz diesel engines range in power from 2 to 74 hp (1.5 to 55 kW) and are known for their reliability and durability and are manufactured to be worldwide emissions compliant. There are six different Hatz Diesel Engine Series available:

- **B-series** - air-cooled single cylinder diesel engines with horizontal or vertical crankshaft, power range from 2.6 to 10.3 hp
- **D-series** - air-cooled single cylinder diesel engines with horizontal or vertical crankshaft, power range from 5.6 to 15 hp
- **G-series** - air-cooled single cylinder diesel engines, power range up to 20 hp
- **M-series** - air-cooled 2, 3 or 4-cylinder diesel engines, power range from 29.7 up to 70 hp
- **L-series** - air-cooled 2-, 3- or 4-cylinder diesel engines, capsuled, power range from 25 up to 66 hp
- **H-series** – New Liquid cooled 4-cylinder diesel engines power range to 74 hp, compact, lightweight, powerful, low emissions with no DPF from 38.5 to 74 hp

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Global Economies | Politics

Responses by Candace Schnoor,
Director, Public Affairs, Construction & Forestry Division and John Deere Power Systems

BRIC remains essential in the construction world

Infrastructure development delays in the U.S. and emerging industry in Mexico and Canada provide opportunities for construction equipment manufacturers.

What emerging economies have the most potential for off-road equipment?

The BRIC countries continue to be a focus for John Deere and are the areas of the world where we see the most potential for expansion and growth for our construction class equipment.

Manufacturing began in our two Brazilian factories in Indaiatuba, Sao Paulo last year. In 2011, John Deere and Hitachi expanded their relationship with the creation of a second hydraulic excavator manufacturing joint venture in Indaiatuba.

In China, we recently announced plans to enhance our presence by constructing a Deere wholly-owned facility to manufacture wheel loaders and excavators near Tianjin.

We participate in India's growing economy through our joint venture with Ashok Leyland, located in Chennai, India.

We've made significant investments in Russia and the Commonwealth of Independent States – including investments in sales and training. We've recently committed to doubling the manufacturing space at our Domodedovo production facility, allowing us to expand our product offering in Russia as we move into the future. In addition to the manufacturing investment, we're establishing a leasing company in Russia through our John Deere Financial services division to augment current retail financing offered by local banks and leasing companies. This will help us provide retail financing solutions, enhancing service to our customers in this important market.

What government legislation was passed that most affects off-road OEMs?

John Deere monitors legislation at the federal and state level, and works with its dealers to advocate for robust public infrastructure investments, the removal of statutory barriers to private investment, and encouraging projects to move forward to construction. Safe and reliable infrastructure is critical to provide clean drinking water, food, energy and safe transport for people and goods. Whether these projects are driven by the public or private sector, modern infrastructure is also essential to the economic viability of a country and its competitiveness.

Surface transportation programs that fund and authorize road, bridge and mass transit projects have continually been underfunded and delayed in the U.S.

Elsewhere, broader reforms of the Mexican economy, and opening up the oil and gas industry to the private sector will provide opportunities for construction equipment sales in the coming years. The Canadian federal government launched a "New Building Canada Plan" which will provide $53 billion over 10 years for provincial, territorial and municipal infrastructure investments.

In other growth markets outside the U.S. and Canada, such as Brazil, Russia, India and China, the race to build and fund infrastructure, and the rapid development of urban centers, creates a lot of opportunity for [OEMs].

Read Online

Visit www.oemoffhighway.com/12006362 to read all of the responses from Candace Schnoor, as well as Jena Holtberg-Benge on technology solutions.

Consolidation & Engineering Refocusing | Technology of the Future

Responses by Anders P. Larsson,
Executive Vice President of Volvo CE's Technology function

Back to customer-focused R&D

As machines become more customized for niche applications, freed up engineering resources can focus on the customer again.

Now that Tier 4 Final is underway, many companies' engineering resources have been freed up. What does this mean for future equipment designs and advanced system development?

With Tier 4 Final machines launched, the resources and budget allocated to these projects have been freed up allowing our engineering focus to shift away from emission compliance and back to customer-focused R&D. The Tier 4 Final legislation brought a great benefit to society as a whole, and now that we have achieved this we can refocus our efforts on introducing new features that benefit our customers.

What current technologies have the most potential for future gains?

Volvo Construction Equipment (Volvo CE) is working on technology to support the following focus areas which we believe represent the future of the industry. This vision has the potential to drastically reduce the cost of machine usage and increase safety in hazardous environments. Reaching forward and working on futuristic technology drives the development of new innovations which support short and mid-term developments before it's possible to realize the ultimate goal much further down the line.

Zero unplanned stops: A world without machine breakdowns where equipment can predict and plan its own maintenance, making unplanned stops a thing of the past.

Zero accidents: With pioneering safety innovations machines could instinctively avoid accidents – creating a completely safe working environment.

Intelligent machines: From active safety to fully autonomous machines that do the work for you—even without you—increased machine intelligence will bring numerous advantages. A Volvo research project has already devised a wheel loader and an excavator that can demonstrate simple loading and digging tasks without an operator on board. This technology may still be decades away from production but the progress being made is exciting. In the future we will see systems that detect obstacles and humans in the vicinity of the machine. This technology will not only help to avoid collisions but also facilitate an efficient flow of equipment. Volvo has set itself the target of reducing accidents relating to its equipment to zero, and future technology like machine-to-machine communication (where machines 'talk' to one another and to a central control point) will play a major part in achieving this.

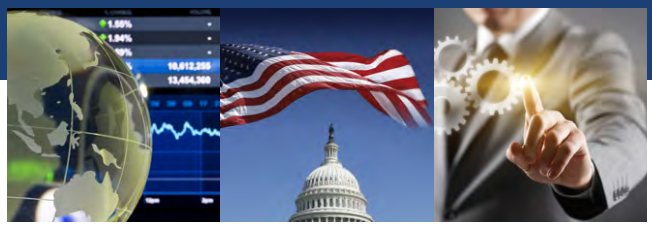
10x higher efficiency: The electrification of construction equipment will produce cleaner, quieter and more efficient machines. Together with site optimization, this will reduce energy consumption to a fraction of today's requirements.

Zero emissions: Zero emission machines and fuel-for-life solutions will make businesses environmentally sustainable.

Total business solutions: All machines, products and services will be tailored to the specific needs of the customer, providing a completely integrated business solution.

Read Online

Visit www.oemoffhighway.com/12006877 to read more from Anders P. Larsson on the future of technology development and challenges that have arisen from increased demand for customization.



Global Economies | Politics | Technology of the Future

Responses by Peter Lauwers,
President, Road Construction Equipment, Atlas Copco

Political uncertainty slows infrastructure development

Substantial economic potential exists around the world, though political and civil situations create negative impacts.

Have the current conditions in Russia affected opportunity? If yes, how?

In Russia there are, of course, sparks of uncertainty, and it's not clear in which direction the situation will develop. Despite a fluctuating ruble, our business as a whole has not been affected substantially. But issues escalate, and it's possible we'll see the situation there begin to impact markets for our equipment. There are rumors that Russia might implement a form of market protectionism, favoring equipment with high local content of components, and that is concerning.

What government legislation was passed that most affected off-road OEMs?

It's quite clear that Tier 4 Final regulations have had a major impact on our business, from engineering to sales. But we've welcomed that change, as it supports Atlas Copco's overall mission to create sustainable products. Where we might see more of a challenge is with the costs of new equipment. The additional R&D, as well as higher costs of the Tier 4 engines and components, means higher prices than what contractors are used to seeing. What we do, in addition to adding Tier 4 technology to new models, is incorporate upgraded or additional value-added features. For example, ECO Mode on our rollers and VarioSpeed on our pavers give owners a fuel savings of 10 to 20%, depending on the load of the equipment. With these kinds of additional features we're trying to help contractors save where they can and shorten the ROI of Tier 4 models.

Where is vehicle technology lagging?

There is a big opportunity to reduce emissions on equipment by replacing hydraulic components with electric ones. For example, manufacturers could consider replacing hydraulic pumps with electric motors powered by batteries, which would lower the kW size of the main diesel engine. This not only reduces emissions, but also results in a quieter machine.

What technology breakthroughs would help propel mobile off-road vehicles ahead?

Long-lasting battery technology would be well received in this industry. This will allow contractors to maintain the same production rates they get with their diesel-powered equipment, but without the fuel costs.

What current technologies have the most potential for future gains?

It would be most beneficial if there were a standard data transmission protocol that could be used across all manufacturers' models. Most of our customers run mixed fleets with equipment from multiple manufacturers, and each one of those manufactures has its own programs for monitoring data, such as information related to material density and fuel consumption. One standard program across all makes and models would mean operators could view data more efficiently and easily.

Read Online

Visit www.oemoffhighway.com/12006879 to read all of the responses from Peter Lauwers.

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  - › Integrated Drive Systems
  - › Sensors and Controls
  - › Wheels, Hubs & Spindles
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Further information on our products and services can be found at www.gknlandsystems.com

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GKN Land Systems is a leading global supplier of power management solutions and services.

Further information visit our website **www.gkn.com/landsystems/**

We design, manufacture and supply products and services for the Agricultural, Construction, Mining and Utility Vehicle markets and key Industrial segments, offering integrated powertrain solutions.

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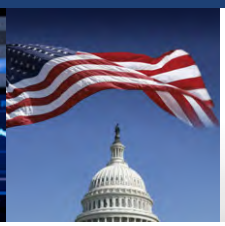

Global Economies | Politics | Consolidation & Engineering Refocusing

Responses by Walter Koellner,
Sr. Director Mobile Mining, Siemens

Coal restrictions and natural gas demand

Traditional mining economies remain the most likely opportunities for a slowing and consolidating global mining industry.

What are the economies you are looking at for growth?

We are working with large mobile mining equipment like haul trucks and electric rope shovels, so our opportunities are limited to several hundred large open pit mines around the world. We see the largest growth opportunities still in the traditional mining countries like Chile, Peru, Australia, South Africa, the U.S. and Canada, but also in China, Russia, India, Brazil and Mexico.

Business with Russia is down but I do not believe that this is caused mainly by the "Ukraine situation," it is just similar to the mining downturn we see all over the world.

What government legislation was passed that most affected the how you go to market?

Typically our equipment is used 50% in coal and 50% in ore. The regulations put on the coal business have not enticed coal companies to invest a lot in mobile mining equipment, and the cheap price of natural gas has been another factor. However, in China and India there are still a lot of coal fired power plants commissioned every month so we hope our business in these countries will compensate our difficult situation here in the U.S.

We believe there will be a continued pressure on coal. We expect an upturn in the business in 2016.

Have you seen an increase in industry consolidation this year?

There has definitely been a trend towards consolidation of mining companies and mining equipment manufacturers over the years. Fundamentally the companies believe that consolidation will allow them to grow the business, reduce costs and increase revenue and profits. Companies like ours will continue to be competitive through organic growth, and through acquisitions in key vertical markets that may provide profitable growth and product/service portfolio synergies.

What positive or negative effect has this had?

We mainly deal with large equipment OEMs. Here the consolidation has opened some opportunities to increase business with products for new types of machines, e.g. not only for electric rope shovels but also for hydraulic shovels. This is not automatically given, but can be a growth opportunity for us. Dealing with corporate mining conglomerates allows us also to see requirements for many mines around the globe and not only for one mining location.

Where is the industry lagging?

Two areas which are lagging are: First – better efficiency which could be addressed with engine fuel savings, capture of the lost electric braking energy, trolley operation and energy storage with Ultra capacitors and batteries. Second – the truck drivers could benefit from more operator assist functions e.g. auto park and there could be more semi- or full-autonomous operation.

Read Online

Visit www.oemoffhighway.com/12006365 to read all of the responses from Walter Koellner, with more commentary on the future of mining technology including Siemens' eHighway concept.

EVOLVED TIER 4 COOLING

3D PACKAGING FLEXIBILITY

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Technology of the Future

Responses by Ian Fountain,
Director of Application Segments, National Instruments

Vehicle-performed features and capabilities continue to rise

Data collection and distributed system architectures allows engineering teams to build upon validated pieces and integrate into larger systems.

Where is the heavy-duty vehicle industry lagging?

In many ways, the heavy-duty vehicle industry is actually ahead in terms of key technologies. For example, there have been some projects to advance vehicle electrification, but we have not seen the widespread adoption of these technologies in this industry like we have in the passenger car market. There is also still a bit of a brute force approach to systems engineering of embedded electronics in heavy-duty vehicles which leads to a slight lag in quality. Passenger vehicle manufacturers are very concentrated on vehicle quality due to the high cost of a recall, but heavy-duty manufacturers have significantly less volume, allowing them to tolerate some potential quality issues by offering field support to their customers.

What current ideas and new technologies have the most potential for future gain?

The industry seems to be heavily investing in technologies like robotics and general automation. This desire for vehicle automation creates a heavier reliance on embedded software to control different aspects of their tasks, which means that their ability to test and validate the systems more easily and efficiently becomes critical in the development process. Similar to passenger vehicles, the more embedded software is present, the more emphasis there is on safety and making sure the vehicles will reliably operate as expected.

How will distributed system architectures be incorporated into the heavy-duty vehicle industry?

Distributed systems are ideal for transportation-related industries because the growth in capabilities and functions needed to be performed by a vehicle continues to rise due to consumer, environmental and legislative demands. This means there will be growing networks of embedded electronics in heavy-duty vehicles.

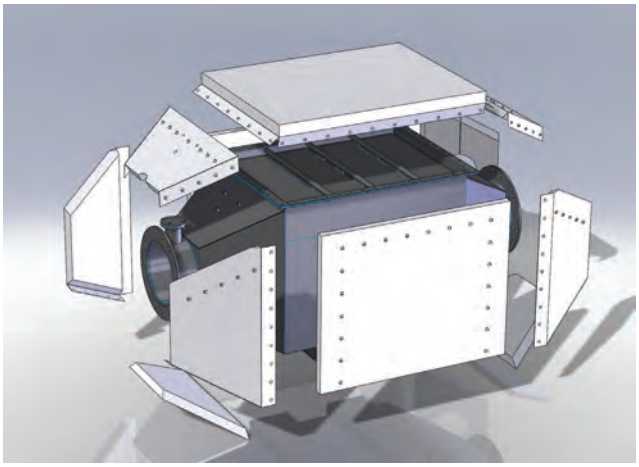
This network of distributed ECUs is great for engineering because it allows for engineering teams to break down the overall functionality into specialized pieces and focus on one problem at a time. The systems can then be integrated into larger systems and more and more components once functionality is validated.

This approach is part of the typical design V for embedded software. Companies should always be doing this system-level test by simulating different parts of the vehicle and ensuring that they are testing early and often for the entire system. This reduces the number of bugs introduced into the software that could cause problems for the end user.

With the National Instruments test platform, we work to provide our customers with a scalable platform that easily allows them to test a single component and then reuse these test components as the pieces scale to a larger system, ultimately implementing this in a full vehicle.

Read Online

Visit www.oemoffhighway.com/12006488 to read Ian Fountain's responses on the role Big Data and 'The Internet of Things' will play within the industry.



Firwin Corp – An industry leader in removable and permanent insulation systems for engines & exhaust components.

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Firwin has been supplying OEMs with custom-designed removable insulation blankets for over 30 years.

Our extensive engine library of engine design patterns means that we are often already familiar with the engine and exhaust components in question, and can quickly swing into production without the need for dimensions and drawings.

High temperatures? Firwin's Removable Insulation Blankets can be designed to withstand heat as high as 2000°F/1100°C.

Prefer a particular fastening system? Firwin's insulation blankets can be designed with the fastening system that best meets your needs.

Have a particularly challenging heat related issue? Our experienced team of designers and engineers are well versed in 3D modelling, heat flow simulation, and material selection to help you meet your insulation challenges.

Firwin Corp. is certified to ISO 9001:2008 and UL 2200.

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Global Economies | Politics

Responses by Tim Jackson,
Chief Technology Officer, Tenneco

Clean air beyond pollutant reduction strategy

Increasing emissions restrictions beyond Tier 4 mean continued demand for advanced aftertreatment technology solutions.

What are the economies you are looking at for future expansion and growth?

Tenneco serves the world's leading on- and off-road commercial vehicle and engine manufacturers, and sees significant growth opportunities in the BRIC countries as well as the Mercosul countries in South America, with Argentina and Chile now adopting emission regulations similar to Brazil. Japan also represents a good growth opportunity for Tenneco as we have recently expanded our technical center in Yokohama, established our first manufacturing facility in Osaka, and new regulations are impacting both on-road commercial trucks as well as non-road engines produced in Japan.

What political/government regulation/ standard/bill was passed in the past year that most affected the way you do business and go to market?

Several recent examples of regulations that present growth opportunities for Tenneco include US Tier 3 for light vehicles, and China NS VI.

How do you foresee this effect continuing into next year and in years to come?

Emissions regulations are a fundamental growth driver for Tenneco, and we expect increasingly stringent regulations around the world to continue to support the demand for new aftertreatment technologies. For example, our electronic exhaust valves, which are in production today, and our waste heat recovery systems currently in development could both play a role in helping engine and equipment manufacturers meet future GHG regulations.

Now that Tier 4 Final is underway, many companies' engineering resources have been freed up to refocus on developing new products instead of refining existing products to meet regulatory expectations. Have you seen this refocusing? What does this mean for future system development?

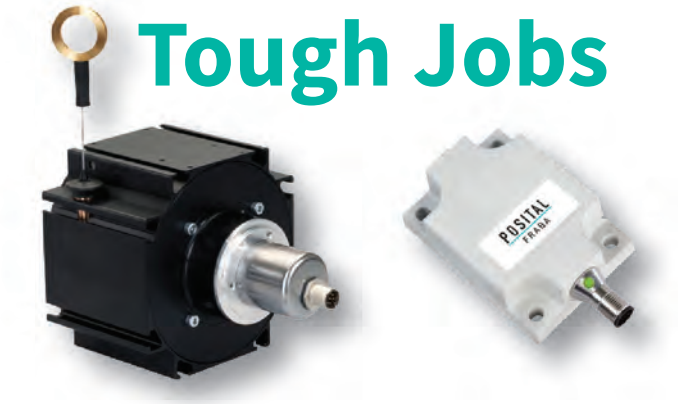
Even with Tier 4 Final systems now in production, there will be a continued focus on optimizing these system designs for better performance and lower cost, so we expect to see engineering resources split between product refinement and innovation. For the long term, emissions regulations are a fundamental growth driver for Tenneco, and we expect increasingly stringent regulations around the world to continue to drive demand for new aftertreatment technologies.

In addition, we see opportunities for Clean Air technologies that go beyond the reduction of criteria pollutants to help contribute to improved fuel economy and lower greenhouse gas emissions.

Read Online

Visit www.oemoffhighway.com/12006366 to read all of the responses from Tim Jackson.

Rugged Position Sensors for Tough Jobs



POSITAL, a unit of the international FRABA group, has been in the business of building position and motion sensors for over 50 years. Over this period, POSITAL has been in the forefront of developing and refining the technologies used in rotary encoders, inclinometers (tilt sensors) and linear position sensor and has contributed significantly to improving the accuracy, reliability, versatility and cost-efficiency of these devices.

The latest generation of sensors from POSITAL offer a winning combination of precision and durability. Devices that were once found mainly in in the world of manufacturing can now be trusted to deliver reliable results for control systems built into construction vehicles, agricultural equipment, mining equipment and other off-road machinery.

POSITAL provides some of the most rugged position sensors available. Armoured housings, heavy-duty shafts and bearings and protection from dirt and moisture up to IP69K levels ensure that POSITAL sensors have what it takes for off-road vehicles and mobile machinery. POSITAL sensors are based on flexible modular designs that allow customers to select the performance levels, mechanical features and communications interfaces that are right for their application. Over 140,000 variants are available.

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Consolidation & Engineering Refocusing | Technology of the Future | Challenges

Responses by Mahendra Muli,
Director of Marketing and New Business Development, dSPACE Inc.

Software solutions remain essential for efficiency

The significant push for mechatronic solutions and embedded software in vehicle design encourages innovation, and with it a need for powerful design tools.

Now that Tier 4 Final is underway, many companies' engineering resources have been freed up to refocus on developing new products instead of refining existing products to meet regulatory expectations. Have you seen this refocusing? What does this mean for future equipment designs and advanced system development?

Electronics and mechatronics are leading product innovation in both vehicle and implement control. In addition to powertrain electrification, there is also interest in converting traditional hydraulic controls to electric drives. Advanced driver assistance systems (ADAS) leading to full autonomous driving is one of the most active product development areas. This involves a lot of technology infusion into the vehicle, including a variety of sensors, electronic control units (ECUs), and software to enable this technology.

Where is the heavy-duty vehicle industry lagging (technologically and/or manufacturing process)?

Computing and electronics technology are rapidly changing and opening new possibilities in product innovation. Additionally, there is significant collaboration among OEMs to understand the non-competitive technology components that could benefit from the economies of scale leading to standards such as AUTOSAR. On the other hand, with increasing software content there is a renewed focus on the software development process. This highly dynamic technological environment provides the heavy-duty vehicle industry an opportunity to benefit from technical advancement to create a competitive edge, while reducing cost by leveraging standards. The heavy-duty vehicle industry has an opportunity to benefit from:

- Vehicle-to-Infrastructure (V2I) capabilities with changing on-road infrastructure
- Leverage electronics/mechatronics to create a competitive edge
- Economies of scale by leveraging cross-industry standardization (such as AUTOSAR)

What new challenges have arisen that effect the way you design or manufacture your product? How you do business? How you go to market?

Mechatronics and embedded software are a very innovation-rich segment of product development. Increasing electronic content in the vehicle is leading to fast growing system complexity. To manage this system complexity and large amounts of data, we are continuously innovating on our side to provide tools to manage data, while increasing product development efficiency. We have developed several products to support customers' model-based design (MBD) tool chains.

Read Online

Visit www.oemoffhighway.com/12006485 to read all of the responses from Mahendra Muli.

SKF Agri Hub for independent tillage discs offers a relubrication-free, cost-effective solution for driving farm productivity

Even under the most severe conditions, the SKF Agri Hub's advanced sealing solution helps protect against mud, dust and other contaminants that could lead to premature bearing failure. According to SKF testing, the reduction in bearing failures can enable farm productivity increases of up to 150%.

SKF testing also revealed that the SKF Agri Hub for tillage discs can significantly reduce downtime and extend total service life up to three times longer than traditional bearing designs.

Greased and sealed for life, the SKF Agri Hub provides a reliable, easy-fit hub sealing solution that's suitable for implements with independent tillage discs. The hub units include a flanged outer ring that is pre-drilled and tapped to accommodate a disc, and a stationary inner ring fitted with a threaded stub shaft for easy mounting.

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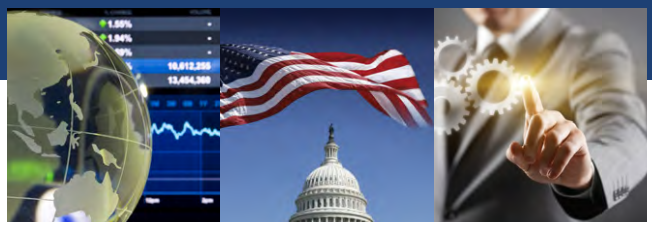
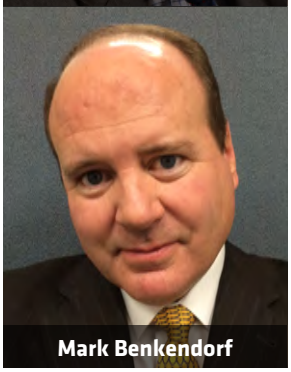


Global Economies | Politics | Technology of the Future

Responses by Jules Carter,
Divisional Chief Engineer, New Product Innovation and by
Mark Benkendorf, Vice President of Sales & Business Development - Americas, GKN Land Systems

Jules Carter



Mark Benkendorf

Tremendous progress in electrification

Reduced operating costs drive product changes, and precision systems and electrification deliver results and reliability.

What are the economies you are looking at for future expansion and growth?

GKN Land Systems is a global enterprise and we continue to grow and invest in the markets that are performing strongest, namely North America, Brazil and China. The Agriculture market has slowed down considerably across the globe, but we continue to see growth in Construction Equipment and the Industrial Segment in most of the regional markets that we serve.

Has the current conditions in Russia/Ukraine or other international situations affected your current or future business plans? If yes, how?

The situation in the Ukraine is of concern to GKN Land Systems and like most companies operating in this region, our revenues and prospects for this area have been adversely impacted. As a global company, however, we are not highly reliant upon any one single region that our long-term future will be negatively affected.

What political/government regulation/ standard/bill was passed in the past year that most affected the way you do business and go to market?

GKN is most impacted by any legislation or regulation that affects farm income and construction spending. We strive to continuously improve our products in terms of quality and other factors that lead to better fuel efficiency so that our customers see a competitive advantage in utilizing GKN products and engineering services.

How do you foresee this effect continuing into next year and in years to come?

GKN Land Systems has made major investments and tremendous breakthroughs in the field of equipment platform and attachment electrification. This should be a tremendous growth market over the next decade and will lead to lower costs and improved productivity for our customers.

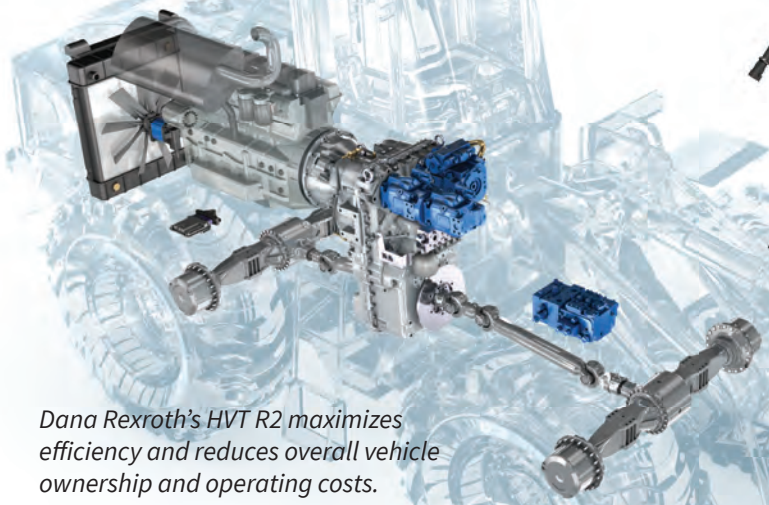
What current ideas and new technologies have the most potential for future gain?

Hybrid and electrification of driveline systems will have a significant gain in the future on two levels. Firstly, through the reduced running costs and improved emmissions, but also the secondary benefit of controlability. An electrified machine is fully computer contolled and can achieve a higher level of accuracy. These systems will easily interact with precision operation tools such as autonomous control, highly accurate GPS, drone monitoring, and they will have the ability to report their current state very accurately.

Read Online

Visit www.oemoffhighway.com/12006423 to read more from GKN Land Systems, including details about the company's hybridization efforts.

Dana Offers Full Range of Transmissions for Front-End Loaders



Dana Rexroth's HVT R2 maximizes efficiency and reduces overall vehicle ownership and operating costs.

The Spicer® TE18 transmission will be managed by Dana's new series of lead-free electronic transmission controls

Global manufacturers of construction equipment are continually asking suppliers to deliver front-end loader drivetrain solutions easily adapted to market preferences and local needs.

Dana Holding Corporation offers a full range of drivetrain options for mid-sized front-end loaders to meet a full range of market needs, including everything from value-driven solutions to premium configurations with advanced technologies.

This system flexibility allows machine designers to configure a series of vehicles in a single power range that offer a variety of basic to advanced features while requiring a minimum of alterations to the design envelope.

The new Spicer® TE18 powershift transmission is specially engineered to supply front-end loaders with higher input power capability, reduced maintenance, and smoother, quieter operation. Rated from 200 to 260 hp, the TE18 is a four-speed transmission platform that provides superior shift quality through high energy-capacity forward and reverse clutches, adaptive clutch modulation, and helical gears.

Dana will offer the Spicer TE18 transmission with an optional technology package that includes a five-speed transmission with lock up, enabling direct drive even at low speeds to further reduce fuel consumption by up to 10 percent.

The Spicer TE18 transmission will be managed by Dana's new series of lead-free electronic transmission controls, which offer wider systems integration through upgraded software and enhanced hardware capacity, flexibility, and expandability. These improvements will enable Spicer transmissions to offer the latest features such as eco-drive, power drive, and next-generation overlap control.

The Spicer TZL18 powershift transmission – a basic version of the TE18 – is available now for premium ZL50 front-end loaders produced in China and other emerging markets.

The R2 hydromechanical variable transmission (HVT) from Dana Rexroth uses a modular platform to deliver a full suite of configuration options and software controls, such as direct or remote mounting, flexibility in shift control and drive strategy parameters, and the deployment of up to three power take-off pumps. The transmission offers flexibility in shift control and drive strategy parameters through varying transmission output ratio configurations.

Designed to maximize efficiency and reduce overall vehicle ownership and operating costs, the HVT R2 is ideal for front-end loaders and other off-highway applications requiring 180 to 260 hp of engine output power.

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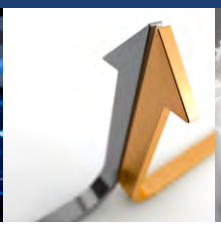
Global Economies


Consolidation & Engineering Refocusing


Technology of the Future

Responses by Fausto Carboni, General Manager, Mobile and Wind Solutions Business Unit, Bonfiglioli

Globalization is a challenge for the small, opportunity for the big

Consolidation provides the significant resources necessary to introduce new innovation.

What are the emerging economies you see with the most potential for expansion and growth for off-road equipment?

In our opinion, BRIC economies have a great potential, although today the growth rate of all of them is somehow lower than their real potential. We believe MINT (Mexico, Indonesia, Nigeria, Turkey) also have potential, and in fact they have a bigger percent growth potential, but the scale of the market is so much smaller for a start, that it will be hard to compare to BRIC. We expect within BRIC, a good percentage of growth in India due to political stability.

Have the current conditions in Russia/Ukraine affected that outlook and opportunity?

Yes, most definitely. Ukraine being a very large agricultural market (one of the largest in Europe) and Russia being a very large market for all the German manufacturers of Ag and Construction machinery, the crisis there has severely affected the result of some of our large OEMs. If the situation does not get sorted out soon we will start seeing the real potential effect. Also, our direct sales into Russia are affected by the current and potential economic sanctions.

Have you seen an increase in industry consolidation through mergers and acquisitions this year over previous years?

Yes, surely we have seen this in Construction as well as in the Ag market. The reason, in our opinion, is the increased need of resources to design a new range of machines, introduce new innovations, extend distribution networks, etc., which demand larger company size. It will continue for sure; globalization is a challenge for the small and an opportunity for the big.

What positive or negative effect has consolidation had on your business?

In consolidation, it becomes very important [to know] "who is your customer." Our strategy has been always to be with the largest possible customers, accepting the challenges (quality, service level, price expectations) in light of the stability in the long term. We believe this strategy pays off: when large OEMs take over smaller firms, the supplier of the buyers are more likely to stay on board than the suppliers of the bought-out. Other companies in our business made different choices, and they are suffering for that.

Where is the heavy-duty vehicle industry lagging technologically?

Efficiency, particularly fuel efficiency, is not yet a factor considered enough in selecting mobile equipment, particularly in the small-medium range (up to 100/150 kW). This is strange, because fuel is a very high portion of the vehicle lifetime running cost, and is hardly regarded as a factor. It is a factor in very large machinery, but we have to think that a lot of companies run large fleets of small equipment.... [Fuel] costs a lot in the long run, often much more than purchasing a more expensive but more efficient machine.

Read Online

Visit www.oemoffhighway.com/12006487 to read all of the responses from Fausto Carboni.

Lines for the front-axle drive withstand extreme pressures

- **Vehicle-related testing at ContiTech simulates later applications**
- **Snap-on connectors aid fitting and avoid torsion**

Up to 30 such lines for the front-axle drive are required per vehicle.

Photo: ContiTech

Part-time front-wheel drives for trucks which spend a large proportion of their operating time on the road but also occasionally need off-road capability. Ultimately, they represent an inexpensive alternative to a permanent all-wheel drive system. ContiTech has developed lines for this application which withstand extreme pressures. The lines carry-hydraulic oil which is pumped to motors and drive the vehicles' front wheels under extreme pressures. ContiTech supplies between 15 and 30 such lines per vehicle.

The new lines must withstand pressure up to 450 bar (6527 psi). This is ensured by a spiral steel sheath which forms the strength member. ContiTech offers these lines up to a nominal diameter of 25 mm and can also fit them with snap-on connectors. This not only simplifies installation in the customer's plant, but also prevents any torsion on the line which is unavoidable with screw unions and which would be detrimental to the component's pressure resistance.

"To ensure that the lines remain permanently leakproof, they are subjected to rigorous impulse and movement testing before leaving our plant," emphasizes Head of R&D Christof Kirsch. This also includes vehicle-related tests in which the later applications are simulated.

Politics | Global Economies | Technology of the Future

Responses by Jeff Herrin,
Director, Danfoss Power Solutions, Global Advanced Engineering Systems

Ready-to-go subsystems

With engineering resources being freed up, integrated system solution demands can be met.

What are the economies you are looking at for future expansion and growth? Has the current conditions in Russia/Ukraine or other international situations affected your current or future business plans?

Danfoss has specific growth and investment strategies associated with China, India, Brazil and Russia. Danfoss will be reviewing the economies of the MINT (Mexico, Indonesia, Nigeria, Turkey) countries to understand potential for investment and growth.

The current conditions in Russia/Ukraine are contributing to an overall slowing in the demand for a variety of mobile equipment, including agricultural machinery. We of course continue to align with the sanctions against Russia as required, and we continue to monitor the business development in Russia to align our investment plans with the market requirements.

What political/government regulation/standard/bill was passed in the past year that most affected the way you do business and go to market?

Tier 4 Diesel Engine Emission regulatory standards, and the safety regulations in Europe.

How do you foresee this effect continuing into next year and in years to come?

The Tier 4 Diesel Engine Emission standard has required companies to direct their engineering resources on integrating new engine packages in off-highway equipment. By many accounts, this activity is only 60% complete and will require the next eight years to fully complete. Equipment manufacturers will be seeking solutions that allow them to manage power more effectively, improve fuel efficiency, add new machine capabilities, and offset the costs associated with the Tier 4 engine implementation. Due to the Tier 4 effort, minimal investments in machine innovation and technology development have been made over the past six years. Now that engineering resources are being freed up, equipment manufacturers will invest in technology development and new types of innovation. Similarly, the safety regulations in Europe have and will continue to drive new product development to help our customers meet the safety requirements.

Where is the heavy-duty vehicle industry lagging (technologically and/or manufacturing process)?

Technology development, particularly in the areas of electric drives and telematics. There are also opportunities for improvement on design processes that leverage modern, digital tools to accelerate design, development and release of complex vehicle systems. One example is vehicle systems simulation and linking development to manufacturing through digital collaboration and automation.

Read Online

Visit www.oemoffhighway.com/12006367 to read more from Jeff Herrin about the continued emphasis on electrification within the industry, as well as the growing collection and use of machine data.

Logan PTO-Power Take Off Clutches

The Logan LC-318 Bell Housing PTOtransmits 10,000 lb. ft. of torque @ 200 psi.

The LC-318 Generation III is now available from Logan Clutch. The LC-318 transmits over 10,000 lb. ft. of torque @ 200 psi. Logan offers a full range of standard power take off clutches to suit a variety of OEM Industrial, Mobile, Oil & Gas, and Marine applications. Engineered, modified standards are available to meet specific application requirements. Logan products are engineered and manufactured in Cleveland Ohio, U.S.A.

Key product features include:

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- Self-adjusting disc pack
- Push button actuation
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- No pilot bearing
- Ideal for In-line or Heavy side loads
- Hi torque, small envelope

Applications Include:

- Snow Blowers
- Road Milling and Grinding
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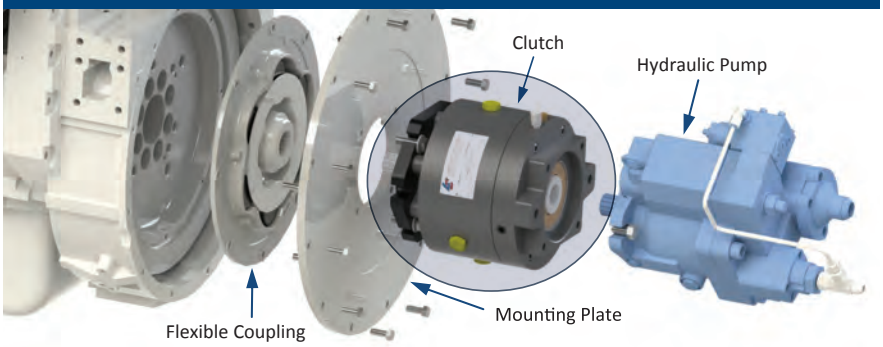
Logan Direct Drive PTO Clutches



Features:

- Air/Fluid actuation, self-adjusting, disc pack
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- SAE A thru E Splines/ISO mounting flanges/bore and keyway
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- Prevents over-speeding of pumps when disengaged

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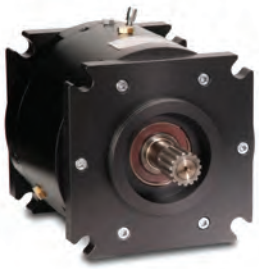

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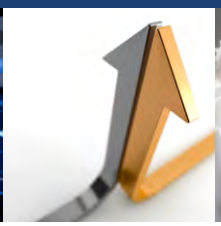

Consolidation & Engineering Refocusing

Technology of the Future

Responses by Ian J. Faass,
Vice President, Off Highway, The Timken Company

Innovation based on customer wants and needs

Refocused engineering resources will go beyond Tier 4 to address customer needs for improved performance, reliability and efficiency.

What are the economies you are looking at for future expansion and growth?

The well-established BRIC countries continue to present growth opportunities in varying degrees and we are planning accordingly. Sales and technical support are available in these regions and we continue to monitor manufacturing expansion in targeted areas. In addition, we are expanding our sales reach with new offices in Turkey.

Now that Tier 4 Final is underway, many companies' engineering resources have been freed up to refocus on developing new products instead of refining existing products to meet regulatory expectations. Have you seen this refocusing?

The implementation of Tier 4 represents one of the largest technical commitments for manufacturers in a long time, and as those efforts come to a close, highly skilled resources are being redeployed to tailor products to suit regional preferences for features and durability. The need for the right products at the right price and that deliver the reliability and performance that customers demand has never been higher.

Where is the heavy-duty vehicle industry lagging?

The heavy-duty industry continues to drive innovation based on customer needs, like precision planting, and meet government regulations, like emissions control. However, there still is opportunity to make strides in off-highway in comparison to the improvements in fuel economy made in the automotive and heavy truck industries. For us a primary focus is using our sophisticated analysis and testing capabilities in reducing parasitic losses in powertrain and wheel applications.

What current ideas and new technologies have the most potential for future gain?

In the mining loading and haulage space, the desire for automated mining vehicles will drive new technology developments. In the future, not needing to design a driver's cab may allow for changes in the vehicle structure and powertrain architecture that could fundamentally change designs to be more productive and efficient.

What new challenges have arisen that effect the way you design or manufacture your product? How you do business? How you go to market?

The size of opportunities and pace of development in certain markets create challenges to deliver the greatest value to the end user across the spectrum of performance levels and how our customers approach those needs.

Read Online

Visit www.oemoffhighway.com/12006492 to read about Timken's DeltaX Initiative which focuses on more collaboration for improved concept-to-commercialization.

Read additional State of the Industry interviews EXCLUSIVELY ONLINE

A player in 'The internet of things'

Marc Eisenberg, CEO, ORBCOMM Inc.
oemoffhighway.com/12006364

Still waiting for Tier 4 Final to begin

Scott Woodruff, Director of Industrial Engine Sales, MTU
oemoffhighway.com/12006496

A niche opportunity in seeders

Douglas A. Duesing, Product Manager – Air Springs, Industrial & Off-Highway, ContiTech
oemoffhighway.com/12006491

Cab-free design implications

Bob Straka, Business Development Manager, Transportation, Southco, Inc.
oemoffhighway.com/12006489

The next big thing in engine design

Michael Franke, Director, LD Diesel and Commercial Engines, FEV North America, Inc.
oemoffhighway.com/12006497

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Publisher (Name and Complete Mailing Address)
Sean Dunphy, Group Publisher
1233 Janesville Avenue, PO Box 803
Fort Atkinson, WI 53538-0803

Editor (Name and Complete Mailing Address)
Michelle EauClaire, Associate Publisher/Editor
1233 Janesville Avenue, PO Box 803
Fort Atkinson, WI 53538-0803

Managing Editor (Name and Complete Mailing Address)
Sara Jensen, Associate Publisher
1233 Janesville Avenue, PO Box 803
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Carl Wistreich, President & CEO — 09/12/2014

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Truck-mounted and self-propelled cable excavators

Intrigued by a special vehicle request not yet available in the existing market, a company develops the first cranes designed specifically for mounting on trucks.

by Thomas Berry, Archivist, Historical Construction Equipment Assn.

The John F. Byers Machine Company Traveler was an example of self-propelled shovels built in the 1940s. Self-propelled and truck-mounted excavators were popular for highway and road departments because of their mobility. (Byers brochure 1248, 1948)

During World War I, the American Expeditionary Force (AEF) requested 125 cranes mounted on motor trucks in order to both expedite the handling of cargo on the docks of France and enable the cranes to move quickly from job to job. At that time, no manufacturer offered motor truck-mounted cranes. Instead, The Thew Automatic Shovel Co. filled the order with 65 gasoline-powered cranes mounted on traction wheels. The AEF's idea intrigued Thew president F. A. Smythe, and he spearheaded the development of the first crane designed specifically for truck mounting. The first truck crane was built in 1918, and the concept gained quick market acceptance.

The success of the truck crane led to the next logical step in excavator development. Excavators had been available on steel traction wheels for several years, but traction wheel-mounted excavators had little advantage in off-site mobility over crawler-mounted excavators. Like their crawler-mounted counterparts, they had to be moved by trailer or flat car, or else at the plodding speed of a crawler excavator but with the advantage of being less harsh on road surfaces.

In 1922, Luke E. Smith addressed this problem by mounting the upper works of a military surplus power shovel on a used truck. The result was America's first excavator that could move from job to job on its own at highway speeds, modest though they were. Smith's prototype underwent extensive testing, and in 1929 Smith founded the Quick-Way Truck Shovel Co. in Denver, CO, to manufacture his machines. The company was successful and went on to produce cranes as well as crawler-mounted excavators, remaining in business until acquired by Marion Power Shovel Co. in 1961.

Vern Schield of Waverly, IA, expanded on the idea in 1941 when he mounted a home-built dragline on a surplus International truck. Schield's design, the Bantam, succeeded to the point that he built some three dozen draglines before the Schield Bantam Co. was incorporated in 1946. Bantam achieved even more success than Quickway, and was acquired by Koehring Co. in 1963. Koehring continued the Bantam name for the former Bantam line of hydraulic cranes and excavators for years afterward.

Other manufacturers of crawler cable excavators also offered truck mountings on conventional over-the-road trucks, or purpose-built carriers furnished by firms or designed and built in house. Many also offered excavators on self-propelled, rubber-tired carriers; these were similar in principle to the old traction wheel excavators, but could move at suitable speeds for city streets.

As hydraulic excavators rendered cable-operated excavators obsolete in the 1960s and 1970s, so too were the truck-mounted and self-propelled cable excavators phased out of the market.

The Historical Construction Equipment Assn. (HCEA) is a 501(c)3 non-profit organization dedicated to preserving the history of the construction, dredging and surface mining equipment industries. With over 4,000 members in 25 countries, activities include publication of a quarterly educational magazine, Equipment Echoes*; operation of National Construction Equipment Museum and archives in Bowling Green, OH; and hosting an annual working exhibition of restored construction equipment. Individual memberships are $32.00 within the USA and Canada, and $40.00 US elsewhere.*

HCEA seeks to develop relationships in the equipment manufacturing industry, and offers a college scholarship for engineering students. Information is available at www.hcea.net, by calling 419-352-5616 or e-mailing info@hcea.net.

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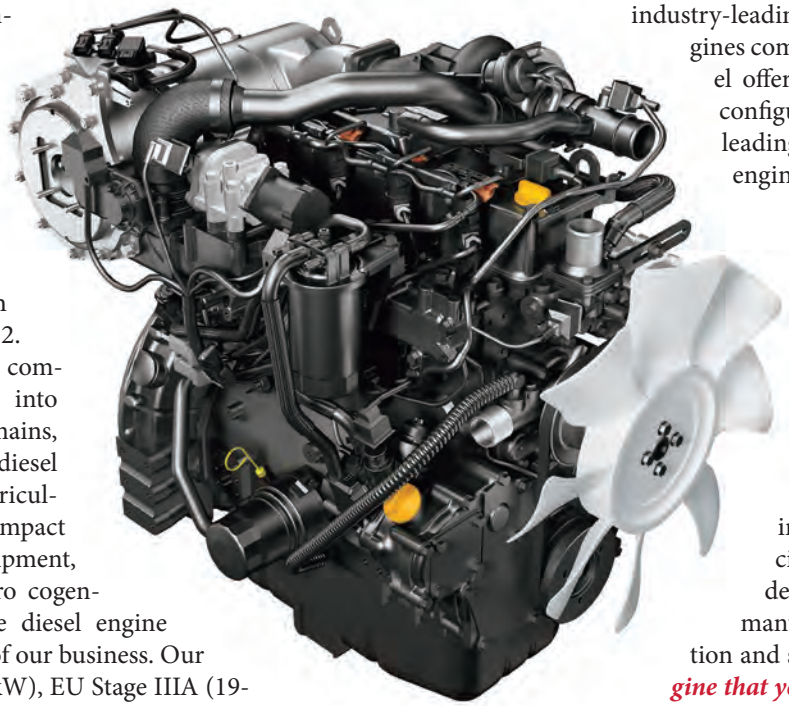

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