

GLOBAL REPORT

CONSTRUCTION EQUIPMENT 2017

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Global Report Construction Equipment

Print ISSN 2057-3510

Digital ISSN 2057-3529



WELCOME

Welcome to the Global Report Construction Equipment 2017. Once again, this award-winning annual publication aims to provide an incisive, insightful and extensive read for anyone involved in specifying the machinery used in the world's highway construction and aggregates production markets.

Our team of expert writers has provided feature articles on a number of important topics, giving guidance on changing business trends as well as providing pointers to future demand.

This year, the report focuses on areas such as the outlook for road building and construction equipment sales in India, on the latest trends in supply chain management, on the fast-growing rental markets in Latin America, on the future of compaction technology, on how Cummins is unlocking the power of data, on the demand for reconfigured machines in the non-Tier 4 world, on the thinking behind hybrid drivelines, on why the bitumen market is thinking big ... and much, much more.

We hope that you will find plenty of relevant facts and figures, as well as detailed thought pieces that are of interest to you and your business.

Mike Woof

Editor, World Highways

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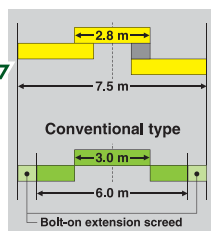
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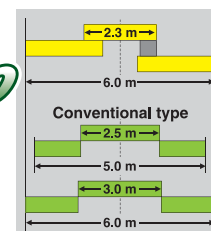
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THE CONSTRUCTION EQUIPMENT SECTOR MOVES INTO RECOVERY

There is cautious optimism pretty much everywhere you look across the global construction equipment industry - *Guy Woodford* reports.

Let's look at some of the leading independent industry research firms' forecasts to gauge this optimism.

The 'Timetric - Global Construction Outlook 2020' report states that despite volatility in the global financial markets in early 2016, the world economy is set to show signs of recovery until 2020, with the pace of growth edging upwards.

However, Timetric is one of a number of respected construction market analyst names noting a prevailing sense of concern over the precarious state of key markets.

The Chinese economy remains sluggish, suppressing construction equipment demand. Yet there is talk of significant

investment in public infrastructure over the next few years. The North American construction industry has been encouraged by newly-elected President Donald Trump's repeated pledge to spend big on infrastructure. In Europe, construction equipment sales are stable but, it's fair to say, are far from spectacular.

Another leading construction equipment market research firm, Off Highway Research (OHR), is forecasting a slow but steady recovery in machine sales worldwide in the next few years, with India being one of the key growth markets for the future.

OHR also notes how market trends are changing, with the excavator being of

growing importance for overall machine sales. David Phillips, OHR's managing director, believes that in 2015 around \$28 billion of the \$78 billion worth of construction machines sold worldwide were excavators. He expects excavators to account for around 30% of total machine sales globally in the near future.

If India delivers stellar construction equipment demand, coupled with some kind of renaissance in the Chinese and North American markets, then the overall global construction equipment sector could lose much of its cautious trading approach. 2017 could well be a pivotal year in shaping equipment demand for many years to come. □



EUROPE

The year 2016 surpassed expectations for the European construction equipment market, according to CECE (Committee for European Construction Equipment).

Citing different sources, including CECE statistics and information provided by Off-Highway Research, the Committee, which represents the views of its member associations and their companies in the EU legislative and political process, says double digit growth across all sub-sectors and regions was driven by a strong construction industry in most markets. Stable development at high levels in Northern and Western Europe underpinned a continuing yet slowing recovery in Southern Europe, and fairly weak growth in Central and Eastern Europe.

ABOVE RIGHT: Tower cranes from German manufacturer Liebherr played a key role in the bridge tower construction work for the new Queensferry Crossing over the Forth Estuary in Scotland.



Despite this positive news, CECE notes how the machinery industry continues to be cautious about the situation in the near future. There are two main reasons for this: many markets outside of Europe are still facing significant difficulties, and, more importantly, there is still a lot of uncertainty in the market.

In fact, uncertainty levels increased during the year. There are many unresolved political and economic crises in Europe

and worldwide; the shock and impact of UK Brexit has not been digested or fully understood yet, and most recently, the outcome of the US presidential election has introduced a further sense of unpredictability.

This situation is reflected in the CECE Business Barometer, the monthly index of opinion among construction equipment manufacturers. While the business climate continued to improve, gains were much



The continent's
construction sector
has the potential to
grow by 2.1%

→ smaller than what would be expected against a background of positive market data. Future sales expectations remained below the levels of most of 2014 and 2015. Nevertheless, a majority of manufacturers expect business to improve further.

Confidence was echoed at the most recent CECE Congress, the biannual European conference and network opportunity for the sector. "The sector has used the last decade to make its production leaner," said CECE president Bernd Holz (SVSS, Ammann). "We feel we are well-placed to compete with each other and the rest of the world. We are confident we can increase our market share world-wide. And we are transforming our business models, becoming more service- and customer-oriented than ever before."

More growth is expected to come from the Northern and Western European markets, and Russia should finally start to see some growth. At the same time, Central and Eastern European countries are not viewed positively by manufacturers for the near to mid-term, and a deterioration of business is expected in Turkey.

The CECE believes a key question for future market demand is whether rental companies will continue to invest in the near and medium-term, after renewing and extending their fleets on a significant

scale in 2016. This segment of the market has become increasingly important in recent times, and a fall in demand from this sector would have a significant impact on equipment manufacturers. In addition, demand from the mining sector continues to be very weak, which also has a knock-on effect on construction equipment sales.

EUROCONSTRUCT publishes recent, accurate, comparable forecasts on European construction markets based on the expertise of its 19 members, all consulting and non-profit research institutes specialising in construction. Its members include UK-based Construction Futures, Experian; France-based BIPE, one of the leading European providers of forward-looking economic analyses and consulting services, and the IFO Institute for Economic Research, based in Germany.

For 2017, EUROCONSTRUCT forecasts that while early indications point to 1.4% GDP growth in Europe, the continent's construction sector has the potential to grow by 2.1%. This will create very encouraging opportunities for construction OEMs.

As EUROCONSTRUCT notes: "There is an interesting window of opportunity created by a combination of cheap credit and a more favourable perception of building as an

investment shelter. However, this opportunity may be ephemeral, and not a driver for the longer term. The key factor for strengthening the construction sector is public demand, which EUROCONSTRUCT expects to keep improving, but only marginally and in some countries."

EUROCONSTRUCT says that whilst any confirmed reported increase in construction output in 2016 will come mostly from Germany, that country's pull on European construction will begin to fade. EUROCONSTRUCT tips that Germany will disappear from the list of top contributing countries. This, says EUROCONSTRUCT, will leave France as the main generator of extra output.

Off Highway Research, a leading management consultancy specialising in the research and analysis of international construction, sees the European construction equipment market as a stable performer. Speaking at a Construction Equipment Association (CEA) event in autumn 2016 David Phillips, OHR's managing director, said: "Europe is very difficult. The market peaked in 2007 at over 200,000 units, fuelled by easy financing." Phillips explained that this figure was unsustainable, which is why, in 2009, machine sales in Europe were less than a third of what they had been two years earlier. □



NORTH AMERICA

Donald Trump's victory in the US presidential election surprised many, and leading construction industry analysts are keen to see whether America's new Republican man in the White House follows through on his campaign pledge to spend big on infrastructure.

As the Republicans also maintained control of the US Congress, President Trump will find it much easier than his predecessor did to fully implement his policies, heightening expectation of increased infrastructure expenditure.

Danny Richards, lead economist at Timetric's Construction Intelligence Center, notes that in his victory speech, Trump spoke of his determination to rebuild US infrastructure – its roads, bridges, airports, schools and hospitals – as well as "fix" its inner cities. As Richard notes, in the lead up to the bitterly-contested election, Trump did

not reveal any specifics with regards to an infrastructure investment plan, aside from his campaign pledges to "at least double" Hillary Clinton's spending proposals. The defeated Democrat Party presidential candidate had revealed plans to deliver a US\$275 billion, five-year programme for investment in transportation, water, energy and other projects, as well as to launch a federal infrastructure bank.

According to the American Society of Civil Engineers, the backlog of infrastructure projects is expected to cost US\$3.6 trillion by 2020.

Richards believes it's likely that Trump's administration will push ahead with infrastructure development plans; in so doing, he will ensure the creation of jobs

RIGHT: *International Peace Bridge that joins Ontario, Canada and New York, USA.*





LEFT: Widening of the US 331-SR83 highway in Florida's Panhandle area.

and improve the prospects for stronger economy growth in the long-term. Nevertheless, Richards also states that there are many unanswered questions relating to how a Trump administration will raise the funds for such projects, either through tax reforms or a stimulus spending bill, and whether such policies will be passed by the Congress.

Current Timetric forecasting puts annual average growth (in real terms) in construction output of 3.3% in the period 2016–2020, based on the assumption of economic growth of just over 2% a year. However, this forecast was based on a victory for the Democrat presidential candidate, Hillary Clinton, which would have meant a broad continuation of former President Obama's policy.

Less positive news comes from the latest Association of Equipment Manufacturers' (AEM) statistical analysis of U.S.-made construction equipment exports, which fell 25% overall year-on-year in the first nine months of 2016, to a total of US\$8.2 billion shipped to global markets.

All world regions were in decline, from

single-digit drops for Europe and Central America to decreases in the 50% range for Africa and South America, according to the Association of Equipment Manufacturers, citing U.S. Department of Commerce data it uses in global market reports for its members.

Over the analysed period, U.S. construction equipment exports to Canada dropped 21%, to a total \$3.5 billion; exports to Europe declined 6%, to a total \$1.2 billion; exports to Central America fell 9%, to a total \$1 billion; and exports to Asia decreased 30%, to a total \$972 million. Meanwhile, U.S. construction equipment exports to South America declined 49%, to a total \$733 million; with further equipment export declines to Australia/Oceania (- 36%) to \$427 million; and to Africa (- 51%) to \$317 million.

Commenting on the latest export figures AEM's Benjamin Duyck, director of market intelligence, said: "For the past 15 quarters U.S. exports of construction equipment have declined year-on-year. In the third quarter of 2016, that trend remains unchanged. A key factor affecting the reduction in exports is most likely due to the strong dollar making

U.S. manufacturers less competitive in the global marketplace. Of course, the strong currency is a problem that plagues all U.S. exports. Some international markets are still viable; exports are up year-on-year to Belgium and Germany, for example.

"Our expectations for the fourth quarter remain subdued as the U.S. dollar is experiencing its longest rally in 16 years. With the global economic malaise, the slowdown in emerging markets and the negative interest rates seen in several economies' bond markets, investment is flowing to the U.S. and U.S. stocks, driving up demand for our dollar, inadvertently affecting our competitiveness abroad."

The top countries buying the most U.S.-made construction machinery during the first three quarters of 2016 (by dollar volume) were Canada - \$3.5 billion, down 21%; Mexico - \$831 million, down 9%; Australia - \$392 million, down 38%; Belgium - \$294 million, up 33%; Germany - \$202 million, up 24%; China - \$190 million, down 8%; Peru - \$181 million, down 30%; Chile - \$165 million, down 60%; Japan - \$147 million, up 6%; and Brazil - \$145 million, down 61%. □

• *The AEM is the North American-based international business group representing the off-road equipment manufacturing industry.*

CENTRAL & SOUTH AMERICA

Much effort has been made in recent years to try and galvanise what has been a depressed construction and mining sector in Central & South America. This has included the inaugural CONEXPO Latin America in Santiago, Chile in October 2015, which attracted more than 32,000 registrants from more than 90 countries.

Continued growth in construction activity and significant investment in large surface mining projects will help Central and South America recover from the sales declines registered between 2009 and 2014, according to the Freedonia Group. The independent US-based business market research firm says demand in the region had dropped largely due to declining sales in Brazil, which had purchased a significant amount of new construction equipment in the intervening years in preparation for the 2014 FIFA World Cup and the 2016 Summer Olympics.

Indeed, the Brazilian economy is in its worst shape in three decades. With Brazil traditionally making two thirds of all South American equipment sales, the wider regional market is pinning its hopes on this huge country getting back on track economically.

Timetric's 'Construction in Brazil – Key Trends and Opportunities to 2019' report says that, in real terms, the Brazilian construction industry's output value contracted from US\$226.3 billion in 2013 to US\$214.9 billion in 2014. This decline was mainly due to a large budget deficit and the implications of 'Operation Lava Jato', instigated to investigate the country's corruption scandal. This resulted in weak business confidence and a delay in the construction of several infrastructure projects, which affected the demand for

Mexico's infrastructure construction expenditure is poised to grow at a relatively strong rate

construction activity in 2014.

Growth prospects will be limited over the Timetric report's forecast period (2014–2018), owing to the deteriorating economy and the weak property market, subdued public spending and lack of investor confidence.

However, there are some huge infrastructure megaprojects earmarked for the region. All these will create construction equipment demand. One of these projects is the creation of a US\$50 billion, Chinese-funded new rail corridor, running from Brazil's Atlantic coast to Peru's Pacific waters.

Mexico's infrastructure construction expenditure is poised to grow at a relatively strong rate over the next decade, according to the recent 'Infrastructure Insight: Mexico' report by Timetric.

RIGHT: *The Chilean government plans to invest CLP18.9 trillion (\$28 billion) under the Infrastructure Master Plan.*



→ The total value of the infrastructure construction market reached MXN961 billion (US\$51.9 billion) in 2015, according to Timetric, up from MXN766.7 billion (\$37.16 billion) in 2010, and it will rise to MXN1.2 trillion (\$58.16 billion) in 2020 (in nominal value terms). This rapid growth in spending is based, says Timetric, on the assumption that a number of the large-scale infrastructure projects move ahead as planned, including the MXN171 billion (\$8.28 billion) Mexico City New International Airport, the expansion of Veracruz port, the Mexico City-Toluca high-speed train and the Oriental Nuclear Power Plant.

When its current infrastructure is compared to the other regional peers (Argentina, Brazil and Colombia) through the World Economic Forum's 'Global Competitiveness Report, Mexico' performs better in terms of overall quality.

In real terms, the Chilean construction industry registered a growth rate of 2.8% in

2015. This was preceded by an annual growth rate of 1.6% in 2014, 3.2% in 2013, 7% in 2012 and 6.8% in 2011. Timetric's 'Construction in Chile – Key Trends and Opportunities to 2020' also states that the country's economic recovery, coupled with government investments in infrastructure, and residential construction, increased issuance of building permits and a greater total surface area for construction contributed to growth. In addition, reconstruction projects after the catastrophic earthquake and tsunami in 2010 supported industry growth during the period 2011–2015.

The country's construction industry will, says Timetric, continue to expand

in real terms over the forecast period (2015–2019) due to investments in transport infrastructure, energy and utilities, and affordable housing projects.

The Chilean government plans to invest CLP18.9 trillion (\$28 billion) under the Infrastructure Master Plan to develop the country's infrastructure by 2021, creating huge opportunities for construction equipment manufacturers. Under the plan, Timetric says CLP2.0 trillion (\$3 billion) will be invested to develop Chile's submarine fiber optic network between Aysén and Magallanes, and to construct 20 wastewater treatment plants in the northern region by 2021. □



CHINA

The Chinese government is this year continuing its part in the delivery of the One Belt One Road project, also known as the Silk Road Economic Belt and the 21st century Maritime Silk Road. Encompassing around 60 countries, the US\$4 trillion-plus mega infrastructure project aims to significantly improve land and waterway connectivity, primarily between China and the rest of Eurasia.

Despite headline-grabbing megaprojects like One Belt One Road, China's construction industry has faced relatively difficult times in the last two years. Timetric's 'Construction in China – Key Trends and Opportunities to 2020' report states that the Chinese construction industry's output contracted by 0.8% in 2015, following an average annual growth of 8.9% during the preceding four years. Weak economic conditions, low global commodity prices, poor fixed-capital investments, high debt-to-GDP ratios and low investment in real estate contributed to this decline, says Timetric.

Over the Timetric report's forecast period (2015–2019), the Chinese construction industry is expected to grow more slowly than during the 2011–2015 period, due to poor economic growth. However, expected expansion in the industry over the forecast

period will be driven by investment in public infrastructure and renewable energy, and improvements in consumer and investor confidence.

Timetric notes that government flagship programmes such as the 13th Five-Year Plan (2016–2020), the National New-Type Urbanization Plan (2014–2020), social housing programs, China's 2016–2020 Energy Plan and Free Trade Zones (FTZ) schemes are expected to support growth over the forecast period. All these initiatives will present unit sales opportunities for global construction OEMs.

The Freedonia Group says construction expenditure in China will be fuelled until 2023 by continued industrialisation, a rising urban population and consumer income levels, and greater foreign investment funding.

China's north-west region is tipped by Freedonia to see the biggest national regional construction industry expenditure growth. This, says Freedonia, will be fuelled by the Chinese government's Great Western Development strategy and the region's abundant natural resources. However, Freedonia states that China's central-east region, being home to about one-third of the country's total population and economic output, will remain the country's largest

regional market, accounting for 43% of the overall construction spending in China in 2018.

While the wheeled loader has long been the major seller in China in the past, excavator sales are also growing. Speaking in autumn 2016, David Phillips, managing director of Off Highway Research (OHR), said: "I think that in the longer term crawler excavators will reach 30% of the Chinese market."

Chinese manufacturers are also having to cope with over-capacity, according to



BELOW: *bauma China 2016 showground.* (pic: Mike Woof)





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Chinese firms
developed the capacity
to build over 250,000
wheeled loaders/year

→ Phillips. Having built some 220,000 wheeled loaders in 2011, OHR believes the Chinese market will account for around 50,000 wheeled loaders for the next few years. Similarly, he said that in 2011 Chinese firms built around 160,000 excavators, but the market will account for around 35,000 units for the next few years. Chinese firms developed the capacity to build over 250,000 wheeled loaders/year, in excess of the total world demand for these machines of some 114,450 units. And for excavators Chinese firms developed the capacity to make some 430,000 units/year, compared with global sales of 354,062 units. Phillips said: "They've taken steps to reduce production." However, he added that there is still excess capacity, particularly for wheeled loaders, while manufacturers also

have to contend with a large pool of second-hand machines that have clocked low hours, making attractive deals for customers looking to replace old units. Phillips does not see mergers and acquisitions being a major factor and he is also certain that the 10 key Chinese manufacturers have a strong future.

Phillips added that Chinese manufacturers are also learning fast about how to boost the residual values of their products. Machine quality of the products from the leading firms is now vastly improved while these companies are also gearing up to provide much better product support for customers. Chinese firms have achieved good penetration into developing markets, according to Phillips, but have yet to develop the global brand recognition that will allow them to compete

in developed markets. However, he added that this is coming.

bauma China 2016, the 8th International Trade Fair for Construction Machinery, Building Material Machines, Mining Machines and Construction Vehicles, was deemed a success, after attracting more than 170,000 visitors from 149 countries and regions.

The huge volume of visitors to the industry showpiece event held 22-25 November at the Shanghai New International Expo Centre (SNIEC) was seen as particularly encouraging given the backdrop of economic slowdown, ongoing change and industry modernisation.

Preparations for bauma China 2018 at the same venue 27-30 November are well underway. Perhaps the earmarked increased investment in public infrastructure will generate even greater interest in this next staging of the global showpiece event. □

JAPAN

With its construction industry worth close to US\$250 billion, Japan is a key Asian country for major and ambitious SME construction equipment manufacturers.

The world's 61st largest country, Japan has around 1.2 million kilometres of roads, giving it the fifth-largest network. Japan also, reportedly, has 680,000 bridges, nearly 10,000 tunnels, 250 bullet trains and 98 airports – including Ibaraki, 85km north of Tokyo, widely referred to as the 'white elephant'. Opened in 2010 and costing around \$225 million, the earmarked hub for low-cost carriers is said to be handling just six flights a day.

Among several major Japanese highway network expansion projects attracting strong construction equipment demand is the \$32 billion construction of a second Tomei-Meishin Expressway, connecting Tokyo and Kobe via Nagoya. The main feature of the new expressway is its high 140 km/hr design speed, compared with 100 km/hr for the existing expressway.

Timetric's 'Construction in Japan – Key Trends and Opportunities to 2020' report states that, in real terms, the Japanese construction industry will expand slowly over the forecast period (2015–2019), with investments in infrastructure, healthcare, education and housing construction projects continuing to drive growth.

Growth will also be driven, says Timetric,

by the country's Vision 2020, under which the government aims to develop road, rail, airport and other infrastructure projects.

Infrastructure and commercial building projects related to the Tokyo 2020 Olympic Games will also be a key source of growth.

Indeed, many construction OEMs believe contractors' need to upgrade old local machines to cope with the demands posed by Japanese infrastructure megaprojects, offers key sales opportunities. Some manufacturers also point to a likely big increase in demand for specialist demolition and reconstruction equipment connected to work on the 2020 Olympics.

However, Timetric's latest Japanese report highlights some major downside risks associated with the national construction industry's outlook over the next three years. The largest of which addresses concern that deflation – despite massive government stimulus packages and high government debts – will hold back government investment in infrastructure projects.

As such, the Japanese construction industry's output value in real terms is expected by Timetric to rise at a compound annual growth rate (CAGR) of just 1.26% in the 2015–2019 period, compared to 1.99% in the period 2011–2015.

Many construction and other Japanese industry observers will also have noted how Japan's Prime Minister Shinzo Abe was one of



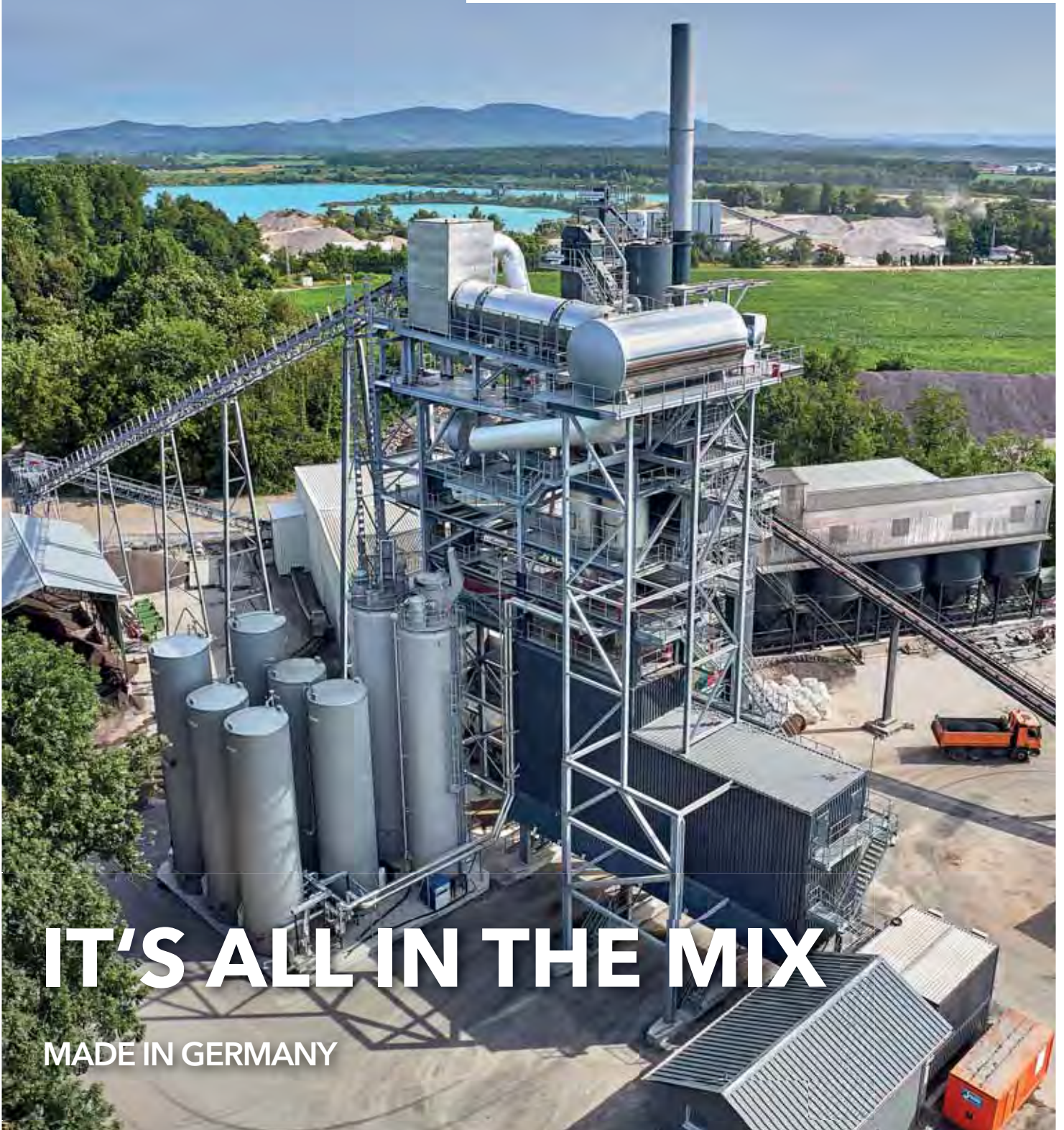
ABOVE: Japan has around 1.2 million kilometres of roads, giving it the world's fifth largest network.

the first G7 leaders to have face-to-face talks with then U.S. President Elect Donald Trump after his November 2016 election victory over Democrat Hillary Clinton. Whether this is an indication of a closer political and economic working relationship between the two nations remains to be seen. However, you can easily draw comparisons between Trump's key campaign pledge to spend big on U.S. infrastructure and Prime Minister Abe's vow after coming into power in December 2012 to spend 10 trillion yen (\$107 billion) on infrastructure in the first 15 months of his government. □

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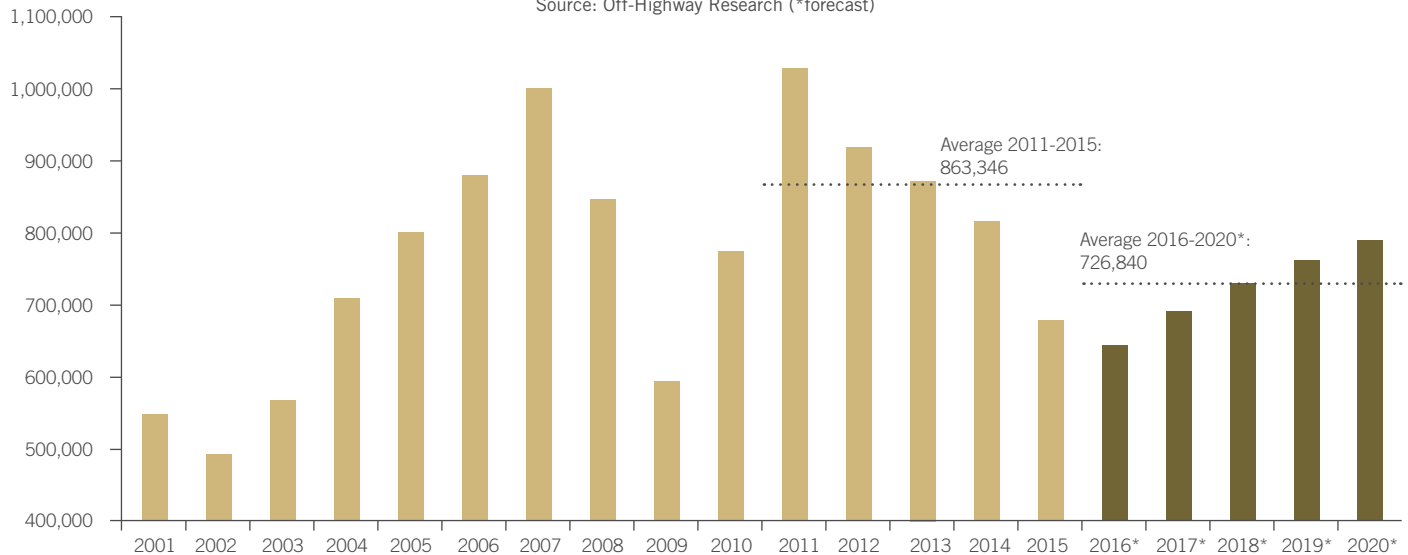
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Global sales of construction equipment 2001-2020* (units)

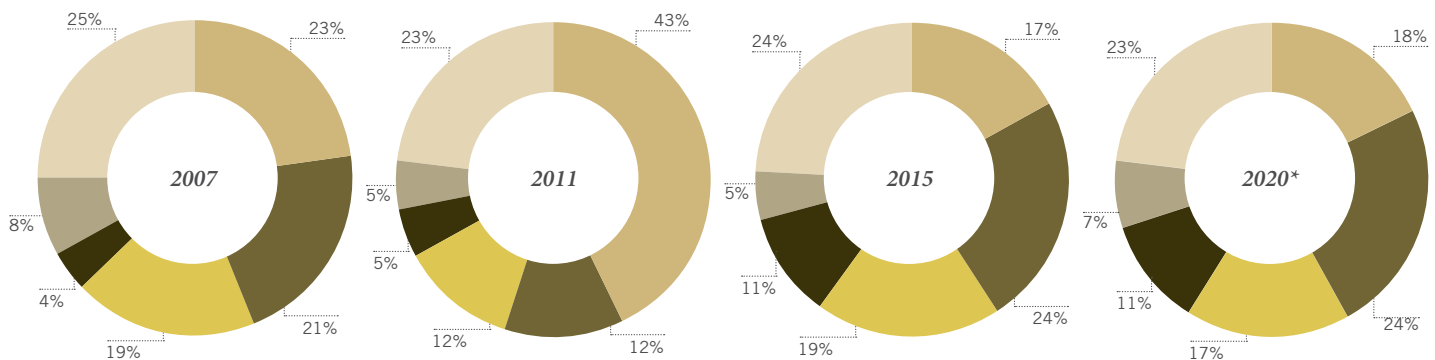
Source: Off-Highway Research (*forecast)



Changing structure of global demand 2007-2020* (% of total)

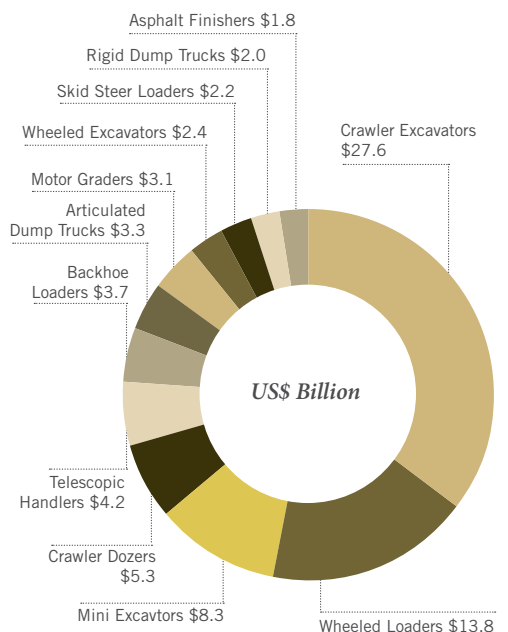
Source: Off-Highway Research (*forecast)

China Europe North America India Japan Rest of the World



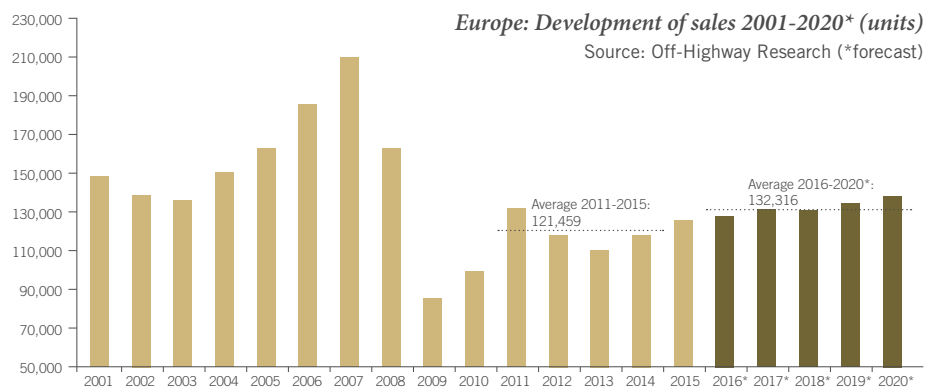
Global value of construction equipment, by type 2015 (\$ Billion)

Source: Off-Highway Research



Europe: Development of sales 2001-2020* (units)

Source: Off-Highway Research (*forecast)



China: Development of sales 2002-2020* (units)

Source: Off-Highway Research (*forecast)





REST OF ASIA

South Asia will be the Asian region's fastest growing sub-region in 2017, according to the Asian Development Bank (ADB). This is likely to lead to new infrastructure and residential construction projects, generating increased demand for new state-of-the-art construction equipment.

In its 'Asian Development Outlook 2016' report, the ADB also says that while the UK's June 2016 referendum resulting in a vote to leave the European Union has affected developing Asia's currency and stock markets, its impact on the real economy in the short term is expected to be small.

With fiscal pressures from continued low oil prices more acute than anticipated, the ADB's growth forecast for Central Asia was adjusted down in mid-2016 by 0.4% to 1.7% in 2016. However, ADB believes growth will pick up pace in 2017. The Pacific as a whole should meet forecasts, says the ADB, as tourism boosts some economies.

The governments of Central Asian nations rich in minerals such as Kazakhstan and Uzbekistan are keen to invest heavily in their aggregate production capabilities in a bid to boost their wider economies, while also looking to attract further investment from overseas. This is set to stimulate construction equipment demand in this Asian sub-region.

Myanmar's construction industry is forecast by Timetric to record rapid growth in the next few years, at an annual average rate of 10.37%. In real terms, the industry's value stood at US\$8.2 billion in 2015, and is anticipated to

reach a value of US\$13.5 billion in 2020.

Timetric says that the growth will be supported by the country's improving economic conditions, but will mainly depend on government investments in residential, energy and utilities, and public infrastructure projects, as well as a rise in foreign investments.

Meanwhile, Timetric's 'Infrastructure Insight: Indonesia' report, published in October 2016, says the South-east Asian country of 260 million people and more than 300 ethnic groups, making it the world's fourth most populous nation, is likely to see strong growth in infrastructure construction over the next five years; a continuation of the trend seen in the early part of this decade. Timetric notes that the total value of Indonesia's infrastructure construction market reached US\$157 billion in 2015, and is expected to grow to US\$269 billion by 2020 (in nominal value terms).

This growth in spending, says Timetric, is based on the assumption that a number of the large-scale infrastructure projects will move ahead as planned, most notably the Indonesia Power Program 35,000MW, the National Capital Integrated Coastal Development, and the Trans-Java and Trans-Sumatra Highways.

According to its government, South Korea has the third largest economy in Asia, behind Japan and China (its largest trading partner and export market), and is fourth behind China,

Japan, and India by purchasing power parity.

One of the Four Asian Tigers, South Korea is a nation that has achieved rapid economic growth through exports of manufactured goods. Indeed, it was proudly among the top 20 exhibiting nations at bauma 2016 in Munich, Germany, with 56 exhibitors.

Despite its government's enthusiasm for growth, the lack of high quality raw materials in South Korea is limiting the development potential of its infrastructure, such as the railroad network, commercial and non-commercial buildings, and industrial hubs, and thus the growth of the entire nation.

Much to the relief of the country's rulers, the International Olympic Committee Coordination Commission was satisfied that preparations for the staging of the Olympic Winter Games in PyeongChang in 2018 remain on track, with demand for construction equipment set to intensify in the final year-and-a-half of the project.

Timetric's 'Construction in the Philippines - Key Trends and Opportunities to 2020' report foresees continued growth in the Philippine construction industry, which is forecast to reach a value of US\$47 billion in 2020. The growth will be bolstered, says Timetric, by greater focus on infrastructure improvement and the continued expansion of residential and commercial buildings.

A major player in the South-east Asian hauler market, Terex Trucks' impressive range of articulated and rigid dump trucks was recently made available in Malaysia through the Volvo Malaysia dealership. The manufacturer describes Malaysia's economy, the fourth largest in South-east Asia, as both vibrant and relatively diversified.

Once the world's biggest producer of tin, the nation enjoys ample oil and gas reserves, as well as natural resources, such as rubber and palm oil, forestry and minerals. With the construction sector strengthening, Terex Trucks says Malaysia has varied opportunities for the company and other OEMs. □

According to its government, South Korea has the third largest economy in Asia



LEFT: Indocement's Citeureup factory, West Java, Indonesia is one of the largest cement factories in the world.



AFRICA

Africa is expected to be a hotbed of construction activity in the coming years. While many of its nations remain highly reliant on mineral exports, it is an unfair generalisation to say that the continent's infrastructure spending is totally dependent on mineral resources.

Emphasising this, KPMG's 'Construction in Africa' report states that GDP per capita levels in many African countries have soared past the vital US\$1,000 level, enabling consumers to purchase more than just the basics. Urbanisation and policies focused on how best to benefit from it are high on most African governments' 'To Do' lists. As the KPMG report states, Africa had 22 cities with more than two million inhabitants in 2010, and will have another 14 of that size by 2020.

Energy and power projects are the principal focus of construction in North Africa, with nearly 60% of the financing of these projects derived from domestic sources or development institutions on the continent. Southern Africa remains a vital gateway into Africa. Apart from the commencement of South Africa's massive transport and energy projects, the southern Africa region benefits from many large real estate projects focused on retail shopping centres and mixed-use developments, mostly driven by the local private sector.

The relentless drive of regional integration in East Africa has led to mammoth investments in mega transport construction projects,

mainly centred on road and rail networks, as well as port facilities.

Kenya and Ethiopia are the two regional heavyweights when it comes to current infrastructure investment. Ethiopia's construction sector will outgrow that of its neighbours over the next 10 years, growing at 11.6% per annum on average, fuelled by a swell in infrastructure investments in the region, according to BMI Research International. With US\$20 billion worth of projects in the pipeline, Ethiopia has double the amount of infrastructure investments compared to Nigeria. Kenya's construction industry growth is predicted to be 9% this year and will maintain this trend over the next 10 years.

Uganda and Tanzania's construction sectors will grow at 7.3% and 9.5% year-on-year, respectively.

According to Timetric's 'Construction in Nigeria - Key Trends and Opportunities to 2020' report, the Nigerian construction industry will continue to expand, with investment in infrastructure construction driving growth.

Timetric says in real terms, the industry's output value is expected to rise at an annual average of over 9% over the 2015-2019 period, having already posted annual growth close to 12% during 2011-2015. Consequently, Timetric notes that the industry is expected to increase from \$56.1 billion in 2015 to \$88.2 billion by 2020, measured at constant 2010 US dollar exchange rates.

The Nigerian government is introducing

Kenya and Ethiopia are the two regional heavyweights when it comes to current infrastructure investment



ABOVE: An excavator at work at Aristocrats' Syokimau quarry in Kenya.

new bills to encourage private investors to invest in rail infrastructure, continues the Timetric report. In 2015, Benin, Nigeria and France's Bolloré Group signed an agreement to upgrade the 438km Cotonou-Parakou line and to construct the 574km line to connect Niamey with Ouagadougou.

Infrastructure construction is the largest market in the Nigerian construction industry, accounting for nearly 30% of its total value in 2015. Timetric expects the market to maintain its position, and to record annual growth (in nominal terms) of 19% (2015-2019), to a value of NGN7.6 trillion (US\$26.1 billion) by 2020.

The growing number of public-private partnership (PPP) projects and the increasing pace of foreign investment will drive industry growth in Egypt to 2020, according to Timetric's 'Construction in Egypt - Key Trends and Opportunities to 2020' report.

The government, the report states, signed 20 economic agreements with the Chinese government. The agreements, worth EGP111.7 billion (\$15 billion), will include investments in the country's housing, transport and energy sectors.

Government flagship programmes such as the October Oasis, Sustainable Development Strategy 2030, Local Development for Upper Egypt governorates and the development of Cairo Metro Line 6, are expected to support industry growth to 2020.

In real terms, the construction industry's output value recorded a compound annual growth rate (CAGR) of 8.24% in the period 2015-2019.

Elsewhere in North Africa, Timetric says the government of Morocco is also seeking help from private investors to improve the country's infrastructure. The government was due to launch the country's first construction project as a PPP before the end of 2016. □



LEFT: Haver & Boecker equipment at a Kenyan cement plant.

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INDIA

India is one of the world's fastest-growing economies. Indeed, it has been predicted that by 2020 it could be a US\$5 trillion economy, up there with the traditional economic heavyweights of USA, China and Japan.

Leading construction market research firms see the huge potential offered by India, a market at the forefront of strategic growth planning by all ambitious global construction equipment manufacturers.

David Phillips, managing director of OHR, believes India will be 'the' major regional growth market for construction equipment. "India is the real body-builder of our industry. In the last six months we've been seeing quite a lot coming through." Phillips notes that Narendra Modi's Indian government has been making major steps both in tackling corruption and untangling bureaucracy, which is helping release pent-up demand for infrastructure development.

India, Phillips continues, has been a major market for backhoe loaders. However, while sales of backhoe loaders remain stable, they are losing market share to growing sales of 14tonne, 18tonne and 20tonne class excavators, seen as better equipped for use on infrastructure projects.

According to Timetric's 'Construction in India – Key Trends & Opportunities to 2020' report published in March 2016, increasing investments in residential construction and transport infrastructure will drive growth in India's construction industry over the forecast period (2015–2019). Consequently, the average annual growth in real terms is expected to improve from of 2.95% in 2011–2015 to 5.65% by 2020.

Timetric forecasts the construction

"In India many planned projects stalled in the past and some of them are now being driven forward again"

Igor Palka



industry to rise impressively from a value of US\$428.1 billion in 2015 to US\$563.4 billion by 2020, measured at constant 2010 US dollar exchange rates. Due to industrialisation, urbanisation, a rise in disposable income and population growth, Timetric says the demand for construction services is set to rise. The leading construction market research firm also believes government efforts to improve India's residential and transport infrastructure will play a vital role in supporting growth.

Infrastructure construction accounted for 23% of the total construction industry's value in 2015, reports Timetric. The same source anticipates it to be the industry's fastest-growing market in the period 2015–2019, with a CAGR of 9.94% in nominal terms, to a value of INR9.5 trillion (US\$140.1 billion) by 2020.

Residential construction was the largest market in the Indian construction industry during 2011–2015, and is anticipated by Timetric to remain relatively sizable over the next few years, with a 30.6% share of the industry's total value by 2020.

The Indian Construction Equipment Manufacturers' Association (iCEMA) is also optimistic about the prospects of growth within the national construction industry, and the role the Indian government must play in delivering it.

In its publication 'Rebooting Indian Infrastructure—Indian Construction Equipment Industry Vision 2020', the iCEMA writes: "India will need world class infrastructure to enhance its competitive advantage globally. India will require smart housing solutions that will balance the

ABOVE: Access to the Taj Mahal has been improved with the opening of the Yamuna Expressway connecting India's capital Delhi with Agra.

affordability and availability grid. India will require serious investments in power, transportation, airports and ports to overcome its logistical challenges. Indian GDP will grow at precisely half the rate at which construction industry will grow. That puts a significant responsibility on the government of the day to encourage the construction sector."

Another positive sign for Indian construction equipment demand in 2017 and beyond, was the successful staging of the bauma CONEXPO India 2016 exhibition in Gurgaon, Delhi (12–15 December 2016). Rising demand for construction machines in India, fuelled by the resurgence of the country's highway programme as well as other infrastructure developments, was a key talking point among the 28,000 plus attendees and nearly 700 exhibitors, including leading global OEMs such as Caterpillar, CASE, BKT, Astec, JCB, Sany, XCMG and Wirtgen.

Speaking ahead of what was the fourth staging of bauma CONEXPO India, Igor Palka, CEO of bC Expo India, the company in charge of organising the showpiece event, said: "In India many planned projects stalled in the past and some of them are now being driven forward again. For the construction machinery sector, for example, 11.8% growth is expected by the year 2020, to more than 80,000 units. That isn't a dramatic rise, but it is nevertheless a very respectable outlook." □

BELOW & RIGHT: When fully opened in 2017, the Dubai Water Canal will range in width from 80 to 120m and be six metres deep.



MIDDLE EAST

The Middle East has a reputation for eye-catching infrastructure megaprojects, and Dubai is the location of a current one. The Emirate's ruler Mohammed bin Rashid Al Maktoum, is determined to transform the once-humble Gulf port town into a global city, with his latest project being the creation of a 3.2km waterway through downtown Dubai.

When fully opened in 2017 the waterway – which will be known as The Dubai Water Canal – will range in width from 80 to 120m and be six metres deep. The construction of the two billion dirham (US\$544 million) canal is reportedly progressing at breakneck speed. The construction works are due to be finished in September 2017.

The International Monetary Fund's (IMF) January 2016 forecast identified the Middle East, along with sub-Saharan Africa, as the key regional players behind a slight increase in global economic growth, from 3.1% in 2015 to 3.4% in 2016. However, the IMF also noted how global geopolitical and macroeconomic risks had increased considerably going into 2016 compared with the previous year.

According to Timetric's 'Construction in UAE – Key Trends and Opportunities to 2020' report, the UAE's construction industry will continue to expand over the forecast period (2015–2019), with investment in infrastructure, commercial, residential and energy projects continuing to drive growth.

Large-scale investments in infrastructure development, supported in part by the nation's hosting of the 2020 World Expo, will be a key driver of growth. Moreover, the country's strong economic growth, strategic location and large consumer base will continue to attract investors.

The industry's output value in real terms is expected to rise at a compound annual growth rate (CAGR) of 6.52% over the forecast period, up from 3.55% during the review period (2011–2015).

According to the United Nations Department of Economic and Social Affairs (UNDESA), Saudi Arabia's population is forecast to increase by 30.7% between 2010 and 2030, which will boost demand for new residential buildings and, as a result, construction equipment.

The outlook for Saudi Arabian construction remains bright as the industry's output value is forecast to rise at a CAGR of 7.05% to 2020, compared with 6.35% during the 2011–2015 period.

According to Timetric's 'Construction in Saudi Arabia – Key Trends and Opportunities to 2020' report, the country's construction industry is consequently set to rise in value from US\$105.6 billion in 2015 to US\$148.5 billion in 2020, measured at constant 2010 US dollar exchange rates.

The growth will be supported by increased government participation and investment in sectors such as healthcare, education and infrastructure construction to diversify the country's economy away from oil and to support economic growth. The government's White Land Tax initiative to address the country's housing shortage will also support industry growth.

The lifting of economic sanctions on Iran related to nuclear weapons capability in January 2016 unlocked project investments worth up to \$200 billion, claims MEED, the leading source of Middle East business intelligence. Indeed, Iranian President

Hassan Rouhani wasted little time in pursuing new business opportunities – overseeing \$40 billion-worth of agreements with Italian and French companies during a five-day visit to Europe just days after the sanctions were officially lifted.

Qatar's construction growth is being driven by the National Vision 2030 – the country's economic diversification policy – and football, in the shape of its preparations for the 2022 FIFA World Cup.

Meanwhile, Kuwait's delivery of key infrastructure projects and investment in healthcare, educational facilities and new housing projects will, says Timetric, contribute to the future growth of the nation's construction industry. Furthermore, the country's Vision 2035, under which the government aims to develop the country's road, rail, airport and related infrastructure, is also expected to drive construction equipment demand. □


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TAKING A MATURE APPROACH

Getting the correct heavy equipment – and their parts – to major construction projects on time is increasingly requiring a more grown-up attitude to contracts. *Adam Hill* reports.

Ensuring that the right equipment and materials turn up exactly where, and when, they are needed is the key to good management of the construction supply chain. A range of stake-holders – most obviously the construction equipment owners themselves, but also builders, designers, other suppliers, engineers, maintenance staff, financiers and spare parts delivery networks – are all reliant on one another as they bid to keep projects on track.

To take one example, the UK's Crossrail project, which is due to open in December 2018: the route will pass through 40 stations from Reading and Heathrow to the west of London, along new twin-bore 21 km tunnels to Shenfield and Abbey Wood to the east. Jointly sponsored by the Department for Transport and Transport for London, the Elizabeth line (as it will be called) has required the help of multiple suppliers to achieve completion. Contracts are awarded via the CompeteFor service, run by BiP Solutions and London Business Network, on which Tier 1 contractors are also required to advertise all appropriate subcontract opportunities.

COMPLEXITY OF CROSSRAIL

An excerpt from the list of successful suppliers provides a glimpse into what is involved these days in the construction equipment supply chain. Specialist heavy lift contractor Mammoet, based in Newcastle with depots in Teesside and Leeds, supplied heavy telescopic mobile cranes and specialist jacking, skidding and transportation equipment to assemble and transport the huge, thousand-tonne tunnelling machines at Royal Oak portal in west London. It also supplied smaller mobile cranes for putting up gantry cranes at Crossrail's Limmo and Canary Wharf sites. Meanwhile, Preston-based Lifting Gear UK supplied a contract-lifting service to the Plumstead site in south-east London to manage the lowering of Crossrail's thousand-tonne tunnelling machines, Sophia and Mary, into the earth. Ground engineering company Romtech, from

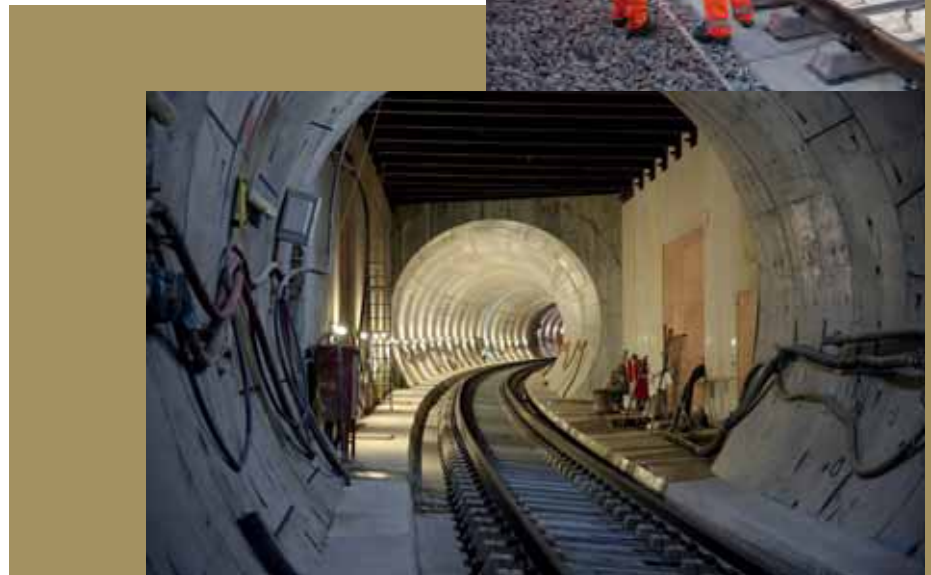
Sheffield, supplied reinforcement cages used for piling and foundation works on Crossrail projects at Bond Street, Farringdon and Tottenham Court Road stations with a total value of around £10 million. Finally, when it came to ensuring that the right vehicles were in the right places, Edinburgh technology company The PODfather provided an innovative hand-held PDA system to capture trucks' arrivals and departures from Crossrail sites. The real-time reporting of vehicle movements replaced paper-based work-sheets, saving time and reducing mistakes, the company says.

BREAKING THINGS DOWN

This is far from a comprehensive list: Crossrail makes a great deal of its use of UK businesses as contractors, and maintaining the construction equipment supply chain – even in a relatively small area such as the British Isles – still requires disparate elements to make it to the right place, in good time, to ensure the minimum of downtime. Other construction projects require more complex route maps to be created: it is one thing getting pieces of construction equipment in the right place at the right time – but what

BELOW: Engineers survey Crossrail track running through Custom House station.

BOTTOM: Permanent track installed through Crossrail's Limmo shaft heading towards Canary Wharf.



happens when the equipment itself is too big to be moved in one piece? This is the case with Liebherr's activities in the Australian mining industry: the dump bodies for the 237-tonne Liebherr T 282 C haul trucks are built in Brisbane, before being taken nearly 1,000km by road to an assembly site in North Queensland. However, the chassis parts are manufactured in the US - half a world away in Newport News, Virginia. At the port of Savannah, they are loaded onto roll trailers for a 27-day sea journey to Brisbane. The vehicles' drive systems and planetary gear sets are manufactured in and shipped from Biberach, Germany, with the wheel rims coming all the way from Toronto, Canada. Even when assembled on the build site, the trucks' journey does not end there - the mine itself is still more than 300km away.

So much for the complexity of individual heavy duty projects - what does the wider picture look like? Regardless of whether the construction equipment supply chain is long or short, things appear quite rosy for the whole industry at present. The McKinsey Global Institute has estimated that \$57 trillion worth of infrastructure investment will be required by 2030 just to keep up with the global economy. "For engineering and construction companies, that translates into a steady 4% annual growth rate," say McKinsey & Company's Jose Luis Blanco, Mauricio Janauskas, and Maria Joao Ribeirinho in "Beating the Low Productivity Trap: How to Transform Construction Operations". "Many industries would be happy with that prospect."

PRODUCTIVITY PROBLEM

There is a problem however: the sector is hampered by stagnating productivity and low profit margins in many markets. The authors point out that, while overall labour productivity in Germany and Britain has risen by almost 30% between 1995 and 2016, construction labour productivity in those

countries is up by only about 7% over the same period.

The consulting firm's analysis of the financial performance of 30 major public engineering and construction companies from 2005 to 2015 found that fewer than 15% "consistently enjoyed double-digit growth". The report identifies several areas for significant improvement. Chief among these is fragmented value chains, with each element not necessarily working together well.

"Each typically gets its own contract, with no overall management," it points out. "In effect, one participant can (and often does) create problems for the next." Since their priorities often differ, this is not surprising - for instance, contractors look to pass on additional costs to the owner rather than working together to reduce them. This is the crux of another problem the report highlights: extensive subcontracting. "Many subcontractors are small and unsophisticated, lacking effective governance and talent management, and the companies that hire them don't see it as their responsibility to improve matters," the report says. "That affects productivity not only at the specific stage where a subcontractor is hired but also at every stage thereafter."

The fact that many construction companies typically want subcontractors to accept most of the risks does not exactly foster a spirit of collaboration. To sum up: a more grown-up approach is required.

MATURING RELATIONSHIPS

The price of failure in multi-million dollar projects can be considerable: creeping penalties for overruns, sanctions for missing other deadlines, even the breaking of contracts altogether - as well as customer dissatisfaction which could have a potentially catastrophic impact on companies' future abilities to bid for, and to fulfil, major works.

This means that engaging with all players is crucial. David O'Neil,

BELOW LEFT: *Installing trays for cable management system in westbound tunnel approaching North Woolwich Portal.*

"Construction is hampered by poor productivity and low profit levels"

CASE STUDY: WWL TRANSPORTS CATERPILLAR MINE SHEARER

Getting Caterpillar's super heavy 17-metre EL3000 longwall shearer from Europe to Whitehaven Coal's Narrabri North mine in New South Wales, Australia, was the first time this 102-tonne unit had been shipped in a single piece. In a process managed by WWL, it left Zeebrugge in Belgium for Australia's Port Kembla, with a specially-designed 16-metre Samson rolltrailer with low ground clearance used to move and stow the machine for the sea voyage.

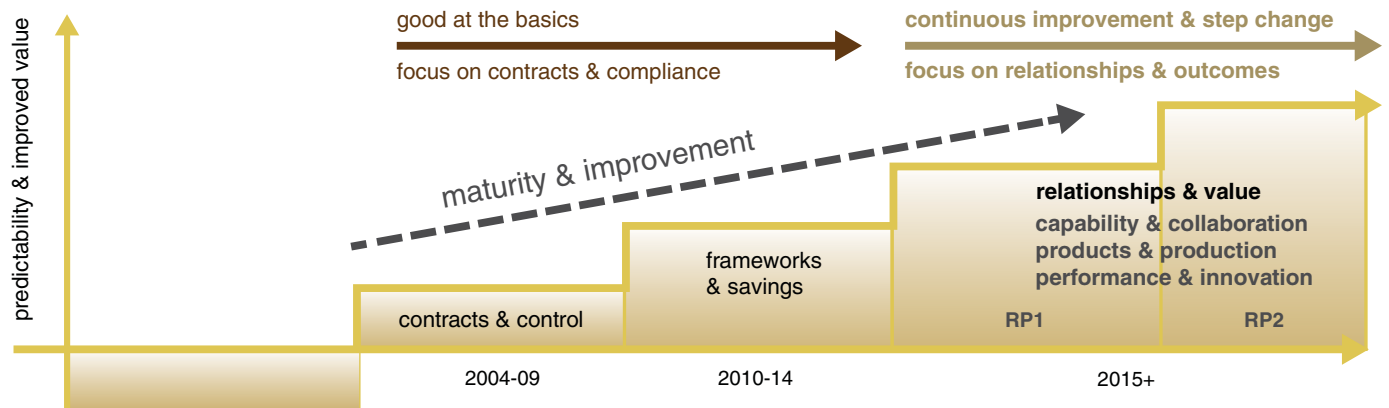
Previously it had been cheaper to ship such bulky equipment as separate components but doing it this way reduced lead time for the customer - as well as costs, the company says. In such a complex supply chain task, regular contact was needed between WWL and Caterpillar's transportation teams in Europe and Australia, Caterpillar engineers and project managers, and WWL's technical advisers.

The operational blueprint of the handling process was first approved by Caterpillar and then shared with the port and vessel operators. "The direct interaction with the customer enabled them to explain what they wanted and needed from WWL, allowing us to respond directly with suggestions for how best to comply with their expectations," says Andreas Söderberg, technical equipment adviser in WWL's Cargo Solutions team. Tom France, director of logistics and transportation management for Caterpillar, said that WWL was able to comply with all of Caterpillar's special requirements, "from reducing the cost of shipping and meeting critical delivery times, to finding innovative solutions and setting up a close and successful collaboration".



Develop relationships: Maturing our approach

Source: Highways England



→ Highways England's head of supply chain management, says it is possible to increase innovation and productivity through effective management of the construction supply chain. Speaking at the Construction Equipment Association's Construction Productivity Forum in London in June, he said that his organisation and its suppliers were "aligning around clear and transparent shared objectives and engaging on structures to deliver performance and improvement".

He talked of an "unprecedented challenge" for Highways England and its contractors in the construction supply chain, with the UK government currently investing £11 billion to deliver 112 major improvements, including 15 smart motorway projects, to create a more accessible road system with over 150 new cycling facilities and crossings.

The McKinsey report suggested that a reluctance to share best practice was also holding back construction productivity. Highways England appears to be taking steps to improve this situation in its own operations. To ensure that it gets the most out of equipment suppliers, it introduced Supply Chain Strategy 2015 which outlines how relationships should work.

"Collaborative relationships will allow us to draw more strongly on learning and innovation, pulling both UK and overseas best practices," the strategy document says. "We will change the way we work with highway suppliers moving from managed contracts to developing more efficient peer-to-peer relationships with highway suppliers where value is added."

The language used by Highways England suggests an acknowledgment that a more thoughtful way of doing business is overdue. Using phrases like "maturing our approach"

and "more advanced relationships", it says: "The new performance challenge requires Highways England to adopt more mature practices." The document summarises these as:

- More time on relationships, outcomes and less time on contracts and compliance
- More motivating success, less penalising failure
- More value improvement, less process adherence
- More shared outcomes, less man-for-man marking
- More tomorrow's innovation, less refining yesterday's solutions

It is a list likely to find favour with the authors of the critical McKinsey report on the shortcomings of the construction industry. Likewise, the pledge to "establish relationships with suppliers that are proportionate, targeted and mutually beneficial" will be music to the ears of equipment suppliers on the organisation's myriad building projects. Creating value "through more traditional transactional relationships that leverage value by aggregating demand and by buying against tight performance specifications" sounds like a fair enough place to start.

OUTSIDE INFLUENCE

Individual companies and organisations can only do so much. While it is important to ensure the supply chain is as robust as possible, the construction industry – and therefore the equipment suppliers which rely on its health – is strongly influenced by outside factors. "Although single-family home construction has doubled in the US since the spring of 2009, construction activity

continues to be notoriously volatile and slow growing in established markets such as North America and Europe," says Gill Devine, VP Western Europe for Synchron. "This means that OEMs operating in these territories will need to look beyond their immediate markets and towards emerging ones to drive growth."

Changes will need to occur in the way distribution is handled in order to meet the inventory, repair and equipment demands that crop up in each new market. "This will be particularly difficult, given the distribution infrastructures in

markets such as Asia and Africa are either nascent or non-existent," Devine says. "OEMs moving forward will need to lean more heavily on solutions that can help them gain greater visibility over performance and general demand. This will help them establish themselves firmly in new markets where competition is becoming increasingly fierce."

This emphasis on emerging markets will propel rentals, Synchron believes. "The heavy equipment rental industry is projected to be worth more than \$110 billion by 2019, and its growth potential is particularly intriguing when it comes to emerging markets like Asia," Devine goes on. "With labour costs continuing to rise and slow economic growth in major economies like China and India, renting equipment instead of buying new machinery is a good way for builders to reduce overhead costs. The Asian equipment rental segment is set to hit \$24 billion by 2019. Furthermore, given the relative scarcity of major construction players in Asia, the rental market could grow far more quickly than expected as more companies jump into equipment rental."

The Asian equipment rental segment is set to hit \$24 billion by 2019

THE PROBLEM IN INDONESIA

Academic research on specific markets has suggested that the importance of the supply chain to construction has taken second place to the idea of project delivery – even though the supply chain itself is vital to achieving that goal successfully. In Indonesia, as Togar M. Simatupang and Achmad F. Hendarman say in ‘An Analysis of Heavy Equipment Supply Chain in Supporting Infrastructure Construction’: “Heavy equipment suppliers hold an important role to ensure the realization of the construction project. However, the common practice of construction mainly focuses on project delivery rather than heavy equipment supply chain.” Indonesia wrestles with problems common to some developing countries, namely that there is a limited national supply of heavy equipment manufacturers, which in turn

The problems in more mature markets tend to be less fundamental

affects the availability of heavy equipment for construction. Yet as one of the so-called MINT countries (with Mexico, Nigeria, and Turkey) which have been earmarked as possible future economic giants, Indonesia's construction industry is expanding.

However, heavy equipment tends to be seen in a subservient role, as a supplier or an input to the supply chain – rather than as an integral part of the chain itself. To counter this, Simatupang and Hendarman suggest ten points which should be addressed in the Indonesian construction industry. These include ideas for financing and registering equipment, as well as incentives for suppliers (such as fuel subsidies so long as projects remain on time) to make available more units for use in infrastructure construction.

The report is an insight into the nuts-and-bolts problems which blight the construction equipment supply chain in

some countries. The problems in more mature markets tend to be less fundamental – but no less important to generating profit.

For the next 12 months, market conditions are likely to place more emphasis on the after-market in established territories, says Synchron's Gill Devine. “Given the unpredictable nature of construction and building in established markets, the aftermarket will draw more attention from OEMs in 2017,” Devine believes. “A high-margin opportunity, the aftermarket presents a reliable and continuous revenue stream for OEMs based in stagnant building markets.”

AFTERMARKET IMPORTANCE

Research from McKinsey has suggested that 56% of European-based OEMs say the after-market will be of increased importance to them moving forward. “This largely mirrors a trend in other categories as well, as companies across the board will look to leverage the after-market as a way to boost revenue as competition and consolidation



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→ begin to increase,” Devine concludes.

To take one large example: JCB, one of the world’s leading manufacturers of construction equipment, produces a range of over 300 machines. With a worldwide network of 9,000 staff, 14 part distribution centres and more than 2,000 dealer locations, its problem is not getting contracts but ensuring that customers’ expectations are fulfilled.

One major aspect of this is service parts inventory management on a global scale. JCB had a complex supply chain and multiple enterprise resource planning (ERP) systems which mitigated against handling things in a coordinated and integrated way. This made service parts planning a fragmented process requiring a lot of manual effort with each parts distribution centre being responsible for its own inventory.

To make things more difficult, JCB’s inventory planners could not view demand between different stocking locations – thus creating challenges with forecast accuracy and maintaining a balanced inventory. JCB introduced Synchron’s Global Inventory Management solution and saw a 7.4% point increase in customer service levels as parts availability was improved across

the network. The companies say that complete visibility and control of inventory at each stocking location now supports quicker reaction to changes in demand, while automated inventory management processing has reduced manual effort. “With each regional warehouse and depot location linked into one common inventory system, JCB today operates a streamlined and more efficient operation for global parts inventory planning, replenishment and optimisation,” says Chris Buckler, general manager world parts operations, JCB Service.

A newly-formed central planning team manages the solution, which JCB says has enabled its planners to concentrate on managing exceptional items and spend more time on adding value in other areas.

ADDING VALUE

This notion of added value will be increasingly important going forward. Frost & Sullivan’s latest research on logistics as a whole suggests that the use of technology is reshaping the industry and that, by 2025, value capture and creation will be its driving forces and apps and online brokerages will be commonplace. The speed at which products can be delivered – and the quality

of customers’ experience – will be crucial factors in success. “Firms must rethink their strategies and devise more agile models that leverage economies of scale and still meet consumer demands,” says Frost & Sullivan Visionary Innovation Group senior research analyst Vijay Natarajan.

While there is a world between the activities of, say, Amazon or Apple and the delivery of diggers or heavy-duty plant to where they are needed, this research provides food for thought. Some of the ways in which things work on large-scale infrastructure projects look increasingly outdated – not least in terms of the way the individual stakeholders interact.

With construction productivity an issue, there are opportunities to tighten up the construction equipment supply chain and achieve efficiencies. More collaborative relationships are the way forward, sharing best practice and adding value – rather than encouraging a ‘them and us’ attitude with suppliers, which does little to persuade them to go the extra mile. A more mature approach, with a view to creating less fragmentation in the supply chain, and a greater emphasis on getting relationships right, will require more work – but it should benefit everyone. □

CASE STUDY: PREVENTATIVE MAINTENANCE KEEPS VOLVO AHEAD

Preventative maintenance was among the keys to success in the construction equipment supply chain during road repair work in the Florida resort of North Port.

Ajax Paving Industries used the Volvo 7170 paver in its work milling and resurfacing 108,862 tonnes of asphalt, which included putting an inch-and-a-quarter of SM-9.5 overlay onto existing roads.

Supplied by local dealer Flagler Construction Equipment’s south-west Florida branch, the 7170 is fitted with the Ultimat 200, allowing paving widths of up to six metres. Due for completion in 2017, the three-year, \$46 million Road Bond Project will renew 428km of highway and include multiple bridges which had fallen into disrepair. “Our preventative maintenance technician does a full machine

inspection and we report back to Ajax if we see anything that’s a point of concern,” explains Dean Bengford, branch manager of Flagler. “Between the preventative maintenance agreements and extended warranty, we help Ajax get a better fix on operating costs and help reduce downtime.”

Dan Maitland, equipment operations manager at Ajax, says the Volvo Million Ton Guarantee initially encouraged him to look at the paver.

“I looked at the cost of ownership throughout the entire life of a paver,” he explains. “We typically run a five-year lifecycle, so about 5,000 to 6,000 hours. I track our repair costs and our maintenance costs. By my calculations, for every metre hour of runtime, the Volvo 7170 consistently outperforms its competitors.”

Ajax Paving Industries milled and resurfaced more than 100,000 tonnes of asphalt using Volvo equipment on preventative maintenance contracts.



KOMATSU DRIVES FORWARD WITH HYBRID TECHNOLOGY

Hybrid technology is now well established in the automotive world. Many car manufacturers offer plug-in, series or parallel hybrid systems, each aimed at reducing fuel consumption and cutting engine emission levels. *Dan Gilkes* takes a look at what is happening with hybrid drivelines in the world of construction equipment, and how Komatsu has been working hard to stay at the front of a fast-moving pack.

The idea is simple, in theory. In a parallel hybrid the combustion engine and the electric motor work together to drive the vehicle, while a series hybrid has an electric motor that provides all of the motive force, with the combustion engine used as a generator to power the batteries. A plug-in hybrid, as the name suggests, can be plugged into a mains source to top-up the batteries and reduce combustion engine use.

While not yet mainstream perhaps,

BELOW: Two views of Komatsu's third-generation 36-tonne HB365LC-3 hybrid in action.



hybrid technology has been available on construction equipment for almost a decade too. Indeed, Komatsu, which leads the way in hybrid machinery, started development work on its first hybrid excavator back in 1999.

The company's first generation commercial hybrid, the PC200LC-8EO, was launched in 2008. Initially for sale in Japan only, sales soon expanded to include the USA and China and when the second generation HB215LC-1 arrived in 2011, the machine was offered to customers worldwide.

The Komatsu hybrid drive system is almost a combination of both series and parallel hybrid technologies. It is based around an electric swing motor for the machine's upper structure, which replaces the standard hydraulic motor.

The machine uses electricity, stored in ultra-capacitors rather than batteries, to power the slew motor and rotate the machine's upper turret. As the motor slows and brakes, it recovers energy from the slew brake, which is converted and stored as energy in the ultra-capacitors.

There is also a generator/motor mounted between the machine's combustion engine

and the hydraulic pumps. This is used to power the ultra-capacitors when required, but also feeds electrical energy back, to assist the combustion engine. This can be to boost acceleration or to speed up the starting process.

With the 21 tonne machines, Komatsu originally applied the hybrid system to its standard PC210 excavator, equipped with the normal six-cylinder diesel engine. However, by the second generation of the machine the firm had been able to reduce the size of the engine, to a four-cylinder unit, using the hybrid technology to maintain the same overall productive output.

This resulted in the HB215LC-2 using 30% less fuel than the conventional PC210LC-8 and 20% less than the later PC210LC-10. The second generation machine also delivered a 5% saving over Komatsu's original hybrid excavator.

In 2013 Komatsu started looking at adapting the hybrid technology to work on a larger earthmoving machine, basing its second hybrid model on a 30-tonne class excavator. To start with, an HB335LC-1 was made available in Australia. Now, however, the firm's third generation hybrid, the 36-tonne HB365LC-3, has once again been made available to customers worldwide.

Where Komatsu has used the hybrid system to reduce fuel consumption by switching to a smaller combustion engine in the 21-tonne machine, the company has opted to increase productivity in the 36-tonner, maintaining the standard 202kW (217hp) Tier 4 Final diesel engine. The ultra-capacitors then provide up to 53kW of electrical assistance, to boost overall performance.



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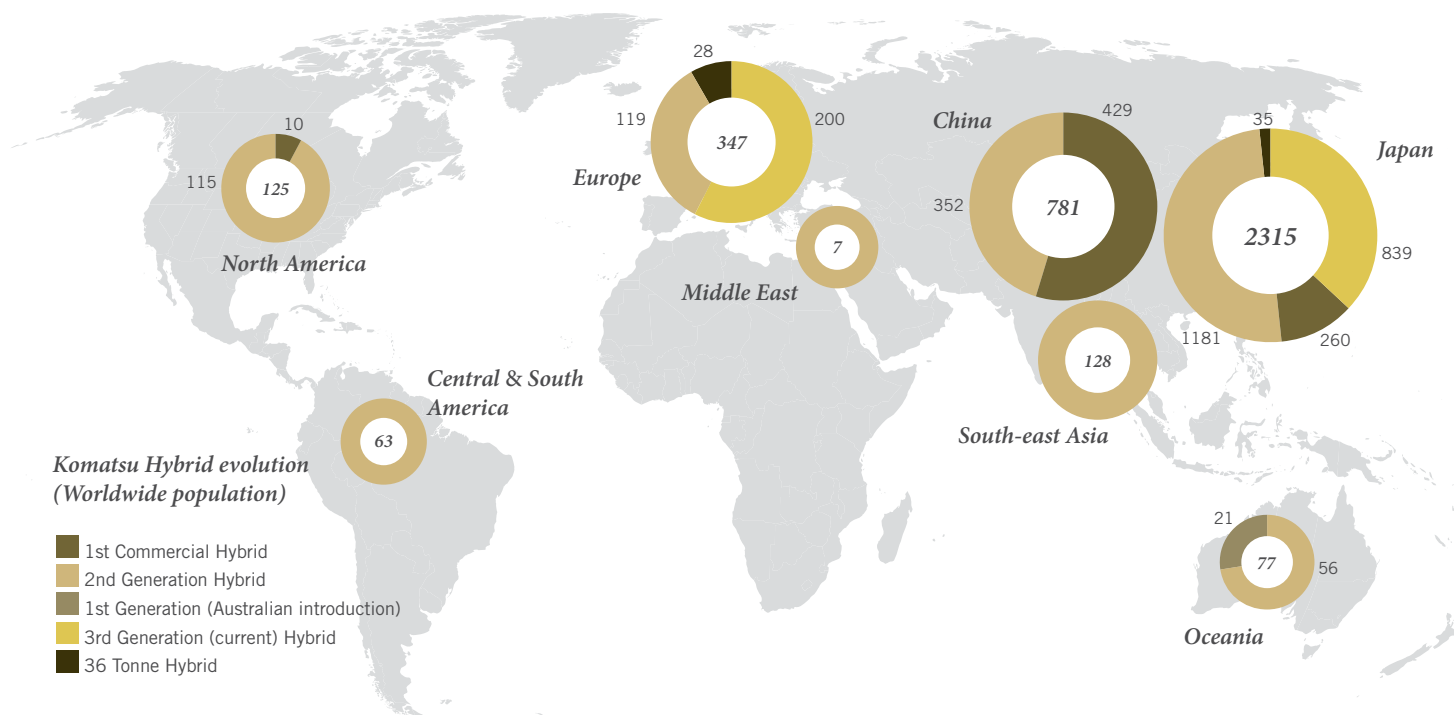


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→ It is also worth noting that while productivity was the main focus of the larger hybrid design, the fact that the electrical system is assisting the diesel engine allowing it to run at lower revs, means that fuel savings of around 20% are also possible, despite a 15% rise in productivity.

As the slew function is completely separate to the machine's hydraulic system, 100% of hydraulic oil flow can be routed to the boom and dipper arm, reducing the power required from the engine. This, in turn, has led to a cut in engine noise levels of 3dB, or around 50% given the logarithmic nature of noise measurement. As the engine is not working as hard, the machine is equipped with an on-demand cooling fan, which also contributes to the lower noise levels.

Independent rental company Hawk Plant Hire was among the first to trial the HB365LC-3 in the UK, putting the machine to work in a quarry application with customer Welsh Slate.

"We already had a Komatsu PC360 in use at the Welsh Slate quarry site in Bethesda, North Wales, and were interested to see how the hybrid would compare, both in terms of fuel usage and productivity," said Hawk Plant's national operations manager Mike Brazendale.

"At the end of the week's trial we had a rough idea what the fuel saving looked like. We were estimating around 60 litres less fuel each day, which represents a massive saving over the course of a year.

"The results are staggering. Based on an actual work rate of 87.3% the hybrid machine saved 7.9 litres per hour. Assuming an eight-hour working day and a conservative 200 working days a year, that equates to 12,640

litres per year. At current prices that's an annual saving of over £6,000 (€7,150)," he said.

"On top of that, CO₂ emissions would be reduced by a staggering 33-tonnes per year," added Brazendale.

"This test has proven just how efficient the Komatsu hybrid system can be under the right circumstances. For machines that are primarily used to load, slew, unload and slew back with very little travelling, the hybrid system operates at its peak, as hybrid regeneration occurs during slewing deceleration."

Hawk Plant Hire was so impressed with the Komatsu hybrid that the company has ordered three HB365s and 10 of the smaller HB215 Hybrid machines. The company is not alone in recognising the benefits of a hybrid drive though. To date Komatsu has sold more than 3,800 hybrid excavators around the world, clocking up more than 10 million working hours.

Hybrid product manager Koenraad Staels reports that, although Komatsu offers a five-year/10,000 hour warranty on all hybrid components, the company has yet to see a hybrid-related component failure. Unlike some competitors, Komatsu manufactures the entire machine, including the ultra-capacitors, allowing the company to control quality and ensure that the engine is always working at its optimum.

"That's one of the successes for Komatsu, as we have all our own components," said Staels.

"Our oldest hybrid machines now have more than 20,000 hours and they are all running on original components."

For instance, Komatsu purchased a 16,000-hour hybrid excavator from a customer and

stripped it down, to examine the driveline. The company said that the machine would happily have run to more than 25,000 hours without major overhaul work.

A secondary benefit for customers is that there is no maintenance required on the hybrid components, so the machine has no additional running cost or service expense. Of course there is a premium purchase price, nothing in life is free after all. However, Komatsu insists that the hybrid machines will more than pay their way.

"There is a two-year payback with the hybrid," said Staels. "After two years the customer makes a profit."

So why not adopt hybrid technology on the full range of Komatsu excavators? Well, Komatsu could equip all of its crawler excavators with the system and in time may well do so. It is also true, of course, that not all customers want to take on the new technology right now.

"Hybrid will not take over completely," said Staels.

"In Bulgaria for instance, in the 21-tonne sector, hybrid is almost 100% of our sales, but in other countries it is as low as 30%. However, we feel that customers for a 36-tonne machine are more open to new technology. Rental can be more difficult to convince though."

That said, there are plenty of major construction projects, in countries like Switzerland and the Scandinavian territories, where local authorities and governments now call upon contractors to demonstrate their environmental credentials. Hybrid technology could prove an asset when tendering for this type of contract. □

HYBRID COMPETITION

While there is little doubt that Komatsu has led the way in hybrid excavator production, there are other manufacturers in the market. Caterpillar first produced a hybrid with the 336E crawler excavator, which has since been upgraded to the 336F XE.

The 336F XE Hybrid uses Cat's standard Stage IV C9.3 diesel engine rated at 235kW (320hp). Rather than an electric slew motor though, the Caterpillar machine retains the hydraulic motor with Swing Energy Recovery (SER) technology, that captures kinetic energy during swing deceleration. This is stored in high-pressure hydraulic accumulators.

The stored energy is then released to assist swing acceleration when required, reducing the load on the hydraulic pumps and cutting fuel consumption by up to 20%.

Hitachi Construction Machinery has also been working on a hybrid crawler excavator, the ZX200-5B. This 20-tonne machine uses both hydraulic and electric swing motors. During swing deceleration the system charges capacitors, much like the Komatsu's. The ZX200-5B also has an electric motor that assists the diesel engine when required too, to reduce fuel consumption.

Hitachi's hybrid excavator is said to cut fuel use by up to 15% through the use of the firm's TRIAS-HX energy-saving hydraulic system.

BELOW: Volvo recently announced the LX1 hybrid wheeled loader prototype.



The hybrid electric system recovers energy when the loader slows

The benefits of a hybrid system seem to be greater when a machine undertakes a repetitive operation, such as digging and loading. This has led some manufacturers away from hydraulic excavators and towards wheeled loaders. In effect, loaders are much more like the automotive hybrid model, as they are constantly stopping and starting, with the deceleration used to power electric drives.

John Deere is one manufacturer that has grasped the benefits of a hybrid drive in a wheeled loader and the firm now markets two machines, the 644K Hybrid and the 944K Hybrid. The smaller machine uses a brushless generator instead of the standard machine's torque converter.

The engine runs at a choice of three constant speeds – 1,200, 1500 or 1,800rpm – making it highly efficient. Even at 1,800rpm noise levels for the smaller 644K Hybrid are just 68dB(A), which is incredibly quiet for a machine of this size.

The engine charges the electrical system through the generator, which then powers the machine's purpose-built PowerShift transmission. However, direction changes are performed by the electric motor. Deere claims that the 644K Hybrid can be up to 25% more fuel efficient than its standard loader, as well as twice as quiet.

The larger 944K Hybrid boasts a 108dB(A) external noise level and uses the electric motor to power a hydrostatic drive system with individual wheel motors. The hybrid electric system recovers energy when the loader slows. Deere is a little bit more circumspect about fuel savings, simply stating that they can be significant.

Volvo recently announced the LX1 hybrid wheeled loader prototype, which has been put to work in trials in a waste management operation in North America. The LX1 is a series hybrid that uses electric drive motors mounted at the wheels, rather than a conventional transmission and axles.

The machine also has electrically-powered hydraulics, an on-board energy storage system, a considerably smaller diesel engine and new machine architecture. Details are understandably scant at present, but Volvo claims fuel savings of up to 50% could be achieved by the hybrid loader.



ABOVE: Caterpillar first produced a hybrid with the 336E crawler excavator, which has since been upgraded to the 336F XE.

"Hybrid technology remains relatively niche in the construction equipment market"

Wheeled loader drivelines also appeal to component suppliers, with Dana Spicer already offering manufacturers the hybrid PowerBoost system. Suitable for telescopic handlers and wheeled loaders, PowerBoost captures and stores waste energy from braking, to provide a source of hybrid power to supplement the machine's diesel engine.

PowerBoost machines use a hydrostatic driveline and the system uses high-pressure hydraulic pressure cells to store energy. Dana Spicer is claiming fuel efficiency gains of up to 40% could be possible with the system.

Hybrid technology remains relatively niche in the construction equipment market. As fuel prices continue to rise, there has to come a point where contractors and rental companies can no longer ignore the fuel saving benefits on offer.

Hybrid vehicles have become mainstream in the automotive market, pushed in part by the Volkswagen diesel emissions scandal. While it seems unlikely that there will be a similar driver in the machinery sector, growing environmental concerns will have an effect on earthmoving equipment. With Stage V emissions standards expected to add yet more cost to regular combustion-engined machinery in the coming years, the purchase premium of a hybrid looks set to fall too, resulting in a rapid pay-back.

The good news is that manufacturers should be able to meet growing demand, with a range of hybrid systems under development. □

INDIAN MANUFACTURERS SET FOR INFRASTRUCTURE GROWTH

Equipment manufacturers look set for steady growth thanks to the government's long-term infrastructure strategy, writes *David Arminas*.

At nearly 3.3 million square kilometres, India is the seventh largest country by area. It is also the second largest by population, which is just under 1.3 billion, according to recent estimates by the International Monetary Fund. By 2020, another 62 million will have been added, putting increasing pressure on all infrastructure, not just highways.

With such population growth, there can be few countries, apart from China, that are in more need of better infrastructure. The central Indian government has recognised this and made infrastructure development - roads in particular - a budgetary priority.

The driver for infrastructure development is the Make in India campaign that the government launched in September 2014. It encourages multi-national and national companies to manufacture their products in India. The major objective behind the initiative is to focus on job creation and skill enhancement in 25 economic sectors, including pharmaceuticals, chemicals, food processing, bio-technology, tourism, media and - importantly - roads and construction.

If you are going to manufacture it, then

you'll have to ship it and India's road network is on the brink of a major upgrade, according to the National Highway Authority of India. The NHAI says that national highways make up about 2% of the network but account for 40% of road traffic. Last September, Raghav Chandra, chairman of ASSOCHAM - Associated Chambers of Commerce and Industry of India - said that the NHAI is focussing on these major logistics routes. A.T. Kearney, consultants, has undertaken a massive study of truck movements across all India's highways in terms of delivery times.

The Indian government's focus on infrastructure spending comes at a good time for those global equipment manufacturers that already have set up shop in the sub-continent or elsewhere in the region. As China's rate of economic growth slows down, India could be taking up the slack in equipment sales.

Off-Highway Research, a UK-based research organisation, estimates that India's total construction equipment sales will steadily increase up to 2020, reaching 63% above sales in 2015 (see table).

Sales in the Indian market will continue

to be led by six equipment types - backhoe loaders, crawler excavators, mobile cranes, mobile compressors, compaction equipment and wheeled loaders. Since 2011 they have accounted for between 93-96% of all equipment types sold. Their slice of the market in 2016 looks set to be about 94%, according to Off-Highway's latest Indian market report, published in December.*

Of all proposed infrastructure work, it will be road development that will push up future demand for equipment. While final sales figures are not in for 2016, it is expected that backhoe loaders, crawler excavators, motor graders and mobile compressors will show the biggest increase, estimated to be over 20%.

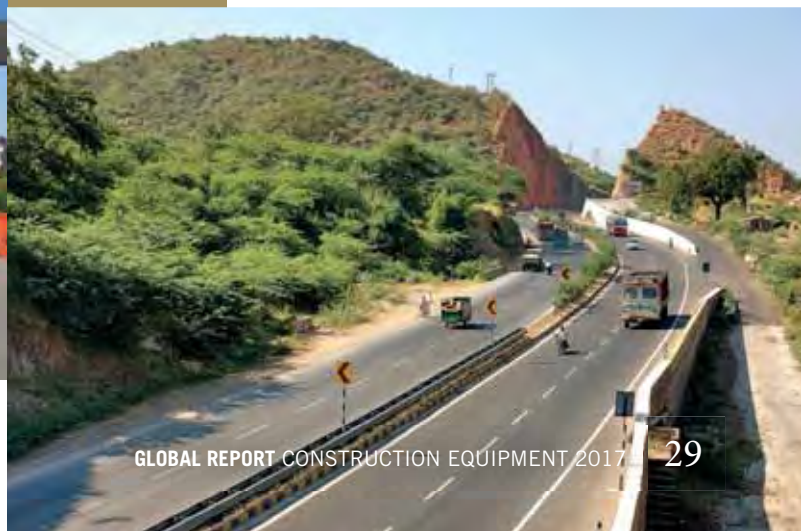
Compaction equipment sales are forecast to rise by more than 15% in 2016 and demand for mobile cranes, skid-steer loaders, asphalt finishers and wheeled loaders should rise by more than 10%.

"However, demand for crawler dozers and rigid dump trucks is expected to decline in 2016, mainly on account of low power off-



LEFT: India's road development plan will push up future equipment sales with backhoe loaders and crawler excavators up by more than 20%.

BELOW: The National Highway Authority of India says that national highways make up about 2% of the network but account for 40% of road traffic.





LEFT: Poor quality roads, especially from rail and road depots to airports and seaports, are holding back India's manufacturing sector.

"We are beginning to see a lot of interest from long-term, sensible investors back in the country"

Suresh Goyal

NATIONAL HIGHWAYS AUTHORITY OF INDIA

The National Highways Authority of India (NHAI) is an autonomous agency of the central government's Ministry of Road Transport and Highways. It manages more than 70,000km of National Highways. In late 2015, it decided to work with the Indian Space Research Organisation to prepare 360-degree mapping of all national highways by 2017. This is done using the GPS Aided GEO Augmented Navigation (GAGAN) satellite and Indian-developed Bhuvan software to explore 2D and 3D representation of the earth's surface, specifically India. The goal is to help improve timely repairs of roads as well as schedule maintenance, monitor road construction and formulate detailed project reports.

The NHAI's business arm, the NHIDCL (National Highways and Infrastructure Development Corporation Limited), was set up in July 2014 as a fully-owned company of the central government's Ministry of Road Transport and Highways. NHIDCL promotes, surveys, establishes, designs, builds, operates, maintains and upgrades national highways and strategic roads. These include interconnecting roads in regions bordering neighbouring countries.

→ take by distribution companies leading to the build-up of coal stockpiles," notes the report.

Sales of all construction equipment last year are expected to rise a massive 27% on 2015, which was up only 2% on 2014. Looking past 2016, annual sales increases for construction equipment will vary greatly up to 2020. In 2017 and 2018, sales could rise between 10-11% with a slowing down towards 2020. With India's general elections set for 2019, demand for all equipment is expected to decline marginally to 74,495 units, but is predicted to grow by 7% to 79,645 units in 2020.

The construction sector is getting ready for what it hopes will be a wave of infrastructure contracts, both large- and small-scale, as part of the central government's infrastructure strategy.

The urgency for an improved transportation network was outlined in early 2016 in a private sector study called 'The Indian Auto Industry: The way ahead', conducted by ASSOCHAM and Roland Berger Strategy Consultants. It highlighted that engineering work in India has a cost-advantage over Europe of 44%. But this is declining and could drop to 30% by 2023.

Increasing wages and poor infrastructure – from rail and road to airports and seaports – are pinching India's manufacturing sector.

"There is a need to encourage industry-academia collaborations to better understand innovation requirements [and to attract funds] from the private sector to support research at academic and research & development institutions," recommended the study. "Availability of both basic infrastructure facilities and skilled workforce can increase the scope for R&D centres in smaller cities and towns."

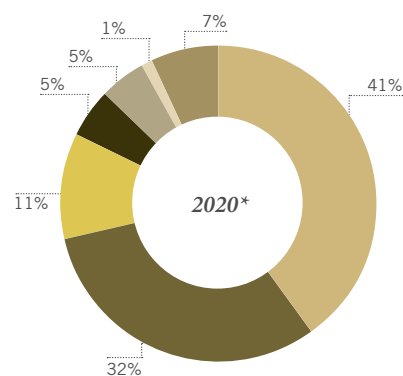
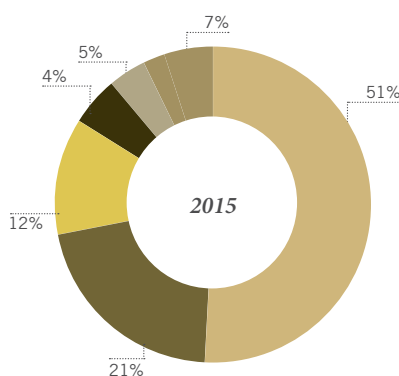
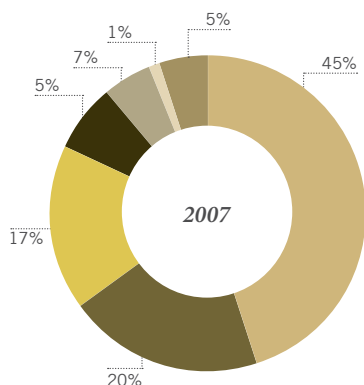
The ASSOCHAM-Berger report suggested many improvements apart from upgrades to transportation infrastructure. These included labour law reforms, the cutting of governmental red tape at central and state levels as well as creating guidance for entrepreneurship. There should be deregulation of tariffs at major ports to attract private investment, more roll on-roll off facilities, cranes and handling equipment.

The report noted: "A lack of initiatives to address India's rapid urbanisation poses a major threat for inclusive development." The study further suggested the government

Structure of sales by product 2007-2020* (% of total)

Source: Off-Highway Research (*forecast)

Backhoe Loaders Crawler Excavators Mobile Cranes Wheeled Loaders
Compaction Equipment Crawler Dozers Others





LEFT: The Indian government is keen to develop new freight corridors and logistics parks.

encourages foreign direct investment by providing benefits for special economic zones and providing tax holidays to overseas investors.

Finally, the government should develop freight corridors and logistics parks. This last recommendation means better roads are critical – particularly from the interior to coastal ports – for maintaining India's manufacturing edge over Europe and elsewhere. The government is listening as it perhaps has not done in the past several decades, according to some observers.

Prime Minister Narendra Modi marked his first year in office in mid-2015 by unveiling an ambitious strategy to improve roads. A report back then in the *Economic Times* newspaper noted that Modi had committed his National Democratic Alliance government to upgrading existing roads and constructing links to connect remote areas in the interior.

A separate so-called "religious circuit" is being planned to improve the connectivity of religious centres in an effort to boost tourism to these often remote regions. These centres include the major Sikh pilgrimage city of Nanded in Maharashtra state, as well as Katra, a small town 40km from the city of Jammu, in Kashmir state where sits the holy Hindu

shrine Vaishno Devi.

However, the *Economic Times* reported, private investment has not been very forthcoming in the sector. The ministry remains hopeful that it could start up to 45 projects using the so-called "hybrid annuity model" – the HAM contract. In such a contract, 60% of a project's cost comes from private investors and the remaining 40% in five equal instalments from the National Highways Authority of India (see box). This will need the creation of the right business environment to encourage direct foreign investment.

It is early days for the government's strategy, but optimism by construction equipment manufacturers as well as sellers of equipment may not be misplaced. Writing in April last year, Suresh Goyal, head of Macquarie Infrastructure and Real Assets, said foreign investors and the central government have learned lessons from the past 15 years. Too often, inertia kept procurement processes and construction work stalled for months at a time.

In the first quarter of 2016, government capital spending increased by 18%, while the number of stalled projects was reduced as the government makes a conscious effort to intervene and speed up key approvals

processes. "Modi is trying to fix things quickly, so we need to wait some more time until the message about change flows through," Goyal wrote. "Having said that, we are beginning to see a lot of interest from long-term, sensible investors back in the country."

It's cornerstone for attracting foreign direct investment is the US\$6 billion National Infrastructure and Investment Fund, a sign that the government is serious about infrastructure development, Goyal said.

The NIIF is structured such that the government holds a 49% stake. Cash-rich public sector undertakings and foreign investors hold the controlling stake, with each of the funds that the NIIF seeds run by external professional investment managers.

"There are scars in the minds of investors from what happened in 2013-14," Goyal says, referring to a devaluation in the currency, which, mixed with high inflation led to a rapid correction in asset valuations and the exit of capital from development projects.

Given that reforms are largely aimed at reducing risk for the private sector, their participation is set to pick up under the Hybrid Annuity Model of contract, explains Rajesh Nath, managing director of the Indian →

INDIA'S STRATEGIC ROAD MAP

- Central government plans to construct 30km of highway per day during 2016-17.
- In 2015-16, the government averaged 11km per day, totalling nearly 8,000km in the year.
- Around 350 railway bridges and level crossings will be built.
- The Sethu Bharatam project will create 150 railway bridges and 204 level crossings; several highway projects have been stalled because such bridges haven't been completed.
- The Rashtriya Rajmarg Zila Sanjoyukta Pariyojana programme will upgrade or build more than 5,600km of highway to link 123 local government centres to the National Highway network.
- Backward Area Highways programme is aimed at improving the lowest grade of roads in remote villages.
- The National Highways Development Project has identified 123 local government district headquarters not linked to National Highways. Roads to these areas will be upgraded to NH standards. Around 60% of the programme cost will come from private investors and the remaining 40% from government.
- The Bharatmala Programme will upgrade 5,500km of highway in India's border regions to boost international road connections. Many roads will be in the country's more remote north-east areas where infrastructure has suffered because of clashes between government forces and rebel groups, including the Naxalites.
- Revenue risk in public-private partnerships in areas with low anticipated traffic flow will be borne by the government.



"It is expected that NHAI will award close to 11,000km of road projects over the course of the current fiscal year and the next"

Rajesh Nath

Table 1. India: Sales and forecast of construction equipment, 2015-2020* (Units)

Source: Off-Highway Research (* forecast)

	2015	2016*	2017*	2018*	2019*	2020*	% Change 2015-2020
Articulated Dump Trucks	-	5	10	10	10	10	-
Asphalt Finishers	683	750	850	950	900	950	+39
Backhoe Loaders	21,192	24,500	26,000	27,000	27,000	28,000	+32
Compaction Equipment	2,771	3,300	3,400	3,500	3,400	3,500	+26
Crawler Dozers	391	350	450	550	600	650	+66
Crawler Excavators	11,013	15,000	17,000	19,000	20,000	22,000	+100
Crawler Loaders	6	5	5	5	5	5	-17
Mini Excavators	583	750	850	950	1,000	1,100	+89
Mobile Compressors	3,542	4,300	4,700	5,000	4,800	5,000	+41
Mobile Cranes	4,863	5,500	5,900	6,300	6,500	6,800	+40
Motor Graders	581	750	800	850	800	850	+46
Motor Scrapers	-	-	-	-	-	-	-
Rigid Dump Trucks	535	250	550	650	650	700	+31
RTLs	103	125	150	175	175	200	+94
Skid-Steer Loaders	518	575	625	650	600	625	+21
Wheeled Excavators	5	5	5	5	5	5	-
Wheeled Loaders	2,097	2,300	2,600	2,900	3,000	3,200	+53
Total Construction Equipment	48,883	58,465	63,895	68,495	69,445	73,595	51
Annual % Change	+2	+20	+9	+7	+1	+6	

→ division of the VDMA - German Machinery and Plant Manufacturers Association.

India awards road projects under three models: Engineering, Procurement and Construction (EPC) in which the government foots the entire bill; Build, Operate and Transfer (BOT) and HAM. “The Hybrid Annuity Model for national highways is clearing the way for stranded road projects,” Nath told Global Report. “While EPC was the preferred mode for highway development between 2013-15, it suffered from an inherent problem - financial resources available to the government.

“It is expected that NHAH will award close to 11,000km of road projects over the course of the current fiscal year and the next,” he said. “About half would be through HAM. This represents a distinct shift from the previous two fiscal years, where three-quarters of the about 7,200km awarded were through an EPC contract.”

While construction equipment manufacturers and rental companies can look forward to growth in the coming five years, the government said it will clamp down on the use of sub-standard used parts for repairs. In December, Girish Shankar, the government's Heavy Industry Secretary, said that in the interest of quality control and safety, legislation is coming to “discourage the

use of spurious spare parts” for repairs to off-road construction equipment.

Shankar said the government will also consider relaxing tax rules whereby Indian companies use external commercial borrowing (ECB) to finance domestic equipment manufacturing, except where manufacturing is done in a Free Trade Area. ECBs refer to commercial loans in the form of bank loans, buyers' credit and suppliers' credit from non-resident lenders. “How to improve on the input costs via financing external commercial borrowings, those things are being considered,” Shankar said.

The government is setting up centres for advanced manufacturing to explore the benefits to Indian manufacturers if they adopt Industry 4.0. The creation of so-called smart factories under Industry 4.0 for manufacturing focuses on the use of automation and data exchange, including cyber-physical systems, the Internet of Things and cloud computing. “We have already finalised one with partnership with Indian Institute of Technology Kharagpur, in the state of West Bengal,” Shankar said. □

**The Construction Equipment Industry in India: Market Report, December 2016, available from Off-Highway Research, at www.offhighway.co.uk/market-reports.asp*

PUBLIC-PRIVATE PARTNERSHIPS MAKING INROADS

By mid-2016, there were 1,270 PPP projects in India, of which 658 were related to roads and bridges, worth in total \$670 million. Projects awarded under BOT – build, operate, transfer contract model – make up 20% of the total awarded projects for fiscal year 2016.

Until 2005, the road construction market was dominated by public sector companies. With the emergence of private players over the past decade, road construction has become fragmented and competitive. Some of the major projects in this model are Mumbai–Pune BOT Project by IRB Infrastructure, North Karnataka Expressway by IL&FS and the Bandra–Worli Sea Link by HCC.

A public-private project of particular note is the 165km Yamuna Expressway connecting the cities of Greater Noida with Agra in the state of Uttar Pradesh, which is India's longest six-lane controlled-access expressway. The \$1.9 billion project opened in 2012 after five years of construction overseen by Jaypee Group under a BOT contract.

(Source: VDMA India)

SPEED BUMPS LIE AHEAD FOR LATIN AMERICA'S FAST-GROWING EQUIPMENT RENTAL MARKETS

Latin American infrastructure spending, especially in key Spanish-speaking economies like Mexico, Argentina, Chile and Peru, is big. In turbulent times, wary contractors are choosing the rental sector over up-front investment in construction equipment fleets. Construcción Pan-Americana editor *Enrique Saez* reports on the region's growing rental market.

It is essential, when analysing the construction equipment rental sector in Latin America, to divide this vast territory country by country. It is the only way to get a realistic picture of the political and economic scenarios that are driving activity across the region. For instance, in big Spanish-speaking countries like Mexico, Argentina, Chile and Peru, a boom in the construction of highways, bridges, railroads and airports is clearly pushing up demand for the rental sector. Elsewhere, things are much quieter and the pace of change is slower.

According to the results of a 2016 survey conducted by AEM (the US-based Association of Equipment Manufacturers), more than 70% of respondents confirmed that projects investing in the region's transport infrastructure are now the most important market sector for equipment rental in Latin America.

The second most important sector is projects involved in the oil, gas, dam, water and sewage markets. Mining and extraction came next followed by residential, commercial and industrial building sector projects.

And, when asked what sort of equipment is being rented, the survey revealed that the most popular categories are backhoe loaders; excavators; hydraulic crawlers; wheeled loaders; generator sets and rollers.

The study also found that Latin American rental managers are working hard to juggle market demand. Their clients want to see well-maintained and large fleets of equipment despite high levels of demand. They want competitive rates, long-term rental options



and ... surprise, surprise ... discounts. As a result, it is probably fair to say that a saturated market has kept rental rates stable up to now. However, as interest rates rise and inflation takes its toll, cost increases will inevitably start to filter through.

According to AEM, nearly two-thirds of the region's subcontractors (66.7%) are now renting to meet their equipment needs. 46.7% are renting due to a weaker economy, and a subsequent fall in business confidence, while 26.7% are renting rather than buying because they are new companies and they lack the financial muscle to acquire new equipment. It can be hard to borrow the sums necessary if the banks are jittery. And, amazingly, 20% have moved away from buying their machinery because there is a shortage of supply. Local dealers simply lack

ABOVE: According to Jose L Protoko of Caterpillar Rental across Chile, Argentina and Bolivia, it's "not about selling machines, but how to improve your business ... whether through buying, renting or leasing new and used machines. When the construction sector is healthy, the economy is healthy."

the equipment needed, or cannot get it to site on time.

So, as you can see, the true picture - as always - is a mix of things. Some countries already have an established and fast-developing construction equipment rental sector in place ... while others can see a new business model beginning to take shape. The market is changing and there are fresh options on the table. What was



RIGHT: In Mexico, Komatsu works through a local distributor to handle both construction and mining equipment. The company can see how the rental option is going to go on growing fast across the whole Latin American region as new finance options drive the business into new channels.



→ once a non-existent business model in the Latin American construction sector is emerging, and rental suppliers are creating opportunities.

For instance, Cristián Jarpa, commercial manager at Komatsu Colombia, has seen rapid growth in the country's construction equipment rental market. "There is going to be a higher demand (for equipment) than usual," he says. "Because of Colombia's 4G road building scheme, contractors are looking for different options rather than just simply buying machines. When other alternatives can be taken into consideration, buying becomes their last resort".

Germán Alzate, JCB's director for Latin America and the Caribbean, agrees. He can see a genuine growth scenario in several countries across the region ... but he is also quick to point out that in Peru and Chile, the rental channel is contracting due to the decline of the mining sector. "Many companies have an excess of equipment," he says.

For Carlos Franca, marketing manager at Case Latino America, the trend towards rental is easy to see as well, as contractors try to lower their workshop overheads. "Rental is still a good alternative for customers who prefer not to have maintenance responsibilities," he says. "The maintenance work is done by the company that rents out the equipment."

In Colombia, Jarpa explains, the strength of the US dollar is encouraging contractors to opt for options in rental and avoid buying new equipment. "I think that there are going to be a lot more opportunities for rental equipment in the future. Machines for rent have to be young, with few hours of use on the clock ... and they need to be in good condition."

Jose L. Protko, a rental expert at Caterpillar, can see the sector evolving fast: "We must not forget that many entrepreneurs enter the market by renting well-used equipment," he says, "and, in many cases, with operator services and fuel included. Then they realise that their business model is short term and that if the market matures and the rental payments become more acceptable, they can gradually incorporate used machines with fewer hours on the clock. This then allows them to finance more new machines or to rent with a purchase option included. As customers demand better services, they incorporate new and more varied equipment."

AND THE MARKET GROWS.

Credit ratings are important too. Komatsu's Jarpa believes that "it is difficult to dictate a rule," but "all options are available in terms of financing. Making timely payments is

important and I would say that in Latin America it is common to experience a certain amount of delay in getting paid."

Carlos Franca agrees, adding that delayed payments impact negatively on the market and damage the development of leasing.

Another problem, he adds, is local currency depreciation. A foreign exchange shift usually means that the rental firms are forced to renegotiate their rates and this "is not easy" ... especially "if a rate review clause has not been specified in the original contract."

Nobody wants to lose money of course, so the cost gets passed on. Rental rates go up, and future business margins are squeezed. However, this whole scenario "is a bit complex" according to Franca, "because here

SPECIAL FOCUS: COLOMBIA

Long-term projects work well in Colombia. According to Cristián Jarpa, commercial manager at Komatsu Colombia: "My experience is that the end customer never agrees to rent for long periods. There are exceptions of course, especially for large international companies that are well disposed towards rental, but local companies do not have the same sort of culture and they prefer to own their machines. However, the capital requirements on these long-term projects are so large that the rental option works just as well for local contractors as for the big multi-nationals. I would say that sooner or later, the construction equipment rental market is going to be positioned centre stage in the Colombian market whether it is wanted or not. The world is evolving towards outsourcing."

Although Jarpa believes that

the Colombian rental market "is still a very green pasture with few bidders," Victor Saldaña, Carmix Latin America's sales manager, is pleased with progress to date. He remains positively optimistic: "At one time there was no rental income in Colombia ... and now there is. This year comes with good financial prospects in Colombia and Peru."

Carlos Franca, marketing manager at Case Latino America, is a bit more sceptical. After "two years of partial prohibition," banning the entry of used equipment in to Colombia, the market has been badly affected forcing contractors "towards the purchase of new equipment. Many rental companies were not in the right position."

JCB's Germán Alzate is not so sure. He believes that the restrictions on importing construction equipment into

Colombia did not affect the majority of the country's rental market. "It can affect small companies that import used machines at low prices for renting out, because they then had to buy new equipment at a higher price ... or just not buy at all." The overall effect was negligible, he argues.

Jarpa hopes that over time the rental channel will become as welcome in Colombia as it is in many other countries in the region. "Companies are happy to rent for up to eight consecutive months," he says. Beyond that, "they prefer to buy new equipment." In Colombia, Jarpa expects 4G will significantly help to develop the rental channel. At present, the typical rental period there is 3 months.

Alzate agrees, and can see the rental sector growing fast. Saldaña believes that the focus of growth

will come from Central American countries like Nicaragua, Costa Rica and Honduras. Mexico shouldn't be ruled out either, he says.

For Protko, the rental channel continues to evolve. Latin America is still a maturing market he says. "For example, the use of time should be measured in days. The renter sells time. The equipment rented is charged in maximum hours. There are many ways to calculate rates: monthly, weekly and daily. In many cases, minimum hours are charged per period. What we have seen is that the projects have been reduced in scope and many large contractors are deciding to rent (to minimise their risk.) Super-large contractors can move machinery between countries using the temporary import legal figure. It is indisputable that the tendency to rent in our region is increasing".



LEFT: A 2016 Association of Equipment Manufacturers survey revealed that wheeled loaders are one of the most popular rental options in Latin America, along with backhoe loaders, excavators, hydraulic loaders, gensets and loaders. The AEM survey showed that infrastructure investment in highways is a key driver of the rental market.

the supply factor of the different companies is decisive." It is often more a question of getting the right machine to the right place at the right time than it is a question of cost.

At JCB, Germán Alzate sees no need for panic. The big rental companies "usually have good lines of credit," he says. And, as a result, "a currency devaluation affects the rental rate and not the credit available".

Protko is very clear on this too. "If a dealer has to buy machines in dollars and the rental rate is in a stable local currency, there is no problem. The problem arises when the dollar becomes more expensive in the local currency and it is necessary to change the rental rates, which is complicated since the customer is working and renting in his local currency. The customer, of course, does not want to feel the negative impact of a more expensive dollar. Therefore, it is important that equipment renters impose clauses in their rental contracts that establish how the fluctuation of the dollar would affect billing".

For example, says Protko, in Chile, rental rates are in UF (Development Unit), an accounting index that establishes a nominal currency in order to mitigate exchange rate volatility. "The renter must be aware that the rental rates must be in the same currency as debts or accounts payable. If the value of the dollar falls, this can lead to certain gains for the rental company," he warns, "but this should not be part of the business model".

Right across the credit front, Protko can see change taking place. "Initially, no credit was given to strangers and the process itself was unsophisticated. It was difficult to get and keep new clients. Today, the situation has evolved and, in countries such as Bolivia and Peru the municipal savings banks and credit associations are offering loans to micro entrepreneurs. These loans can go as

far as US\$300,000 for trucks and equipment purchases. These municipal funds have to be ruled by the same laws as the banks and they must be competitive if you are financing the purchase of construction machinery."

According to Alzate, "the availability of credit in Latin America is measured to a great extent by country risk. Venezuela, Argentina, Nicaragua and other countries in the region have low ratings and are regarded as high risk. This affects the availability of international resources and credits."

Until now, too many contractors have favoured used equipment over new machinery when tendering. Again, things are changing. And, as Victor Saldaña, Carmix Latin America's sales manager, points out: "During the tender process, it is more common to include the cost of renting new equipment, and of not buying used equipment." This pushes up demand of course, but Alzate believes that large rental companies are not affected because they have high levels of inventory. "These provisions may affect small rental companies, but not the larger volume companies," he says.

Franca disagrees. He thinks that currency movements hold the Latin American construction equipment rental sector back because the companies involved are forced to maintain new equipment and offer up-to-date models despite the fact that they are nearly always "required to buy the equipment in dollars" and then bring in "rental rates (are) in the local currency."

In Colombia, according to Jarpa, things are fairly stable. The number of business restrictions is "no more than what we have always seen. We must keep in mind that the works are progressing slowly. When we see tender winners with used equipment we realise that the restrictions are not so hard." Sometimes, he says, the rental company concerned has brought machinery over from Africa with a reasonable number of hours on the clock.

"It is not against the rules to deploy used machinery on a 4G road scheme," he says. "Some companies that are finishing projects will allow their machines to go on working on a new project. It is lawful and, if they comply with those terms, there is no problem."

It is not all good news though. Things remain very depressed in the mining and energy industries for the rental suppliers.

"This is a sensitive subject," says Jarpa. "Due to the drop in the price of fuel and coal, there is a large amount of machinery available at very low rental prices. Entrepreneurs who do not take advantage of this situation are blind. They have to cash in. There are a lot of machines available that were not intended originally for rent but for oil prospecting jobs, for example. Those machines are going to be used by the 4G winners as a great way to get very cheap equipment."

This is why Jarpa thinks that the future is bright for used rental machines. "There are 4G winners who are buying used machines and opening up new rental channels. And, due to the high value of currencies like the dollar, contractors are avoiding new equipment purchases." □

Entrepreneurs
who do not take
advantage of this
situation are blind

SPECIAL FOCUS: BRAZIL

Many economists believe that Brazil, the largest South American economy, accounts for 65% of the region's total GDP. But times are tough in Brazil. In a recent interview with the Brazilian Rental Equipment Association, ALEC, Marcelo Scigliano, manager at crane company Grumont, said that the Brazilian economy is still falling and there is no real sign of an end to the country's long-running economic and political crisis. However, Scigliano is encouraged by the restart of some major Brazilian infrastructure projects.

Which sector has been hardest hit? Cranes, says Scigliano ... without hesitating. The crane market is battling through the worst crisis ever known. "It is time for restructuring," he says. Things won't pick up for "at least 18 months to two years". Scigliano wants the crane sector to maximise new technology to improve product appeal. He was disappointed to see leading manufacturer Manitowoc cut back its Brazilian operations recently.

ALEC hopes that a more stable Brazilian government in 2017 (the country has been ruled by an interim government since former President Dilma Rousseff was impeached in 2016) will boost both the construction and rental sectors. "Hopefully, the inauguration of a new government and the continuity of the country's economic team will be of great help," says the association, adding that it hopes "recession will not turn into a full economic depression. Everything depends on political and economic stability in the months ahead."

WHAT IS COLOMBIA'S 4G ROAD BUILDING SCHEME?

Colombia is now well underway with what is known as the fourth generation (4G) road concession programme, which is a major public-private investment initiative.

According to a recent report from the Oxford Business Group (OBG), "work on designing the programme first began in 2011. The first 4G concessions were awarded four years later in 2015, with the first construction work commencing in November 2015.

Luis Fernando Andrade, president of the National Infrastructure Agency (Agencia Nacional de Infraestructura, ANI), says that the programme is designed to resolve Colombia's long-standing deficit in road transport infrastructure and reduce its high logistics costs, to help make the economy more competitive. He has calculated that 4G could add 1.5 percentage points to Colombian GDP growth during the construction period, create 200,000 direct jobs and cut the unemployment rate by one percentage point."

OBG goes on to say that "A key feature of 4G is its size." Some sources say that total investment in the programme could be as much as COP50trn (\$18.4bn) over seven years, while banking association Asobancaria calculates the amount of pre-construction and construction investments to be COP36.7trn (\$13.5bn) which, it points out, is 2.7 times greater than the cumulative total invested in the first-, second- and third-generation road building schemes that preceded it. The programme should have a major impact on Colombia's macro-economy.

Daniel Velandia, chief economist of Credicorp Capital, said, "We expect a rebound in 2017 because of the 4G projects. The government is auctioning 26 projects with a capital expenditure of COP30trn (\$11bn), and we expect them to be executed in three to four years and to impact positively on the economy."

According to Andrés Escobar Arango, the deputy minister of finance, bank lending of up to one-third of the total value of 4G investments could be required. Asobancaria also sees the programme boosting GDP growth, although its calculation differs slightly from that made by ANI – it expects an extra 0.4 percentage points of GDP growth on average during the lifetime of 4G in 2015-22. Mauricio Cárdenas, the minister of finance, said in December 2015 that in the first and second waves of 4G auctions, a total of 18 concessions had been awarded, and of those, six had closed their financing arrangements. In the third wave two public sector projects were being auctioned and nine private sector initiatives were awaiting Ministry of Finance approval. Cárdenas said infrastructure investments like these would be "the engine of the Colombian economy in 2016".

Major challenges for Colombia in getting the 4G programme up and running were instituting new concession models and raising enough finance on the markets to prime the pump. OBG says that "the basic (concession) model for the 4G programmes is that the investment costs will eventually be recovered from toll road revenue over the lifetime of the concessions. Contractors

will go through a bidding process, and those whose project plans offer the lowest level of public sector funding are most likely to be selected, but this is not the only criteria. Major efforts have been made to attract initial capital to set the projects in motion. The Ministry of Finance has offered up to COP5trn (\$1.8bn) in financing to attract foreign companies into the bidding process. New legislation allows Colombia's pension funds to invest up to 5% of their total assets into 4G project finance debt funds, which Andrade described as "a really interesting mechanism to provide long-term money at reasonable cost". Most recently, in January 2016 the Colombian government sold its controlling stake in the power company Isagen for \$2bn in order to provide funding for the infrastructure investments. It is Colombia's biggest move to privatisation in a decade.

According to OBG, this has been "an important change" and "the way in which the government approaches 4G has had a big impact on the involvement of local banks. In the past, contractors who had won road-building contracts received upfront payments from the government, which were criticised as a source of inefficiency and potential corruption. Now, payments flow at a later stage in the project life-cycle, and are conditional on meeting delivery dates and quality standards.

The 4G concession holders are therefore required to cover 20-30% of the overall capital requirement themselves, by raising bank credit or equity capital. They are also supported by a new development bank, the Fondo de Desarrollo Nacional (FDN) which provides subordinated loans to the projects for up to 15% of the total cost. This is designed to reduce the equity capital requirement and to give the banks a greater cushion against their loans. FDN was set up in 2014 with capital contributions from the government and multilateral agencies."

Another challenge, says OBG, is that "the banks and the construction companies have continued to debate the terms and guarantees required for 4G loans. In many cases the banks are now lending to a 4G



LEFT: Total investment in the programme could be as much as COP50trn (\$18.4bn) over seven years.

project or consortium rather than to an individual construction company, which has required a new set of legal contracts. There were some delays in the launch of the bidding for 4G projects, with Rupert Stebbings, director of equity research at Bancolombia, commenting, "The financing was always going to be complicated given the enormity of the projects." In effect, the size of the loans concerned, combined with the financial difficulties encountered by Conalvias, a major construction firm with cash-flow problems that had to reschedule its debts, led the banks to adopt a cautious position, asking construction companies seeking loans to make provisions against possible cost overruns.

In November 2015 Asobancaria said it was recommending some modifications to 4G regulations, such as allowing construction companies to have a higher proportion of bank debt relative to the total value of projects. One way this might be achieved was by applying the 25% upper limit independently to each project, and not in a cumulative fashion.

Asobancaria was also calling for clarification of legal guarantees and "step-in" rights, where contracts may be taken over if a contractor fails to meet its obligations. Asobancaria also wanted greater certainty on loan disbursement dates, and suggested that loan payments should only commence after all environmental permits and approvals for

a project had been issued." And, "while 4G presents the banks with a major source of business, a key challenge will be to ensure that sufficient finance can be raised, and that risks are adequately managed. ANI has estimated that eventually between 35 and 40 4G concessions will have been allocated by the end of 2016.

The real test is whether enough projects are well-structured. It is encouraged, however, by the involvement of international banks such as the US's Goldman Sachs, Japan's Sumitomo, Chile's CorpBanca and Spain's BBVA in some of the agreed projects. Analysts say there will be more international involvement in 4G than in any other previous infrastructure scheme." □

WHO ARE THE MAJOR PLAYERS?

Power generation specialist hirers like Aggreko, APR Energy, Soenergy and Sullair all have leading positions in the Latin American construction equipment rental sector. They are followed by general equipment rental firms like Mills, Ouro Verde, SK Rental and Komatsu, all of whom offer earthmoving and lifting equipment. Some companies offer a very diversified portfolio, such as Maquinas Diesel.

The economic situation continues to be challenging for these big players. For instance, ... Aggreko, probably the largest worldwide rental corporation operating in Latin America, stated in its Q3 2016 report that "the payment situation in Venezuela continues to be very challenging. However, discussions with both our customers are regular and constructive, and we have had success in getting some of our overdue invoices converted into a debt instrument". In Argentina, where Aggreko has been operating since 2008, the company works through two types of contract: fixed (270MW) and fixed (180MW) ... both of which are due to expire in June 2017. Then it will be time for another review of how to make the rental equation work.

Brazil-based Ouro Verde is one of the largest equipment rental

companies in the region. During the first nine months of 2016, the company invested heavily in expanding its fleet, spending US \$66.2 million, which represented a 32% decrease compared to the same period a year before. It has a rental fleet of 29,397 machines at Ouro Verde and Finame (the Brazilian Government's financial arm) is a major lender to Ouro Verde. In order to qualify for those loans, the equipment must have 65% of its components manufactured in Brazil.

Komatsu, a mayor player in Chile through Komatsu Cummins Chile Arrienda, recently announced that "in Latin America generally, demand for construction and mining equipment was sluggish." However, "mainly in Brazil, sales of mining equipment increased." There was also a jump in the market for "super-large dump trucks to major mines in Peru, which improved sales, on a local currency basis, from the corresponding period a year ago. However, as the Japanese yen appreciated, the first six-month sales decreased year-on-year".

Finning, Caterpillar's biggest dealer group worldwide, announced in Q3 that "South America achieved significant improvement in adjusted ROIC (1)(2)(3) driven by sustained

profitability and reduced invested capital. Revenues in South America declined by 9%. However, equipment rentals for that period saw an even sharper fall of (29%) compared to the same period in 2015. The overall reduction for Jan-Sept 2016 was (24%) to a total revenue of US\$170 million."

In Peru, Ferreyros, which has been the country's leading Caterpillar dealer since 1942, revealed that their market was in overall decline last year as well. The group, which has a rental fleet of 1,360 units, reported a revenue drop of (29%) in 2016 Q3 due to a contraction in the Peruvian construction industry.

"Without a doubt, Ferreyros is one of the pioneers in the Latin American rental market," says Cat's Jose Protko, "along with other companies such as Ramirez in Uruguay." And, "Sullair in Argentina has also been a major player since 1987. Mills Rental in Brazil and other family-owned companies have been working in rental with excellent results. Baja Rental in Mexico is a good example. All of them, and Unimaq/Rentando especially, are the creators of the rental channel in Latin America".

He wants to see them all go on flourishing. After all, he says, "when the construction sector is healthy, the economy is healthy."



THE GLOBAL BITUMEN MARKET IS BEGINNING TO THINK BIG

The transformation of bitumen supply from a local to a global operation continues. But the true implications of these changes are yet to be fully understood further down the chain. By *Kristina Smith*.

In February 2016, oil company Vitol and bitumen transportation and trading company, Sargeant Marine, announced the launch of a new venture, Valt. With hubs in Boca Raton in Florida, Geneva, London and Singapore, Valt expects to move around 1.3 million metric tonnes of bitumen every year.

With 14 dedicated bitumen vessels, Valt can lay claim to the largest such fleet in the world. And among that fleet is the 37,000-tonne Asphalt Splendor, the world's largest specialist bitumen vessel which was built on the Yangtze River in China and delivered in late 2015. A sister ship is reported to be on order this year.

Valt is thinking big, which in today's bitumen market makes sense. Refineries producing bitumen are fewer and hence must have a higher output. The distances bitumen must travel are getting greater, vessels are getting bigger and so are the ports and storage facilities that receive them.

While some oil companies have abandoned bitumen, employing new technologies to create higher-value products from the residue left over after the refining process, others such as Vitol and Shell are embracing it. Shell now has nine bitumen manufacturing facilities and 25 terminals around the world.

"We have taken a conscious decision to continue to produce bitumen, focussing on nine refineries around the world – 'mega refineries' in terms of bitumen - which produce at least 1m tonnes of bitumen a year," says Professor John Read, general manager specialties technology for Shell Bitumen.

Though global volumes of bitumen have traditionally remained steady at around 100m tonnes, researchers seem to agree that the global bitumen market is now



growing. According to a report published in August 2016 by Persistence Market Research, 'Bitumen Market: Global Industry Analysis and Forecast 2016-2022', global consumption of bitumen between 2016 and 2022 is forecast to grow by a compound annual growth rate (CAGR) of 3.2% with global sales revenue expected to grow at a CAGR of 5.2%.

Paving grade bitumen dominates global consumption, accounting for around 75%. Much of the growth is attributed to more roads being built in developing countries such as China, India, Russia, Brazil, Asia Pacific and Latin America. Developed regions such as the US and the Middle East will also see a rise in bitumen consumption over the next five years as infrastructure is built and renewed.

ABOVE: *Asphalt Splendor is the world's biggest specialist bitumen vessel. The 37,000 tonne vessel carries bitumen for Valt, a newly formed venture between oil company Vitol and transporter Sargeant Marine.*

GROWING OPERATIONS

In the US, last year saw ExxonMobil ramping up production of bitumen from oil sands as it completed an expansion project at its Kearl oil sands asset in Alberta, US. The facility can now produce 110,000 barrels per day, double its previous output and the plant employs newer technology which reduces operating costs, energy usage and environmental impacts, according to ExxonMobil.

Trafigura subsidiary Puma Energy has also been robustly expanding its bitumen operations over the past few years, growing its fleet of bitumen vessels from seven in early 2015 to 11 today. "We see a definite upward trend in the number of nautical miles for

Developed regions such as the US and the Middle East will also see a rise in bitumen consumption

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ABOVE: Nynas re-opened the Harburg refinery in summer last year, having acquired it from Shell and converted it into a speciality oil refinery, producing bitumens and naphthenic oils.

→ bitumen,” Valt chief commercial officer Nick Fay told the Financial Times. “All the new refineries that are getting built don’t make bitumen.”

Demand in Europe is picking up too. Nynas’ Harburg refinery in Hamburg, which it had acquired from Shell five years earlier, opened for business last summer.

Nynas converted the Harburg facility into a speciality oil refinery, producing naphthenic oils as well as bitumens. As Nynas’ first bitumen refinery in Germany, Harburg will supply a wide range of penetration bitumens to its home country, Switzerland, UK and other Western European countries.

“Our intention is to supply most of the European market,” said Mario Jentzsch, sales manager bitumen Western Europe for Nynas. “There have been lots of closures of refineries in Europe so bitumen has to travel a longer distance. At Harburg we are right on the water so we can go by ship or rail to reduce the number of trucks on the road.”

Total has been looking at a new way to approach logistics: it has been trialling an online bitumen buying application developed and launched in its home market of France around a year ago with plans to roll it out across Europe. Bitume Online allows Total’s customers to buy bitumen online at a fixed price – effectively bitumen hedging – to give suppliers and contractors cost certainty for up to two years.

Although bitumen only makes up around 5% of the materials in an asphalt mix for road construction, its cost is significant. The price of bitumen can fluctuate significantly, leading to increased risk, especially for suppliers involved in longer-term contracts.

Last year also saw Total open its biggest-ever polymer modified bitumen (PMB) plant in Arnay-le-Duc in France, with a production capacity of 30,000 tonnes a year. The plant is producing a range of PMBs under the Styrelf brand, tailored to different applications: Styrelf ECO2 for warm mixes, Styrelf IntaKt where improved resistance to hydrocarbons is needed, Styrelf GO for racing tracks and Styrelf RC for use with recycled aggregates.

“Styrelf RC is probably the most important,” says Agnès Villautreix, head of communications for Total’s bitumen business. “We used to have between 10 and 20% of recycled material in a mix; now with new grades of PMB we are able to have 90 to 100 %.” Total is working with Colas, Eurovia and Sanef to develop these applications.

“The new plant is very flexible, so that we can adjust the product,” says Villautreix. “There is an opportunity with PMB to formula to meet the needs of the customer. Over the past few years we have been evolving our service to work more with our customers.”

DIVERSIFY TO SURVIVE

It is not just the bitumen suppliers that are getting bigger. Further down the production chain, manufacturers of PMB and bitumen emulsion plants are also finding that they need to expand.

“If you stay in this area of business, it is not easy to survive,” says Hugo Guimarães,

CEO of WeedsWest. “We are all fighting for the same market and it’s not a big market. Big companies are not buying emulsion plants: they buy one and then maintain it.

“You need more than just bitumen emulsion plants. If you are developing equipment, you need to invest a lot. If you don’t have the sales, you cannot pay for the technical development.”

In order to offer its clients more – and up its turnover – WeedsWest has spent the last couple of years expanding its activities through acquisition and partnerships. In 2014 it acquired structural steel company Laurel and has set up an agreement where it distributes Siefert Trigon Mills.

At the end of 2016, WeedsWest established a commercial agreement to act as a worldwide distributor for a firm called Jotex which specialises in a range of equipment, including bitumen emulsion distributors and sprayers, chip spreaders and asphalt maintenance and service equipment. At the same time it announced a new venture in partnership with Bitubag, B2bag Logistics which aims to provide transport and logistics services between refinery and job site.

Italian bitumen technology and PMB plant expert Massenza also expanded its operation through acquisition last year, becoming a majority shareholder in Polish firm Strassmeyer, which produces a range of equipment including jet patchers, surface repair machines and crack sealing machines. “We are now starting to promote the brand through our network of agents which covers almost 100 countries in the world and we have started the process of integrating the new range of products into the Massenza line,” says Massenza director Diego Massenza.

Having grown significantly until 2006, Massenza’s turnover has remained stable since then. Diego Massenza’s ambition now is to double the turnover of Strassmeyer over the next five years.

MORE RAP PLEASE

Over the 40 years that used asphalt – or recycled asphalt planings (RAP) – have been employed by the road industry, there has been a shift in the reasons for its use. For many years it was contractors and materials producers who were looking for savings in materials costs; today there is political pressure to reduce carbon emissions and also to be seen to be green.

The proportion of RAP used in mixes varies considerably between countries. Those with few aggregate resources – or a keen appetite for sustainability – lead the way.





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→ According to Lars Forstén, director of research, development and innovation for Lemminkäinen Infra who chaired a session on recycling at the Eurasphalt and Eurobitume 2016 conference in Prague last year, the world's highest recyclers are Luxembourg, the Netherlands and Japan using over 40% RAP. Forstén also identified Belgium, Denmark, Finland, Germany and Italy as enthusiastic recyclers, using between 20 and 30% RAP in their mixes.

Many bitumen technology companies are looking to ride the wave of political support for recycling with solutions which they say allow higher and higher proportions of RAP to be used. One such firm is Arizona Chemical, a subsidiary of Kraton Corporation, which created its Sylvaroad RP additive from chemicals produced from pine trees as a by-product of the paper manufacturing industry.

"Sustainability and support for a circular economy are growing objectives around the world," says Maria Di Nolfo, business unit manager, roads & construction for Arizona Chemical. "There's a general attention to recycling and environmentally friendly products; the challenge is of course not compromising the performance."

The idea behind a circular economy is that materials and products are kept in use for as long as possible, getting the most value out of them as possible and recovering and regenerating them at the end of the cycle. Often old asphalt is re-used, but at a much lower value level, for paving farm roads for instance which some people see as a waste of resource.

"With our bio-additive, reclaimed asphalt can be used in higher value applications, for example in the top layer pavement," continues Di Nolfo. "Thus, the asphalt not only is recycled, but there is an economic advantage in how it gets reused."

One of Arizona Chemical's latest trials with contractor Eurovia in France looked at trying to recycle very hard RAP, which would normally be used only in the unbound sub-layers of the road, to be used in the upper layers of a road. RAP from the Niort region was sprayed with Arizona's Sylvaroad RP additive and added at a proportion of 40% to an asphalt mix and then used to repave a local road. The pavement was successfully laid and meets the required performance specifications. Ongoing measurement and observation will reveal how it fares in service.

Bio-additives, such as Sylvaroad RP, are a growing area of interest for many researchers and companies. US corporation Kraton's



acquisition of Arizona Chemical, completed in January 2016 underlines this interest. "Given the renewable nature of Arizona's product and technology offerings, this complementary growth can be accomplished while reducing our overall exposure to hydrocarbon-based feedstocks," Kraton's president and CEO Kevin M. Fogarty said in a statement released as the deal was sealed.

Some are looking to go even further in the treatment of RAP as a valuable product rather than a waste material to be down-cycled. Contractor BAM, in a research project carried out with the help of a grant from the European Commission's LIFE+ programme, has been breaking RAP down into its constituent components and treating them to try and achieve close to 100% re-use, made at lower temperatures to be used in the wearing course of a road which delivers reduced noise emissions.

BAM's Low Emission2 Asphalt Pavement (LE2AP) process includes separating the stone and mortar from recycled asphalt, heating and treating it to get binder with a constant proportion of bitumen, foaming the mortar and mixing with the stone which has been heating. According to BAM, the decomposition process means that there is control over the mixture's composition and hence, performance.

To date BAM had produced a 60,000 kg batch of porous asphalt containing nearly 95% reclaimed materials and produced at 100 degrees C at its Brabant Asphalt Plant in the Netherlands. The next step will be the production of a 1km-long stretch of demonstration project incorporating two layers of porous asphalt, some of which will contain between 90 and 95% recycled materials.

RECYCLING FOREVER

So can we just keep recycling forever? Not without a better understanding of what we are actually doing, says Shell Bitumen's Read.

"There are some critical questions that need to be answered," says Read. "At the current point in time, most people are going

ABOVE: *Appetite for bio additives is growing: Arizona Chemical's SYLVAROAD RP aims to allow higher percentages of RAP.*

along making the assumption that we can recycle asphalt ad infinitum. I don't believe that's true. In my working life, this may not be an issue, but for the next generation we could be creating a terrible legacy if we continue to recycle and recycle.

"If you look at the chemistry of the asphaltene that are created during ageing, they are very different to the ones we create when we age mixes in the laboratory to see what the effects of recycling might be."

Read says that most people, when using recycled material, carry out 'viscosity blending': recovering bitumen, measuring how hard or soft it is and adding elements until the right viscosity is reached.

"It's not the same as virgin bitumen, even if it has the right viscosity," says Read. "We need to understand this far better. How many times can we recycle? We need to either put a marker into the asphalt so that we know how many times it has been recycled or we can measure the uptake of oxygen in the asphaltene and when it reaches a certain percent, we can't recycle anymore."

"Sustainability and support for a circular economy are growing objectives around the world."

Maria Di Nolfo



→ Read also points out that recycled material can be difficult to come by. "There are not piles of it lying around," he says. "It's either all been used or sold to make self-binding farmers' tracks."

It would seem that successful recycling strategies require an organised and scientific approach to the re-use of road paving materials. In the future national and local road agencies will need systems that allow them to plan and link up all their road building and road maintenance activities so that RAP is earmarked and used at its highest possible value, depending on its life and characteristics.

NEW STANDARDS NEEDED

The new world order for bitumen production and distribution, recycling and modification, has repercussions all the way down the

supply chain. Bitumen is no longer a material produced in a single process and then distributed and used locally. It is now often blended from a range of sources, modified through the addition of polymers, and mixed with older binder as materials from existing pavements are re-used.

However, while large-scale, international specialists are emerging at the start of bitumen's journey, at the pavement-laying end of the process, it's largely business as usual. The vast majority of roads are not main highways built by national and international contractors, they are secondary and smaller loads, constructed by small, local contractors.

At this end of the scale, most specification and standards are well-established, created at a time when bitumen supply was a local affair and variations in mixes and mix types

were far fewer. Performance-based testing, as pioneered in the US and now spreading round parts of the world, is a step in the right direction, says Read, but doesn't take us far enough:

"There is a need to move towards performance testing everywhere," he says. "But beyond that we really need to re-evaluate and re-calibrate the performance tests with the materials of today in order to ensure that the limits we are applying are appropriate."

The impact of getting it wrong could be that roads fail earlier than expected, wasting resources and damaging local and national economies. Conversely, we could be over-engineering roads, again wasting resources and limiting our ability to build and maintain roads. □

DRIVERLESS CARS DRIVE CHANGE

In November last year, a modified E-class Mercedes-Benz car made the 125km journey from Dubai to Abu Dhabi without the driver having to use the steering wheel, brakes or accelerator. The driver's only task was to switch on the indicator when he wanted the car to change lane.

In the UK, national road authority Highways England was preparing to begin trials on dynamic charging of vehicles late last year, using wireless power transfer technology for electric and hybrid vehicles. Meanwhile, Korea has already deployed dynamic charging for buses in five locations, most recently in the new Sedjun City.

These two trends, together with a move from ownership to sharing of cars will change how roads are used and constructed, according to Dr Thierry Goger, secretary general for the Forum of European National Highway Research Laboratories (FEHRL): "These three things will be at the centre of a big revolution. At the moment we are only just realising the way mobility will be changed. We may put more vehicles on the same area of road or we may reduce the size of the road and use part of it for other purposes."

Goger predicts that the roads of the future will be self-healing, pre-fabricated and with the ability to power and harness energy. Connected cars – which can receive, collect and communicate all sorts of data – are likely to be with us before totally automated vehicles. Think of all the information about the condition of the roads that will be available, how it could be used, and what that means for the road owners.

Tomorrow's roads will no longer be purely surfaces for vehicles to drive over, they will be multi-functional. Some materials suppliers are already coming up with solutions that meet this new brief.

Colas has developed Wattway, a means of retrofitting photovoltaic panels onto roads, which requires a special clear resin to coat the panels. The result of five year's research and development with INES, the French National Institute for Solar Energy, Wattway has now been laid on its first road in the village of Tourouvre-au-Perche in Normandy, France.

Shell Bitumen has a number of technologies to make roads do more, developed a number of years ago and waiting for the



Shell imagines a world where roads make electricity, glow at night and soak up pollution.

right political environment to turn them from R&D to reality. These crossover technologies include conductive asphalt which harvests and conducts electricity, phosphorescent asphalt which lights up at night, active asphalt and slurry surfacing which do away with PM10 particles and nitrous oxide respectively.

Strict demarcation between government departments dealing with transport, energy and

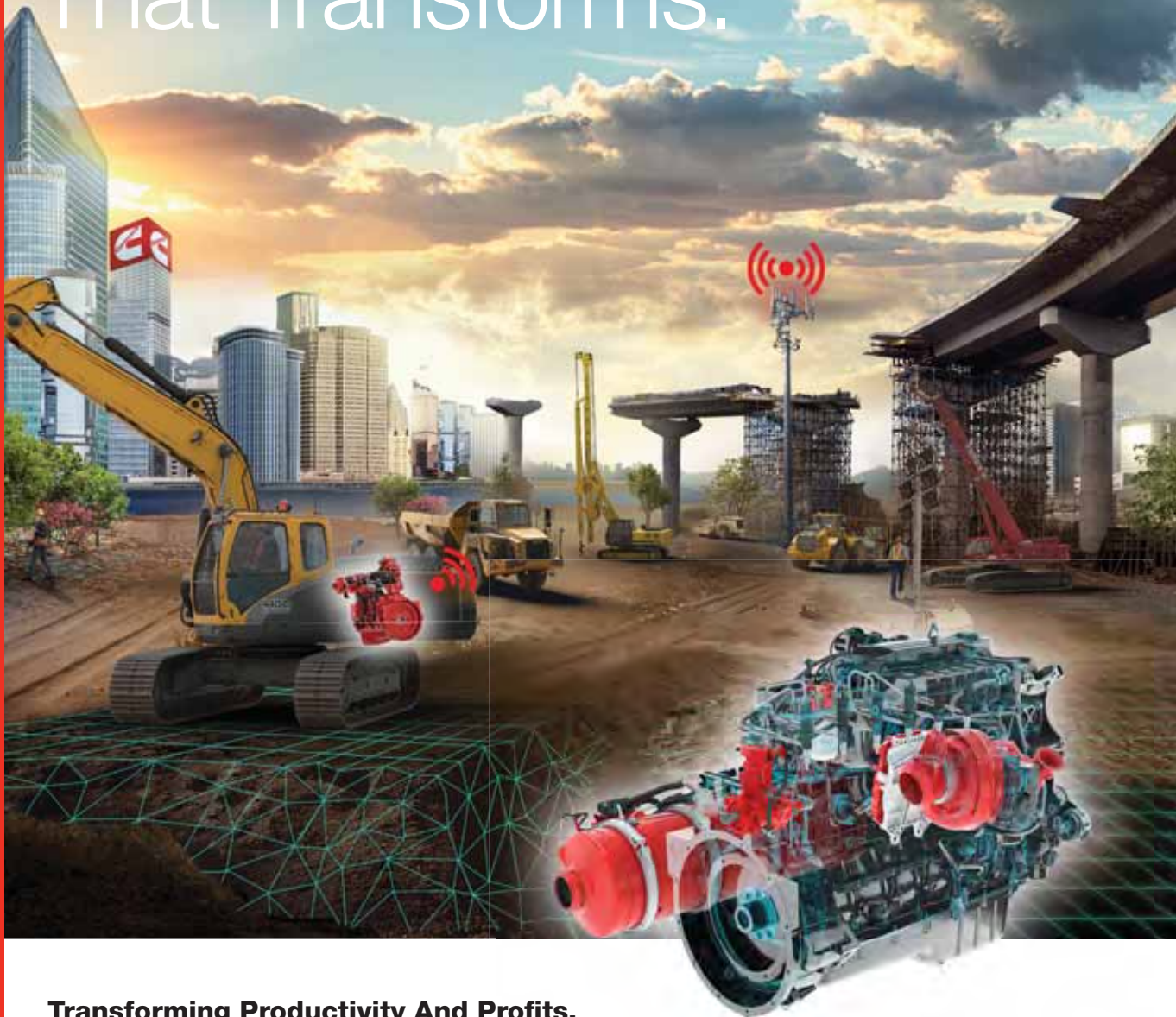
environment mean that no one has had the appetite to try out these new ideas. But this could change.

"The needs of society are changing," says Shell's John Read, who is also professor of pavement materials at the University of Nottingham. "The way we currently tender and procure our contracts has got to be looked at and some mechanism developed that genuinely allows new technologies to be proposed and adopted."

Highways England is preparing to trial dynamic charging of vehicles to push forward its plans for 'electric highways'.



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CUMMINS UNDERSTANDS HOW TO UNLOCK THE POWER OF DATA

The world we live in is changing – the way in which we understand and use data is advancing at a rapid pace. In no area is this more evident than in the automotive sector. Data is transforming the automotive industry to enable greater efficiencies, cost savings and improved safety. **Lori Cobb**, vice president of connected solutions for Cummins, reports on advanced diagnostics.

Commercial vehicles around the world are harnessing billions of pieces of data every day, and analysing everything they do in order to reduce the impact of maintenance, to improve logistic planning, to provide better route guidance and to understand driver behaviour.

The need for ever-increasing levels of efficiency and reduced downtime is driving rapid growth in the use of connected technology ... and not just with large fleets, but with mid-sized operations and small owner-operators too.

The construction sector is seeing the same demands for increased efficiency and reduced downtime. The diversity in types and size of machines from multi-storey cranes to small purpose-built machines or utility equipment is a major challenge. OEMs (original equipment manufacturers) like Cummins are working hard to develop robust solutions which can be tailored to this wide variety of machines.

Connected data gathering is becoming a vital part of the whole construction and mining chain. The equipment used in these two massive global industries is often located in remote areas, which drives challenges for telematics-driven maintenance and repair solutions. Indeed, servicing and repairs are often performed on site in dirty and difficult locations because, in many cases, the machine cannot be transported to and from the site efficiently.

As a result, being able to remotely diagnose a fault the first time is key to ensuring the right tools, parts and technician skillset are brought onsite to reduce the impact on a customer's operation. Downtime is minimised.

The key to having a correct diagnosis comes down to the process of interpreting data, starting with fault code interpretation. A simple blinking light in the cab is not enough to stave off operator confusion about what to do next. By leveraging manufacturer expertise, the confusion can be eliminated in order to provide clear direction, actions, and recommendations to the operator that prevent downtime and maximise productivity, even when faults occur.

Interpretation is the key.

BELOW: *Hand-held devices are becoming a more viable solution. They can be hooked up to the machine's data bus, with processing done over a Bluetooth link. Once the connection is made, the device can instantly access maps and service knowledge to optimise locations and uptime throughout the day.*

DATA STREAMS HAVE THE POWER TO FURTHER UNLOCK PRODUCTIVITY

Telematics solutions essentially provide three main benefits for the construction sector and other off-highway markets. These include: reducing capital cost through optimised maintenance; minimising progressive damage; and providing prognostics to prevent a fault developing.

REDUCING CAPITAL COST

The key to reducing capital cost is extending the life of the equipment between overhauls. Progressive damage occurs when maintenance techniques are improperly applied or recommended service intervals are ignored. This can dramatically impact the effective life of the machine.

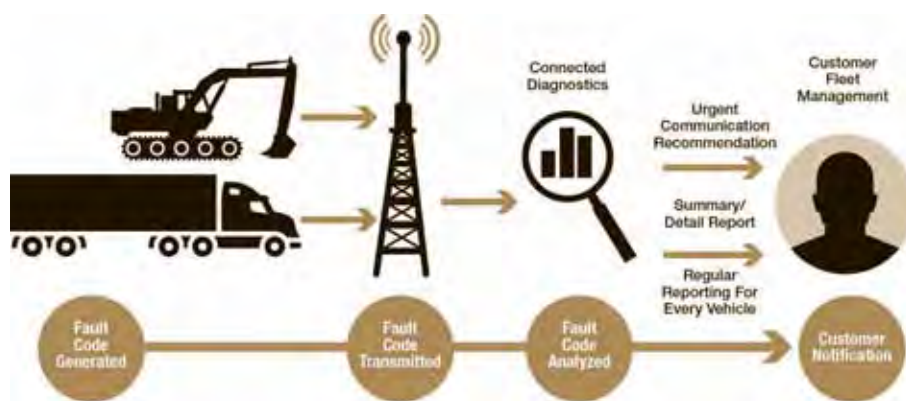
Using data to drive OEM maintenance recommendations, and fixing issues as they arise, significantly reduces the possibility of progressive damage, resulting in longer





LEFT: Contractors are getting more and more focused on using data analytics to improve equipment performance. Over the next few years, “the exponential awareness of this need will drive the desire for greater connectivity to improve asset utilisation and uptime,” says Cummins.

BELOW LEFT: Commercial vehicles around the world are harnessing billions of pieces of data every day, and analysing everything they do in order to reduce the impact of maintenance, to improve logistic planning, to provide better route guidance and to understand driver behaviour.



equipment life and lower distributed capital cost.

Equipment data can also be used to reduce capital costs by analysing idle mapping data to reveal any inefficient uses of the equipment. In some cases, inefficiencies can be quite expensive in terms of wear on the machine and fuel use.

By using this sort of data, a contractor on site can immediately see areas where inefficiencies or safety issues are occurring, and action can be taken. Furthermore, it is possible to make site-to-site comparisons and unit-to-unit comparisons in order to optimise across construction sites. If you can measure it, you can manage it.

MINIMISING PROGRESSIVE DAMAGE

A sizeable percentage of unexpected failures can be identified early. If addressed, progressive damage can be prevented and the time to repair typically reduced. Additionally, if parts are saved through early-failure intervention, unplanned expenses drop off.

Examples of this include the prevention of a failed camshaft from a stuck injector on a haul truck, or avoiding damage on the engine bearings by addressing the improper performance of the lubrication system when oil pressure falls during an operation.

PROGNOSTICS TO PREVENT FAULTS

As manufacturers continually acquire data on what faults are occurring and the circumstances of those faults, it becomes possible to predict and and pre-empt faults.

Predictive capability is when emerging issues can be identified ahead of the standard detection time, providing ample opportunity to take action and minimise impact on the operations.

This predictive capability, or prognostics, can have some of the greatest benefits for the off-highway market. Prognostics are characterised by processing the data streaming from the equipment with smart algorithms and providing early warning of impending failures.

When the data is close to real time, significant failure prevention has been proven. However, not all failures are directly related to faults, so a certain amount of expertise must be applied to determine the reasons behind the identified trends.

When the systems do indicate a reason for concern, processes are put in place to take action at an earlier opportunity, often avoiding unplanned expense and downtime.

Predictive capability has already proven itself across the off-highway industry by minimising the impacts of a failure and preventing catastrophic problems. For

example, an elevated blow-by fault indicates a future end-of-life situation for an engine and identifying this potential issue before it occurs can help optimise the total lifetime of the equipment.

The predictive capability provides ample warning to those responsible for managing the operational life of the equipment, from general maintenance to overhauls, as well as equipment retirement and replacement.

Beyond the optimisation and efficiency enabled by connected technologies, telematics also improve understanding of driver behaviour, including fuel consumption, incidents of speeding, idling, and even harsh steering or braking. This means safety can be improved by identifying where operators can make slight adjustments to their behaviour, to make greater improvements to the overall operation.

A BRIGHT HORIZON

As customer needs evolve, new technologies will bring new solutions to the forefront.

Over the next five years, over-the-air-programming capabilities, handheld telematics devices and virtual integration of total vehicle systems will be introduced.

Over-the-air programming (OTAP) has been around for several years, most notably through the adoption by mobile phone developers of software updates to their devices. This technology will provide many benefits to the construction industry where equipment regularly moves sites.

For instance, one key benefit of OTAP technology is the ability to tailor the engine/system operation of a piece of equipment to the particular site on which it is working. In the case of a wheeled excavator that drives on the road between worksites, for example, OTAP technology enables calibration updates in order to optimise the engine/system performance based on how it is being used at a particular point in time.

This technology provides the customer



→ with an opportunity to make usage-based performance changes in a secure, two-way dialogue between the customer and the manufacturer.

Cost-effective, handheld plug-in devices for customers that enable fault diagnosis have been available for some time. The challenge, however, is making the telematics capable in a cost-effective way to, once again, enable a two-way dialogue between the customer and the manufacturer.

Currently, the majority of telematics solutions are provided via a telematics-specific device in a vehicle. This is because while mobile phones are becoming smarter, they don't have the processing capability or memory required for the level of troubleshooting required of a telematics solution.

As data becomes cheaper, however, handheld devices become a more viable solution. They can be hooked up to the machine's data bus, with processing done over a Bluetooth link. Once the connection is made, the device can instantly access maps and service knowledge to optimise the vehicle for different locations and different uses throughout the day.

Finally, virtual integration of total vehicle systems will become more prominent. OEMs will focus on system integration to improve overall efficiency and reduce sub-system complexity. Connected technologies will enable this, with telematics and diagnostics forming a central part of keeping the integrated system in check.

And manufacturers have the opportunity to provide additional value to their customers by applying their connected technology knowhow to solve customer issues related to sub-system components.

While the industry has these new technologies to look forward to, there are still challenges impacting the widespread adoption of telematics solutions, particularly in the road construction sector. These include: evolution of standards; inconsistency of technology across OEMs; and customer acceptance of solutions.

Standards influence the lack of adoption of telematics solutions. While the first set of standards related to common reported data have been proposed, this space continues to

evolve. The proposed standards are a positive step forward in driving a common basis by which data is transmitted from equipment. However, further standards development and adoption by manufacturers will expand the utilisation of telematics solutions for the off-highway markets.

Another challenge is the inconsistency of technology across OEMs. OEMs are looking to develop proprietary systems to keep control of the information and servicing opportunities. For the construction sector, this is particularly challenging as equipment from several OEMs is often utilised on one site and construction companies must manage all of these different systems.

An open and widely shared architecture platform is needed, but the need for security becomes greater with this approach, so standards will continue to evolve in the off-highway space to address these issues.

That being said, telematics developers have multiple opportunities to enter the market with the right products. Over the next five years, every piece of equipment that leaves an OEM will be connected, driving a need for improved solutions. Furthermore, with vehicle electrification on the rise, as it expands beyond the on-highway sector, these solutions will be essential – each piece of software will need to be diagnosed to ensure the smooth operation of the machine.

The challenge for customers will be in

understanding how to fully harness telematics solutions in line with increasing connectivity and how they can be used to improve machine performance and reduce downtime.

Finally, customer acceptance of connected solutions is also impacting adoption. This is due to a variety of factors, including a limited understanding of the benefits of telematics, concerns around data security, and the overall cost of telematics solutions.

As manufacturers have the opportunity to team with customers to demonstrate the value connected solutions can provide their business, such as improving asset utilisation, reducing operating costs, and geolocation services, adoption rates will grow accordingly.

For example, in the construction rental market, combining connected technologies, such as geolocation services and remote equipment monitoring, can directly impact the company's financials. The cost associated with equipment theft can be substantial when you consider the direct cost of the equipment, as well as indirect costs such as project delays and lost production time.

For some construction customers who are self-insured, machine theft comes right off the bottom line. In cases where a telematics device has been installed in the equipment, the machine location can be easily determined and the machines have been recovered.

Operational data is used for not only

Manufacturers will need to take heed of the adoption of mobile technologies by different companies



RIGHT: When servicing and repairs have to be performed on site in dirty and difficult locations, being able to remotely diagnose a fault the first time is key to ensuring the right tools, parts and technician skillset are brought onsite. Downtime is minimised.

management of costs, but to track use for billing purposes. In some cases, where bills are not paid on time for rented equipment, the machine can be taken out of service remotely until the account is made current. This is an effective means of managing customers, where, as in many cases, the exact location of the machine may not be known.

As acceptance grows across the construction sector, contractors are getting more focused on using data analytics to improve equipment performance. Over the next few years, the exponential awareness of this need will drive the desire for greater connectivity to improve asset utilisation and uptime. Manufacturers will need to take heed of the adoption of mobile technologies by different companies.

For example, take the adoption of mobile technologies by different countries ... while India had more challenges in the adoption of landlines than the developed western economies, India was very quick to invest in mobile phone systems. This could be the case for the road construction sector. As telematics

technologies evolve, different regions may pick up the new technologies faster than others.

WATCH THIS SPACE

Telematics and analytics solutions are slowly becoming more important for the construction sector. As the technology develops and becomes more accessible, adoption will increase exponentially. The entire automotive and engineering sector is hurtling towards greater connectivity, and along with it, requiring a better need for diagnostics across the board.

While the off-highway and road construction sector continues to increase its adoption of telematics technologies, the connectivity and analytics space is rapidly working to develop innovative solutions to meet the unique needs and challenges of this market. The key question is: What do manufacturers need to offer the construction industry to encourage it to recognise the value of telematics and analytical solutions? The answer is coming from a site near you. □



Throughout her career at Cummins, Lori Cobb has served in a variety of roles including finance, operations, human resources, strategic alliances, supply chain management, distribution and customer support. Lori holds a bachelor of science degree in accounting from North Carolina Wesleyan College and a Masters of Business Administration from Vanderbilt University. She is also a Kellogg Scholar at the Kellogg School of Management at Northwestern University. Lori is a member of the Institute of Management Accountants, Women in Tech, and the American Truck Association. She serves on the Tech Mahindra Manufacturing CXO Advisory Council and on the board of directors for Turning Point. In this article Lori considers how connected solutions and telematics are driving change in the construction industry, and what new technologies are on the horizon.

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SMOOTH OPERATORS BENEFIT FROM INTELLIGENT ASPHALT COMPACTION TO STAY AHEAD

Everywhere you look, intelligent asphalt compaction is advancing fast. The pace of change means that innovations in asphalt compaction have come thick and fast in recent years with things like on-board computers, GPS positioning systems and sensors in the rollers that allow the operator to measure the rigidity of the material being compacted all contributing to a far more efficient way of working. Where is the market going next? Construcción Pan-Americana assistant editor *Maria Jose Pedrosa* reports.

According to a recent study from the US Department of Transportation's Federal Highway Administration (FHA), "intelligent compaction (IC) is defined as vibratory rollers equipped with accelerometers mounted on the axle of drums, survey-grade global positioning systems (GPS), infrared temperature sensors, and on-board computers that can display IC measurements as color-coded maps in real time".

The experts at the FHA go on to add that IC measurements can include IC measurement values (ICMV), roller passes, asphalt surface temperatures, roller vibration frequencies/amplitudes, and the speed of the machine itself. And, if you put it all together,

the FHA argues that intelligent compaction is the ideal way to ensure good quality control.

The highway industry already knows this and it is already taking full advantage of the new technologies coming on stream. Smoother roads last longer and a well-laid highway means that the contractor involved can finish the project on time and earn the performance-related bonus involved.

Fredrik Akesson, director of technology at the RCE Technology and Application Centre for Dynapac (which was part of the Atlas Copco group until a recent acquisition by Fayat), knows just how well quality standards can be increased and productivity levels improved when contractors use up-to-date intelligent compaction systems. "Being able

to provide information to the operator about material rigidity, temperature and number of passes in real time means that it is possible to detect any potential quality problems immediately and respond appropriately," he says.

According to Akesson, IC has the potential to improve soil compaction outcomes by at least 50% and boost the quality standard of hot asphalt by 30% to 40%.

Akesson should know. Dynapac has been at the forefront of Continuous Compaction Control (CCC) or Intelligent Compaction (IC) with its Dynamac product range since the late 1970s.

One of the major advances since that time has been the accelerometer-based compaction of soil, he says. "The addition of satellite-based positioning has added the possibility of counting and mapping the number of roll passes. The temperature sensors make the system to be used in hot asphalt mixtures, in addition to which the temperature of each pass can be recorded and mapped. The current system we offer is called Dyn@Lyzer."

The company says that its "Dyn@lyzer with GNSS (Global Navigation Satellite System) registers all the compaction meter data and



LEFT: ACE technology means there is improved information as to when compaction is achieved, and the operator and machine move more quickly to the un-compacted areas of the jobsite. Fewer passes also translate to more efficient use of labour, lower fuel costs and reduced wear on machines.



LEFT: If the operator enters the compaction level he wants to reach, the machine will start to vibrate, stopping when the level has been reached. This saves money on fuel, time and working hours. It also allows lower indirect costs because the objective will be achieved in the first few passes.



continuously displays the compaction results to the operator on the in-cab computer screen. The data is, at the same time, recorded and saved allowing full traceability and quality assurance. The GNSS receiver (such as GPS, GLONASS, Galileo) gives the precise position of the roller on the job site at all times."

Ammann has a very similar system, called Ammann Compaction Expert-ACE. This piece of technology is able to provide the absolute values of the compaction process in real time. According to Leoš Tymel, commercial director of heavy compaction at Ammann, "our system can go beyond the user-machine interface and is able to automatically adjust the compaction outputs (amplitude and frequency) to fit the needs of the compacted layers".

In addition, with the ACE Pro system you can reduce the number of passes significantly. "It is enough to compare the passes of the standard static compaction model, four high amplitude passes plus six small amplitude passes, with about seven passes with automatic adjustment of vibration parameters," Tymel adds.

Savings in fuel and time are the prize. Likewise, "ACE systems provide complete information regarding the development of compaction in absolute values of MN/n, a value that can also be obtained with GPS coordinates," says Tymel.

In essence, Ammann says that its Ammann Compaction Expert (ACE) system will

"help contractors improve compaction measurements to the point where multiple passes are eliminated. "What provides bigger fuel savings than reducing the number of passes the compactor makes?" says Kuno Kaufmann, head of compaction technologies at Ammann Group. "With ACE technology, there is improved information as to when compaction is achieved, and the operator and machine can more quickly move to the uncompacted areas of the jobsite." Fewer passes also translates to more efficient use of labour and reduced wear on machines.

The company is proud of its technology and the fact that "ACE technology is an automatic measurement, control and documentation system supported with GPS mapping to provide data regarding the areas the compactor has covered.

All measured values can be displayed and evaluated, including the load-bearing capacity of the material, the number of passes, and the frequency and amplitude values. ACEpro (goes further and) measures and evaluates the characteristics of the ground and automatically adjusts the amplitude and frequency accordingly, while ACEforce measures the absolute value of the bearing capacity of the compacted material. The systems continually measure for precise evaluation, meaning operators know when compaction is achieved. This helps avoid over-compaction and all the costs associated with unnecessary passes and material breakage."

The systems continually measure for precise evaluation, meaning operators know when compaction is achieved

ABOVE: The compaction process should be low cost although, if it is not done properly, it can cost much more when a re-build becomes necessary. "Intelligent compaction can help contractors to monitor the entire work of the area and also help to simplify operator tasks", says the American giant.

At BOMAG, the company has been expertly developing its compaction technology for at least 40 years with a range of road surface and asphalt management products ... including the BOMAG Vario control system. "Our technology allows the machine itself to measure compaction levels and adapt to the frequency and amplitude according to the compacting objectives by the number of passes," says Alejandro Marquez Leal, sales director for Mexico and Central America.

"In fact, the operator only needs to enter the compaction level he wants to reach and the machine will start to vibrate, stopping when the level has been reached. This advantage saves money on fuel, time, working hours ... Of course, indirect costs will be reduced in compaction, since the objective will be achieved in the first few passes."

Mariana Mochizuki, sales consultant for Caterpillar, points out that during the road construction project, the compaction process is one of the least costly phases, although if it has not done properly, it can cost much more when a re-build becomes necessary. Caterpillar therefore agrees that "intelligent compaction can help contractors to monitor the entire work of the area and also help to simplify operator tasks".

→ For Mochizuki, it is evident that on asphalt, intelligent compaction elements, such as temperature sensors, can help operators determine if they are compacting at the correct temperature for the density target in question. The technology helps the operator know when to start the rolling phase, when to stop and how to avoid specific temperature ranges. “Another technological tool is the pass count planning, which ensures that asphalt layer coverage is complete and compaction is uniform,” he adds.

HAMM also puts a lot of emphasis on its long tradition of intelligent compaction, and the German manufacturer is proud of its oscillating machines and its HAMM Compaction Quality (HCQ) standard. Oscillation produces a higher quality of compaction it says, which means that the operator needs to do fewer passes, and create minimal vibration in sensitive areas. A perfectly uniform surface can be produced using equipment that is environmentally safe, self-regulating, and easy to handle says the German manufacturer.

The HCQ system that HAMM has been offering for more than 15 years uses a modular design with components that fit all types of HAMM rollers as well as for the most diverse applications imaginable. HCQ is available on all of the company’s current tandem rollers, compactors and pneumatic rollers.

These HCQ “modules” include the HAMM compaction meter, which is used to measure subsoil rigidity during compaction through sensors in the drum. It also prevents over-compaction and can be used alongside a

temperature gauge and an “HCQ navigator” with a “satellite system for collecting and displaying all of the relevant compaction parameters.”

Operators can go one stage further too, and use HAMM’s WITOS HCQ package, which complements the HCQ browser using software that can store all the data in an easy-to-analyse online tool.

The engineers at Volvo have also developed their own intelligent compaction system. In 2008, the Swedish manufacturer began working on a solution that would allow better control of the pavement asphaltic process, especially in terms of layer compaction. “The objective of this research was to develop a solution to achieve greater durability of the pavement, and at the same time, visual, simple and with intuitive operation,” says Volvo. “The end product is what we call today Density Direct and the new technology we use combines the benefits of Compact Assist with Volvo Co-pilot.”

Compact Assist collects GPS data to determine the number of passes and, at the same time, Volvo uses sensors to collect the temperature of the asphalt as it is laid. The Volvo Co-pilot system uses the RNA Artificial Neural Network (also called Artificial Intelligence) to estimate the density of the pavement and compare it with the technical parameters required to do the job properly.

This solution practically eliminates the risk of not reaching the density bands specified in the project spec, thus ensuring fast execution with high quality and durability of the pavement, together with a potential reduction of costs.

“The objective of this research was to develop a solution to achieve greater durability of the pavement, and at the same time, visual, simple and with intuitive operation”

HYDROSTATIC MOTORS

Hydrostatic motors are fundamental to intelligent compaction. Fredrik Akesson, manager of the “RCE Technology and Application Center” at Dynapac, explains that surface uniformity is key to achieving quality parameters in asphalt compaction. “The smoother the handling of the machine, the smoother and better the uniformity,” he says. “Hydrostatic transmission offers the best control of the machine with smooth steering changes and easy handling. The electronic controls add even more possibilities of adjustment, adapting the machine to varied conditions and demands”.

Leoš Tymel, commercial director of Ammann Heavy Compaction, agrees. Hydrostatic systems bring a raft of benefits he says: “The best thing is that we are not limited by the design of the machine, since the hydraulic pipes and tubes are much smaller compared with the old gearboxes, differentials and V-belts.” A hydrostatic

BELOW: Dynapac: Hydrostatic transmission systems mean well-controlled machines with smooth steering changes and easy handling. And electronic controls add even more possibilities of adjustment, adapting the machine to varied conditions and demands. The end result ... smooth and uniform road surfaces.



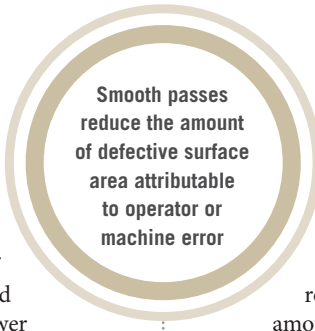
system will help the machine work at its maximum capacity, eliminating the rigid angle. The unit uses the hydrostatic drive in its place. The differential lock function is then provided by the flow divider system, again a hydrostatic component.

Also, operators like the fact that controlling the speed of the machine is much easier with new hydrostatic tubes that can be used either mechanically or proportionately. A very important function of the hydrostatic drive that Ammann uses is the SAHR (spring loaded / hydrostatic applicator), which prevents the machine from unintentional movement. All of this helps to improve safe working too.

BOMAG agrees: "It cannot be doubted

that hydrostatic motors and hydrostatic power trains dominate a large portion of construction machinery," it says. "This is partly due to the fact that other functions, in addition to propulsion, such as the vibration system of the compactor rollers, also need hydraulic force." Hydraulic power packs are installed in many machines right from the beginning as a result.

Another advantage of hydrostatic systems is their size. They are often used when the available space is small and the designers find that a mechanical motor would be impractical. They can also operate at high



Smooth passes reduce the amount of defective surface area attributable to operator or machine error

pressure levels, improving the efficiency of the machinery significantly.

For its part, Caterpillar believes that hydrostatic drive systems enable very smooth acceleration and deceleration of the asphalt roller. Smooth passes reduce the amount of defective surface area attributable to operator or machine error. A smaller amount of defective surface leads to a higher quality of surface and smoothness of the road, and ultimately to a greater durability of the road, says Cat.

HAMM's marketing manager Stephanie Mayer makes the same point. "The major



REQUIREMENTS FOR IC

Peterson Caterpillar explains the five key requirements for IC (intelligent compaction) in a document written by Chris Mata, Tom King, & Al Hodson.

"In order to achieve intelligent compaction and remain competitive in today's paving environment, contractors need five things: Precision Mapping, Pass Count Tracking, Compaction Control, Temperature Mapping, and Documentation of Quality Assurance and Quality Control", says the paper. Compaction technology enables contractors to build a better surface, reduce material use, and significantly improve productivity.

Moreover, as implementation of compaction control technology becomes standard for paving jobsites, the use of these techniques and the equipment involved are becoming more than a smart choice. In fact, it is becoming a paving requirement for the majority of federal highway contracts in the USA.

Precision Mapping, Pass Count Tracking, Compaction Control, Infrared Temperature Mapping, and Documentation of Quality Assurance and Quality Control ... these are essential headings in the paperwork trail for any contractor trying to qualify for jobs

in the United States that list IC as a bid requirement. Countrywide, the United States Department of Transportation (DOT) and Federal Highway Administration have started requiring contractors to use compaction control technology. Federally-funded highway projects now require stringent documentation, quality accuracy and quality control (QA/QC) data, as well as warranty provisions. If you are not into IC, you are not going to get the job.

In fact, documentation of Quality Assurance (QA) and Quality Control (QC) is becoming a standard for all federal project bids. The highways authorities want to see advanced compaction control and up-to-date documentation so that they can keep an eye on what is happening. In-field reporting and an in-cab printer allow onsite supervisors and quality managers to monitor compaction operations and correct possible issues immediately.

The client sees the benefits as: faster material inspections, fewer human errors, improved in-place density, more efficient compaction operations, better pavement performance, longer-life pavements, and clear data for archival and warranty work documentation.

In addition to this, the document

indicates that "entry into IC can be overwhelming, but this technology can be integrated into existing paving fleets". Data management and integration of software packages can be taught by vendors at the point of sale and during implementation of Intelligent Compaction technology.

"It is always important to learn best practices when using any tool. Partnering with a knowledgeable provider is crucial to learning and implementing Intelligent Compaction technology into your fleet. There are dealers with Intelligent Compaction experts that have answers to your questions. Every business has different needs. A good provider can help configure the proper system for specific projects on top of selling you the equipment. These experts can help train your employees on the latest technologies and understand how to get the most profit utilising compaction technology on your jobsite," says the document.

Victor Lee Gallivan, asphalt pavement engineer at Gallivan Consulting Inc, advises contractors to train their people to make sure they understand the data processing involved. It is vital to use and understand IC if you want to win work in the

USA. Roughly two-thirds of the states now require the use of IC in one form or another, and contractors are finding that IC will increase their productivity levels by nearly 25% and reduce costs. "Unfortunately, most contractors are not using the technology as it is intended," he warns. Don't fall behind.

Mark Eckert, global product manager at Volvo Construction Equipment, could not agree more. Having a good-quality IC system and a group of operators who can use it properly can be the difference between winning and losing a bid he says. And it is important for contractors to understand the difference between the various IC systems available.

"While contractors aren't always immediately receptive to new technologies that come with new expenses, the necessity for IC is growing, and contractors need to familiarise themselves with the technology in order to stay competitive," says Eckert. "The list of IC-mandating states continues to grow with reason, and is only expected to continue. Those contractors who have demonstrated experience with IC systems will have a competitive advantage on those bids." It pays to be IC smart.

“As customers can see online what results are being produced by the rollers, information is not only stored locally on the machine but also in the cloud”

Stephanie Mayer



→ advantages of hydrostatic transmissions are high reliability and performance (levels) with lower operating costs,” as well as easier maintenance options. Hydrostatic units tend to be more reliable and offer increased operational safety... a crucial issue that is increasingly drawing attention, explains Hamm.

Volvo sees the advantages of a hydrostatic system as precision operational standards with better controlled movement, increased torque, less system wear and lower fuel consumption stats. Hydrostatic motors also bring safety benefits says Volvo, not least because the braking and emergency systems are more reliable.

There are disadvantages too, Volvo notes, such as higher purchase and maintenance costs and the fact that when a hydrostatic drive fails, the damaged components involved tend to create more pollution and affect the other components in the system.

INTERNET OF THINGS

Smart compaction companies are increasingly using what is known as the “Internet of things,” exploiting the benefits of real-time data and the cloud. For example, Ammann uses cloud databases to power its ACEpro plus GPS units and the company’s Sitelink software systems. Ammann accesses information on compaction activity as it happens and shares the results between the machinery in action on site, and with the administration team in the office.

Ammann is currently working on developing more cloud-based systems such as the BatSerMar system, which allows easy access to information about battery voltage or machine working hours.

Likewise, over at Dynapac, there is the Fleetlink system which enables any device connected to the internet to monitor data from the machine such as engine hours or fuel consumption levels. “We also aim to have the data in the cloud,” says Fredrik Akesson.

“The amount of information is enormous and must be treated properly. This solution is being developed in the Dyn@Lyzer system and has not yet been launched.”

BOMAG sees connectivity as a very important factor here, not least because the internet of things or industry 4.0 offers the opportunity of future solutions. At BOMAG, real-time compaction information is available through BCM, the compaction management system. BCM documents the compaction status at each point in the construction process using GPS and criteria like temperature and Evib values. The system also allows different machines to connect to each other, so that they can operate more efficiently, as if they were in a fleet. In addition to BCB, BOMAG offers telematics systems to obtain information on the location of the machinery and its status, such as the idle speed.

Meanwhile, Caterpillar uses the technology systems in compactors to continuously collect information: passes, speed, frequency, temperature or position are all in the mix and the information collected is often analysed instantly, in real time. Contractors extract the data and use it to make decisions based on real and immediate information trends says Mariana Mochizuki.

HAMM offers its HCQ Navigator WITOS HCQ, which provides real-time data flow and cloud storage. “As customers can see online what results are being produced by the rollers, information is not only stored locally on the machine but also in the cloud, which makes it secure and transparent,” argues Stephanie Mayer.

HAMM provides an interface for information called WIFMS, which allows information to be transferred to a modem. “This service helps to transfer, display and analyse machinery and positioning data,” says the company. “Therefore, Witos FleetView supports customers in managing their fleet of machinery”. □



ABOVE LEFT: Hamm: The major advantages of hydrostatic transmissions are high reliability and high performance levels with lower operating costs ... as well as easier maintenance options. Hydrostatic units tend to be more reliable and offer increased operational safety - a crucial issue that is increasingly drawing attention.

ABOVE: Volvo: Having a good quality intelligent compaction system and a group of operators who can use it properly can be the difference between winning and losing a contract bid. It is important for contractors to understand the difference between the various systems available if they want to win the job.

EUROPE'S UNEVEN MARKET GROWTH

Lean sales years led European manufacturers to introduce lean manufacturing to help boost productivity. It has worked, but there remains an air of caution, reports *David Arminas*.

The year 2016 surpassed expectations for the European construction equipment market, with double-digit growth across all sub-sectors, although sales by regions have been variable.

High levels in Northern and Western Europe underpinned a continuing yet slowing recovery in Southern Europe and fairly weak growth in Central and Eastern Europe.

Despite this, the sector remains cautious about the near future. Many markets outside Europe still face significant difficulties and - more importantly there is still much uncertainty in the home European market because of unresolved political and economic crises in Europe and worldwide. In fact, uncertainty levels increased during 2016.

Ramifications of the UK's Brexit referendum in which the population voted to leave the European Union are not fully understood and they may not be as disruptive as first thought in the immediate aftermath of the vote last June. "We do not expect strong direct effects of the Brexit vote on the equipment sector in Europe," says Sigrid de Vries, secretary general of the Committee for European Construction Equipment (CECE) which represents the construction equipment sector to EU institutions.

"Uncertainty after the vote is, of course, an issue and customers may have postponed or downsized investment plans due to economic uncertainty, though this is practically impossible to measure. In the long run, a 'hard' Brexit with declining EU-UK trade and, consecutively, lower GDP growth, would have the largest impact," says de Vries (see

Brexit Briefing story).

In the US, the presidential election has introduced a further sense of unease about future export and import opportunities. In December, the Brussels-based CECE signed a joint letter along with other European umbrella organisations including CECIMO - European Association of Machine Tool Industries - addressed to the EU trade commissioner. The letter urged the commissioner to continue discussions on improving trade with the US in light of the newly-elected president's desire to review many trading arrangements. Of immediate concern to Europe is the proposed TTIP - Trans-Atlantic Trade and Investment Partnership.

The European Commission has estimated that TTIP would boost the EU economy by US\$125.5 billion (€120 billion), the US economy by \$94 billion (€90 billion) and the rest of the world by \$104.5 billion →

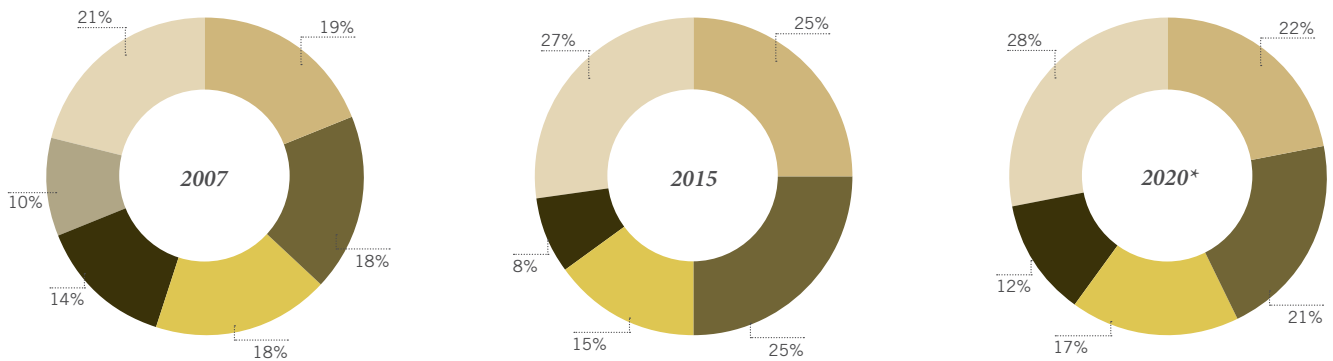


ABOVE RIGHT: European sales are set for a much-needed lift.

RIGHT: Brisk business at bauma 2016 in Munich.

Europe: Structure of sales by country 2007-2020 (% of total)*

Source: Off-Highway Research (*forecast)

→ (€100 billion). European fears are that TTIP negotiations could stall.

The latest CECE Business Barometer, a monthly index of sentiment among construction equipment manufacturers, showed that although the business climate has improved, gains were much smaller than what would be expected against such a background of positive market data. Future sales expectations remained below the levels of 2014 and 2015 (see box). Nevertheless, a majority of manufacturers expect business to improve further. Confidence was echoed at the recent CECE Congress, held in Prague last autumn. "The sector has used the past decade to make its production leaner," said CECE president Bernd Holz. "We feel we are well-placed to compete with each other and the rest of the world. We are confident we can increase our market share world-wide. And we are transforming our business models, becoming more service- and customer-

oriented than ever before," said Holz, who is also managing director and sales director for Northern Europe at Ammann Verdichtung.

Analysis by the CECE and other organisations predicts more growth is yet to come from Northern and Western European markets and Russia should finally start to see some growth. At the same time, Central and Eastern Europe are not viewed positively by manufacturers in the near- to mid-term. Also, they expect a deterioration of business in Turkey.

A key question for equipment manufacturers is whether rental companies will continue to invest in the near- and medium-term, after renewing and extending their fleets on a significant scale in 2016. Sales to rental companies have recently gained in importance for maintaining manufacturers' volumes. In addition, demand from the mining sector continues to be very weak.

Outside Europe, modest declines in North America continue and are not expected to turn around before the second half of this year, while South America remains in a recession. In Asia, India is the only market that is delivering strong growth, with sales after nine months in 2016 showing a 35% increase on 2015 levels. China finally seems to have hit bottom last year, but 8% growth is a limited pick-up in demand after very significant declines for three years.

More sales could be driven by customers in Europe wanting to upgrade their fleet with the latest and constantly improving machine telematics and other digital technology. "This is clearly a big trend as well as a huge priority for many equipment manufacturers," says de Vries. "The customer will decide what investment to make, but the clear aim and expectation is to deliver additional benefits to the customer with the help of these new and sophisticated technologies." □

2015: ONE STEP BACKWARD AFTER TWO STEPS FORWARD

Looking back at 2015, that year's sales growth was down by a moderate 2.5% on 2014, according to the CECE Annual Report 2016, published in March 2016. The report, which analyses sales in the full year 2015, noted that the continued free fall in the Russian market was a decisive factor distorting the overall market statistics. Sales in Europe excluding Russia grew 3.5% in 2015 over 2014.

"This illustrates well that the European market remains

highly diverse in terms of market developments, a phenomenon which is apparent even in the large volume markets. We saw growth of almost 40% in Italy, but also declines of 25% in France."

Over the year, the industry developed a pattern which was very similar to 2014. The first quarter almost kept up with the strong Q1 of 2014, but was followed by two very weak quarters, before Q4 brought back momentum with growth across all sub-sectors.

At the Economic Forum of the

CECE Summit in September 2015, Antonio Mura, director at Italy-based CRESME Ricerche, said 2015 was the world construction industry's worst year since 2009, but this should be followed by significant annual growth of 17% until 2019.

Growth will be concentrated in emerging economies despite a slowdown in their economies. He predicted that by 2019, two-thirds of construction investment will take place in these regions. The good news, however, is that he also

predicted that, with the exception of Japan, there will be substantial growth even in mature markets, though clearly on lower levels than in the past decade.

Therefore, demand for construction equipment should be back on track at least in the medium term, when emerging markets take up their role as engines of growth. Unfortunately, emerging markets are typically not the most profitable ones for equipment manufacturers. Highest margins are generated in North America.

BREXIT BRIEFING

Rob Oliver, chief executive of the UK umbrella group Construction Equipment Association (CEA), argues the case for continued, if not more, cooperation with European Union institutions leading up to and after the UK's exit from the EU*.

The very nature of the construction equipment business today is international. British companies have factories not only in the UK, but in the US, India, China and beyond. Similarly, American, Japanese, Indian and, more recently, Chinese enterprises have taken significant stakes in the UK construction sector.

This investment supports the UK's supply chain, with made-in-Britain components being exported in finished machines. This inter-dependency has been a feature of our industry and government must ensure that the UK remains 'open for business' in this manner. Policies in the area of energy pricing reform and business [tax] rates are practical areas which can reinforce this message.

The European Union cannot exist as a protectionist entity, any more than the UK can pull up the drawbridge to our EU partners. The most delicate negotiations for Brexit - Britain's anticipated official departure from the European Union, likely in 2019 - will be around the issue of market access, while at the same time initiating or sharpening new trade agreements worldwide. The principle of free and fair trade will be tested as never before - but the end goal for CEA members is being able to continue to support UK, European and international markets with the best products at competitive prices.

Both the process leading to the UK's exit from the EU and what happens after that is uncharted territory. For this reason, seldom, if ever, have the interests of British business been more in need of a strong and constructive voice in discussions with the government. However, at the same time, it has been announced that the National Infrastructure Commission (NIC) will become an agency of government. This falls short of a promised statutory body which would have committed the government to consider the Commission's recommendations.

It has been estimated that around 70% of the UK's construction equipment industry's research and development spend has gone towards ensuring that British machines meet

EU regulations and directives. The process of defining the EU directives has also been a tortuous process. To continue to trade products into the EU, the UK must continue to meet these regulations. Where regulations concern environmental standards, such as noise and engine emissions, then it makes sense to have a common agenda with Europe.

The timing of Brexit coincides with the introduction of Stage V engine emission regulations. R&D investment for this new generation of engines has already been made, so we are pressing for the continuation of relevant EU rules in the UK market for machines for at least a transitional period.

The UK equipment sector mustn't wake up on the first day out of the EU having no clear set of rules for machines sold into the UK market. Consider, too, that because the plant-hire sector sucks up around 70% of UK machine sales, anything that interferes with their purchasing plans is bad news.

In other words, there lies anarchy. Supporting common international standards, including those of the EU and US, remains the best path for ensuring the UK equipment sector remains globally competitive - with or without Brexit.

The recent drop in the exchange rate of the UK pound has been a boon for exporters.

"The principle of free and fair trade will be tested as never before"

The recent drop in the exchange rate of the UK pound has been a boon for exporters

But a 15% drop does not automatically deliver a 15% cost saving. It makes imported components more expensive, stokes up UK inflation and possibly wage demands and makes overseas market-entry costs more expensive.

If the UK government thinks that record exports will just happen, then they are in for a shock. This 'market-entry premium' will affect many of the UK's smaller companies that are looking to export. Consider the CEA's planned British pavilion at this year's Conexpo trade show in Las Vegas. This has not been an easy sell, despite a relatively healthy US economy. To this end, the British government needs to get a grip on its export support services which are increasingly marginalised.

The 2014 Sector Report, commissioned by the CEA and the UK's Department for Business, Innovation and Skills (now part of the Department for Business, Energy and Industrial Strategy) was unequivocal about the multi-billion-pound contribution the construction equipment sector makes to the UK economy. Post-Brexit, and in the years to come, this must continue to be the case. □

**This is an edited version of an article that appeared in the CEA's own magazine in late 2016.*



EUROPE IN THE GLOBAL CONTEXT*

A slow but steady recovery in machine sales worldwide is likely in the next few years, with India being one of the key growth markets for the future. However, this comes after the construction equipment sector has seen significant downturns as well as other major changes worldwide in the last few years, according to David Phillips, managing director of Off-Highway Research. He said, "The industry structure has really changed."

Global sales of construction machines were worth around US\$93 billion in 2014 and dropped to \$78 billion according to Phillips, who estimates that total sales for 2016 will be around \$72 billion. These figures contrast strongly with the results for 2011 when global sales of construction machines hit an astounding \$102 billion. This last figure was unsustainable and was driven by the huge infrastructure development programme in China.

However, Phillips explained, "In 2011 the market crashed because the Chinese government put a brake on the development." He also said that the rapid growth in demand for machines in China had a huge impact on the global market. In 2002 machine sales in China accounted for just 10% of the global market, but grew to 50% in 2010, falling back down again as the Chinese government put the brakes on the economy.

Since that time, construction machine sales have remained low in some markets. Phillips said, "North America has come back nicely but Europe is very weak." However, "India is very good".

He continued, "I think in 2016 we will see the market bottoming out," and he added that a slow global recovery seems likely after that, although he cautioned, "I don't think China will get back to where it was."

Phillips also said, "Europe is very difficult. The market peaked in 2007 at over 200,000 units, fuelled by easy financing." He explained that this figure was unsustainable, which is why in 2009 machine sales in Europe were less than a third of what they had been two years earlier.

Phillips said that he expects the construction machine market in the US to grow again to around 190,000-200,000 units/year in the next few years. He explained that India will be the major growth market however and said, "India is the real body-builder of our industry. In the last six months we've been seeing quite a lot coming through." Phillips said that the current Indian government has been making major steps both in tackling corruption and untangling bureaucracy, which is helping with the pent-up demand for infrastructure development.

Meanwhile, market trends are also changing, with the excavator being of growing importance for overall machine sales. Phillips believes that in 2015 around \$28 billion of the \$78 billion worth of construction machines sold worldwide were excavators. Phillips added that he expects excavators to account for around 30% of total machine sales globally in the near future.

The types of machine sales in certain markets are also changing. India, for example, has been a major market for backhoe loaders. But Phillips said that while sales of



ABOVE: Chinese firms built around 160,000 excavators, but the market will account for around 35,000 units for the next few years.

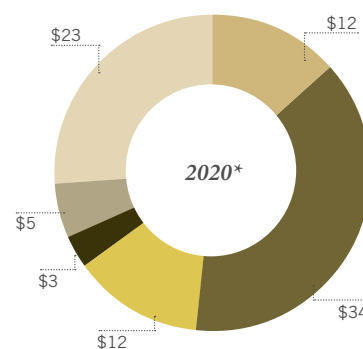
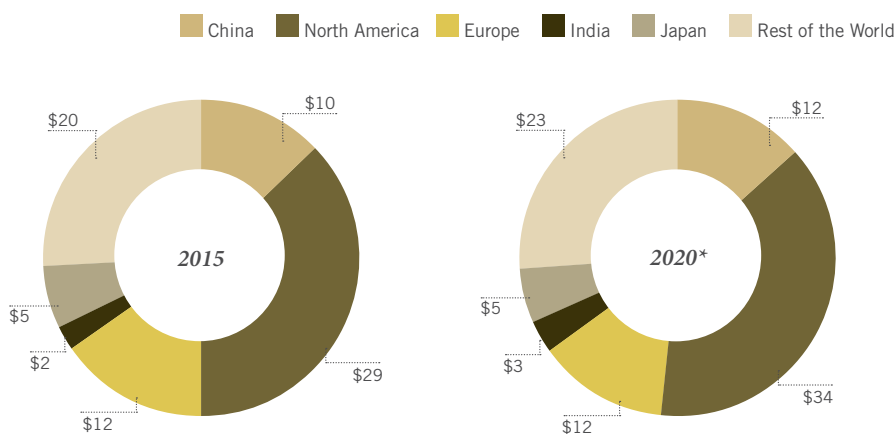
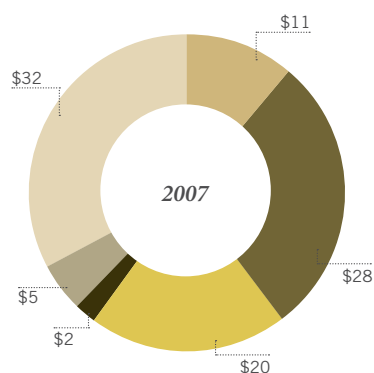
backhoe loaders now remain stable, they are losing market share against growing sales of 14tonne, 18tonne and 20tonne class excavators as these machines are better suited to use on infrastructure projects.

Similarly, he said that in China where the wheeled loader has been the major seller in the past, excavator sales are also growing. "I think that in the longer term crawler excavators will reach 30% of the Chinese market," he said.

Chinese manufacturers are also having to cope with over-capacity. Having built some 220,000 wheeled loaders in 2011, Phillips said he believes the Chinese market will account for around 50,000 wheeled loaders

Global Equipment Sales 2007-2020* (\$ Billion)

Source: Off-Highway Research (*forecast)



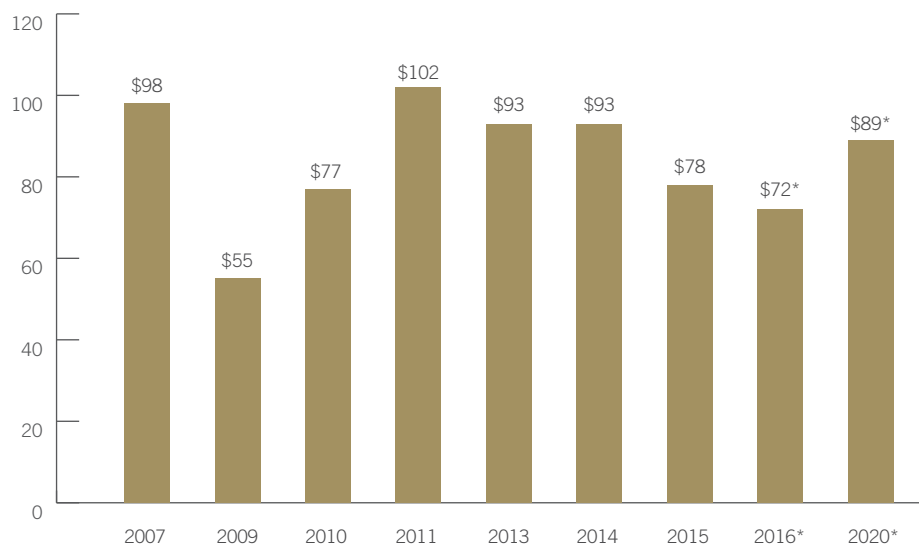
Total Global Equipment Sales 2007-2020* (\$ Billion)

Source: Off-Highway Research (*forecast)

for the next few years. Similarly, he said that in 2011 Chinese firms built around 160,000 excavators, but the market will account for around 35,000 units for the next few years. Chinese firms developed the capacity to build over 250,000 wheeled loaders/year, in excess of the total world demand for these machines of some 114,450 units. And for excavators Chinese firms developed the capacity to make some 430,000 units/year, compared with global sales of 354,062 units. Phillips said, "They've taken steps to reduce production."

However, he added that there is still excess capacity, particularly for wheeled loaders, while manufacturers also have to contend with a large pool of secondhand machines that have clocked low hours that making them attractive deals for customers looking to replace old units. He does not see mergers and acquisitions being a major factor and he is also certain that the 10 key Chinese manufacturers have a strong future.

Phillips added that Chinese manufacturers are also learning fast about how to boost the residual values of their products. Machine quality of the products from the leading firms is now vastly improved while



these companies are also gearing up to provide much better product support for customers. Chinese firms have achieved good penetration into developing markets according to Phillips, but have yet to develop the global brand recognition that will allow them to compete in developed markets. He added that this is coming however. □

**Monthly and annual market reports are available for purchase from Off-Highway Research at www.offhighway.co.uk/market-reports.asp*

PUBLIC-PRIVATE PARTNERSHIPS GENERATE MORE THAN €15 BILLION*

In 2015, there were 49 PPP deals (valued at €10 million or more) that reached financial close for a total €15.6 billion. In value terms, however, the market decreased by 17% compared to 2014, according to data from the European PPP Expertise Centre. The EPEC is part of the European Investment Bank's advisory services for public sector organisations.

Of the 49 PPP projects in 2015, 12 were in transport, just behind the education sector with 15. But by value, transportation was by far the largest PPP user. Just over €9 billion of the total €15.6 billion spent on PPPs was used for transportation projects.

Turkey was the largest PPP market in Europe in terms of value with a total of €9.2 billion (€3.5 billion in 2014) and the second-largest in terms of number of projects, with seven deals closed (3 in 2014).

The UK remained the most active market by number of projects, with 15 transactions (compared to 24 in 2014). The UK was also the second-largest market with a total value of €2.4 billion (€6.6 billion in 2014).

France was the third largest PPP market in Europe (€1.2 billion) with one large transaction

(the Calais and Boulogne-sur-Mer port) accounting for most of the French PPP market.

With regard to the number of transactions closed, the UK and Turkey were followed by Germany and France (five deals each) and the Netherlands (four).

Ten countries closed at least two deals (11 countries in 2014) and 12 countries closed at least one PPP transaction (13 in 2014). Notably, Finland closed a PPP deal for the first time since 2011 (the Hamina-Vaalimaa E18 motorway).

Data for the first half of 2016 (full-year data was not yet available when Global Report went to press) shows 40 PPP projects reached financial close. Total value of the 40 projects was €7.8 billion - up 72% in value compared to H1 2015.

Nine countries closed at least one PPP transaction with the UK closing the most deals. The UK was also the largest PPP market in terms of value.

Overall transport accounted for more than one-third of the total PPP market by value, but education was the most active sector by number of transactions

The average transaction size for the first half of 2016 stood at €194 million, a 9% increase compared to H1 2015 and in line with the average transaction size recorded over the past decade (€200 million).

The largest transactions in the first half of last year were three motorway PPPs: the A355 in France, the A94 in Germany and the D4/R7 in Slovakia. Also among the largest projects was the UK's Military Flying Training System Phase II. These transactions accounted for 45% of the overall European market value in H1 2016.

EPEC publications cover transactions in the 28 European Union countries, the non-EU Balkan states of Albania, Bosnia-Herzegovina, Macedonia, Kosovo, Montenegro and Serbia, as well as Turkey. The types of transactions analysed are design-build-finance-operate (DBFO) and design-build-finance-maintain (DBFM). Also considered are concession arrangements which feature a construction element, the provision of a public service and genuine risk sharing between the public and the private sector.

**Source: the European PPP Expertise Centre*

GROW YOUR PROFITS THROUGH EQUIPMENT

Quarry operators are seeking to improve profitability, and innovations in crushing, screening, loading and hauling equipment will help. *Patrick Smith* reports.

Improvements in crushing, screening, loading and hauling equipment for quarries will help owners and operators increase safety, productivity and profitability.

This is why the major quarry equipment manufacturers are pumping millions into research and development, and while innovations are coming thick and fast, others are at various stages of research and development, including the electrification of construction equipment along with autonomous vehicles.

For example, Volvo Construction Equipment's electric site research project aims to transform the quarry and aggregates industry by "reducing carbon emissions by up to 95% and total cost of ownership by up to 25%."

The project aims to electrify a transport stage in a quarry, from excavation to primary crushing and transport to secondary crushing, and involves developing new machines, work methods and site management systems. The company's new award-winning prototype concept HX1 autonomous, battery electric, load carrier, is an element of the project.

Saying that electrification of construction equipment represents the future of industry, Volvo has also unveiled its prototype

hybrid wheeled loader, the LX1, claiming that the machine can deliver up to a 50% improvement in fuel efficiency, and has 98% new parts. It is said to be capable of doing the work of a wheeled loader one size larger.

"Although we believe that there will be a major shift towards electric hybrid technology in the future, our customers, quite rightly, want improved efficiency now. We are delivering this through more conventional technologies and soft offers," says Scott Young, electro-mobility programme manager at Volvo CE.

"This is because we need to meet customers' immediate expectations in terms of total cost of ownership (TCO). A large part of TCO is energy cost, but other significant expenses include purchase price and maintenance. These aspects help drive our hybrid development plans.

"Therefore, before we launch a machine like the LX1, you can expect to see elements of this design incorporated into our products. This supports short and mid-term developments and requirements while the market continues to accept the technology, technology improves and the cost of new technologies decreases."

He says that while hybrid technologies are still a relatively expensive solution and

adoption has been slow, the cost of energy storage systems like lithium ion batteries is steadily decreasing, along with other technology, and that is starting to make hybrids more attractive financially.

"There are still opportunities to further optimise conventional technology, and these developments will compete with hybrid technology for some years. Although having said that, we are currently in a period of exponential technology growth and I believe this industry shift will move at a faster pace than others have in the past."

Volvo also demonstrated prototype autonomous machines, a standard Volvo L120 wheeled loader and an A25F articulated hauler, upgraded with autonomous technology.

ABOVE: Volvo has prototype autonomous machines, including a standard A25F articulated hauler, upgraded with autonomous technology.

BELOW LEFT: Caterpillar's new 980L medium wheeled loader applies proven technologies.

BELOW: Hitachi Construction Machinery (Europe) has more than 200 redesigned features and improved components on its new Zaxis-6 models.



RIGHT: The Keestrack cone crusher H4 is now presented in the full-hybrid version H4e. (Image: Keestrack)

OPPOSITE: The 1100x700 jaw crusher on the Keestrack B4e is driven by a 110 kW electric motor. (Image: Keestrack)

“In the future you could also potentially have one operator for three or four machines, increasing productivity and further decreasing costs,” says Jenny Elfsberg, director of emerging technologies at Volvo CE.

While this is, perhaps, the future, new models that offer exceptional durability without compromising on efficiency offer an appealing return on investment for quarrying customers, and this is what major manufacturers are now producing.

For markets in Asia, South America, Africa, Middle East, Turkey and CIS (the Commonwealth of Independent States), Caterpillar’s new 980L medium wheeled loader is one example.

It applies proven technologies “systematically and strategically to meet customers’ high expectations for reliability, productivity, fuel efficiency, and long service life.”

It is said to be more powerful and fuel-efficient than its predecessor, the 980H, with a significant drive-train and hydraulic-system refinement; operator safety and convenience enhancements; proven Z-bar linkage; Cat Performance Series buckets, and options such as automatic traction control, enhanced ride control system, and Cat Connect Technologies.

The 30tonne class 980L uses a productive and fuel-efficient 303kW Cat C13 ACERT engine, offering 5% more power than the engine on the 980H, and also claims up to 25% less fuel consumption than the 980H.

“The 980L’s innovative powertrain, hydraulic, cooling and electronic systems intelligently lower average working engine speeds and reduce overall system heat loads resulting in significantly improved performance and fuel efficiency,” says the company, the world’s biggest construction equipment manufacturer, which offers a wide range of machines for quarry operators.

Cat LINK technologies, such as the



Product Link system, help fleet owners manage equipment utilisation and lower owning and operating costs through the online VisionLink interface, which tracks critical items, such as location, hours, fuel usage, diagnostic codes, and idle time.

Cat PAYLOAD technology, such as optional Cat Production Measurement system, accurately weighs materials being loaded and hauled to improve productivity, reduce overloading, and track material movement

Volvo CE has recently launched a number of new machines, with its new 75tonne EC750E crawler excavator offering innovative electro-hydraulic technology, optimised to operate in harmony with the robust engine, said to deliver greater operator control and productivity.

The company also introduced its biggest articulated hauler, the A60H, which at 55tonnes is designed for heavy hauling in severe off-road operations, including quarries and opencast mines.

“The A60H helps increase a business’s profitability by moving more for less,” said the company at its launch.

“With intelligent systems from Volvo, such as MATRIS, CareTrack and the On Board Weighing system, customers can optimise production and minimise operational costs.”

With more than 200 redesigned features and improved components, the new Hitachi Construction Machinery (Europe)/(HCME) ZX890LCH-6 and ZX690LCH-6 large

crawler excavators incorporate innovative Hitachi technology developed specifically for the new large excavator range, and offers a high level of comfort and safety for operators.

“They deliver low fuel consumption, as well as high productivity, ensuring a profitable return on investment,” says Burkhard Janssen, general manager Product Management and Engineering at HCME.

In crushing and screening, Metso is promising “the crushing industry’s biggest launch in decades” with a completely new crushing technology that it says increases uptime while cutting the operational costs of its customers.

Three years ago Metso unveiled its innovative compact, track-mounted two-in-one Lokotrack LT220D, the combination of a cone crusher and a screen, one of a number of introductions from major manufacturers at that time.

More recently the company saw the first global use of its first fully-electric

Lokotrack LT130E jaw crusher at an in-the-pit solution at the Lanwehr Naturstein quarry in Sauerland, Germany, where just 12 people operate the whole plant that produces 900,000tonnes of high-quality aggregates.

“The fully electric drive using external power clearly adds to our competitiveness among the regional aggregates producers. And by using electric power, we receive a tax reduction of €6,000-7,000 per month,” says Thomas Lanwehr, managing director.

The LT130E can operate electrically with

**12 people operate
a whole plant that
produces 900,000tonnes
of high-quality
aggregates**

RIGHT: *The MOBICONE MCO 11 PRO from Kleemann, especially designed for quarries.*

→ an external power source or by using an on-board diesel generator when no external power source is available.

Metso says that to produce metals, minerals, aggregates and energy for today's global needs, the mining industry must handle huge volumes of material, sometimes moving entire mountains. It is seeking solutions that result in lower operating costs than conventional truck haulage; use less water; consume less energy, and address stricter occupational health and safety laws.

"Using an in-pit crushing and conveying (IPCC) system to reduce or replace conventional truck haulage to the plant or waste dump brings significant savings in operating costs and lowers energy usage, water consumption, dust, emissions and noise," says Metso.

Belgian company Kestrack says it is also intensively working on alternative drive concepts for all models across its range to reduce operational costs and optimise the sustainability of processing plants.

"Diesel-electric technologies with hybrid or full-hybrid operation are playing a key role, with the new cone and jaw crusher concepts H4e and B4e forming part of a fuel-saving plug-in production line," says Kees Hoogendoorn, company owner.

"As a result, most of the Kestrack crushers, screeners and stackers are today available as conventional diesel-hydraulic units, but also as e-versions with on-board diesel engines and flanged generators to supply electric motors on screens, conveyors, compressors

and other components.

"With plug-in option, those hybrid plants can be externally supplied via mains; another machine in the processing line (for example, a crusher), or via separate genset."

Kestrack says direct cost-cutting is the obvious reason for replacing numerous hydro drives on conventional mobile plants, and reducing with that to a large extent hydraulic power needs, oil volumes and pipework on machines.

"And indeed, Kestrack is reporting for the e-versions up to 30% lower fuel consumption compared to the same models with modern load-sensing hydraulic systems. This might not seem too dramatic at the end of a shift, but live-time cost analyses clearly show that minor additional investments for the e-versions pay off quite shortly, even in recent times of moderate fuel pricing."

Alan Witherow, product manager at Terex Finlay, says: "The introduction of the Terex Finlay I-140 represents a significant step change in our family of impact crushers. Our field test results of extensive testing have recorded significant productivity increases depending on the application, over the model that it replaces."

The I-140 is a direct drive 1,270mm x 1,240mm horizontal impact crusher with variable speed, and the company says a significant engineering approach being introduced in this model is the material flow through the plant.

"The enhanced material flow process of the plant represents a significant step change



to our engineering ethos and in due course will be extended to encompass our range of impact crushers," says Witherow.

The flow of material has been significantly improved by increasing the width of components as the material moves through the machine, and an advanced electronic control system monitors and controls the speed of the rotor and regulates the heavy duty vibrating feeder with integrated pre-screen to maintain a consistent feed of material into the impact chamber for optimal crushing conditions.

Wirtgen group member, Kleemann, says its new mobile cone crusher, MOBICONE MCO 11 PRO, is the first member of its new high-performance PRO Line.

The plant has been designed especially for operation in quarries, and can process up to 470 tonnes of material/hour.

"With the PRO Line Kleemann is developing innovative plants which are particularly powerful and efficient and which meet the demands of natural stone processing," says the company.

"The powerful diesel-electric drive proves to be particularly efficient. The efficiency can be increased even further thanks to the option of an external power supply. Furthermore, the drive concept offers excellent linkage options with other Kleemann crushing and screening plants.

"The cone crusher was completely redeveloped and achieves its high crushing capacity not least thanks to the 250kW electric motor, which is used to power the plant. With the fully automatic gap setting it is possible to make adjustments during operation."

The entire plant can be transported in one piece without the need to disassemble machine parts. □

ABOVE LEFT: *The new, fully-electric Lokotrack LT130E crushes hard limestone at a capacity rate of 400 tonnes/hour.*

OPPOSITE: *The introduction of the Terex Finlay I-140 horizontal impact crusher represents a significant step change.*



SMART NEW TECHNOLOGIES AND INNOVATIVE RENTAL OPTIONS ARE CREATING SAFER WORK ZONES

Highway work zones can be hazardous both for motorists who have to drive through the less than ideal road conditions that they create, as well as for the site personnel who have to work there. What sort of technology should you be using to make life safer for those who have to build, repair, and maintain our roads, bridges, and highways? Road safety expert *Mike Dreznes* reports.

Dangerous work zones are everywhere. Highway repair and maintenance sites pepper road networks worldwide. They are just as hazardous in the developed economies as they are across the developing world, where an abundance of road rehabilitation projects has not been accompanied by commensurate investments to foster a safety culture on road construction sites.

In an effort to tackle the unacceptable rate of work-site injuries occurring on roads funded through loans and grants, the World Bank recently presented an “environmental and social framework” detailing new safeguard mechanisms.

A requirement introduced in this framework states that the World Bank will “take appropriate safety measures to avoid the occurrence of incidents and injuries to members of the public associated with the operation of construction project equipment on public roads”.

Fortunately, technologies and concepts for traffic control have been developed to make construction sites safer for all road users. These apply in equal parts to developed as well as developing countries.

It is critical that every road authority utilizes a set of harmonised guidelines (known in many countries, including the United States, as the Manual on Uniform Traffic Control

Devices) to set the minimum requirements for the design of a safe work zone.

Contractors will be forced to use these criteria to create what is often referred to as a “level playing field.”

Road authorities should not rely on the contractor to design a safe work zone unless the contractor has clear guidance on how to achieve this. →



ABOVE: Portable traffic signal options range from trailer-mounted devices for long-term applications to cart-mounted devices for daily or short-term applications.

LEFT: Modern signals are often self-contained, non-invasive devices that feature on-board solar charged power plants, wireless radio communication systems and wireless traffic actuation systems.

→ The complexity and sophistication of the traffic control devices that are required in a work zone are determined by the length of time the work zone will be in effect, the amount of traffic at the site, the actual speed of traffic at the site and the distance from the travelled way to the work zone. The traffic control devices that are employed should make the work zone as safe as possible for ALL ROAD USERS, including pedestrians, bicyclists, pedestrians with disabilities, and motorists.

Software has been developed that will show the contractor the necessary traffic control devices for a job based on the length of time for the job, the traffic volume, the traffic speed and the proximity of the work zone to the travelled way. This software allows the contractor to prepare a safe work zone layout that can be confidently proposed to the road authority for approval so there are no excuses for the implantation of a work zone that does not meet the minimum safety standards.

In many countries traffic control companies have been created to supply the necessary traffic control devices on a rental basis. They often act as a subcontractor meaning the prime contractor does not need to own the equipment and can just rent or hire it as required on a job by job basis. This reduces the capital expenditures required by a prime contractor to create a safe work zone.

It is extremely important that the road authority inspects a work zone before it is opened to the motoring public to ensure it meets the local minimum safety requirements. It is essential that this inspection be conducted by the road authority or its agent and for all necessary corrective actions to be noted, so that the contractor is liable for the consequences caused by any violations that are not corrected.

Each of the "Five Elements" of a work zone must be designed with safety in mind.

In the "First Element" of the work zone - the "Advanced Warning Area" - sensors should be used to recognise the level of congestion in the area and variable message signs (VMS) should be set up to notify motorists of the blockages, several kilometres ahead of the zone.

These "Smart Work Zones" allow motorists to make educated decisions to reduce their travel time and to avoid slowdowns caused by congestion in work zones.

Signal programming can be accomplished quickly and easily by inputting project parameters



The technologies used in dynamic message signs, also known as variable message signs, now being employed in "Advanced Warning Areas" have improved significantly in recent years. These state-of-the-art variable message signs are brighter, with more colour and with longer lasting batteries and solar power options. The messages on these signs, which can be changed remotely, are more visible from further distances giving motorists the information they need to safely navigate a work zone.

Also in the "Advanced Warning Area", as well as in the "Second Element" of the work zone called the "Transition Area," flaggers are often used to slow down vehicles entering the work zone and to direct traffic through it.

Technologies have been developed to move these flaggers away from traffic out of harm's way or to eliminate human beings completely from the flagging task. This technology continues to evolve. When human flaggers are used, they must be properly trained for their own safety as well as for the safety of their fellow workers and the motoring public.

Technological advancements in work zone devices have made the addition of portable traffic signals a logical cost-efficient option for the majority of work zone traffic control applications. Portable traffic signals are available in several different platforms from trailer-mounted devices for long-term applications to cart-mounted devices for daily or short-term applications.

Portable traffic signals are self-contained, non-invasive devices that feature on-board

ABOVE: It is important to choose the necessary traffic control devices for a job based on the length of time for the job, the traffic volume, the traffic speed and the proximity of the work zone to the travelled way.

solar charged power plants, wireless radio communication systems, wireless traffic actuation systems, and a variety of add-on components to meet specific project requirements.

Today's portable traffic signals are highly reliable systems that have been designed to facilitate fast, efficient set-up and removal from the project site. Signal programming can be accomplished quickly and easily by inputting project parameters.

One concept that is changing the way motorists enter a work zone at the "Transition Area" is called "late merging," though advocates prefer the term "zipper merging" because it does not have a negative connotation. As motorists in two lane roads approach a work zone that is reduced to one lane, drivers should fill in both lanes in equal measure until they get close to the actual single lane "Transition Area." Within a few car lengths of the two lanes ending, the cars in both lanes should take turns filling in the open lane and resuming speed in the work zone.

Experience has shown that Zipper Merging can reduce backups by as much as 40% on average, since both lanes approach the merge with equal stake in maintaining speed. The challenge is to educate motorists to use this concept since many motorists consider "lane cutting" rude and offensive and they prefer to start the lane merging well in advance of the work zone.



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→ Truck Mounted

Attenuators (TMA) should be used to protect motorists from the back end of trucks that are parked in the "Transition Area" or at the "Buffer Space" or in the "Work Space," which are the "Third and Fourth Elements" of the work zone.

Some of the newer models of TMAs are trailers, so they do not require a dedicated vehicle. These TMAs are designed to protect motorists impacting the TMAs at speeds up to 100 km/h. TMAs also provide protection for the driver of the work vehicle as well as the work vehicle itself.

Another product used effectively in the "Transition Area" and in the "Buffer Space" is the portable rumble strip. This product can be quickly installed at the approach to the work zone to give motorists an audible signal to slow down as they enter the area. These portable rumble strips are extremely effective and they can be very easily and quickly deployed and removed.

New technologies have been developed to notify workers when an errant vehicle does enter the "Buffer Space" or the "Work Space" of a work zone. These devices utilise sensors to detect these intruding vehicles and set off audible and/or visible alarms to warn workers.

Some of these systems include personal warning devices that are carried by the workers. These warning devices vibrate and send off an audible alarm when a vehicle penetrates the buffer space or the work space of a work zone to allow the workers to move to safety.

A "Zipper" provides positive protection for the workers and the motorists

When the work zone conditions warrant positive protection in the "Work Space," the contractor must select the appropriate barrier. Although portable concrete barriers traditionally have been used in work zones, a variety of very good steel portable barriers are now available.

Both concrete and steel portable barriers provide excellent positive protection. However, the ability to move as much as six times more steel barrier than concrete barrier on a truck can have a significant economic impact for a contractor.

In addition, these steel barriers can be configured in a variety of ways to provide protection in a curved section of a work zone. Some of these steel barriers are provided with wheels to allow the contractor to move them easily both longitudinally down the road or laterally to the side of the road.

It is also possible to move portable concrete barriers using the concept of the "Zipper." This "Moveable Concrete Barrier" allows contractors to have wider work zones to permit them to use larger equipment and stage truck movement when there is little traffic present yet return the road to the motorists when traffic flows increase. A "Zipper" provides positive protection for the workers and the motorists, yet it returns full access to the lanes to the motorists when traffic is at its highest level, thereby reducing traffic congestion.

The "Mobile Barrier" is ideal for short term projects where the work must be done close

to the travelled way. The "Mobile Barrier" is a truck that can be driven to the site to provide positive protection for the motorists and the workers without the time and equipment required to install portable concrete barriers.

The truck bed of the "Mobile Barrier" can be extended to up to thirty metres to provide the workers with a safe working area. After the work is completed the truck can be simply driven away from the site.

Once the motorist is in the actual work zone "average speed safety cameras" are being used to ensure the motorists travel through the work zone at a constant speed that has been deemed safe based on the conditions in the work zone.

These cameras are helping to eliminate differing speeds by motorists that can create dangerous conditions. The length of the work zone is measured and the time it will take to get through the work zone is calculated.

Motorists' licence plates are photographed as they enter the work zone and again as they exit the work zones. Vehicles whose calculated speeds exceed the speed limits are sent violation notices.

Work zones can be very dangerous for both motorists and workers. However, the tools and the know-how are available to make work zones safer. Contractors must be given clear instructions to tell them what must be done to make a work zone safe for all road users. It is the road authority's responsibility to provide these instructions to the contractors to be sure every motorist and worker can travel safely through any work zone in the world with a minimum of inconvenience.

It pays to stay safe. □

"The tools and the know-how are available to make work zones safer"

RIGHT: The local road authority must always inspect a work zone before it is opened to ensure it meets the local minimum safety requirements ... contractors are usually liable for accidents caused by violations that have not been corrected.



THE SHAPE OF THINGS TO COME

Many quarries are optimising aggregate processing plants and fleet management with drone and cloud-based solutions, and other plant automation. *Patrick Smith* reports.

Quarries, and the equipment in them, are big and expensive items, so optimising aggregate processing plants and managing fleets efficiently is essential.

With safety and productivity among the watch words, any help in achieving both, along with other benefits, is a must for operators.

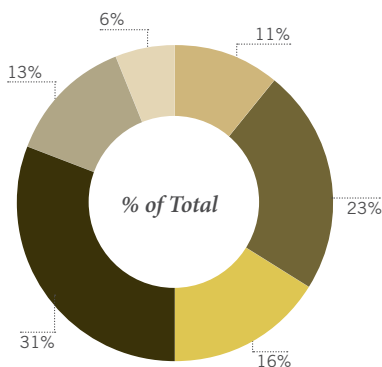
The quarry of today often bears no resemblance to those of say 40 years ago, with modern high-tech plant automation possibilities, and the digital age opening doors to drone and cloud-based solutions.

"Today, large quarrying companies already have their own department to develop automation systems. What they don't normally have is the capability to intervene analytically and to process all the information needed to calculate an accurate production cost," says Giorgio Manara, CEO of Italian company Ma-estro.

"Concurrently, small and medium quarrying companies normally cannot afford a dedicated automation department."

In both the above cases, Ma-estro, along with other specialist automated quarry plant solution companies, can help to find a bespoke solution to effectively run a quarry or quarries, where variable materials put machines under varying degrees of stress, thus affecting their production capacity.

Ma-estro average aggregates production costs (not considering loading and transport).



ABOVE: *Haver & Boecker's NIAflow program recognises potential for plant optimisation.*

This can raise or lower production costs by up to 30%, says Manara, while the capability to push a quarry processing plant to its real production limit, without overloading, is something that is almost impossible for an operator to do manually.

Manara says that a Ma-estro plant automation system checks the costs of screens and conveyors; crushing machines; maintenance (ordinary and extraordinary); energy; staff productivity and sludge treatment in real-time (every five seconds) and interferes continuously with the production process.

Its Q-Automation system uses special sensors installed on all the production machine fleet which are controlled by dedicated algorithm software.

"Nowadays, most new machines have control systems. But what is missed in many quarries is a plant solution capable of automatically managing the variability of raw material and to control all the production machine fleet from a single checkpoint," says Manara.

"The system optimises the entire process; brings impressive reduction of production costs; increases the quality of the final

Aggregates processing data analysis is becoming more important to every quarrying business

product; increases security for operators, and provides all the information needed to manage, in an industrial way, an aggregate production plant." Finnish crushing and

screening equipment manufacturer

Metso also offers an impressive list of applications for its Metso Metrics Services, an element of its Life Cycle Services packages for aggregates sector customers.

"Aggregates processing data analysis is becoming more important to every quarrying business, and Metso Metrics is just the beginning of what we can offer," says Janne Kytökari, Metso's global director, Monitoring and Control.

"The aggregates sector can also benefit from taking on board what is being done with plant automation in the mining sector."

Metso Metrics involves mounting a remote communication device on the company's Lokotrack crushing and screening equipment to enable easy and secured transmission of key operational and maintenance data, gaining critical data and insight on a fleet's operational performance and maintenance needs.

RIGHT: This is how Metso Metrics connects the machine to the customer.

→ Metso says that customers can see and compare data from their Metso Lokotrack mobile crushing fleet through the new plant automation tool, enabling them to deal with low utilisation and performance more effectively. Comparable data covers key areas including fuel consumption, effective and non-effective machine hours, and production statistics from belt scales.

Metso Metrics also allows customers to see when scheduled maintenance is required, and is said to make spare part and maintenance package ordering easy. The tool also offers remote expert recommendations done by Metso's specialist on how to improve a Metso fleet's performance.

The system offers secure collection and storage of data on a cloud database, and works off an Iridium satellite network available almost anywhere in the world. It also comes with a terrestrial mobile network option.

Usefully, Metso Metrics comes with no maximum history of data points, aiding customer's detailed, long-term performance and efficiency analysis. Customers can create as many users of the tool as required, with reports on machine information, such as hours and alarms, generated and sent by email daily, weekly or monthly.

"We currently offer Metso Metrics for our Lokotrack mobile models, but in a short time we will be offering it for our stationary crushers," says Kytökari.

"We are developing our analytics capability more and more, refining the data sent from the field to the customer. Data transmitted by satellite is expensive, so we are also developing our ability to send data through mobile networks. This allows us to send vast volumes of data compared to the satellite, whilst also expanding the scope of what we are collecting. Customers tell us they want more frequent data, including, in some instances, on a minute-by-minute basis.

"Aggregates processing data analysis is becoming more important to every quarrying business, and Metso Metrics is just the beginning of what we can offer. The aggregates sector can also benefit from taking on board what is being done with plant automation in the mining sector."

Haver & Boecker's NIAflow program instantly analyses existing or proposed processes, records plant statuses, and recognises potential for plant optimisation.

"As part of our ongoing efforts to optimise

plant efficiency for our customers, we are constantly developing innovative machines, programs and software to help them be successful," says Karen Thompson, president of Haver & Boecker Canada.

"NIAflow will serve as a cornerstone in the development of process engineering projects. When paired with other Haver & Boecker technology, such as Pulse vibration analysis software, our customers will hold all of the tools they need to optimise process flow and increase productivity and profits."

NIAflow is said to allow users to analyse more than 90 different process equipment pieces, from crushers and vibrating screens to material washers and conveyers.

"NIAflow will significantly impact the efficiency and profitability of our mineral processing customers," says Joachim Hoppe, Haver & Boecker Mining general manager.

"The thought process behind this software development was to give our partners tools to closely monitor their plant setup as a whole, allowing them to identify problems and plant bottlenecks. NIAflow helps producers discover the most efficient set up for existing equipment as well as determine equipment needed to enhance productivity and increase production."

Trimble's Loadrite InsightHQ, a quarry management portal for a web browser or mobile device, shows near real-time productivity, availability and performance dashboards and reports for extraction, processing and load-out.

The company says it provides visibility to respond to issues, optimise productivity, availability and performance in real-time,

with totals for each customer, product and machine by accessing data from LOADRITE scale-equipped loaders, excavators and conveyors, all in one place.

"To view changes over time, you can adjust reports to suit either the shift, day, week, month or year," says the company.

Siemens UK and Ireland has developed a



RIGHT: Trimble's Loadrite InsightHQ is a quarry management portal for a web browser or mobile device.



number of partnerships with key operators in the aggregates industry, aimed at optimising plant processes, automation and asset performance, including a partnership with Hanson.

This is said to be bringing the cement and aggregates specialist benefits in energy savings and CO2 reduction at several UK sites where Hanson is utilising Siemens' integrated drive systems (IDS) and total engineered solutions to upgrade and improve many of its existing operations, with fan and clinker cooler upgrades and dewatering projects, among others.

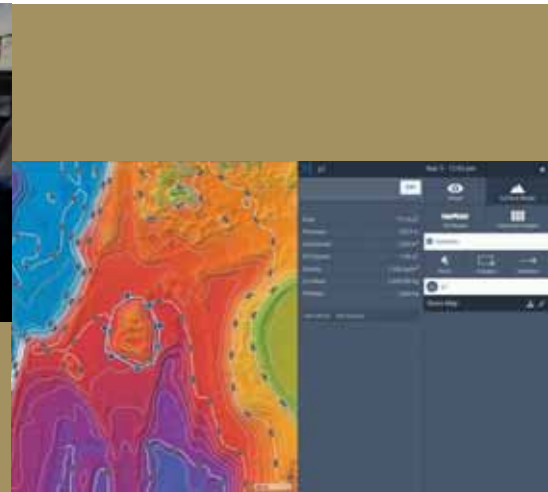
At one site, Hanson says it has made energy savings of 36% with a fan upgrade to one of its mills, also reducing CO2 emissions by 1,487tonnes to date, while at another plant a kiln fan upgrade has resulted in CO2 reductions of more than 1,900tonnes to date.

"We have a challenging target to reduce carbon emissions by 10% per tonne by 2020 based on 2010 baseline data so energy efficiency is critical to our business," says Martin Crow, senior sustainability manager at Hanson.

Other companies are also offering or developing plant and equipment automation systems, and one of the strongest trends highlighted recently is in drones, or unmanned aerial vehicles (UAVs), and their ability to map a site from the air, an asset that could have financial as well as technical benefits for contractors.

Some drones can communicate directly with machines on the project site, alerting them to areas that should be tackled next, and the aggregates industry has been quick to latch on to the possibilities of this growing industry.

It already has some big players, including Redbird, Kespry, Aibotix, Trimble, Topcon



Positioning Group, and now Intel, which has big plans to become a major player in the UAV market, with a special interest in developing aerial technology for the construction industry.

It recently unveiled its first drone, the Falcon 8+, and Intel says it can quickly and efficiently survey large sites, being designed to significantly reduce the number of hours required to conduct field inspections.

Intel's acquisition of MAVinci, a Germany-based commercial drone software company, will see enhancement of the surveying capabilities of its current drone technology using the algorithm for flight planning developed by MAVinci. Additionally, MAVinci will provide Intel with insights into drone design for larger, fixed-wing models.

Established in 2013, Redbird was among the leading start-ups in the analysis of spatial data collected by UAVs, and the company's global marketing agreement with Caterpillar opened up a huge potential market for its drone analytics solution.

Indeed, it was the conversations between a representative from Bergerat Monnoyeur, the French Caterpillar dealer, and Groupe CB senior management that led to drones

BELOW: Redbird was among the leading start-ups in the analysis of spatial data collected by UAVs.

ABOVE LEFT: Siemens UK and Ireland partnerships aim to optimise plant processes, automation and asset performance.

ABOVE: A Kespry Cloud screen shot showing contours and stockpile measurements.

and the Redbird solution being deployed at Groupe CB quarries in France.

Redbird was recently acquired by Airware, a San Francisco, US-based provider of complete commercial drone solutions, and it is claimed that the merging of Airware's powerful enterprise-focused workflow, compliance, and security features, and Redbird's innovative analytics application, produces an end-to-end solution for the heavy industries, from the drone flight to the powerful analytics cloud solution.

Indeed, Remi Fontaine, CB Quarries' financial controller, finds that the Redbird solution gives him an accurate overview of stockpile management while ensuring time efficiency and increased productivity.

"We fly drones regularly here. Every month, I use the Redbird solution for stock management work. It gives me up-to-date stockpile volume information which I can then use to work out the value of my limestone products," says Fontaine.

"Using drones and the Redbird solution enables me to deliver stock and other data to Groupe CB management more quickly."

As part of a trial of the potential use of drones to support its operations, Hanson UK (part of the HeidelbergCement Group) has used a Kespry automated drone system to measure limestone aggregate stockpiles at its Chipping Sodbury Quarry, county Gloucestershire, England, where 1 million tonnes/year is produced.

"Currently we have an independent stock survey carried out on a monthly basis," says James Veakins, manager of the site.

"Using this information for the stock on the ground relative to the sales for the month over the weighbridge gives me an idea of how much material we need to process in the coming period.

"This Kespry technology allows me on a



→ weekly or even daily basis to get very accurate stockpile measurements of all the different sized aggregate products I have available.

"I can then use that information to determine how I set up my crushing and screening plant to optimise the production of

different materials."

Topcon Positioning Group's Sirius Pro fixed-wing unmanned aerial system (UAS) is designed to produce accurate solutions for automated mapping of quarries, mines, construction sites, building facades, disaster



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ABOVE: A Topcon Positioning Group Sirius Pro fixed-wing UAS.

areas, and more, without regard to terrain.

Two new mapping kits for the system, the Sirius UAS City Mapping Kit and the Sirius UAS High Resolution Mapping Kit, include an enhanced MAVinci Desktop Flight Planning software upgrade.

"It allows the image capture of vertical facades such as buildings, infrastructure and construction sites," says Charles Rihner, vice president, Topcon GeoPositioning Solutions Group, of the City Mapping Kit.

"The upgraded flight planning software optimises the planning, preparation and processing to automatically produce a textured 3D model."

The Sirius UAS High Resolution allows the collection of images at the highest possible resolution for applications such as construction site monitoring, survey and mapping topography.

"The way surveyors and inspection professionals are working has changed significantly during the last five years," says Lothar Assenmacher, Aibotix managing director.

Aibotix is a provider of UAV solutions, including its Aibot X6 UAV, which was introduced in 2011. Many organisations worldwide are said to have relied on the accuracy and advanced technology of the Aibot X6 UAV and its accompanying software, Aibotix AiProFlight, which has recently been redesigned.

"The success of UAVs like the Aibot X6 is not only capturing aerial data but saving time and costs. We have been able to develop new features that complete the system, enabling us to offer everyone the opportunity to invest in the latest technology for aerial surveying and inspection."

Tom Rudolph, director of research and development, says: "These new features in the Aibot X6 UAV and AiProFlight software provide for results-oriented and time-saving processing of large projects.

"Professionals in areas like surveying, construction and monitoring will benefit from these latest developments. Standardised workflows and less processing time will be the visible results." □

PREPARING YOUR EQUIPMENT FOR A NON-TIER 4 WORLD

How are the world's leading construction equipment suppliers de-contenting and reconfiguring their engines for used machinery sold in non-Tier 4 markets? How easy and how cost-efficient is it to pare back used equipment for those parts of the global market that do not require Tier 4 technology? *Dan Gilkes* reports.

Internal combustion engines have been powering agricultural, construction and industrial machinery since they first started to replace steam. Increased speed, performance, productivity and reliability have made the diesel engine the motive force of choice throughout the developed world.

However, while the benefits of using an internal combustion engine have been clear for almost 130 years, the environmental downsides of pollution and emissions have only become increasingly noticeable in the past two decades.

Manufacturers have worked to improve efficiency over that time, producing ever more powerful outputs and continually cutting fuel use. This, in part, has reduced exhaust emissions, but environmental concerns have driven governments and regulating bodies to control emissions further through legislation.

For more than 16 years there have been increasingly tough emission standards that engine and original equipment manufacturers (OEMs) have had to comply with. North America led the way, with the introduction of Tier 1 legislation in 1994, for engines over 50hp (37kW). For European buyers the equivalent EU Stage I standard was introduced in 1999.

Stage II followed in 2001-2004, depending on engine output, while Stage IIIA and Stage IIIB came into force from 2006-2013. US legislators had been equally busy, calling for Tier 2 and Tier 3 standards between 2000 and 2008, followed by Tier 4 Interim and Tier 4 Final from 2008-2015. EU Stage IV was adopted in 2014, though many machines only moved to the latest standard during 2015.

Despite engine manufacturers and equipment firms finally taking a breath of relief during 2016, Stage V emissions standards are expected to be announced



Sales of secondhand machines from developed markets of North America and Europe have been a key issue for the development of low emission engines

during 2017, for implementation in 2019-2020. However, particularly at the lower end of the power range, many engine suppliers believe that their Stage IV or Tier 4 Final engines will meet Stage V without any additional work or expense.

Engine giant Cummins presented a new generation of engines at bauma in Munich during 2016. Across a 74-400hp (55kW-300kW) range they are expected to go beyond meeting Stage V near-zero emissions regulations. This was achieved by taking a different approach to combustion, air flow and fuel injection, allowing Cummins to realise the full potential of its 4-cylinder and 6-cylinder engines.

Speaking at the launch, Hugh Foden, executive director, Cummins Off-Highway Business, said: "Cummins is taking the opportunity offered by the introduction

of Stage V regulations in 2019 to redefine engine performance in terms that our customers care about, with easier installation, simplified servicing and more responsive power delivery. In the process, we will be raising the engine performance bar higher for the industry."


Crucially, the engines are being supplied as part of an integrated system, with the firm's Single Module exhaust after-treatment system. This was developed by Cummins Emission Solutions in response to the needs of increasingly space-constrained equipment manufacturers.

The efficient packaging of the Single Module has been achieved in conjunction with ultra-clean performance, that removes 99% of particulate matter (PM) emissions, as well as reducing Oxides of Nitrogen (NOx) emissions to extremely low levels.

It's a similar story for the majority of engine builders, all of whom have to meet standards in time for equipment manufacturers to install their engines to comply with the regulations. Which is good news for those customers in North America, across Europe, in Japan and in other regulated territories, as they can be sure that they will be supplied with machinery that is compliant.

The potential problem comes though, when those machines reach a few years of age and customers look to upgrade and update their fleets. In the USA, for example, there are around 3 million machines working with some form of emissions-controlled engine. Cummins alone has produced more than 160,000 Tier 4 engines over the last few years.

Traditionally, around 20-30% of those new machines will be resold each year, or traded-in against new equipment. That's 600,000-900,000 emissions-compliant machines just in North America, that will arrive on the used equipment market. →



The costs involved
must be borne by the
new owner or
by seller

→ There are probably a similar number from Europe too, with further contributions from other countries.

In the past those machines have mainly been sold in Latin American, African and Middle Eastern countries. Now, however, there are issues with their export. The problem isn't lack of service back-up or concerns over electronically-controlled engine management, though they certainly play a part. The biggest problem is fuel quality.

Emissions-compliant diesel engines have been designed to run on ultra-low sulphur diesel (ULSD), which is readily available in North America, Europe and in many developed countries.

Tier 1-3 engines were able to run on diesel with around 3,000ppm of sulphur, which is available around the world. Since June 2007 however, low sulphur diesel for non-road applications has contained a maximum of 500ppm, dropping to just 15ppm (ULSD) in June 2010.

"Tier 4 and Stage IIIB/IV engines, which meet the US Environmental Protection Agency (EPA) and European Union (EU) standards, use leading technologies that operate only on ULSD fuels containing fewer than 15 parts per million (ppm) of sulphur," said Cummins' off-highway communications specialist Naomi Buckland.

"ULSD is not available in every region of the world, which means Tier 4 engines must be adapted when moving into the second-hand market in these areas. They need to perform in an environment that they are not originally designed for."

To allow the export of older machinery Cummins introduced a Sulphur Tolerance Kit, which allows engines to operate with higher sulphur fuels. This removes exhaust after-treatment components and alters the engine control systems.

This kit is the only recognised method of de-regulating an engine for Cummins engines from 49hp to 675hp (36kW-503kW). The type of kit and process varies depending on the engine model, but it is solely intended for used engines that are exported into non-regulated regions.

"The kits increase the flexibility of Cummins products for the second-hand market, ensuring that subsequent owners experience the same reliability and durability expected from Cummins. So far, Cummins has had a positive uptake from customers for this kit as equipment's marketability and overall resale value increases," said Buckley.

"The introduction of the Sulphur Tolerance

Kit allows customers to sell used Tier 4-powered machines into a non-emissionised country, helping to retain resale value and ensuring that the next owner will experience the reliability and durability that customers have come to expect from Cummins," Cummins' executive director, Off-Highway Business Hugh Foden adds.

Of course Cummins, is not alone in offering this type of assistance to customers. Caterpillar and its Perkins engine division offer a similar service, offering an authorised modification process that includes decertification to remove after-treatment. This work can be carried out by any Perkins or Cat dealer around the world.

Volvo Construction Equipment launched a Tier 4 Interim/Stage IIIB conversion kit in 2014 for its articulated dump trucks, wheeled loaders and crawler excavators. The Volvo conversion kit consists of hardware that is exchanged and software that is updated. New owners can contact their local Volvo dealer in the destination country to arrange for the conversion kit to be fitted.

JCB is a growing force in the engine market, both with its own equipment and as an OEM engine supplier. The company was among the first to offer a process that allows dealers around the world to alter its EcoMax engines for use in countries with higher sulphur fuels. This involves recalibrating the engine control unit to shut off the engine's exhaust gas recirculating (EGR) system and to reduce fuel injection pressures.

The conversion also requires the fitting of a lubricity filter to ensure sufficient lubrication within the fuel injection system. The dealer also removes an electrical connection that would normally make the engine test the EGR system prior to start-up.

It's a similar story at Komatsu, John Deere, Bell Equipment and many other leading manufacturers. However, in each case the customer must use the manufacturer's dealer to carry out the de-emissioning work and in the case of North America, that work must take place once the machine has left the country. This work cannot be undone and the machine may never return to an emissions regulated territory.

"The Sulphur tolerance kit must be installed by a Cummins authorised distributor. The kit content and procedure varies by engine model and the engine must have a new electronic calibration and new data plate which only Cummins can manage," said Buckley.

"Certain regional and local regulations

related to environmental and emissions policies can require additional steps and Cummins can only ensure continued quality and reliability after the process when our distributor has done the work.

"For instance, the Cummins distributor installing the sulphur tolerance kit on a Tier 4 engine must be located outside of the Environmental Protection Agency emissions-regulated regions. European Union regulated locations are permitted to install these kits on Stage IV engines as long as the engine is then exported to the non-regulated region."

Engines do not have to have a new serial number, but the data plate must show emissions certification and compliance information. De-emissioning includes a new data plate that shows that the machine can never be re-imported into a regulated country.

Of course there is a cost involved in this work, which must either be borne by the new owner of the machine or by the company selling the equipment. This is on top of the purchase cost of the machine, which will already be higher from an emissions-regulated country.

This in turn may result in a rise in used equipment availability within regulated countries, pushing prices down. Where equipment is leased or purchased with a guaranteed future value, dealers may be less keen to offer generous purchase terms to customers, as they know that they will have more of a job moving the used machine on at the end of the first ownership period.

Manufacturers and dealers will no doubt point out to customers that the latest machinery is far more productive, or fuel efficient than older models, offsetting the additional purchase cost. But if that purchase premium doesn't translate to a residual value boost, there will a shortfall somewhere in the buying chain.

In some areas of the market manufacturers have been able to offer machinery with downsized, smaller engines, typically under 55kW, that are not as heavily regulated. This is particularly noticeable in the telescopic handler market and in the case of some smaller excavators and wheeled loaders.

By improving control systems, transmission and hydraulics, performance and productivity have been maintained with the lower output engines, with customers able to operate without costly after-treatment systems such as Diesel Particulate Filters (DPF) or Selective Catalytic Reduction (SCR). These models should also be easier to sell on in the used equipment market, boosting their residual value. □

THE NON-TIER 4 WORLD

Record on-site attendance and a general increase in pricing were noted at a recent Ritchie Brothers auction in Dubai.

"We also noticed an improvement in the general business optimism including the regional economy," says Karl Werner, chief operational support development officer, a global role with global auctioneers Ritchie Brothers. "There wasn't as much doom and gloom as we have seen recently before from customers."

Ritchie Brothers does some business with United Nations organisations and the Red Cross in the Middle East, selling their used equipment. Syria has been off limits for several years and Werner expects that when hostilities end, the country will, as is usual in the Middle East, start rebuilding immediately, increasing the demand for used equipment.

Despite regional wars, such as those involving Iraq and the Syrian crisis, the Middle East remains an active area for successful auctions, explains Werner, an American working out of Ritchie Brothers' head office close to Vancouver on Canada's Pacific coast.

He has seen many changes in his 20 years with Ritchie Brothers, none more seismic than the introduction of on-line bidding. This has been a boon to sales especially in the non-Tier 4 regions of Asia, Africa, Middle East and South America.

For potential buyers in regions where international travel is expensive or simply prohibitive for various political or geographical reasons, on-line bidding has been a game changer, he explains. "I've looked after our on-line auction operations since 2005 and in general every quarter we set a new record for on-line participation. This year [2016] we're close to US\$2 billion in on-line sales out of around \$4 billion total. It's been a significant impact on our business."

The more electronically complex Tier 4 machines with their data capture and

visual display units for operators are driving on-site efficiencies including lower fuel consumption. These machines occasionally show up in auctions in non-Tier 4 regions and many will go to more developed countries. "If these units are EPA compliant or CE compliant, then there can much more internet bidding with an eye to shipping them into Tier 4 regions," says Werner.

There is some interest in these more complex machines in the non-Tier 4 regions. But there remains an obvious preference for Tier 3 equipment because the

machines are less complex and their fuel requirements allow for lower-grade fuel. "The Tier 3 machines have fewer electronics so they are easier to maintain in the field and find parts than is the case for Tier 4 equipment," he says.

"We are also seeing increased interest in all non-Tier 4 regions in used equipment because of an increase in mining and resource activity," says Werner. It points to a regeneration after sales tumbled on the back of falling commodity prices. Mining companies, from Australia, Asia, Africa and South America, were paring back their front-line operations soon after.

In the Middle East, Werner has noticed "a bit of an up-tick" in activity from Chinese equipment owners and Chinese OEMs selling equipment at Ritchie Brothers Dubai auctions, cranes in particular but not a flood of units. Cranes in the Middle East sales have been stable, as have 20 tonne excavators, telescopic lifts and rollers - all standard construction equipment. "There are usually more fluctuations in the larger more specialised equipment, such as for mining operations."

Ritchie Brothers has been holding auctions in Dubai for 20 years. Equipment on the block at the latest event, in December, showcased more than 60 cranes, including a 2014 Sany SAC2200F 220-ton 10x8x10 all-terrain unit, and over 70 excavators,



Karl Werner

including a 2011 Caterpillar 336DLN hydraulic model. Also sold were around 75 compactors, including 10 unused 2016 Dynapac CA255 vibratory rollers.

It is the the Indian subcontinent that is turning into a standout region for new and used equipment. There are many road and pipeline projects in Pakistan, despite political issues. But it is India that is grabbing attention. "There is a lot of excitement in India related to the new Modi government and announced road infrastructure work," explains Werner who also holds the role of managing director for Africa, Middle East and India.

Narendra Damodardas Modi, India's prime minister since elections in May 2014, immediately embarked on setting up a more business-friendly regime. He eliminated much red tape for direct foreign investment and restarted many stalled infrastructure projects, as well as kick-started new ones. Importantly, he spearheaded an ambitious road-building programme, allocating billions of dollars for the construction of new roads and the upgrading of others, amounting to upward of 10,000km.

As 2017 unfolds, the new Trump administration in Washington is beginning to flex its muscles, particularly in relation to its trade with China. "We're in uncharted territory. But on a positive note any market nervousness that was apparent during the US presidential election is over. Regarding possible US importation tariffs on new equipment, who knows," says Werner.

Used equipment is not usually subject to similar tariffs but only time will tell. "Nothing has been determined. The likelihood of an all-out trade war is pretty slim." □

Any market nervousness that was apparent during the US presidential election is over

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