

VROOOOOM ...

“When I grow up I want to be a digger driver.” Dennis and his son had already known that for a long time.



Dump trucks, wheeled loaders, cranes and compressors – the world of construction equipment is endlessly fascinating. As well as their massive proportions and enormous power the machines have something else in common – an MTU engine inside.



The Mercedes-Benz industrial engines marketed by MTU are based on commercial vehicle engines. MTU has optimized them for duty in the toughest of off-highway conditions.

« In construction and industrial applications, engines are severely tested. Be it performance, economy or life expectancy – the maximum is always demanded. And the higher the demands, the stronger the argument for our engines. »

Rainer Breidenbach, Tognum COO with responsibility for the Engines Division

The monster excavator moves purposefully through the fine yellow sand, its bucket full of stones. “Vroooooom!” Dennis adds the sound effects to accentuate the speed of his giant white digger. The excavator is the fastest in the whole sandpit and in any case the biggest. Dennis is quite certain none of his friends has a digger this big. And another thing he’s sure about: “When I grow up I want to be a digger driver.”

Series 4000 for the world’s biggest Mining-trucks.

The white monster truck throws itself into the bend at nearly 60 kilometers an hour carrying a massive pile of rock. Its mighty “Vroooooom!” is impossible not to hear. Dust and dirt are sent spiraling into the air. The truck looks like a toy in the vast expanse of the Cortez gold mine that now, 30 years later, is Dennis’ new sandpit. The old one of his childhood days would fit many thousands of times into the mine, where the sand is dark brown rather than golden yellow. But Dennis still wears the same look of pride. He now drives the Liebherr T282B dump truck – one of the biggest on Earth at almost 15 meters long, over seven meters high and nearly nine meters wide. It can carry a load of up to 360 metric tonnes, which is equivalent to a fully laden and fueled Boeing 747, four railway locomotives or 314 VW Golf cars. The Liebherr T282B is one of the largest dump trucks in the world. When Dennis stands next to one of its wheels, his head doesn’t even reach the hub. They are more than four meters high and weigh nearly eight tonnes. The rear wheels of the truck are driven independently by separate electric motors. The motors are supplied with power by a generator driven by a 20-cylinder MTU Series 4000 engine. With an output of 2,720 kilowatts at 1,800 rpm and a capacity of around 90 liters, it propels the giant dumper to a maximum speed of 64 kilometers per hour.

And the search for superlatives goes on. In April 2010 at the world’s largest construction machinery fair, the Bauma show in Munich, Liebherr unveiled its latest model, the T282C. The new truck is slightly bigger again and can carry a larger payload. Like its predecessor, it is powered by a 20-cylinder MTU Series 4000, an engine that comes as standard with something that is indispensable for construction vehicles. It has supreme dynamic response. Its high torque from very low revs delivers colossal pulling power. What is more, the engine gives the dumper absolutely outstanding economy. It uses very little fuel and has long oil-change intervals, both of which lower the engine’s operating costs.

« It can carry a load of up to 360 metric tonnes, which is equivalent to a fully laden and fueled Boeing 747. »

Mega wheeled loader with 45-cubic-meter bucket capacity

A few meters away, Dennis’ colleague is driving a Le Tourneau wheeled loader that is almost as big as the dump truck – almost 20 meters long, nearly seven meters wide and just over six meters to the top of the driver’s cab. With its 45-cubic-meter bucket it can fill the dump truck in just a few shovelfuls. In the engine bay of the mighty wheeled loader is an ultra-reliable 16-cylinder MTU Series 4000 capable of 1,730 kilowatts (2,350 bhp). “These engines are used wherever maximum availability, safety and reliability, minimal fuel consumption, excellent support services and economical lifecycle costs are what matters,” imparts Norbert Eisenblätter, the man

Motiveline as co-driver

The Motiveline driveline control and automation system developed specially for mining vehicles by MTU is an innovative technology that monitors and controls all engine functions and the system components necessary for its operation. The interaction between the vehicle components, the engine and the system components functions fully automatically (and within an integrated network). The modular automation system guarantees adaptation of the engine system to the multilayered operating conditions in everyday mine work. As they are expected to deliver the highest levels of performance under very variable conditions, mining vehicles benefit in particular from flexible adaptation to vehicle components, automatic power adjustment and connection to the integrated engine life data recorder that stores information for the service personnel. For the operator, that means fewer breakdowns, lower fuel costs and, consequently, money savings.

The basic components of the Motiveline system are the Advanced Diesel Engine Control (ADEC), Power Output Module (POM), Service and Application Module (SAM) and Engine Monitoring Unit (EMU). Designed for advanced, high-performance diesels and precisely matched to the common-rail technology used on the Series 4000, the ADEC smartly and reliably manages the extreme loads that the vehicles are regularly subjected to in their tough daily tasks. An integrated safety and self-testing system automatically adjusts the engine output to the prevailing operating conditions or shuts it down altogether in an emergency in order to prevent costly damage. The ADEC is supplemented by an Engine Monitoring Unit (EMU) that further improves engine availability due to additional monitoring and diagnosis options. The ADEC controls the Power Output Module (POM) via a CAN databus. Like the ADEC, the POM is an electronic control module permanently attached to the engine and a component of the Motiveline system. Wired up to the starter motor and alternator, it controls their electrical power circuits in order to optimize the starting sequence. Interfaces are managed efficiently by the compact and intelligent Service Application Module (SAM). Another interface (Global System for Mobile Communication) allows the operator to receive engine-specific operating data and so remotely monitor and diagnose the vehicle's performance. In addition, the Motiveline automation system provides an optional interface for subsequent integration of exhaust treatment systems.

responsible for mining engine application technology at MTU. The electronic engine management adjusts the most important operating parameters such as injection volume and pressure to suit the onsite conditions. And the insulated exhaust pipes limit the surface temperatures to around 200 degrees Celsius, so minimizing the fire risk. In addition, the oil filter system equipped as standard with two large oil centrifuges reduces the life-cycle costs, protects the engine and increases the vehicle's availability.

But it isn't just the "big" MTU engines like the Series 4000 that are present in high numbers in the mine. Their smaller siblings, the Series 2000, drive many of the vehicles as well. Like the "smaller" Le Tourneau wheeled loaders, for instance. They can "only" lift around 30 tonnes rather than the 70 that the L-2350 is capable of.

Mercedes power for the lightweights.

One wonders whether Dennis thought about it when he was playing in the sandpit as a four-year-old. He and his friend dreamt of trying out construction vehicles in the big wide world. His career began not many years later on a building site in his home town not far from his sandpit. And so engines from MTU became his constant companions. His toys were then no longer trucks and diggers in the sandpit but jackhammers, pneumatic drills and sprayguns. The compressed air that powered them came from a compressor driven by a Mercedes Series 500 engine.

Some years later, the sandpit dream came true. Dennis was in the driver's seat of a Bell dump truck. Instead of transporting sand as he had in his boyhood games, he was now shifting heavy rubble. The engines supplied by MTU made sure that the vehicles accelerated powerfully and traveled swiftly even when asked, as they often were, to tackle some pretty steep slopes.

The Series 500 engines are based on Mercedes-Benz power units that have proven themselves thousands of times over in commercial-vehicle applications and have been optimized by MTU for duty in the toughest of off-highway conditions.

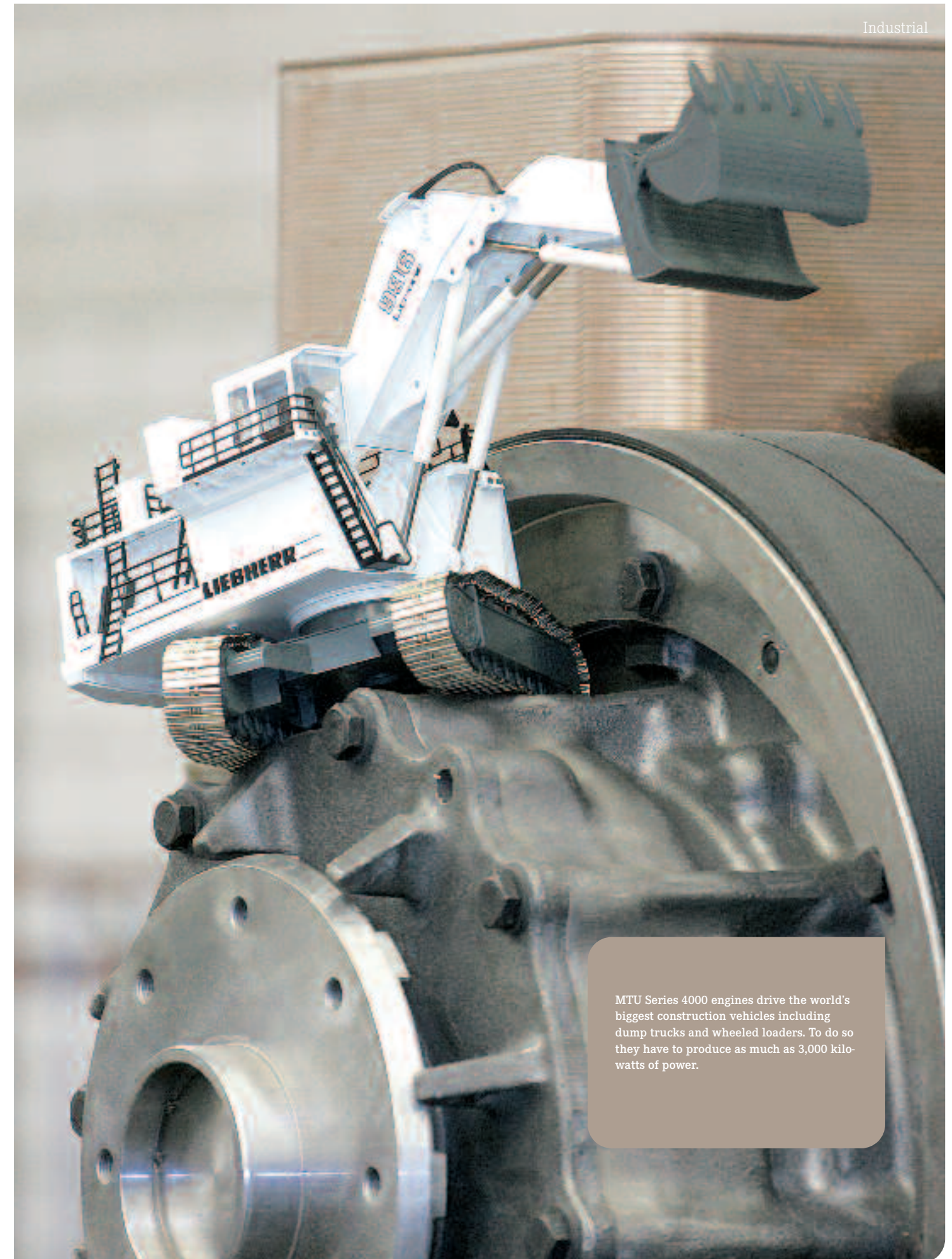
« These engines are based on Mercedes-Benz commercial-vehicle power units that have proven themselves thousands of times over. »

Huge mobile crane

Dennis' best friend right from those far off days in the sandpit now drives a crane. Not just any old crane, but one of the largest offroad mobile cranes in the world, the Terex AC 1000. It can lift a weight of 1,000 tonnes – equivalent to nearly four fully laden Boeing 747s. And it still has to be extremely versatile as well. The crane must be just as safely and reliably drivable on unsurfaced tracks and rough terrain as on tarmacked roads. It demands the immense power required to lift and carry the heaviest objects and position them accurately to within millimeters. And that is provided by a Mercedes engine supplied by MTU.

SCR system removes nitrogen oxides.

In future, the engines of both vehicles will be fitted with SCR catalytic converters in which the nitrogen oxides contained in the exhaust are converted into water vapor and harmless nitrogen. That is something Dennis certainly didn't think about in the sandpit. His engines went "Vroooooom" and were



MTU Series 4000 engines drive the world's biggest construction vehicles including dump trucks and wheeled loaders. To do so they have to produce as much as 3,000 kilowatts of power.



MTU Series 4000 engines power the biggest dump trucks on Earth. They have water-cooled exhaust pipes to minimize fire risks.



Mobile cranes have to meet the toughest demands. They must not lose agility and maneuverability even on rough terrain if they are to be able to precisely position their loads to within a few millimeters. At the same time, they have to be able to move quickly on surfaced roads. The Mercedes engines are purpose-designed for such requirements. They develop high torque right from very low revs.

absolutely zero-emission. The Series 500 and 900 engines will be fitted with the SCR system from 2011 for compliance with the Stage IIIB emissions legislation. "The SCR system has already been tried and tested hundreds of thousands of times over in Mercedes trucks and so is absolutely reliable," explains Gerhard Kramer, Head of Applications Technology for Industrial Engines at MTU. In terms of their dimensions, fixing points, external connections and power-take-off points, the basic engines are identical with the present models. The cooling system is slightly modified as the amount of heat generated during operation is different. The vehicle manufacturers also have to accommodate the SCR catalytic converter and the pump and tank for the reducing agent in the machine. So that less additional space is required, MTU combines the SCR catalytic converter and the silencer in a single component. And so that the engines produce less particulate matter, MTU has also further optimized the fuel injection, turbocharging and electronic engine management systems and very precisely adapted all parameters that affect emissions to the new requirements. As a result, combustion is now even more efficient and produces so little soot that the engines will meet the particulate matter emission limits of the future Stage IIIB and EPA Tier 4i standards by internal engine design features alone. In other words, they will not require a diesel particulate filter to comply with those requirements. What is particularly clever about this engine is that even though it produces lower emissions than the model designed for compliance with the previous phase of the emissions legislation, Stage IIIA, it uses less fuel and has even better dynamic response at low revs.

Today, Dennis' son plays with diggers and dump trucks in the sandpit. With a loud "Brrrrm" he pushes the toy excavator through the yellow sand. And a few days ago he came up to Dennis and said, "Dad, when I grow up I want to be a digger driver." By the time that day arrives, the engines will only produce a minute fraction of the emissions they do today. "The development

of our engines is advancing at amazing speed," states Rainer Breidenbach, COO with responsibility for the Engines Division at MTU's parent company, Tognum.

« The diggers in the sandpit went "Vroooooom!" and were absolutely zero-emission. »

Engines for the next legislation phases

The renowned Series 400, Series 500 and Series 900 engines from Mercedes are to be replaced from 2014 by five new engines specially designed for off-highway applications. These will cover the power range up to 500 kW and their designations will be 4R and 6R 1000, 6R 1100, 6R 1300 and 6R 1500. "These engines complete Series 1600 at the lower end of the power range and together, they will set a new standard", explained Mr Kramer. Depending on application, they will be up to five percent more powerful than their forerunners and boast very low fuel consumption, high power outputs at low speeds and significantly improved engine brake power. Use of exhaust gas recirculation, a diesel particulate filter and an SCR system will ensure compliance with US emission standard Tier 4, which will then be in force. The complete exhaust aftertreatment system will be contained in compact housing and replace the conventional exhaust silencers.

Above the outputs covered by the 1000, 1100, 1300 and 1500 models, the Series 1600 will offer the required motive power. With a capacity of 1.75 liters per cylinder, the design caters for power requirements up to 730 kilo-

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watts. The engines are compact and easy to integrate in the machine. With only a small number of external connections, such as for coolant pipes and air ducting or electronic interfaces, installation is fast and economical. As the intercoolers are attached directly to the engines, the complication of fitting them in the machine is removed. What is more, the cooling system for the machine's hydraulics can be integrated in the engine cooling sys-

« These engines will complement our Series 1600 at the lower end of the power spectrum and will collectively set new standards. »

Gerhard Kramer on the new engines from the Daimler Group

tem. The engines will meet the EPA Tier 4 emission standard applicable as of 2014 by means of optimized combustion, exhaust recirculation and an oxidation catalytic converter. Exhaust treatment systems will not be required.

A Series 2000 engine with Common Rail injection.

In 2011, a new version of the MTU Series 2000 engine will also come onto the market. In contrast with previous incarnations, it will have common-rail fuel injection instead of the unit-pump system. The engine has already been undergoing bench tests at MTU for some months. The emission limits are to be achieved with the aid of an exhaust recirculation system only. The mining models with power outputs in the range of the Series 4000 will

comply with the stricter emission limits in 2015. But the MTU developers are already working on an even more advanced version of the engine that will be available for other applications as early as 2011.

“I can assure you of one thing – whenever a new emission stage comes into force, we have the technical solution. That applies to Stage IIIB for industrial engines and will also be the case for the big Series 2000 and Series 4000 engines,” Breidenbach promises.

“Vroooooom!” That noise is another thing we can be sure will continue to be a common sound and inspire future generations of digger drivers. Listening excitedly to the stories of grown-up excavator drivers about the massive sandpits where gigantic dump trucks are made to look as small as toy cars until the day comes when they feel the power of the MTU engines below them.

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“Do you remember? We used to play with toy trucks in the sandpit and now we drive the real thing,” Dennis reminisces with his workmate on the building site.



8 Le Tourneau wheeled loader 9 Liebherr dump truck
10 Terex offroad crane 11 Perlini dump truck
12 - 13 Terex and Manitou cranes 14 Bell dump truck



MTU engines are in use in construction plant of all kinds.
1 Liebherr mining excavator 2 Wirtgen road miller 3 Faun crane
4 Sandvik underground mining dump truck 5 Hitachi wheeled loader
6 Terex mobile crane 7 Liebherr dump truck

