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MTU Series 1300 engine

Power. Passion. Partnership.

MTU report

The magazine of the MTU and MTU Onsite Energy brands | Rolls-Royce Power Systems brands
Issue 01 | 2016 | www.mtu-report.com

Power. Passion. Partnership.

Looking to the future

Have you ever asked yourself what our lives will be like in 20 years' time? Will ships still need a captain? Will we be using drones to fly to work? Will you still be able to buy diesel engines from us? I can already answer that last question with a very definite 'Yes'. At this point I will not anticipate the answers to any of the other questions, but I would recommend that you take a look at the main section of this issue because it focuses our attention on the future.

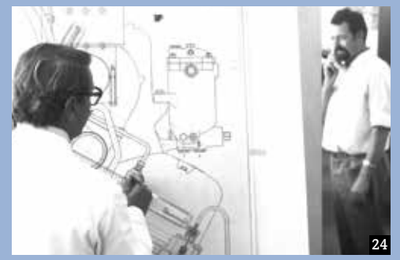
The future really is a fascinating place. Throughout history, those who attempted to predict the future often got it very wrong. In 1895, for example, Gottlieb Daimler, a true genius in his own field, predicted that the number of vehicles in the world would never exceed 1 million. The Danish physicist Niels Bohr was not so far off the mark when he said that predictions were difficult – especially when they concerned the future. Nevertheless, when I say that megatrends like digitalization or Industry 4.0 will fundamentally change our company, I suspect I am not leaving myself open to any overwhelming risk. These phenomena offer entirely new possibilities for working together with our customers and our suppliers. To be certain that we are maximizing this potential and ensuring that MTU is future-proof, we are currently taking a very close look at every area of our company. We want to keep a firm hold on our own future and to develop new ideas for creating products that exactly match our customers' needs even more quickly and efficiently. And we aim to do that in a company where everyone involved feels comfortable in the knowledge that they can contribute to our success.

That is our program. But it is also part of a transformational process initiated by our parent company, Rolls-Royce. We are currently one of five Rolls-Royce business divisions, and we work very closely with our British colleagues. Together, we are working to create an even better future for our company and thus also for you, our customers. I look forward to that future – whether it sees us using drones to get to work or continuing to commute in cars powered by combustion engines.

Yours,

Dr Ulrich Dohle

Dr Ulrich Dohle is Chairman of the Executive Board of Rolls-Royce Power Systems AG and Chairman of the Board of Management of MTU Friedrichshafen GmbH.



Keep up with MTU

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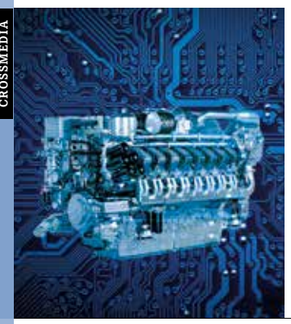


Title: An engine without a circuit board? Inconceivable. As the cover picture suggests, there is simply no getting past the circuit board. MTU engines, however, are becoming smarter and will be able to transfer their operating data and tell the operator when they need to be serviced and how they can be operated as cost-effectively as possible. They will also network with their environment. All this without a circuit board? Inconceivable.

Crane whispers

Where are the biggest construction machines with MTU engines? What are the main show trends? Who is buying from MTU? And what is MTU offering its customers? The answers to those questions can be found at the Bauma show – the world's leading trade fair for construction, building material machines, mining machines, construction vehicles and construction equipment. And anyone who is unable to be there in person can find the answers online at **www.mtu-report.com/Bauma2016.** Checking back in to the site is always worth the effort, because it is constantly updated before, during and after the show.

www.mtu-report.com/Bauma2016

Engine rebuilds at a fixed price

They might be old, but there's life in them yet: MTU's 'classic' series - the 538, 595, 1163, 183, 396 and 493 are almost legendary. These are powerful, high-class, reliable engines - 'old-timers' - that many customers are loath to part with. That's why a lot of customers take the opportunity to have their classic engine - which might be 30 or 40 years old or even older - completely rebuilt as an as-new unit. This complete MTU service package is named *Factory Rebuild* and is available at a fixed price, with a warranty for top quality. "A factory rebuild involves a complete major overhaul - from disassembly and inspection to re-conditioning, re-assembly, testing, re-spraying and packaging," said Christian Halder, service sales manager of the global service sales team in Friedrichshafen. During the rebuild, the engine components are inspected using certified methods and overhauled in the series production section, where the highest level of process reliability is assured. Each overhaul in production takes place according to specifications provided by engineering departments and is approved by them. A *Factory Rebuild* provides the customer with an as-new engine at a fixed price with full warranty cover. This distinguishes it from the normal major overhaul.

The gas engine learns how to swim

The ferries on Lake Constance are still exclusively powered by diesel engines. That is now set to change. The first ferry powered by a natural gas engine is due to go into service on Lake Constance in 2019.

In the development of the 8V 4000 engine, MTU benefits from its previous experience with stationary gas engines and from development work now being carried out for a 16-cylinder marine gas engine which is currently underway with initial tests just being completed on the test bench.

A new ferry powered by an MTU gas engine is due to go into service on Lake Constance in 2019. Rolls-Royce and the city of Constance public utility company joined forces on the project. The new ferry will be one of the first in Europe to be powered by a high-speed pure-gas engine. It will feature low pollutant emissions and improved cost effectiveness, while delivering the accustomed high performance.

Dr. Norbert Reuter, Managing Director of Stadtwerke Konstanz GmbH, at the announcement of the cooperation agreement on 10 December 2015 in Constance said: “We are delighted that MTU, our partner of many years' standing, is developing a natural gas propulsion system for our new ferry. The deciding factors for us to venture into a new world of propulsion for our fleet are the excellent environmental compatibility of the gas engines and the possibility of saving fuel costs, while maintaining our current requirements in terms of the performance and maneuverability of the vessel. As a ferry operator on Lake Constance, Europe’s largest reservoir of drinking water, it is very important for us to guarantee safe and environmentally sound operations.”

Marcus A. Wassenberg, Chief Financial Officer at Rolls-Royce Power Systems AG, speaking in Constance, added: “We are convinced that gas engines will become increasingly important as supplements to tried and tested diesel engines for shipping. Natural gas is an important fuel for the future. It will be available for a longer period of time and is cheaper in many regions throughout the world, in addition to having a far better carbon footprint than either heavy oil or diesel. With the development of the new gas engine and its trials in the ferry operated by Stadtwerke Konstanz, we are taking up the challenge of further improving the emissions and efficiency levels of gas engines, in order to be able to meet future emission regulations and the needs of our customers. The development of gas engine technology and the associated fuel infrastructure will also require state funding until they become economically viable.”

The new 8-cylinder gas engine with a rated output of 750 kilowatts now to be developed by MTU, is based on proven MTU Series 4000 diesel engines for workboats. The clean combustion concept will make it possible to meet the IMO Tier III emission standards without the need for additional exhaust aftertreatment. By comparison with a diesel engine without exhaust aftertreatment, the gas engine will emit no soot particles and no sulfur oxides, 90% less NOx and 10% less greenhouse gas. The new 8V 4000 gas engine will also incorporate gas injection for individual cylinders, a dynamic engine control system and a safety concept optimized for natural gas operation. The new gas engine series is being developed to ensure that it meets the particular load profile of the Lake Constance ferries, with acceleration comparable to that of the MTU diesel engines.

Speeds up to 60 knots help save lives at sea

FB Design is currently testing a lifeboat that is twice as fast as other lifeboats.

The majority of rescue vessels are capable of speeds up to 30 knots. However, in Italy, a rescue vessel that boasts twice this speed and can move at 60 knots (111 km/h) is currently undergoing trials. The SAR 60 is aimed at the coastguard market where boats have to carry out both patrol and life-saving duties. "To reach our design speed of 60 knots, I needed engines that had a good power/weight ratio and engines that were totally dependable," said Fabio Buzzi from FB Design to explain why he opted for MTU engines.

"Research showed that around 85% of lifeboat rescues were carried out in moderate or fine sea conditions where speed can be important," commented Buzzi. "Most current lifeboat designs operate at around 30 knots but I knew we could double that speed potential and still create an all-weather lifeboat design. The SAR 60 is aimed at the coastguard market where the boats have to carry out both patrol and life-saving duties."

The new SAR 60 built by FB Design incorporates a wide range of safety features developed from 50 years of experience in building fast boats. "The boat is self-righting in the event of a capsize, it is built using our Structural Foam system to give added integrity and we increased the length/beam ratio to improve the performance in rough seas. In addition we have developed special Tecno seating to protect the crew and used our anti-stuff bow shape to improve following sea performance," said Buzzi.

The two MTU 10V Series 2000 engines each produce 1,200 kilowatts and they drive through ZF Trimax surface drives. The engines are fitted with the MTU 'Rough Kit' that enables the engines to operate reliably in extreme conditions. Buzzi's Tri-Tab flap concept gets the boat quickly onto the plane and gives better controllability and acceleration, features vital for operating in rough seas. "We think this is the first time that surface drives have been used on a lifeboat but our drives keep the propellers within the hull depth for added safety."

The biggest from Turkey

The 80.1-meter vessel will not only be the longest yacht ever to have been built by the Bilgin Shipyard, it will also be the biggest vessel in this class ever built in Turkey.

MTU Turkey has signed a contract with Istanbul-based Bilgin Yachts for the supply of six MTU engines. These will be deployed to power two 47.6-m Bilgin 156 motor yachts, as well as the largest yacht ever built in Turkey in its class – the Bilgin 263. Bilgin Yachts recently won the construction order for the 80.1-m superyacht from a long-standing customer. It will be powered by twin MTU 16V 4000 M63R engines. Bilgin also decided to embark on the construction of two 47.6-m motor yachts – each of which will be powered by an MTU 12V 2000 M72 unit. MTU is part of Rolls-Royce Power Systems.

The 80.1-m superyacht will also be the largest vessel that Bilgin Yachts has been entrusted to build. Bilgin CEO İsmail Şengün said: “Realization of this large-scale project definitely represents a major step forward for Bilgin. And this important project will also enable us to continue our excellent cooperation with MTU. We may be increasing the engine order to eight units, as another contract for an 80-m vessel is on the way.” Construction is scheduled to begin in March 2016, and delivery is planned for 2019.

Ekrem Kuraloğlu, Managing Director of MTU Turkey, said: “This is an exciting and challenging opportunity for us in today’s yacht market, and we very much appreciate the opportunity to collaborate again with Bilgin.” MTU and Bilgin have been working together for 20 years.

MTU will supply the engines for the 47.6-m yachts in September 2016 and mid-2017, while the engines for the 80.1-m superyacht are to be shipped in late 2016.

Joint engine production: Guangxi Yuchai Machinery and MTU Friedrichshafen, a subsidiary of Rolls-Royce Power Systems, will assemble the MTU Series 4000 engines in future in the south-east Chinese city of Yulin on a joint basis.

Joint Venture in China

MTU and China Yuchai International Limited's main operating subsidiary, Guangxi Yuchai Machinery Company Ltd. (GYMCL), have today signed an agreement to set up a 50/50 joint venture for the production, under license from MTU, of MTU diesel engines in China. Each party will invest 75 million RMB (around 10.5 million Euro) in the joint venture.

The joint venture will be based at GYMCL's primary manufacturing facilities in Yulin City in Guangxi Province, south China, and is expected to begin production in 2017. The joint venture will produce MTU Series 4000 diesel engines compliant with China Tier 3 emission standards with power outputs ranging from 1,400 to 3,490 kW, primarily for the Chinese off-highway market, in particular for power generation and oil & gas applications.

The joint venture will open up new growth opportunities for both partners, particularly in China and Asia. The joint venture will enable better access to the Chinese market for the MTU Series 4000 diesel engines, via the extensive sales and service network operated by GYMCL. GYMCL will, as a result of the joint venture, be able to offer its customers technologically advanced engines that have a proven record on the global market. The joint venture engines will be marketed by GYMCL and MTU Suzhou within China and by MTU and its subsidiaries exclusively outside China.

Dr Ulrich Dohle, President of Rolls-Royce Power Systems, and Yan Ping, Chairman of the Board of Guangxi Yuchai Machinery, signed the joint venture agreement in Yulin on 19 February, 2016.

From 2020, the sales territory of GYMCL will be extended to selected countries in South East Asia, such as Vietnam, Thailand and Malaysia. After a ramp-up phase of three to five years, the scope of the joint venture might (subject to further discussion) be extended to research and development activities as well as potentially direct sales from the joint venture to the customer. The establishment of the joint venture is subject to the fulfillment of certain conditions, including but not limited to approvals by the relevant authorities.

The locomotives will be exported to Argentina for service with Belgrano Cargas y Logisticas S.A. of the Argentinian Ministry of Interior and Transport.

Argentina buys locomotives in China

MTU will deliver a total of 100 MTU Series 4000 engines from Chinese locomotive manufacturer China Railway Rolling Stock Corporation (CRRC). The total contract value is above €30 million. The 16V 4000 R43 type engines will be delivered to CRRC to build 100 freight locomotives, which is part of the contract with the main contractor CMEC (China Machinery Engineering Corporation). In turn they will be exported to Argentina for service with Belgrano Cargas y Logisticas S.A. of the Argentinian Ministry of Interior and Transport. The MTU 16V 4000 R43 type diesel engines each have a power output of 2,200 kilowatts. The MTU brand is part of Rolls-Royce Power Systems.

"We are pleased that again CRRC trusts MTU to deliver engines for one of its important projects," said Dr Ulrich Dohle, CEO at Rolls-Royce Power Systems. "This order underscores the importance of our relationship with CRRC and our presence in the Chinese market", Dr Dohle added. The 100 new locomotives will be built by CRRC subsidiaries CRRC Dalian, CRRC Quishuyan, CRRC Beijing and CRRC Ziyang. CRRC is scheduled to receive all engines by 2016. Produced in Friedrichshafen, Germany, the first 70 engines have already been delivered.

The new grinder is supplied by an MTU 6R 1300 390 kW engine.

Grinding power from MTU

The new AK 560 Eco Power multi-purpose grinder from environmental technology specialist Doppstadt is powered by an MTU Series 1300 engine delivering 390 kW. The engine meets the Tier 4 final emissions standard without the need for a particulate filter. "The engine's electronic engine management means it can deliver extremely high torque within an optimum torque band," explained a Doppstadt specialist. "In addition, the MTU engine is quieter than the previous diesel engines, and it uses considerably less fuel."

Its high throughput capacity and load-sensing material feed system mean the AK 560 Eco Power is particularly efficient for processing wood waste, wooden pallets, forestry cuttings, tree trunks and roots, bio-waste and substitute fuels. The Eco Power grinds the material fed in by holding it against a pressure plate and reducing it with hardox teeth or cutter bars. The machine also comes in an AK 560 Eco Power Plus version, and since January, both vehicles have been in series production with MTU engines.

In brief:

CHP on the Danube

A 20V Series 4000 Combined Heat & Power Module (CHP) from MTU Onsite Energy has been delivered to the public utility company of Neuburg an der Donau, a major district town located on the Danube in Germany. The 20-ton powerhouse is to go into service in March 2016.

MTU Onsite Energy wins

An MTU Onsite Energy gas-fueled genset has taken the coveted "CHP of the Year 2015" award. The low-emission system supplies lighting company Osram's plant in Eichstätt, Bavaria, with cooling, heating and electrical power. An expert panel from the Federation of Cogeneration Associations (B.KWK) selected the CHP from a total of 11 plants previously presented as "CHP of the Month" in the January to November 2015 issues of the "Energy & Management" journal.

The 16V 4000 L64 gas-engine genset delivers 1,999 kW of electrical power and around 1,900 kW of heating power.

Partnership with Sanmar

MTU and the Turkish shipbuilder Sanmar Shipyards have signed a letter of intent for the supply of MTU engines. The Class RAstar 2800-E Azimuth Stern Drive tugs currently being built by Sanmar are to be powered solely by MTU Series 16V 4000 M63 and M63L engines and by a Rolls-Royce or Schottel propeller system.

Sanmar AS is the biggest tugboat operator and builder in Turkey and is recognised as being amongst the leading specialist tug constructors worldwide.

In brief:

MTU America receives award

MTU America was recently honored with the South Carolina Chamber of Commerce's inaugural Workforce Innovator Award for a medium-sized business, in recognition of its innovative youth apprenticeship program. Award winners were recognized for using their own resources and ingenuity to implement private sector workforce development solutions.

One million injectors

L'Orange, the large engine injection systems specialist, has produced its 1 millionth injector. The diesel injector for an MTU Series 4000 engine was made at the company's Black Forest production facility in Glatten. L'Orange products featuring common rail technology have been a big success around the world for almost 20 years and set standards for others to follow.

The common rail injector is among the most reliable high-tech components in a large diesel engine and helps improve performance, fuel consumption and emissions.

The new power generation plant in Mozambique is equipped with thirteen 20-cylinder gas-based Rolls-Royce engines B35:40, which have the capacity to generate a total of 120 MW.

100 MW in Mozambique

In Ressano Garcia, a new power generation plant designed to provide electrical power supply for Mozambique's rapidly expanding economy, went into operation. Core equipment includes thirteen 20-cylinder gas-based Rolls-Royce engines, which have the capacity to generate a total of 120 MW. The medium speed engines are of type B35:40V20AG2, supplied by Bergen Engines, like MTU Friedrichshafen a Rolls-Royce Power Systems subsidiary. This is the biggest medium speed power plant powered by Rolls-Royce.

The 100 MW plant is located close to the border between Mozambique and South Africa just outside the town of Ressano Garcia. It is owned and operated by the independent power producer Gigawatt Mozambique, and will supply electrical power to the national grid through a power purchase agreement with the state-owned utility, Electricidade de Mozambique (EDM).

Dieter Klingenberg, technical director of Gigawatt Mozambique, said: "The decision to buy the Rolls-Royce generation sets was based on a detailed technical, commercial and financial evaluation, taking the full term of the power purchase agreement into consideration. We are looking forward to a long and healthy partnership with Rolls-Royce and plan to make this plant the flagship for Gigawatt and Rolls-Royce." Matthias Vogel, Vice President Power Generation at Rolls-Royce Power Systems, said: "Our medium-speed combustion engines enable efficient use of natural gas to develop power supply. For countries like Mozambique, this technology solution is an important element in building up national electrification."

MTU Onsite Energy and VPower strengthen partnership

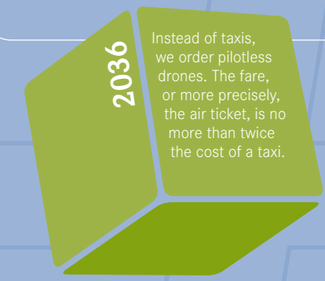
MTU Onsite Energy has enjoyed recent success in Asia with the signing of a contract to support the extension of a gas power station in Myingyan, Myanmar. It is equipped with 96 MTU Onsite Energy gas gensets based on 16V 4000 L32 units with a total power output of 144 MW.

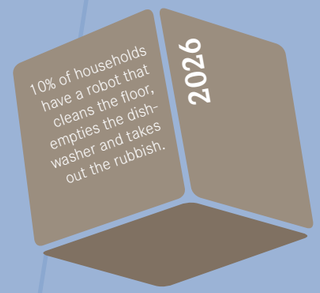
MTU Onsite Energy and the VPower Group have recently signed a strategic agreement that strengthens their partnership in power generation markets across China and the rest of Asia. A framework agreement for 2016 was also signed for the supply of 160 MTU Onsite Energy gas gensets based on 16V 4000 L32 units, each with 1,560 kW electrical power output. These agreements cement a long-lasting collaboration between MTU Onsite Energy and VPower, a world leader in decentralized power generation. By signing the framework agreement, VPower is able to secure production capacity within MTU Onsite Energy enabling it to meet the needs of its customers at short notice. The MTU Onsite Energy brand is part of Rolls-Royce Power Systems. Rorce Au-Yeung, Co-CEO, VPower Group said: "Our past successes in cooperation with Rolls-Royce on numerous power plant projects have motivated us to develop our partnership. The high rates of efficiency, outstanding reliability and low service costs of gas gensets from MTU Onsite Energy make them the ideal product for this application." VPower customers also benefit from the worldwide service networks that MTU Onsite Energy and VPower have in place to ensure swift delivery of spare parts. Matthias Vogel, Vice-President Power Generation, Rolls-Royce Power Systems, said: "China and the Asian region as a whole are key strategic markets where MTU Onsite Energy is very keen to grow by joining forces with a strong partner such as VPower."

#Future

Future

Today in 2016, every child is running around with a computer in his or her pocket. Anyone who had predicted that in 2006 would have had a hard time. But the smartphone is now part of our everyday lives – just as robots may be in 10 years' time. Or driver-less cars. What will happen to the internal combustion engine now that everyone is talking about electric vehicles? What role will be played by artificial intelligence? And will unmanned ships become reality? The next few pages reveal how exciting, fascinating, and sometimes difficult looking into the future can be.





Futurologist Lars Thomsen has looked ahead for *MTU Report* and attempted to predict what the world will be like in 10, 20, 30 or even 100 years. Look out for these cubes, which pop up repeatedly on the next few pages.

The head of development at MTU and a futurologist talk about technology in the future

Two for the future

How can we increase the availability of engines, reduce their maintenance costs and run them more economically? And where will natural gas be the dominant fuel? What part will hydrogen play? What opportunities does the fourth industrial revolution bring? MTU development chief Dr Andreas Lingens and futurologist Lars Thomsen take a peek into the future.

MTU engines are getting smarter all the time. That helps our customers because it makes their engines more economical, more predictable and more reliable in operation.

Robots and drones will be as much a part of our lives as the smartphone is today. People still wanting to drive their cars themselves will have to pay higher insurance premiums. Artificial intelligence will govern our lives in the very near future.

Dr Andreas Lingens has held the post of Executive Vice-President of the Series engines development division since 2012. With a doctorate in mechanical engineering, he previously worked at Deutz, Daimler and the US truck manufacturer Paccar.

Lars Thomsen is one of the world's leading futurologists. Born in Hamburg in 1968, the trend forecaster and future studies expert is one of the most influential authorities on the future of energy, transport and smart networks.

“Our engines are getting smarter”

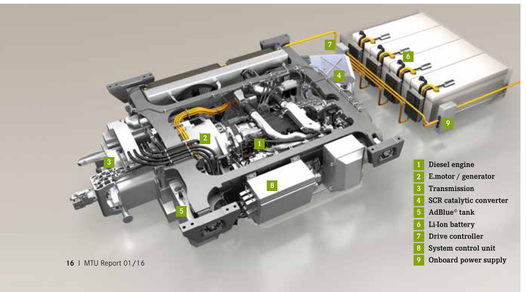
MTU development chief Dr Andreas Lingens talks about the technological possibilities for increasing the availability and cost-efficiency of MTU engines and reducing maintenance costs.

Will dump trucks, trains and ships still be powered by internal combustion engines in 2020?
Yes, definitely. Other types of drive system are not yet capable of delivering the power that those vehicles need. Electric drive systems running on fuel-cells or accumulators would theoretically also be possible, but both have limited power density and range, particularly on account of their energy storage systems. But there will undoubtedly be an increasing level of electrification around all aspects of the IC engine. And we will make engines smarter so that our customers will be able to run them more economically and in a way that suits the specific application better.

So what are “smart engines”?
Ultimately, it is about three things: our clients want to run their engines economically, they want the engines not to break down and they want to be able to maintain them as cost-effectively as possible. Up to now we have always serviced all engines of a particular class at a fixed rate according to a set maintenance schedule. In future, engines will be able to tell us when highly stressed components, consumables and filters need replacing. We are developing remote data analysis methods for that purpose. We use data loggers to record operating data from the Engine Control Unit and send it to our analytics systems via the mobile phone network or LAN. The engine data is then analyzed so as to provide the customer and ourselves with information about the engine and the application. Servicing is no longer carried out after a fixed number of operating hours, but exactly when it is necessary according to specific utilization. What is more, the maintenance of our engines is becoming more predictable and so causes less disruption to the operator’s processes.

Do smart engines offer operators other benefits?
Yes. We can, of course, offer customers many more analyses relevant to economical operation of their plants or fleets. Our clients can use the data as indicators of how to run their engines more economically, that is to say for optimum operating cost efficiency. They can be notified when the engine is not running at optimum efficiency, for example, when the person operating it is not doing so in the best way – by being too heavy on the accelerator, for instance. Smart engines can tell us, so to speak, how they can be operated and maintained in the most economical way.

What part does electrification of the diesel engine play?
That is the second big issue we are concerned with. It will be many years before large off-highway vehicles can be powered completely by electric motors. But at least partly electrifying the powertrain is an effective means of making our engines more economical and compact. For example, a smaller internal combustion engine could be used as the main drive unit, with extra power available from the electric motor when required. We have already applied that principle in a railcar driven by our hybrid powerpack. And it also has the advantage of regenerative braking. Whenever the railcar has to brake, the braking energy is converted into electrical energy that can be used for motive power. And this concept also enables us to provide power for other electrical equipment in the railcar. Hybrid configurations of this type are also conceivable and likely for use in ships, large construction vehicles or agricultural applications.



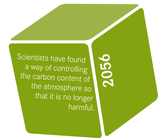
1 Diesel engine
2 E.motor / generator
3 Transmission
4 SCR catalytic converter
5 AdBlue® tank
6 Li-Ion battery
7 Drive controller
8 System control unit
9 Onboard power supply

Practice-proven: the MTU Hybrid PowerPack is a compact unit in which all individual components are installed on a joint raft.

As yet there are only a few hybrid applications in the off-highway market. What is the hybrid drive system lacking in terms of a breakthrough into the off-highway market?
Designing a hybrid drive system is very complex and more costly when there are only a few applications, as has been the case so far. But I am certain that in future there will be more systems of this type with standardized interfaces and cheaper components. A particularly important aspect is the cost of energy storage systems, i.e. battery technology. In that area we can benefit from improvements in the automotive industry. Economical operation is becoming a big issue. However, in terms of the engine itself, the possibilities for more reductions in fuel consumption are limited. With many operating profiles, we can only significantly reduce consumption by moving towards a hybrid system.

And looking at the diesel engine on its own, what are the parameters that you can still adjust?
Firstly, we will continue along the path of emissions reduction that we have followed in recent years. Over the past ten years we have lowered the emission of nitrates and soot particulates by between 50 and 90% depending on application. And although emissions reduction works against efficiency, we have still been able to reduce fuel consumption by as much as 10%. In doing so, we have undoubtedly secured the future of diesel engines. At the same time, we are increasingly using exhaust aftertreatment systems to lower emissions even further.

Regardless of how efficient or clean the diesel engine can be made, it will ultimately not get past the problem that oil reserves are finite. What role will synthetic fuels play?
Synthetic fuels will play a part even if their spread is being held back by the low price of oil just now. But oil reserves are finite, and we have two possibilities: producing fuels with the properties of diesel from other sources (e.g. gas to liquid), or directly using alternative fuels such as gas or methanol or other biogenic fuels. We are examining this issue by looking into the approval of gas-to-liquid fuels of various specifications for use in our stationary gas engines.



“The internal combustion engine will still be with, us but it will be smarter and more electrified,” says MTU development chief Dr Andreas Lingens.

In which areas will natural gas be the dominant fuel?
Wherever the cost of fuel is a major factor. For continuous-duty power generation, gas engines have virtually displaced diesels. And, of course, we are testing gas engines for marine applications. But even locomotives, large pump engines and mining vehicles could be operated much more economically with gas. One challenge is the fuel supply, i.e. storage in tanks and delivery to the engine. But we will find ways around that. Apart from lower fuel costs, lower CO_2 emissions and more economical emissions control for future emission stages are increasingly important aspects.

> “We use data loggers to record operating data from the Engine Control Unit and send it to our analytics systems. The engine data is then analyzed to provide the customer and ourselves with information about the engine and the application.” **Dr Andreas Lingens, MTU development chief**

Will hydrogen one day become the fuel for off-highway engines?
Hydrogen is an attractive fuel which will have a role to play. But there are many challenges to overcome before we reach that point. Infrastructure and storage are the biggest issues. In both cases we are in a sort of interplay with the automotive sector. The decisive factor will be whether the fuel cell is widely adopted in cars or whether straightforward electric drives establish themselves. In my view, it is still very much an open race. But it will certainly be possible to build off-highway engines that are fueled by hydrogen when the time comes.

“Artificial intelligence will change our lives”

Robots and drones will be as much a part of our lives in the future as smartphones are today. People still wanting to drive their cars themselves in 2025 will have to pay higher insurance premiums. And heavy machinery will be a thing of the past. Futurologist Lars Thomsen presents his visions.

What will the life of a child born today be like when it is as old as its parents are now?
That child will grow up in an era when the child itself will be the world’s rarest commodity. Businesses and employers will fight over it. It will also be amazed to hear from its parents how they had to go to work every day and work 40 hours a week before getting paid. The child, by contrast, will be paid according to what it can do well. At home, there will probably be a robot to do the cleaning, empty the dishwasher and tidy up. That might sound Utopian, but if you had told your parents that we would all be walking around with little computers in our pockets and be permanently connected to the Internet, they would not have believed that either.

Will the child learn to drive?
There will be no need to. It will get from A to B by pressing a button to call a driverless vehicle which will then pick it up and take it to its destination. Driverless vehicles will be common as soon as 10 years from now. There will still be people who want to drive themselves, but they will have to pay higher insurance premiums because driving an auto-piloted car will carry a much lower risk of accident than driving yourself. This is a development that, even for me as a futurologist, is progressing at a surprisingly fast pace. Even now, there are drones that can land on a car park, pick up passengers, and fly to the next town. So far they are just prototypes, but the fact is that the technology to do this exists.

How much longer will vehicles be driven by IC engines?
That depends on the vehicle. The last cars to be powered by internal combustion will have rolled off the production line by the end of the 2020s. At present, you have to pay around twice as much for an electric car as for a fuel-burner. But the battery prices are dropping by about 9% a year, and at some point there will be parity between fuel-burning and electric vehicles. Some heavy-goods vehicles will be powered by internal combustion engines for longer – fueled either by gas or diesel. That is because, over long distances, the internal combustion engine can run very efficiently. But I expect that by the end of the 2030s at the latest, the electric motor will establish itself as a better alternative in this area too. And by then lorries will no longer look like they do today. Containers will drive themselves about - they will just sit on an electrically powered, driverless chassis. Whether there will be a fully automatic battery replacement system by then, or whether the system will be recharged by induction loops in the road, is a question we cannot answer at present.

And what about off-road vehicles?
That depends entirely on application. In towns with good infrastructure, construction vehicles will undoubtedly be electrically powered in the near future. In remote areas such as a mine in Alaska or a difficult-to-access railway line, for example, off-highway vehicles and trains will certainly continue to be powered by IC engines. I think there will be two options for every vehicle category - either a conventional powertrain with IC engine, or an electric motor. Which option the operator prefers will depend on the environment in which the vehicle is to be run.

> “For a long time we thought that the most computers could do was perform calculations or play chess better than us. Now we are finding out that computers can drive cars better than us or produce better financial analyses than human analysts.” **Lars Thomsen, futurologist**

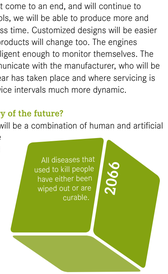
So what will our engines mainly be powering in the future?
I need to expand on that a little. We are living in a time that we futurologists call ‘the end of stupidity’. For the first time ever, machines are being invented that can partially replace the human brain. This often comes under the general concept of artificial intelligence. For a long time, we thought that the most computers could do was perform calculations or play chess better than us. Now we are finding out that computers can drive cars better than us or produce better financial analyses than human analysts. Such artificial intelligence will change our lives entirely in the coming years. Just take a look at a building site for instance, where today lots of people and a few very large construction machines work. In 20 years’ time, robots will undoubtedly have taken over most of the routine work from humans. That will also mean that machines will change. There will be an army of smart machines all networked together. They might excavate ditches on their own or carry away soil automatically. Those machines would no longer require one large engine but lots of small motors instead.

So which major trends will be relevant for the engine industry?
First and foremost, demographic change. Before long, businesses will have to compete for employees rather than people competing for jobs. And they will not be able to attract talented staff by money alone. Businesses are changing from being straightforward employers to shared-value communities. So corporate culture will play a decisive role when it comes to finding new staff. The second major trend that is relevant to industry is artificial intelligence, which I have just mentioned. It will firstly have an effect on machinery, both in development and production. Secondly, we should be prepared for a second generation of robots. In about 10 years, robots will work with people in an integrated way in production. And we will use artificial intelligence in the office too. In five years we will hardly bother with e-mails any more. Computers will be able to read and understand them. They will become genuine assistants who relieve us of more and more routine tasks and help us deal with the information overload. Not to put too fine a point on it, we could say that artificial intelligence will ultimately save us from insanity because the interconnection of systems and the deluge of information will continue to increase – whether we like it or not. The third major trend is the use of renewable energy. Mineral oil and fossil fuels will soon lose their dominant position in the world’s energy mix. Part of the reason is that energy produced by regenerative systems has already become cheaper than oil today. Maybe that also explains the collapse in the price of oil. Part of what is behind the ‘sell-off’ is the fear on the part of oil-producing countries that the age of oil will soon be over.

How will the Internet of Things change industry?
Drastically. Both in terms of product development and the products themselves and their use. Development is already completely digitalized today, but more digital tools are now being introduced. In the past, designers worked on a drawing board, then on a computer, and soon they will be using holographic representations and simulations. So they will be able to test engines before they are put on the test stand. This development has not yet come to an end, and will continue to accelerate. With the right tools, we will be able to produce more and more products in less and less time. Customized designs will be easier to produce as well. But the products will change too. The engines that power them will be intelligent enough to monitor themselves. The product will be able to communicate with the manufacturer, who will be informed as to how much wear has taken place and where servicing is required. That will make service intervals much more dynamic.

How do you see the factory of the future?
Manufacturing in the future will be a combination of human and artificial intelligence. We need people with extensive technical and expert knowledge, quality-consciousness, process know-how and engineering skills together with a production concept that is smart enough to apply the expectations we have of people to production processes. The so-called “dark factory” in which there are no people will not happen. But we will have a production process in which the entire supply, logistics and production chains are fully integrated. Suppliers will know exactly when to supply which parts because they will be constantly informed of the status of production by their clients. Robots will then dispatch the necessary parts entirely automatically. That will substantially improve the efficiency and quality of production. And the other possibilities that it opens up we probably cannot even see at present. When the Internet was talked about at the end of the 1990s, there was massive hype surrounding it but nobody knew what its true potential was. It is similar with the fourth industrial revolution now. Everyone is talking about it but we have not yet properly grasped what it actually means. But there is a lot to come. We could manufacture highly complex products on very small production lines. Production will become localized, more modular, smaller-scaled, and more flexible.

“I think there will be two options for every vehicle category - either a conventional powertrain with IC engine, or an electric motor”, predicts futurologist Lars Thomsen.



Thank you for that fascinating look into the future. Finally, just one more question about your work. How do you make sure that you are really looking into the future and not just into a crystal ball?
Technical developments always follow a certain logical progression. If you have enough information to predict technological developments, then you can forecast the dynamics of trends very well. New technologies are generally more expensive and perform less well in the beginning. But sometime or other there comes a point when they become cheaper and better than the conventional technology. We call it the tipping point. We are always looking for tipping points.

Interviews: Lucie Maluck; Pictures: Stefan Söll, Robert Hack

#Future

Smart ships to sail without crews

Flying Dutchman 2.0

The ghostly specter of an unmanned ship sailing on the open sea was the myth at the center of the 'Flying Dutchman' legend. Today it is a realistic objective at Rolls-Royce. Smart ships are to pilot themselves without crews. This saves on manpower and fuel, and there will be fewer accidents. Rolls-Royce is predicting that the first commercial unmanned ships – maybe ferries or tugs – will be in service before the end of the decade.

Midnight in the North Atlantic. A 50,000-tonne freighter picks up the latest weather report. A storm is approaching. Quickly, quietly and without human intervention, the ship alters its course. It recalculates its required speed so that it will still arrive on time at its destination port despite the change of course. The new course data is transmitted via satellite to a captain on the other side of the world. The ship changes course again to avoid a vessel on its starboard side.

Not if, but when

As yet that is still a vision of the future – but it is not a question of if, but only of when, according to Oskar Levander, Vice-President Innovation at Rolls-Royce. The Rolls-Royce-led AAWA (Advanced Autonomous Waterborne Applications) project is currently looking into the technical aspects of unmanned shipping. Together with experts from a number of Finnish universities, from companies in the shipping business and the classification society DNV GL, Rolls-Royce is investigating how such a sea-going craft would have to be built and how automation and control systems could be integrated – using existing technology wherever possible. The project participants will also be considering the social, legal and economic questions involved, leading to the definition of legal provisions for crewless shipping to ensure safety at sea.

Fewer employees, less fuel, greater safety

The advantages of unmanned ships are clear to see. If fewer crews members are needed, you can save on labor costs. At the same time, the number of accidents can be reduced. The Allianz Insurance Institute has calculated that in 2012, between 75 and 96% of accidents at sea were attributable to human error. Tiredness and lack of concentration are frequent causes. On an unmanned vessel, on the other hand, modern sensors can detect small objects in the water faster than the human eye. Fuel consumption is lower too if the ship is controlled remotely from the shore rather than by a captain on the bridge. Unmanned ships are also less attractive to pirates because they carry no potential hostages. And last but not least, smart ships provide an answer to the shortage of skilled manpower facing the shipping industry. Ships are becoming more and more complex and require ever more highly qualified crews. At the same time, a career at sea is losing its attraction because fewer and fewer people are prepared to work for weeks at a time far away from their families. In the future, captains will no longer be sailing the oceans but will be able to direct whole fleets from an onshore control center.

Onshore engine monitoring

The MTU engines can also be monitored from land. Data loggers record the operating data from the Engine Control Unit and transmit it to the shore, where the land-based captain can see whether there is a problem or if any components need servicing. "We are developing advanced engine maintenance systems and moving away from rigidly scheduled servicing towards condition-based maintenance," explained Stefan Müller, head of marine applications technology at MTU. He also emphasized that the surveillance system on an autonomous vessel needs such information to respond to problems arising with the engine or propulsion system. *Callosum*, MTU's integrated ship automation system, already enables bridge crew to monitor the entire propulsion system, on-board power supply and all ship's services. "In the future, that data will not be viewed by an officer on board but sent directly to the ship's surveillance system instead. Processing and transmitting it for that purpose, and then drawing the right conclusions from it is the big challenge," explained Müller.

Unmanned ships are still a vision of the future, but Rolls-Royce is working hard on making that vision a reality within the next decade. In this picture, there is a noticeable lack of a bridge. This is because the bridge is on the shore. Thanks to cameras and thermal imaging technology, the captain actually has a better overview on the shore than would be possible on the ship.

Oskar Levander is Vice President Innovations in the Rolls-Royce marine division.

His vision for sea captains of the future is for them to work on land, where autonomous navigation, tracking and propulsion systems will enable them to monitor up to ten vessels that are out on the high seas. So a vessel will maneuver on high sea by remote control.

Remotely controlled or autonomous

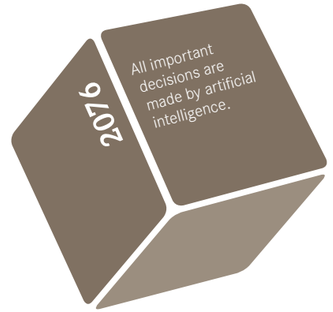
Unmanned craft can either be remotely controlled or autonomous. In practice, it will probably come down to a combination of the two. Large vessels could operate autonomously on the open sea. In that situation, the ship automatically finds the best course, navigates and avoids obstacles. But when the ship approaches the shore and enters busy shipping lanes, a captain on the shore takes over and pilots the vessel by remote control. Smaller craft such as ferries that always operate in coastal waters will only ever be remotely controlled. The land-based captain then sits at a virtual bridge in the remote control center. This is not an identical replica of the ship's bridge, but a virtual environment from which it is easier to assess the situation than on the actual bridge. If the captain needs an all-round view, images from 360-degree cameras are projected onto the virtual bridge. Besides normal cameras, thermal imaging cameras are also used to provide additional information when visibility is impaired by darkness, rain or fog. "HD and thermal imaging cameras are already more powerful than the human eye today," Levander points out. And radar scanners can depict objects on augmented reality displays.

Whether autonomous or remote-controlled – unmanned ships must be able to communicate with their environment. They have to develop the intelligence to navigate on their own, avoid collisions and carry out complex maneuvers. To do so, they have to receive information from cameras and radar equipment, analyze it and respond to it. "The ship's propulsion system also has to receive this data in order to make the logically correct decision," explained Müller.

International rules yet to be established

The technological requirements for building such vessels already exist. But before ships of that kind can sail the world's oceans, the existing regulatory framework will have to be rewritten. How will unmanned ships be insured? Who will be liable in the event of disputes? Those are only two of the questions that have to be answered. Safety is thus a major issue. Because only when the technology is really as safe as on conventionally crewed ships will the rules change. So the vessel will have to constantly assess its current situation. If it loses contact with the on-shore control station or if other faults occur, the ship will have to immediately adopt a pre-defined safe mode – it will have to slow down, weigh anchor or enter idle mode.

"We are assuming that the technical solutions will be available before new regulations have come into force," said Rolls-Royce marine expert Oskar Levander. The trailblazers are likely to be small ferries, tugs or inland waterway vessels. "Such craft also operate within the jurisdiction of a single country, so the operating license will be quicker to obtain," Levander added. He then expects the next phase to see international commercial trade following suit – but only if the freight being carried is non-hazardous. "Oil and LNG tankers will not be unmanned in the short to medium term, and we will continue to see captains on cruise ships," said the Rolls-Royce expert. He firmly believes that unmanned ships will become the norm more quickly than driverless cars. "Ships are much more suitable for auto-piloted control than cars," said Levander. "Cars are in much closer contact with people and so seem more dangerous. What is more, in road traffic, decisions have to be made in a split second. At sea there is much more time to react."



Words: Lucie Maluck
Pictures: Rolls-Royce

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More on this ...

For more pictures of unmanned ships go to http://bit.ly/1RZjuza.

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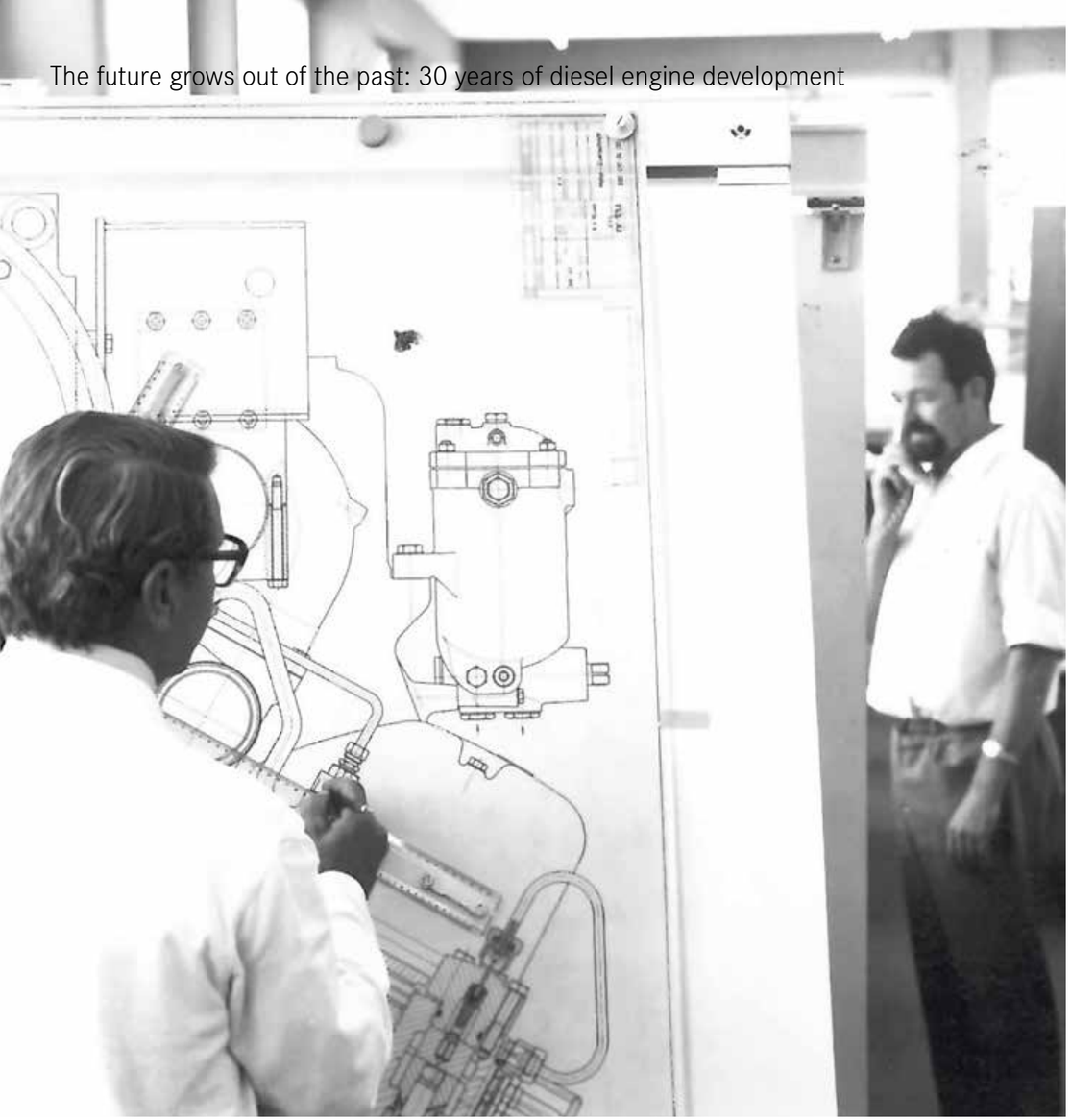


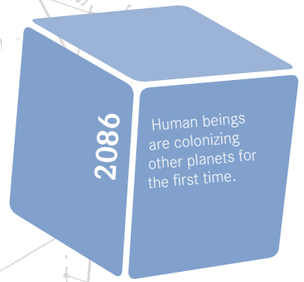
Board meeting: 30 years ago, a design engineer spent his working day at the drawing board, rather than at the computer.

When computers were the future

Josef Schmitz and Hermann Baumann have been developing MTU engines for over 30 years.

Josef Schmitz and Hermann Baumann can look back on 30 years of experience in development. From the introduction of IT as a development tool through to the era of ever-stricter emissions limits, the two MTU design engineers have constantly had to overcome new challenges.

In 1986, when Josef Schmitz started at MTU, he worked in the same open-plan office as Hermann Baumann, who had joined the company two years before. In those days, design engineers worked at large drawing boards. "Those were the days of the white coats," remembered Schmitz. It was their job at the time to get the highest possible power out of an engine – fuel consumption and emissions had not yet become an issue. They drew with pencil and ink and wore white lab coats to distinguish themselves from shop-floor workers. "Although you very rarely ventured into the factory," Baumann recalls. Today, things are different. The design engineers consult their colleagues in Analytics, Value Assessment, Production, Purchasing and Assembly, and right from the earliest stage of conception. They closely track every phase in the development process. "That's what makes it so fascinating to work here – you can always see the complete picture and experience the evolution of a product at first hand," Baumann explained.



Computers replace drawing boards

At the end of the 1980s there were radical changes. Computer-aided design replaced the drawing board. Baumann and Schmitz had already worked with CAD programs as students, but many older-generation designers experienced great difficulty in making the transition to digital design. Some were not even prepared to try, as Schmitz remembers: "As time went on, the most complex jobs were gradually assigned to the CAD designers. So some highly regarded designers who couldn't or wouldn't work with the new CAD tools were increasingly pushed aside. They then tended to be given less important work that could be done at the drawing board, such as amending older drawings." According to Baumann, a good deal of knowledge and skill was lost as a result. Nevertheless, the vast majority of designers successfully mastered the change-over from drawing board to CAD system, albeit with a degree of initial skepticism in some cases.

And there was another aspect that created some annoyance at the time, as Schmitz related: "The computers were comparatively expensive and the company only bought a few of them. Whoever got in the office first in the morning often hogged the CAD workstation the whole day long while others whose work was just as urgent were left to wait in desperation for a free computer." To reduce friction between staff and increase equipment capacity utilization, early and late-shift worktime models were introduced. Today by contrast, it is taken for granted that every designer has his or her own computer workstation. In the early days, that would have been considered a luxury.

But working on computers did have some disadvantages: "One thing that became more difficult with CAD was developing a feel for dimensions, weights, sizes and stresses," Baumann remembers. On the drawing board, components were represented in their actual size, while on the computer screen they could be magnified or shrunk to any scale. "But a good designer still has to be able to mentally picture the full-scale component at all times," emphasized Baumann.

Josef Schmitz recounts that venturing into the production shop was not the norm 30 years ago. In those days, design engineers liked to keep themselves apart from blue-collar staff. Today, they all work very closely on the development of new engines.

New information sources
In the past, the latest stage of development could always be seen on the drawing boards. Heads of department could quickly get a picture of how things were going just by walking round the office, and they could change the drawings directly. Everyone could see right away who was doing what, and so there was no great need for discussion or reporting.

Smoking and drinking in the office were accepted
Whether it was a pipe or cigarettes, smoking in the office was still quite normal until the early 1990s. It was eventually banned not just for health reasons, but also because the computers were damaged by the smoke.

Once the norm, now unthinkable: three decades ago, beer-drinking in the office was nothing out of the ordinary. "When I first worked here, there was a custom known as the holiday drink. Whenever you went on holiday or came back from holiday you bought a round for your colleagues," recalled Schmitz. Baumann added: "You generally spent more time together in those days - the community feeling was stronger than today." This also has to do with the fact that daily routines have changed a lot.

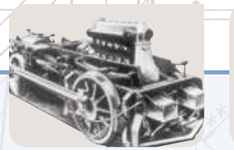
More meetings, fewer shared breaks
As a result of flextime working and computer and project-based work patterns, the daily routine has changed considerably. "In the past, you came to work in the morning and started drawing. There wasn't much telephoning or talking. The design engineer sat in front of his drawing board all day long – interrupted only by coffee and lunch breaks," recounted Schmitz. Over the years, new development processes and methods significantly changed the working day. The actual process of designing is now only a part of a design engineer's job - the rest of the time is taken up with co-ordination meetings and project work. And that means that shared break times have become much less common.

> «A good designer still has to be able to mentally picture the full-scale component at all times.»
>
> Hermann Baumann, MTU Friedrichshafen

From government contractor to global player
In the 1980s, the mission of the business was to develop highly compact engines with as much power output as possible. "Most of our clients were public sector organizations such as Deutsche Bahn or the German Navy. Fuel consumption and emissions were a secondary consideration in those days," said Schmitz. "And we had a lot of paid development. So pressure on costs was the exception rather than the rule."

Development and production costs and low fuel consumption have now become the definitive criteria for market success, and compliance with emissions limits is a base-line requirement. MTU has transformed itself into a global player - the engines manufactured at production plants in Friedrichshafen, Aiken and Suzhou

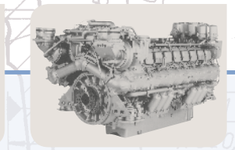
Milestones in MTU diesel engine development



1924
The birth of the high-speed diesel engine. At the international railway exhibition in Seddin, Karl Maybach presents the first high-power, high-speed diesel engine: the 150-HP G4a unit was installed in a railcar.

1934
Maybach develops the GO 6, the first large high-speed diesel engine with turbocharging.

1951
Series MD 650 is Maybach's first series-production engine. Together with L'Orange GmbH, Karl Maybach developed the unit injection system – a forward-looking fuel injection system in which the injection pump and injector are combined into a single unit.



1973
The twin Series 331/396 units are the first MTU development not to be built primarily for rail applications. They cover all applications that need power outputs from 375 to 2,150 kW (510 - 2,900 HP), i.e. heavy-duty vehicles, fast ocean-going yachts, government vessels, industrial locomotives, stationary power generation or oil pumping systems.

are sold worldwide. In a period spanning 20 years, it launched its brand-new Series 4000, 2000, 8000 and 1600 units on the market, primarily for commercial use in a diversity of applications. In 1996, it introduced standard-production Series 4000 units with a common-rail fuel injection system, and was the very first manufacturer of large diesel engines to do so. The new technology enabled injection timing, volume, pressure and multi-phasing to be infinitely varied, opening up a much bigger perspective in engine design.

> «I can hardly imagine a more multi-faceted task than developing a diesel engine.»
>
> Josef Schmitz, MTU Friedrichshafen

Engines developed simultaneously across all series

MTU now trades in highly diversified markets. "In the beginning, there was usually only one engine development project going on at a time. Today – driven partly of course by emissions legislation – we work on new engines for various applications in all series at the same time," said Schmitz.

Today's design engineers also work in a much more customer-oriented way. They have more direct contact with clients and know more about what these expect from a quality product. According to Schmitz, you can tell good design engineers from the way they identify with their products – it is their ambition to improve them continuously. For understandable reasons, deadline and budget constraints place certain limits on those ambitions. However, the enthusiasm of Schmitz and Baumann for their product remains unabated. "Diesel engine development is a discipline covering so many areas of technology. I can hardly imagine a more multi-faceted task than developing a diesel engine," said Schmitz. His vision for the future is of a drive system that integrates alternative power units. As a marine propulsion specialist, Baumann sees scope for future development in that area. "Sailing silently out of the harbor powered by an electric propulsion system is my vision. And it will happen – I'm convinced of it."

Human beings no longer measure themselves in terms of wealth or possessions.

2106

Words: Elisabeth Perkovic
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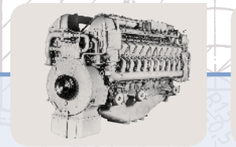
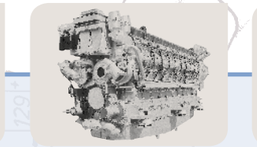


1973
The Series 956 unit extends the power range of MTU engines at the top end. To cover the full spectrum of customer demands, a long-stroke version of the engine, designated the Series 1163, is also built.

1996
MTU introduces Series 4000, the first high-performance diesel engine to be fitted as standard with a common-rail fuel injection system.



2000
MTU unveils its most powerful engine to date: the Series 8000 unit delivering 9,100 kW (12,370 HP).

2005
MTU launches the 16V Series 2000 marine engine with common-rail fuel injection. With an output of 1,790 kW, it is the most powerful engine in its class and unrivalled as a propulsion unit in more than just motor yachts.

2009
The Series 1600 completes the MTU engine portfolio at the lower end of the power range. It is the only model in its power class to be developed specially for off-road use.

Hermann Baumann is an engine enthusiast and loves being able to follow the entire evolution of an MTU engine from start to finish. "It's fascinating," he says.

Wide of the mark

#Future

"There is no reason why anyone would want to have a computer at home."

Ken Olsen, President of the US computer firm Digital Equipment Corporation, 1977

"Gold has even now but a few years to live. The day is near when bars of it will be as common and as cheap as bars of iron or blocks of steel. Before long it will be an easy matter to convert a truckload of iron bars into as many bars of virgin gold."

Thomas Edison, American inventor and entrepreneur, 1911

"Everything that can be invented has already been invented."

Charles Duell, Head of the US Patent Office, 1899

"The world-wide demand for motor vehicles will not exceed one million – simply due to the lack of chauffeurs."

Gottlieb Daimler, Inventor of the motor car, 1895

"Rail travel at high speed is not possible, because passengers, unable to breathe, would die of asphyxia."

Dr. Dionysius Lardner, Irish physicist, mathematician and encyclopedian, 1850

"The coming of the wireless era will make war impossible, because it will make war ridiculous."

Guglielmo Marconi, Italian radio pioneer, entrepreneur and Nobel Prize winner, 1912

"I'm sorry, but with all the will in the world I cannot imagine what submarines can achieve in a war – except to expose their crews to death by suffocation."

Herbert George Wells, English science fiction writer, 1901

"Almost all of the many predictions now being made about 1996 hinge on the Internet's continuing exponential growth. But I predict the Internet will soon go supernova and in 1996 catastrophically collapse."

Robert Metcalfe, co-inventor of Ethernet, MIT graduate, 1995

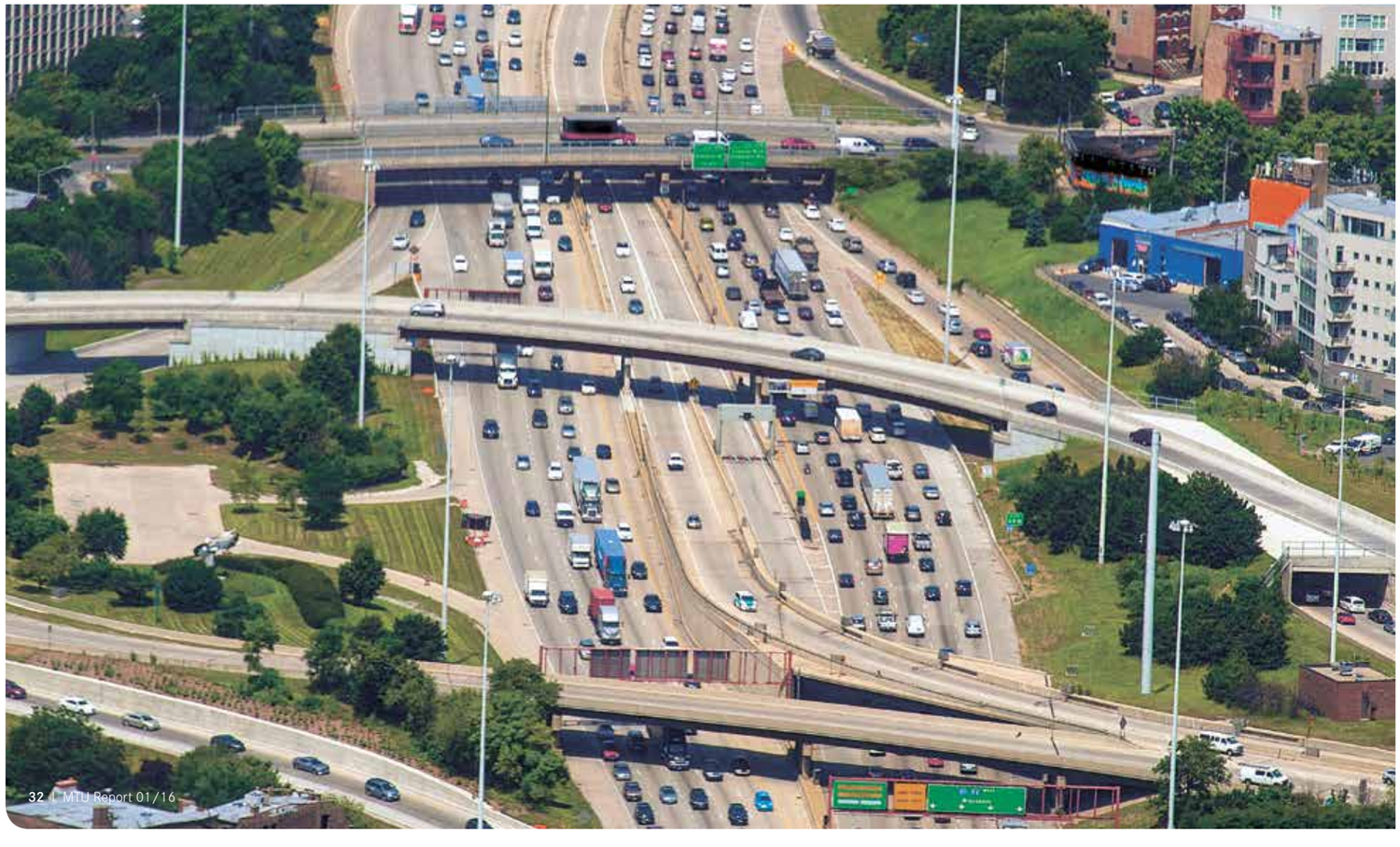
"E-mail is a totally unmarketable product."

Ian Sharp, founder and chief programmer of Canadian IT services provider Sharp Associates, 1979

"Predictions are difficult, especially when they relate to the future" – these quotations show just how right Danish physicist Niels Bohr was when he said those words.

MTU Onsite Energy emergency gensets support active traffic management system

High-tech highway



Progress at snail's pace: the average commuter on the 190 highway spends 90 hours a year in traffic jams. But things are now set to change with a new active traffic management system.

In the state of Illinois, the 77-mile Jane Addams Memorial Highway serves nearly 1 million travelers per day in and around Chicago. The highway is part of Interstate 90 (I-90), the longest interstate in the United States. At more than 3,000 miles long, the transcontinental freeway stretches from Boston, Massachusetts to Seattle, Washington.

As it does on other heavily trafficked expressways, severe congestion frequently cripples I-90 drivers. Built in the 1950s, I-90 became strained beyond its capacity to residential and commercial growth, increasing delays. A 2015 study cites a 12-mile stretch of Chicago's I-90 with the worst traffic congestion in the nation. American commuters spend upwards of 40 hours a year stuck in traffic. The United States' federal government is focused on a number of high-priority efforts to help reduce congestion on the nation's highways.

Easing traffic flow

To modernize and rebuild the aging highway, the Illinois Tollway approved a comprehensive plan in 2004 that included improvements such as lane widening, modernized tolling facilities, resurfacing and the addition of an intelligent transportation system to better manage incidents and increase safety. The state's ongoing efforts to improve mobility and reduce congestion launched Move Illinois, a 15-year, $12 billion capital program that will rebuild the existing Illinois tollway system, including state-of-the-art 21st century "Smart Corridor" features for the Jane Addams Memorial Tollway. This technology expansion will provide drivers with up-to-date information during their travel as well as increase overall efficiency of the corridor.

To ensure a smooth traffic flow on the Illinois tollway, the cutting-edge program needs reliable backup power. MTU Onsite Energy has been chosen to install 23 natural gas generator sets with 100kW output. The units will provide backup power to updated traffic lane monitoring systems on Chicago's Interstate 90. The gas generators will be housed in weatherproof aluminum enclosures to protect against common outdoor elements, like salt. The enclosures' grey color blends in well with the background of the highway, helping to minimize distractions for drivers. Seventeen generator sets have been delivered and will be operational by summer 2016.

Smart improvements

The MTU Onsite Energy generator sets will provide backup power for a number of "Smart Corridor" features on the tollway. Active Traffic Management will provide real-time information to drivers, including nature and status of traffic incidents ahead, advisory speeds, posted alternate routes and real-time lane closures and traffic pattern changes. Roadway cameras along I-90 will be upgraded from analog to digital high-definition, and additional cameras will provide coverage along the full length of the I-90 corridor from O'Hare International Airport to Rockford. State-of-the-art wireless traffic sensors will provide more comprehensive travel time information. In addition to replacing current full-width, monochrome digital message signs with higher-resolution, full-color graphic-cable models, the new I-90 will feature smaller, four-color digital message signs to enhance communications with drivers.

Weather stations along the I-90 corridor will be upgraded with state-of-the-art technology capable of providing pavement monitoring and weather conditions at critical locations, including bridges. Highway infrastructure will be able to communicate with cars over a wireless network, exchanging data about each vehicle's speed, location and direction of travel and providing developing road situations to drivers.

I-90 will also feature the first Pace Bus "Park & Ride" facilities on the tollway. The project is expected to save drivers nearly 30 minutes of drive time on the average trip from Elgin, Illinois, to the Kennedy Expressway. In addition, the improved roadway will accommodate more than 80,000 additional vehicles per day, saving drivers millions annually by reducing congestion and delays. The Illinois tollway is committed to sustainability, with a key goal of minimizing the environmental impact from construction to completion. At a time when the global demand for energy is rising and reliable electricity supplies are increasingly vital, power generation products are being used more and more to meet environmental demands. MTU Onsite Energy's natural gas generators complement the tollway's "Building Green" initiative, which will incorporate renewable energy sources.

Words: Chuck Mahnken
Pictures: iStock Photos, MTU Onsite Energy

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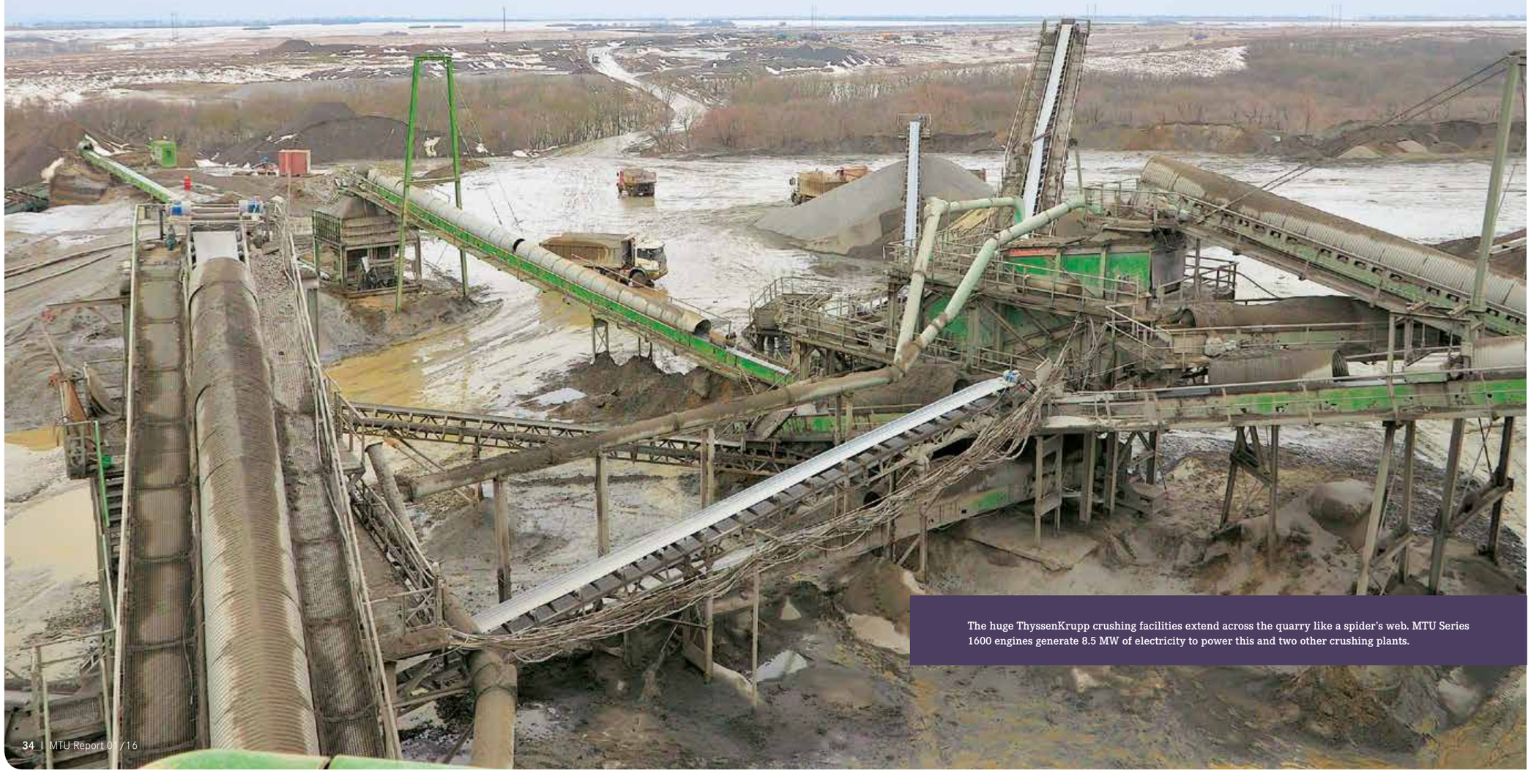
The 23 MTU Onsite Energy gas-engine generators on standby next to the highway can each generate 100 kW in the event of a power outage.

Series 1600 engines supply electric power in Russian stone quarry

Rock and a hard place

Mud, moisture and clouds of dust are hardly ideal conditions for reliable engine operation. Despite these challenges, Series 1600 engines deliver outstanding performance at the Donskoi Kamen stone quarries in southern Russia.

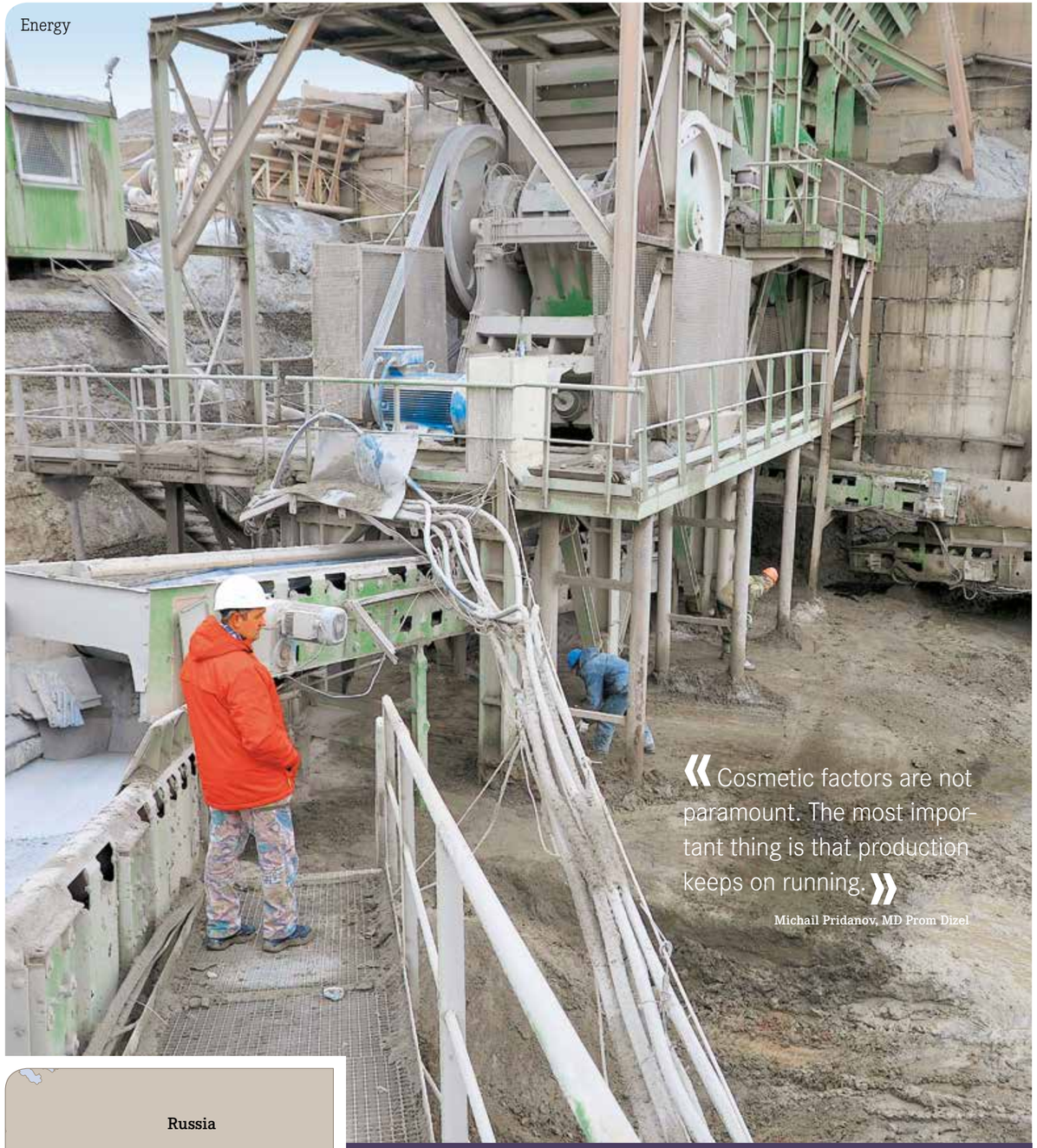


The huge ThyssenKrupp crushing facilities extend across the quarry like a spider's web. MTU Series 1600 engines generate 8.5 MW of electricity to power this and two other crushing plants.

A siren wails at the Donskoi Kamen stone quarry in Russia. The road down to the workings 50 meters below has been blocked by two trucks. Everyone on site knows that access to the pit is now forbidden because blasting is about to start. An explosion reverberates around the 50-hectare oval pit that the quarrymen have drilled and blasted in the earth over the last nine years, and a yellow-white cloud of stone dust billows upward. The Donskoi Kamen site is an opencast sandstone mine. It provides good access to the workface not too far below the surface and is well located to link with the major M4 highway that connects southern Russia and the port of Novorossiysk with Moscow.

Year on year, the quarry team extracts 6 million tons of stone from the earth at the site, but only a little over half of that goes for the production of aggregates. The rest is spoil that constantly adds to a giant heap. Initially, the stone is loosened by blasting. Excavators then load it onto trucks that haul it to the company's on-site crushing facilities. Depending on its ultimate use – for highway construction, concrete manufacture or shoreline and riverbank stabilization – the stone is then reduced to different grades. The finished product is dispatched to customers by truck or is stored on site until it is needed.

Founded in 2006, the Donskoi Kamen company swiftly spotted trends during the economic boom of the time: the demand for quarry stone and aggregates rocketed. The first major customer for stone aggregate was a construction



Giant crushing machines reduce the quarried stone to different grades suitable for their ultimate purpose.

company working on the long-distance Moscow to Sochi highway nearby. The work was part of an investment project for the Winter Olympics. Donskoi Kamen is currently supplying two construction sites linked to the 2018 Football World Cup: a new airport and a football stadium in the Rostov region.

In 2009, when the business had found its feet, the company began to look for smaller new generators to power the three large stone crushing plants. These had to be largely immune to the choking influence of dust (a large 2,000 kW engine had just failed due to dust contamination). Company management decided on an initial purchase of three MTU Series 1600 diesels. Producing 668 kW, the units were small, but they fitted in perfectly with Donskoi Kamen's new energy concept that involved installing small engines in parallel in three production units. That way, if one engine failed, it could be immediately replaced by others.

Today, Donskoi Kamen operates 17 MTU Series 1600 engines. Together, they generate 8.5 MW of electricity for the three large stone crushing plants. The engines are not operated at maximum performance but are regulated to produce 550 kW of electric power, leaving a backup power reserve. The company is now planning the purchase of four more MTU engines. These will provide a reserve in case of problems and can also be called on in periods of particularly heavy load such as during very hot summers.

Never-ending struggle

With its huge, spiderlike crushing plants and its fleets of trucks and shovel excavators, the quarry site is an exciting but hazardous place. The thunder of the grinding machines and the constant roar of engines mean that noise levels remain permanently high.

In January, icy conditions mean the thermometer stubbornly shows temperatures down to minus 10°C. Sleet and slush transform the site into a mire of treacherous puddles and mud. At the other end of the scale, when summer temperatures reach up to 30°C, it is stone dust from the crushing plants that tests both men and machines to the limit. Despite on-site sprinkler systems, the dust is all-pervading.

The production of grit, gravel and chippings keeps the 530-strong workforce hard at work three shifts a day. The 12-cylinder MTU engines run between 12 and 20 hours a day. Because of the heavily dust-laden air, engines are fitted with heavy-duty filters with cyclone pre-separators, but the filters still have to be replaced every day.

The biggest crusher unit is not too far from the administration building. This is a ThyssenKrupp unit and Valery Gromov, Chief Engineer at the quarry, takes pride in recounting how it was put together from components purchased second-hand all over Europe. When the company was founded in 2006, that was the cheapest way to get hold of good-quality German technology. Despite their lack of familiarity with the equipment, the company's Russian technicians somehow managed to put the whole thing together successfully.

Valery Gromov, Chief Engineer at Donskoi Kamen, is always on the look-out for favorably-priced German technology.

What were the reasons behind Donskoi Kamen's decision to purchase MTU engines in 2009? Gromov still clearly remembers that the main issue was how to make up the 2 MW requirement. "It couldn't be done with the generators we had at the time. We would have had to buy a large generator, and that wasn't an economical solution. You don't want to start up a 2 MW generator if you only need 500 kW for one section of the plant."

Michail Pridanov, head of a service company for large engines near Moscow, advised the quarry company to buy Series 1600 engines from MTU. The 12-cylinder MTU unit had just appeared on the market and the signs were that its outstanding emissions performance meant it was likely to find favor with the Russian authorities over the long term. Compared with products from other manufacturers, the MTU engine was also favorably priced. In addition, the engine also benefited from a simple construction that made repairs straightforward, explained the service engineer. So far, service staff have carried out work on six of the 17 engines. The oldest unit ran for five years before it was repaired for the first time.

Communication between MTU and the customer is made much easier because Pridanov speaks perfect German. He learned the language during his work on transport logistics when the Soviet military withdrew its technology from the GDR in 1994. At the time, Pridanov was in charge of

Several MTU engines are connected in parallel. Engine performance is synchronized by special-purpose software to ensure that the engines generate the same current intensity and produce the 50 Hz grid frequency required.

The quarry team extracts six million tonnes of stone every year. Deposits are loosened by blasting before being loaded onto trucks by excavators for transport to the company's on-site crushing facilities.

a repair team and was thus in constant contact with members of the Bundeswehr. His company, Prom Dizel, has been responsible for servicing MTU engines at the quarry since 2009. Major maintenance procedures are carried out at the service company's facility near Moscow. Prom Dizel has been MTU Russia's official service partner since 2015.

Another reason for buying MTU engines, said Gromov, was that Series 1600 units reacted better to varying load demands than competitors' engines. During the stone-grinding process, engine loading fluctuated between 200 and 600 amperes, he explained. "The diesels that had been in use before only had mechanical injection," said Pridanov. "They were not able to respond quickly to changing loads. MTU engines have really good load surge characteristics," added Gromov.

The MTU engines were also outstanding in terms of fuel consumption, said engineer Gromov: "In operation in our partial-load mode with variable load, an MTU engine generating 650 kW uses 45 liters an hour." That is not a huge amount considering that a truck loaded with stone aggregate needs 50 liters of fuel to cover 100 kilometers.

Keeping a keen eye on costs

One very surprising feature is that the MTU engines are housed next to each other in unsealed, sheet metal boxes. The dust gets in and that can lead to problems and cause engine damage, explained Pridanov. Unfortunately, modern, hermetically sealed enclosures for diesel engines are still too expensive, and the operators would therefore have to do without cosmetic niceties until the essential basic capital was available, said service engineer Pridanov.

Making savings obviously comes at a price. Workers constantly have to invest time to keep the crushers and engines free of dust and clear of the grey sludge it leaves after every shower of rain. They need brushes, scrapers and cleaning materials for their never-ending efforts. Even the power cables that run from the boxes are not laid in protective ducts but simply lie on the ground.

"Cosmetic factors are not a priority. The main thing is to keep production running," said Pridanov. And run it does! Since 2006, production of chippings and other grades of stone aggregates has increased from 500,000 tons to an average of 3.5 million tons a year. It has been calculated that construction of a new 10-kilometer stretch of four-lane highway will require 300,000 tons of stone aggregate for the foundations alone.

17 MTU engines generate the power for the stone quarry in southern Russia. Each engine produces 550 kW of electric power.

The engine control technology utilized for the first power generation unit that supplies the big ThyssenKrupp stone-crushing plant is state-of-the-art. Performance is synchronized by special-purpose software that ensures equal current intensity from the eight engines as well as availability of the 50 Hz grid frequency required. The synchronization concept also ensures that even the slightest deviations in engine speed are balanced out.

Zero interest in the public grid

Why was the quarry not linked up to the public grid? That would have meant the operators building an extremely long power line at their own expense, explained Pridanov. Gromov added that the operators also wanted to avoid the possibility of public grid outages and claims by the electricity company in respect of purported unpaid bills.

Efficient communication with the engineers at MTU is vital for smooth production, and in this context, both Russian engineers are extremely satisfied. To ensure that they are able to deal personally with most eventualities, Pridanov and Gromov have both completed two training courses at MTU-HQ in Friedrichshafen. Instead of having to fly MTU engineers out to southern Russia for every hiccup, the two Russian specialists can now deal with many situations themselves. Gromov now has flash memory card access to MTU engine control systems and can connect his laptop directly to the 12-cylinder units for engine diagnosis. He then simply transmits the diagnostics protocol by Internet to the MTU Service Section, which provides troubleshooting advice. According to Gromov, the MTU Service Section sometimes also provides software updates.

The enormous climatic variations that are commonplace in some Russian regions can mean that anyone trying to cut corners on the cost of machinery and equipment can have major problems. Engineers at the quarry learned that lesson very early on. "The first winter after we bought the MTU engines was the hardest," said Pridanov. "At that point, we had not had any MTU training. At temperatures around minus 10°C, we had problems with the diesel fuel." However, the issues involved were resolved before the onset of the following winter. What was the problem? The low temperatures meant that the diesel fuel became so thick it would not pass through the filters. Tank heating systems etc. could have been fitted as a solution. "But why should we do that when the problem only comes up for two weeks a year at most?" asked Pridanov. The quarry is located in southern Russia, where periods of extreme cold are usually short-lived.

The technicians at Donskoi Kamen also had another problem: High quality diesel fuel is not readily available in southern Russia. Consequently, the quarry now purchases its diesel in the Volga region where the winters are even colder and winter diesel is in greater supply.

According to service engineer Pridanov: "Our experience with the MTU Series 1600 units at the quarry in the Rostov region shows that they are extremely well suited to the rugged conditions in Russia." Chief Engineer Gromov confirmed the verdict: "The decision to purchase MTU engines was the right one."

Words and Pictures: Ulrich Heyden

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Donskoi Kamen has decided not to use dust-tight enclosures for its engines. Heavy-duty air filters with cyclone pre-filters ensure that dust does not penetrate the engines. Nevertheless, the engines need to be cleared of dust every day.

Lithuanian Railways opts for remanufacture of the MTU engines in its freight locomotive fleet

Baltic revival

44 locomotives in Lithuanian Railways' locomotive fleet were remanufactured through the MTU distributor Baltic Marine Group.

A 16-cylinder MTU engine has completed 24,000 hours of duty in the Lithuanian Railways freight locomotive ER 20016. Now it is being replaced by an MTU reman unit.

Giedrius Pranckunas of Baltic Marine Group lifts the old engine out of the locomotive by crane.

Andžej Mickevič (left) examines the engine together with Arunas Žėkas before the mighty unit is shipped to the MTU Reman Center in Magdeburg by road.

Naglis Vyšniauskas is director rolling stock for Lithuanian Railways. His dream is to learn how to drive a locomotive (see memo box below).

Each of the 44 MTU engines that had been powering Siemens Eurorunner locomotives in Lithuania for the last eight years had 24,000 hours of service on the clock. So it was time for a rejuvenation treatment – or, to put it another way, the MTU reman process. This involves restoring the engines to as-new condition. Remanufactured or 'reman' engines are as good as new ones but considerably less expensive and still come with the same warranty.

There is a smell of metal and oil, but it is surprisingly bright and clean in the locomotive shed in the south of Vilnius, the Lithuanian capital. A subsidiary of the Estonian company Baltic Marine Group, an MTU distributor, had the shed renovated only three years ago. At 'Vilniaus lokomotyvu remonto depas' as it is called, maintenance and installation work is carried out on behalf of Lithuanian Railways (Lietuvos Geležinkeliai).

Two Siemens type LG ER 20 CF locomotives are standing in the railway depot. On the left is ER 20016 and on the right its sister locomotive, ER 20032. They are two of the 44 Eurorunner locomotives that have been in service pulling goods trains in the Baltic state since October 2007. The beating heart of the locomotive is a 16V Series 4000 R41 engine from MTU.

A 16-cylinder unit weighing 7,880 kg, it has helped deliver smooth-running freight services in Lithuania. "Lithuania is not a big country," explains Naglis Vyšniauskas, director rolling stock in the freight services department of Lithuanian Railways, with a smile. "We don't have many routes. The most important is the link between Vilnius and the Baltic port of Klaipeda. It is divided into two parts with Radviliškis, where the Eurorunners' home depot is located, in the middle. And then there is the transit line between Belarus and the Russian exclave, Kaliningrad. The rest of the goods traffic is local and supplies sites and businesses in Lithuania."

Economical and sustainable

In July 2013, Lithuanian Railways launched a joint project with Siemens, Baltic Marine Group and MTU to overhaul the 44 locomotives and engines. By September 2015, all of the engines, each of which had completed roughly 24,000 hours of service to date, had to be successively removed from the locomotives at the Vilnius depot and sent by truck to the MTU Reman Technology Centre in Magdeburg, MTU's lead facility worldwide for standardized reman processes. The plant specializes in remanufacturing, i.e. standardized industrial reconditioning and complete overhaul of MTU engines. The advantage of reman engines is that they cost less than new units but have the same warranty. What is more, in the course of the complete overhaul, each engine benefits from all technical upgrades so that clients can be certain they are receiving a product with the very latest technical advances. In Magdeburg, the incoming engines are made fit and ready for a new life. The first part of the process is to completely dismantle and examine them. Worn parts and elastomer or defective components are replaced, but the majority of the engine parts, such as cylinder heads, crankshafts or the crankcase, are reconditioned – which is a sustainable process because no raw materials have to be used to produce new components. After successfully completing a bench test, the engines are also repainted, which means they not only meet the same specifications as an equivalent model just off the production line, they also look brand new. Just like the reman unit in locomotive number ER 20032. The Eurorunner's 2,000 kW traction unit shines brightly in its freshly applied blue livery and is once again fully prepared for service on Lithuanian freight routes.

"The money that we save can be invested elsewhere."

Werner Berger is one of the MTU staff looking after the Lithuanian reman project. "This is our first contract for reman engines from a national railway," he says, not without a certain amount of pride.

MEMO

"I want to learn how to drive a locomotive."

"I know how a locomotive works, but I am not a train driver," says Naglis Vyšniauskas, director rolling stock in the freight services department of Lithuanian Railways. He studied mechanical engineering at the technical university of Vilnius and worked in the automotive and aircraft industries before moving to Lithuanian Railways nearly five years ago. He had always dreamed of being an engineer as a small boy. "Absolutely anything that could be taken apart, I would dismantle and reassemble. Although being a train driver was not my dream job, I would still like to learn how to drive a locomotive."

1-3 At the MTU Reman Centre in Magdeburg, engines are remanufactured in a standardized process. First of all, they are dismantled and the components cleaned. Worn parts are replaced and all other components – such as the crankcase and conrod caps in picture 2 or the crankshaft in picture 3 – are reconditioned.


1


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3

The engine compartment is then prepared for the reman engine, which is already standing by to be fitted.

As good as new: The basic components, such as cylinder heads, crankshafts and engine block, have been...

...reconditioned. Only worn parts and defective components have been replaced with new ones.

The locomotive now sports a shiny new traction unit. The reman engine not only looks exactly like its predecessor, it also carries precisely the same warranty as a new unit.

The process was tailored exactly to Lithuanian Railways' requirements. Two engines at a time underwent the reman process in Magdeburg, while two so-called "swing engines" were used in Lithuania. These were units that had already been reconditioned and were ready to be fitted in the locomotive. "This ensured that the out-of-service times for our locomotives were kept as short as possible," explains Naglis Vyšniauskas.

The financial aspect in particular was the crucial factor in the decision to opt for reman engines. "The money that we save by using reman units," outlines Vyšniauskas, "can be invested elsewhere." As he is talking, the chuffing and whistling of a steam locomotive suddenly disturbs the quiet of the office. The noise comes from a wall clock. On the stroke of each hour, a miniature train runs around the clock face, its sound effects attracting attention.

Out of the locomotive and onto the wooden pallet inside two minutes

In the locomotive shed in Vilnius, Arunas Žėkas and Giedrius Pranckunas of the Baltic Marine Group service team are in the process of lifting the old engine out of ER 20016. Giedrius Pranckunas moves the big yellow overhead gantry crane over the locomotive by remote control. By the time it is in position, his colleague Arunas Žėkas has attached heavy lifting chains to the engine block. Within a few moments, the heavyweight engine is hanging from the hook and being carefully lifted out of the locomotive. The fact that it seems to sway quite considerably in the process does not worry the experienced mechanics – apparently that is quite normal. Finally the engine is hovering just an arm's width over the wooden shipping pallet. From start to finish, the operation has hardly taken two minutes. Now some high-precision maneuvering is required to position the steel colossus on the four bolts of the wooden base. "That's no problem," smiles Arunas Žėkas. "After 30 engines, it's just a routine operation for us." The two mechanics rock the engine a little, and very soon it has seated itself satisfactorily. Arunas Žėkas grabs a large spanner and tightens the nuts onto the bolts.

Beside him, engineer Arminas Vilbrantas and the director of the Lithuanian branch of Baltic Marine Group, Andžej Mickevič, observe the procedure. "MTU has an excellent reputation in remanufacturing," says Andžej Mickevič. "They provide support if there are any problems and respond very quickly. Every day matters to us and our clients, Lithuanian Railways." Arminas Vilbrantas adds, "Everything slotted perfectly into place and is running very smoothly. Our partnership with MTU is very solid, and things are dealt with in a very friendly way." Herman Schirmer, who looks after the reman project from the Friedrichshafen end, likewise values his colleagues from Estonia and Lithuania: "The team in Vilnius works very self-sufficiently. The work that Baltic Marine Group does as distributor is text-book."

"The engines are in good hands"

The reman project in Lithuania took two years to complete, and Naglis Vyšniauskas is more than satisfied: "We not only have a partnership, we also have a really close collaborative relationship with MTU and Baltic Marine Group. In these two companies we have partners we can rely on." Naglis Vyšniauskas saw that trust vindicated when MTU invited its partners to the Reman Technology Centre in Magdeburg. "I was glad to see that our engines are in good hands. The plant there has high-tech equipment of the very best quality. And in our discussions I also found out how the MTU experts assess the condition of our engines after such a long period of duty. The positive feedback from MTU about the condition of our engines and, therefore, the standard of work of our maintenance staff gave me a very good feeling."

Since the first reman engine returned to service in Lithuania in August 2013, it has already clocked up 13,000 hours on the track without the slightest problem – as expected. And the last overhauled engine is also back in service – providing the power the shiny red locomotives need to pull heavy goods trains across the Baltic state.

Words: Dagmar Kötting
Pictures: Andzej Mickevic

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MEMO

Individual cylinder temperature measurement

The MTU reman engines supplied to Lithuanian Railways are not run of the mill by any means. They are very special in two ways. Firstly, there is an individual exhaust temperature sensor on each cylinder – a system that originates from marine engines. Its purpose is to identify overheating more quickly and thereby prevent damage. Secondly, the engines have automatic oil filters that are more sustainable than the conventional non-reusable paper-element filters because no filter replacement is required over the entire 24,000-hour service life of an engine.

The refitted Lithuanian Railways locomotives are already back in service with their MTU reman engines.

MEMO

Lithuanian Railways – Broad gauge for goods traffic

Lithuanian Railways, or Lietuvos Geležinkeliai (LG), is the largest railway company in Lithuania. Founded in 1919 as a state-owned railway, it is now a public-stock company based in Vilnius with more than 10,000 employees. LG's importance is primarily in the freight sector. The rail network is made up largely of broad gauge track. It is only at the Polish border that there are a few kilometres of European standard gauge. Until the early 1990s, the LG locomotive fleet consisted mainly of Soviet-made vehicles. Since 2000, there has been a continuous process of modernization and acquisition of new rolling stock. In 2005, LG decided to invest in a fleet of Siemens ER 20 Class locomotives. There are now 44 of them powered by MTU engines currently in service on Lithuania's rail network.

→*How do we make* … things watertight?

More than just hot air: Johannes Hecht uses a special hot-air blower to soften the heat-sensitive components and form a sealed connection.

Are MTU engines watertight? Actually, most of them aren't! But they don't need to be, because the engine compartment is sealed to keep water out. However, the situation is different for tracked vehicles. They do not have sealed engine compartments, and their engines sometimes get wet. To ensure that its electrical equipment is not exposed to moisture, MTU uses a special process to protect engine cabling.

These cables may be anywhere from one to 15 meters long. They have to withstand temperatures from below zero to 450°C and to carry voltages from 24 to 400V. In short, MTU engine cables have to be robust. "These cables provide the interfaces between the high-tech components on our engines and gensets," said Georg Haas, master craftsman in the cable production section at MTU Friedrichshafen. They have to be sealed absolutely tight to ensure that they are impermeable to dust and water and that no engine control or monitoring faults can occur. However, the cables obviously have to be manufactured before MTU technicians can test the engines for leak tightness.

One pin for each core

To start the process, Zoran Krucican cuts several long, slender white cores to length. Later on, these cores will conduct the signals for the engine electronics. Krucican fits a pin – a sort of silver sleeve – over the end of each insulated core to provide a cable connector. Using these pins, he then inserts up to 64 cores into a round connector. MTU assembly technician Johannes Hecht then fits a gray rubber sleeve over the cores before the sealing process takes place and a drop of liquid adhesive sealant is applied between the connector and the connector housing.

Starting the sealing process

Hecht then fits a braided silver shield over the entire length of the cores to protect against electromagnetic waves. "What we are using here is a tin-plated copper alloy that will prevent signal interference later," explained Haas. So the cores are electronically sealed, as it were. Once Hecht has drawn the braided copper shield over the cores, he pushes it over the connector housing, secures it with a stainless steel strip, winds it around and presses it back in again. Finally, he fits a black shrink-fit sleeve over the connection as a protective cable sheath before using a specially designed molding to join the sleeve and the connector housing. A hot-air blower then shrinks the heat-sensitive components to form a watertight connection between the connector housing and the cable sheath.

Under water

At this stage, the cables are finished and watertight. However, electrician Daniel Angele still has to immerse the cables to ensure they are tight and will withstand water pressure. Angele places the cable harnesses in an empty bath and lets water in. He uses a pump to simulate pressure – as if the cables were immersed several meters below the surface. "If any air bubbles rise to the surface now, it means the cable is not tight," said Angele. The cable harnesses are kept under water for 60 minutes to ensure there is no possibility of even the tiniest leak.

Words: Caren-Malina Butscher
Pictures: Robert Hack

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1 Zoran Krucican needs a steady hand to fit the cores and their pins in the round connector.
2 Daniel Angele conducts an immersion test to ensure the cables are watertight.


1

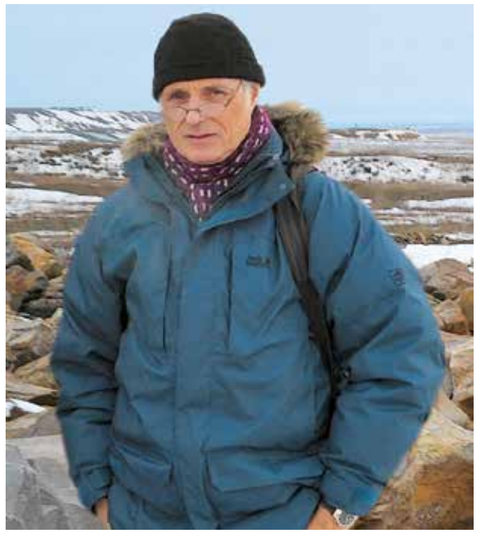

2

Things our editors have been impressed by

Afterthoughts

Familiar smells
It was that mixture of oil and metal that immediately hit my nostrils. A smell that is so typical of so many factories and machinery shops and also welcomed me at the railway depot in the Lithuanian capital, Vilnius. This was where my report on the use of MTU reman engines had led me. It is a very special smell that reminds me of childhood days spent in my uncle's small metal-turning workshop and of the many holiday jobs I took in metalworking shops as a student. So it is a very familiar smell. The gigantic locomotives and massively muscular engines I encountered here, however, were something entirely new and imposing. I was also impressed by the hospitality with which I was received by the staff of Lithuanian Railways and MTU agents Baltic Marine. They were not simply keen to explain their work and offer me an insight into the rail freight sector in Lithuania, they also took the time to show me their home town. So I had the opportunity to get to know a city with a historical heart positively bristling with magnificent churches and declared a World Heritage Site by UNESCO. At dinner I also found out that you can eat 'zeppelins' in Lithuania. Airship-shaped potato dumplings with a meat filling are a specialty of Lithuanian cuisine and are as impressively weighty as the locomotives.

Dagmar Kötting took a trip to the Lithuanian capital Vilnius where goods locomotives were being repowered with MTU reman engines.



Ulrich Heyden visited a quarry in Russia.

“Cold and inhospitable but mysterious”
This is roughly how I imagine it to be on another planet. Cold and inhospitable but mysterious as well. Men in gigantic machines drilling holes in the ground, excavating a whole valley as if they wanted to build a subterranean city. Far and wide, no sign of civilization. Grey sky. No birds. The rock a brownish black color. Grey dust everywhere. No entry to the quarry without a helmet. And when you eventually go inside the small, two-story office building, you feel as if you are in the landing craft of a space mission. The woman in the kitchen folds the pancakes so beautifully into triangles that you could watch all day long. The team in the planning room communicates in friendly tones and is well drilled. In a quarry you have to be able to rely completely on one another. Before it goes dark I get back in the spacecraft for the return journey to Earth – otherwise known as the jeep that takes me back the hotel.

You can find out more about the future on pages 13 to 31.

IMPRESSUM

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