

From repair shop to service specialist

40 years of MTU Maintenance.

A trip back in time.

COVERSTORY

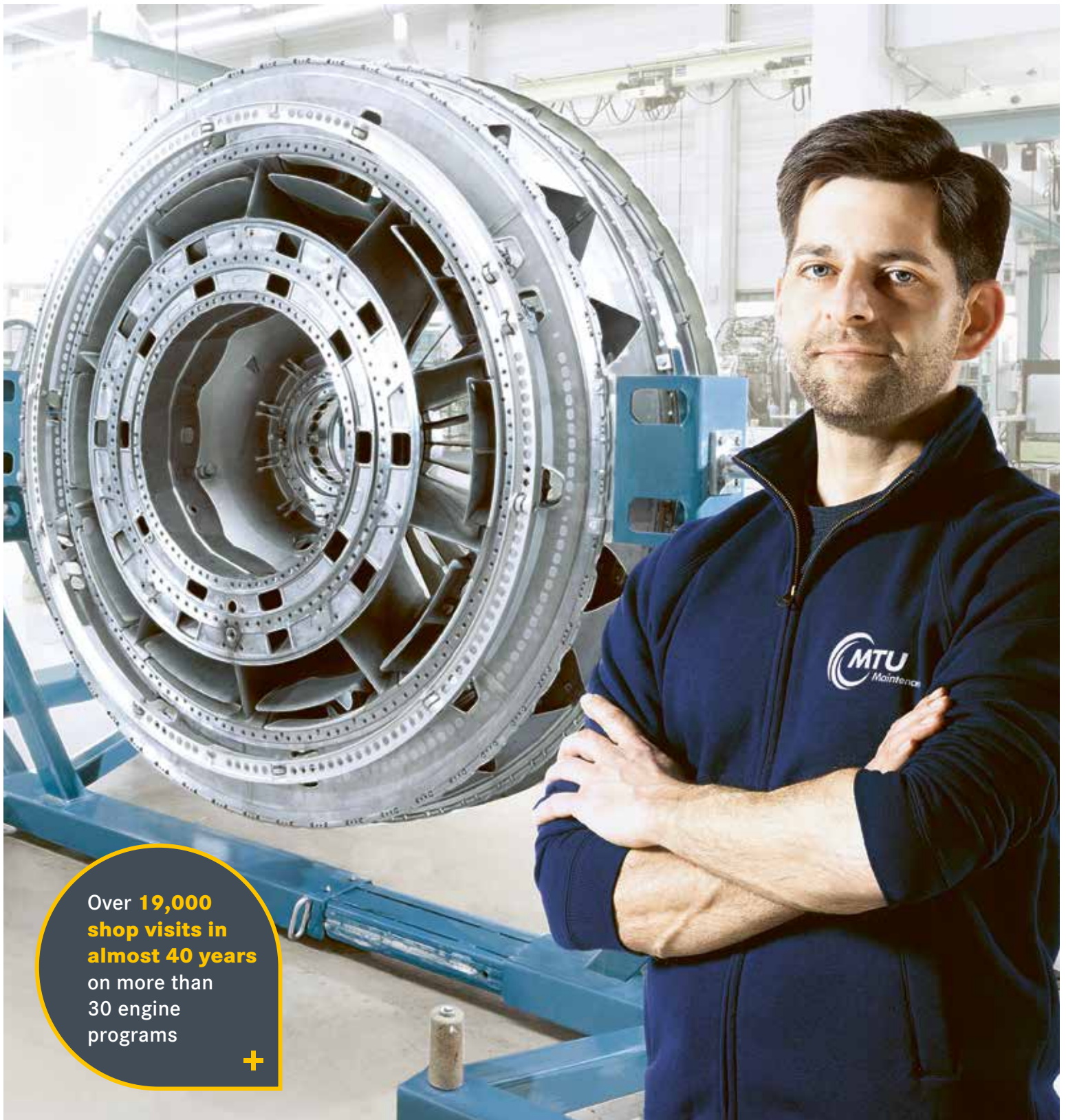
MTU Maintenance –
the early days

INNOVATION

Virtual engine –
a game changer in
the engine industry

AVIATION

Aerial search and
surveillance –
the PW200 in action



Over **19,000**
shop visits in
almost 40 years
on more than
30 engine
programs



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Dear readers,

During the 1970s, air travel became affordable for more and more people across Europe. A holiday flight to the Costa Blanca was no longer out of reach for average earners. This pushed up the volume of air traffic—and, with it, demand for engine maintenance. Even though the MTU name was less than ten years old at that time, the company had the necessary expertise because it could draw on the decades of experience its predecessor companies offered.

MTU Maintenance was founded on November 14, 1979—and this proved to be the starting point for an unparalleled worldwide network of engine experts. Today, of MTU's more than 10,000 employees worldwide, roughly half work at one of our commercial maintenance sites, located, for example, in Vancouver or Zhuhai. The business division generates about 60 percent of MTU's total revenue; in the first half of 2019 alone, it attracted an additional 4.5 billion U.S. dollars' worth of maintenance contracts. Its engine portfolio is the largest of any MRO provider. "Classical" scheduled shop visits are increasingly being supplemented with on-wing or near-wing services, saving the customer time

and money—because costs mount up for every minute that an aircraft isn't flying. We work with digital support on intelligent solutions for our customers so that they can concentrate on their core business: flying.

Our operations are at maximum capacity and we are in the process of greatly expanding all our locations in Europe and Asia. In addition, we are currently building two new maintenance shops in Jasionka, Poland, and in Serbia: EME Aero in Poland is a joint venture with Lufthansa Technik that will support geared turbofan engines starting in 2020; the new location in Nova Pazova, near the Serbian capital Belgrade, is set to commence component repair operations in 2022.

There are some exciting stories behind this development. I invite you to discover them in this issue of **AEROREPORT**. Also in this issue: interviews with MTU engineer Harald Schönenborn about the ASME Turbo Expo and with MTU Purchasing Manager Uwe Böhm about the worldwide supply chain in engine construction, along with a portrait of our maintenance customer China Express Airlines.

I hope you enjoy the read!



Yours sincerely,

Michael Schreyögg
Member of the Executive Board, Chief Program Officer



COVER STORY

MTU Maintenance – the early days

Forty years ago, construction of MTU Maintenance’s first-ever shop began in the immediate vicinity of Hannover-Langenhagen Airport. We take a trip back in time to the company’s early years when the first shop visit was still a real novelty.

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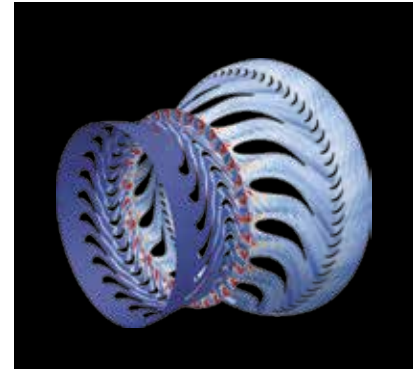


INNOVATION

Virtual engine

Interview with Dr. Stefan Weber, Senior Vice President, Technology & Engineering Advanced Programs at MTU Aero Engines, who gives us the lowdown on the virtual engine—a game changer in the engine industry and a cornerstone of productivity and competitiveness.

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INNOVATION

Awe-inspiring aerodynamics

Successful collaboration: Experts at DLR and MTU have developed TRACE, a simulation tool that aids in engine optimization. Its Harmonic Balance module accelerates calculations by a factor of one hundred.

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**AVIATION**

Aerial search and surveillance

The PW200 provides the power for the H135/EC135 police helicopters in Bavaria and Lower Saxony. Thanks to the Pratt & Whitney Canada Customer Service Centre Europe, the task forces have a reliable repair partner at their side.

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**AVIATION**

China's regional market takes off

Air traffic in China is about more than just serving routes between megalopolises. The country has more than 85 megacities with a population of over a million. Establishing connections between them is the business of regional airlines such as China Express Airlines.

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**PEOPLE**

On an equal footing

Suppliers to the engine industry range from highly specialized medium-sized companies to large corporations—and yet the base is limited because the requirements are so stringent, says MTU's Head of Purchasing Uwe Böhm in an interview.

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MTU Maintenance – the early days

In 1979, MTU launched its MRO business—MTU Maintenance—to provide aftermarket services for commercial engines. We take a look back to when the first engine arrived for a shop visit.

Text: Nicole Geffert and Johannes Angerer



New ground — Engine shops, a test stand and administrative buildings for MTU Maintenance Hannover started to spring up on a greenfield site.



Striking — MTU Maintenance launched its successful career 40 years ago with this logo.



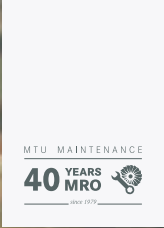
Successful — The commercial engine maintenance business is booming and creating high-quality jobs.

Up until the 1970s, air travel was considered a pure luxury. In 1977, a worker on a standard wage in Germany took home 710 Deutsche Mark per month. Back then, a return flight from Frankfurt to New York in peak season cost 2,400 Deutsche Mark. But that was set to change. As commercial aviation really began to take off in the 1970s, flying started to become increasingly affordable. And with this momentum came a rising demand for maintenance services for commercial engines.

At MTU München (now MTU Aero Engines AG), this development became a much-discussed topic for the executive board as they considered how the company could benefit from it. Until then, MTU's main activity had revolved around military applications, with the company specializing in the engines powering the Tornado and other military aircraft. But now the company was considering branching out into maintenance and repair activities for commercial engines such as the General Electric (GE) CF6

powering the first Airbus A300, the Boeing 747 and McDonnell Douglas DC-10-30. While very few airlines at the time had the know-how and equipment needed for this work, MTU did—thanks to its expertise in military programs.

“In 1976, we carried out our first studies into the feasibility of commercial MRO activities at MTU and visited facilities in the USA,” says Franz Weinzierl, who headed up sales and marketing at MTU Maintenance Hannover until 2002 and is now retired. He was the project manager in charge of setting up MTU's commercial maintenance business. A market analysis delivered promising results: a maintenance facility in Western Europe could meet the needs of 67 airlines with around 1,250 engines. The investment would be extremely high—30 million Deutsche Mark for the initial equipment alone. But this was undoubtedly the right time to secure a firm foothold in the market.



Excellence award _____ In 1982, the administrative buildings at MTU Maintenance in Hannover-Langenhagen received a gold medal in a Germany-wide industrial and urban development competition.



- 01** — *V2500 maintenance at MTU Maintenance Hannover: Using perfectly fitting grips, the high-pressure compressor is prepared for module assembly.*
- 02** — *Taking off: Business at MTU Maintenance grew steadily in the early days. March 1991 saw the 500th engine come in for a shop visit.*
- 03** — *Engines all in a row: The assembly and disassembly line at MTU Maintenance Hannover. Every year, the company expanded its portfolio of maintenance services.*
- 04** — *The GE CF6 and its variants were the first engines MTU Maintenance specialized in as a young company. Here, a fan blade undergoes preparation for blasting.*
- 05** — *Assembly of a CF6-80 engine: In the early days, manufacturer GE would run some of the tests on its engine to power the Boeing 767 at the Hannover test facility.*
- 06** — *A well-trained eye: An expert from MTU Maintenance performs a borescope inspection on a CF6-50 engine booster.*



So, in 1979, MTU decided to begin maintenance operations for commercial engines and industrial gas turbines, and established MTU Maintenance as a new business alongside its existing development, production and military maintenance activities. Given its close proximity to the airport, Hannover-Langenhagen was the logical choice for the location. “At the time, the federal state of Lower Saxony was really keen to create highly skilled employment opportunities in the region to help northern Germany catch up in the hi-tech sector,” Weinzierl explains.

On November 14, 1979, MTU Maintenance Hannover was established as a wholly owned subsidiary of MTU. It was a greenfield development. “Before the ground was first broken, I stood in the field and watched a farmer as he went up and down with his plow,” Weinzierl recalls. Test stands, workshops and administrative buildings quickly started to spring up on the construction site, where a sign read: “A plant for aircraft engine maintenance is under construction here. We are hiring.” Word soon spread in the area. Jörg Schenkemeyer, a young precision engineer, was one of the applicants at the time. Before he and other new specialists could start, they received part of their training at MTU in Munich.

Late in the summer of 1981, machinery was delivered and set up in the shop. Employees assembled welding booths and workbenches, while tooling and specialist equipment and gantries for commercial engine maintenance were located at the end of the hall. The first orders came from MTU in Munich, where airfoils for GE were repaired.

Employees shared many “historic” moments back in these early days, such as the time when they gathered with Wolf Birner, former operations manager, to celebrate the arrival of a new 5-axis vertical turning machine. The first order was a flange for a compressor rear frame—a thick cowl that encases the combustor—that had to be turned to exactly the right dimensions. The machine operator began the turning operation and then almost immediately stopped again. He stooped, picked up the first chip and placed it in Birner’s hand. “We ought to keep this one,” he said. And yes, it is still around today, mounted in resin.

On November 5, 1981, limousines pulled up outside. Out stepped Birgit Breuel, Minister of Economy and Transport in Lower Saxony at the time, and representatives of local government, who had arrived for the official opening of the first MTU Maintenance



04




05



06

site. The ceremony took place in the test facility, where the visitors marked the occasion with MTU management, former CEO Manfred Holz and senior employees.

At the end of 1981, things took off in the shop. The Hapag-Lloyd airline, which primarily operated charter flights to tourist destinations around the Mediterranean, entrusted the young company with its CF6-50 commercial engines, and the CF6-80 for the Boeing 767 completed test runs in the newly established test stand. In addition to that, orders for the maintenance of RB211-22B/524 engines and the LM2500 gas turbine filled the books.

Schenkemeyer still clearly remembers the day in November 1981 when a Unimog truck stopped in front of the shop. It was transporting a CF6-50 operated by Hapag-Lloyd Flug—the first complete engine that the MTU Maintenance team was set to repair. “Almost all of the 200 colleagues gathered to see this huge piece of machinery in the shop. We gazed at the engine as if in awe. This was our future.” 



Do you have any questions, requests or suggestions?
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Text:

Nicole Geffert has been working as a freelance journalist covering topics such as research and science, money and taxes, and education and careers since 1999.



Author:

Johannes Angerer, partner of the employer branding agency identify, strengthens brands by researching the formative stories behind them and telling them in appealing forms, whether as text, video or in an exhibition.

A remarkable career

Disassembly, repair, assembly and the test stand: lots has changed in the MTU Maintenance shops over the last 40 years. We travel back in time and take a look at what the future holds.

Text: Nicole Geffert and Johannes Angerer



With over 18,000 shop visits under its belt, MTU Maintenance ranks among the top five providers of aftermarket services for commercial aircraft engines and industrial gas turbines. If we take a look back, you'll see that alongside all the innovations, the company's 40-year history is also defined by tried-and-true processes. One constant, for example, is the large number of screws that have to be loosened and then removed to dismantle a low-pressure turbine (LPT).

In the 1980s, the maintenance specialists used ratchets and ring spanners for the job. On the desk at each station, a worksheet with details of the steps to perform and a sheet of paper next to it were permanent fixtures. Dieter Schmotz, who has worked as an engine mechanic at MTU Maintenance Hannover since 1981, recalls: "We worked through the instructions step by step. After each step, we noted down exactly what we'd done on the paper, and then signed it, dated it and added our employee stamp. Then we turned back to the module, picked up our tools again and continued the job."

And what's changed since then? The tools, for starters. Instead of ratchets, the engine mechanics now use cordless air screwdrivers, for example, which cut the time it takes for an experienced mechanic to disassemble the LPT in half. Manual paperwork has also become a thing of the past—well, almost. Dating, signing and stamping by hand are still an occasional feature of the high quality standards and reliability that the MTU Maintenance shops deliver to this day.

Most processes, however, have been adapted and continuously improved over the years. It's essential, after all, for a top maintenance provider to move with the times. In line with the compa-

ny's MRO 4.0 drive, MTU Maintenance is embracing digitalization and the digital transformation is in full swing in its shops.

With the support of computers, it is now possible to detect technical problems in engines long before they disrupt flight service or create the need for costly, time-consuming repairs. MTU Maintenance's Engine Trend Monitoring software is a comprehensive solution developed by MTU in-house for monitoring engine parameters. And looking ahead, advanced analytics and machine learning technologies will make it possible to analyze large volumes of data in the future, enabling precise predictions

to be made about the condition of engines without them leaving the aircraft's wing. Such developments improve engine maintenance planning right down to the individual modules, thus helping to reduce costs for the airlines.

MTU Maintenance's top priority is always to minimize engine maintenance costs and downtime. That holds true for every shop visit it performs—whether the engine comes in for full performance restoration, for life-limited parts to be replaced or for engine parts to be repaired.

Given that metal working generates an incredible amount of noise, it's impossible to miss the repair areas in the shops. "It used to be far louder in the old days," says Rudolf Glembozky, a toolmaker by trade who has worked at MTU Maintenance since 1982. He takes the turbine mid frame (TMF) liner—a round, sheet metal part with a diameter of about 150 centimeters—as an example and describes how it was repaired in the past.

In the department he used to work in, one of his colleagues would bring the part in need of repair to the waiting area and put it down with the others. Any particularly urgent parts were

*"It used to be far louder
in the old days"*

Rudolf Glembozky,

Toolmaker at

MTU Maintenance Hannover



given a red sticker. A typical repair would involve changing the four connecting flanges: removing the old ones, welding on the new ones and ensuring all the dimensions were exact. “But first we had to get the part onto the machine. We had no fixture back then, so often two or three of us had to use our brute strength to lift the liner onto the machine.”

As time moved on, thousands of special fixtures replaced muscle power, many of them designed by MTU employees themselves. Clamping devices, protective covers or special measuring instruments, for example, all help facilitate their work today.

It goes without saying that repair work remains a key area of MTU Maintenance’s expertise, but over the years the company has expanded its portfolio beyond classic maintenance solutions. Today, MTU Maintenance specializes in comprehensive services that cover the entire lifecycle of an engine and provides these services worldwide. One solution is fleet management, where the MTU experts develop bespoke maintenance, repair and overhaul (MRO) solutions for each and every engine in an airline’s fleet, thus optimizing engine availability.

Another example is the company’s engine leasing service. In the aviation industry, where time and costs are of the essence, more and more airlines are taking advantage of aircraft and engine leasing options, which give them greater flexibility and free up additional capital that they would otherwise have to invest in

spare engines. To this end, MTU Maintenance Lease Services offers short- and medium-term engine leasing solutions, while SMBC Aero Engine Lease addresses the long-term leasing business. Both companies are joint ventures between MTU and Japan’s Sumitomo Corporation.

Back to the shop. Following maintenance, every engine is put on the test stand. Frank Reimchen, who schedules test stand operations at MTU Maintenance Hannover, takes us on a short trip back in time to the 1990s. Back then, two mechanics “led” the engine through its test run. One employee from engineering and one from quality assurance monitored the metrics on a screen displaying the 30 most important values all in green.

Another member of the team operated a bulky input console to control the computer system used for the measurements. An eight-channel line recorder took measurements of certain values over time. If you wanted different values, you had to unplug the cables and recalibrate the device. “Our quality engineer at the time, Hans Holpert, wasn’t prepared to put all his faith in the computer, so he would often double-check the engine’s performance during a test run himself with a calculator. It was incredible, he knew all the formulas from memory.”

By the turn of the millennium, it took only three people to conduct a test run—thanks in no small part to the rapid development of measurement and computer technology. By that point, the test

Under observation ——— MTU Maintenance’s Engine Trend Monitoring solution enables comprehensive observation and control of the engine parameters.



Repair specialists ——— With its repair techniques, MTU achieves globally unparalleled levels of restoration and long on-wing times.



technicians had a neat overview of all the relevant values on eight color screens and the system automatically stored the temporal progression in the “history buffer” four times a second. In this modern system, the measurements taken were automatically displayed within the range of the limit values.

And what about now? Today’s engines are supercomputers in themselves that use thousands of sensors to capture huge numbers of megabytes in data every second. “The RB211 was fully analog, and then, in 1989, came the PW2000 and V2500. These engines each had two data channels that delivered 12.5 kilobytes of data per second. Today’s PW1100G-JM incorporates three Ethernet channels that each deliver 100 megabits per second,” Reimchen explains.

MTU Maintenance Hannover invested in a new test cell back in 2007, mainly for the large GE90 engine with its 115,000 pounds of thrust. In anticipation of future developments, however, the test cell was built to withstand 150,000 pounds of thrust. MTU Maintenance Zhuhai also offers cutting-edge testing expertise and the infrastructure to test engines of up to 150,000 pounds of thrust on its state-of-the-art test stand.

And how do things look in the future? Computer simulation technology is developing rapidly and some virtual engine tests are already possible. But these won’t replace conventional test runs in the test cell anytime soon. That holds true for EME Aero as

well. Set to launch operations in 2020, MTU’s new joint venture with Lufthansa Technik will, for the foreseeable future, put every engine it handles through its paces on the test stand. Currently under construction in Poland’s Aviation Valley, just a stone’s throw from Rzeszów International Airport, EME will be one of the largest and most advanced MRO service centers for the Pratt & Whitney GTF™ Engine Family. EME’s state-of-the-art test stand will set new standards, just like the advanced geared turbofan engines it accommodates. 



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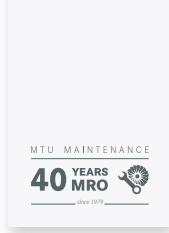
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Johannes Angerer, partner of the employer branding agency identify, strengthens brands by researching the formative stories behind them and telling them in appealing forms, whether as text, video or in an exhibition.

A watchful eye _____ *Test stand control room at MTU Maintenance. Following repair, every engine is put through its paces on the test stand.*



Ultra-modern test cell _____ *A V2500 engine undergoes preparations for test runs at MTU Maintenance Zhuhai.*





40 years

40 is more than just a number: MTU Maintenance employees share memorable moments and opportunities for the future.

You and MTU Maintenance are both turning 40 this year. What makes it a special year from your point of view?

My 40th was very special to me because it marked the start of a new phase of my life: this year I became a father. My family has grown, which makes me happy, grateful and proud. MTU Maintenance is also growing and here, too, I am a "father," figuratively speaking. This year we opened our new logistics center, which I planned; I was also responsible for its construction. It's great that our company is doing well. We're growing and I'm contributing to that. Many of my MTU colleagues helped me celebrate my 40th birthday—they're part of my extended family.

ANDREAS MEINERT, 40, Head of Logistics and Planning, MTU Maintenance Berlin-Brandenburg

You are 40, the same age as the company. How do you view where we are now?

It is great to see that young people are moving away from stereotypes that certain professions are for men or women. I work in the HR department, and I am delighted to see our workforce changing as we speak, with ever more qualified female candidates applying for technical jobs. At MTU Maintenance Canada, we have a very diverse team of 63 nations under one roof—I'd love to see this expand further!

DANGUOLE CHANDLER, 40, Human Resources Generalist, MTU Maintenance Canada

You've been here nearly 40 years — so almost from the beginning. Do you have a favorite anecdote from that time?

My absolute favorite anecdote is that in the beginning we had no office furniture, so there were five of us sitting in a small room with two desks and a typewriter table. Whenever our colleague starting typing on the machine, the whole table began to wobble—not a particularly stable model! To make copies, you had to put on your rubber boots, because there weren't a lot of paved paths and the copier was in the construction trailer at the entrance to the site. We didn't have our own copier back then.

PETRA OHDE, at MTU Maintenance Hannover since July 1, 1981, works in export control

What do you think MTU Maintenance Zhuhai will be like when you are 40?

In 13 years from now, MTU Maintenance Zhuhai could have more than one shop. Then there will be more capabilities for new engine maintenance, and we can manage more technically difficult tasks as well as obtain more licenses and approvals from authorities all over the world.

YUAN MENG, 27, technical operations department, MTU Maintenance Zhuhai



You are very new to the company, where do you think you and the industry will be in 20 years from now, when you are **40?**

I hope to be a senior engineer in twenty years and I expect MRO to be even bigger business then. Asia is likely to become one of the world's largest engine maintenance markets. New engines will dominate, and leasing will be popular for airlines who don't want to invest capital in engines. MROs will be both shops and lessors, even more so than MTU already is today. I can't wait for it!

MAO JIAO, 20, technical operations department, MTU Maintenance Zhuhai

You were already with MTU Maintenance Berlin-Brandenburg when you were **40. What has changed over the past ten years?**

Ten years ago I was the product line manager for the CF34 program in Ludwigsfelde. I oversaw the reintroduction of the repair process for the CF34-10E. We were the first licensed supplier on the worldwide market! Today, ten years later, as MTU Maintenance turns 40, I am Managing Director and Senior Vice President of MTU Maintenance Berlin-Brandenburg and we are still the largest provider of repair and maintenance services for the CF34-10E. By the end of 2019 we will have more than 900 employees, compared with around 600 in 2009. Our joint efforts are paying off: we are increasing orders and sales across our entire portfolio.

ANDRÉ SINANIAN, 50, Managing Director & Senior Vice President, MTU Maintenance Berlin-Brandenburg

What will the leasing industry and MLS be like when you turn **40?**

The leasing industry will be even more important than it is now. Global aviation demand is strong, and the majority is expected to come from Asia - it will be essential for operators to have cash in hand to cope with the expected surge in demand and tighter margins. Provided we are true to our core beliefs of consistent high quality and innovation of products, MLS will be a leader in the engine leasing market by the time I hit 40 and still challenging the status quo.

JOSHUA SEBASTIAMPILLAI, 27, MTU Maintenance Lease Services, Amsterdam

You have been with MTU Maintenance since 1983. What was the biggest surprise for you in the past (almost) **40 years?**

The biggest surprise for me after I joined MTU in 1983 was how much freedom and scope we had to shape our work. That was a truly novel and good approach. I came from an energy supply company with well-established structures, but here we were allowed to do things the way we thought best (there was also friendly assistance, though!). It was the same throughout the whole company; almost everyone seized these opportunities and so together we were able to lay the foundation for today's MTU Maintenance. One thing that's impossible to imagine these days is that we didn't get our first PC in finance until 1988. This miracle machine was in great demand, so we had to draw up a schedule: everyone was allowed to use the PC for two hours a week ... and it could do less than today's smartphones.

PETER SCHMALKUCHE, Head of Financial Accounting, MTU Maintenance Hannover



Virtual engine

*Digital transformation may be one of the greatest challenges facing the industry, but it is also one of the greatest opportunities. Virtual engines play a key role in engine development, as Dr. Stefan Weber, MTU's Senior Vice President, Technology & Engineering Advanced Programs, explained in an interview with **AEROREPORT**.*

Text: Martina Vollmuth



“The virtual engine will be a cornerstone of productivity and competitiveness for all players in the sector. Anyone who’s anyone in the engine business is really embracing this new technology.”

Dr. Stefan Weber,
 MTU’s Senior Vice President, Technology &
 Engineering Advanced Programs

Dr. Weber, what is a virtual engine?

In our industry, we see the virtual engine as a real game changer.

It’s a virtual representation of an engine, generated with digital design tools and numerical simulations. Rendering all geometrical and physical properties in their entirety is vital. To do this, various software tools are linked to calculate and construct—that is, to define—the entire engine from front to end.

Why does the virtual engine matter to MTU?

MTU, like everyone else, wants to make the most of the potential that comes with digitalization. We devised a comprehensive strategy to this end: map and render all the value-adding processes so they can be computed in simulations and connected in smart ways.

The virtual engine will be a cornerstone of productivity and competitiveness for all players in the sector. Anyone who’s any-

one in the engine business is really embracing this new technology.

What are the advantages of the virtual engine?

There are two main aspects here: the economic benefits; and the new possibilities for designing, optimizing and certifying engines.

What are the economic benefits?

The numerical approach has already achieved tremendous efficiency gains today, which are sure to increase tomorrow. This significantly reduces the time and effort required to develop and certify engines, and lets us bring new products to market that much faster to meet customers’ ever-growing demands. Cost-intensive and time-consuming tasks such as building test platforms, prototyping and validation testing can increasingly be replaced by simulations.

One of a kind worldwide

A unique research institution is in the works at the German Aerospace Center in Augsburg: the DLR Institute for Test and Simulation for Gas Turbines (SG). It officially opened at the end of 2018 and is being gradually equipped; the institute is set to move into a new building in 2022.

“We’re talking about eleven state-of-the-art testing facilities,” says Dr. Jörg Henne, Senior Vice President, Engineering and Technology at MTU. “This combination is the only one of its

kind in the world.” With these facilities, developers can simultaneously test for stress exerted by mechanical, thermal and chemical forces, or can make use of the flexible, high-performance spin test stand for components. These test facilities provide the basis for validating the virtual engine model. “We can validate highly innovative proposals for new technologies by adroitly combining numerical and experimental processes,” says institute director Prof. Stefan Reh. Another priority is to process data obtained in simulations and experiments.

So how does digital engine optimization work?

Numerical methods give us new ways of developing innovative technologies, for example, new designs or materials. The computational model of the engine is used to determine its overall performance variables such as thrust, efficiency, fuel consumption, pollutant emissions, manufacturability and reparability. It is also used to calculate components' service life and, by extension, the need for preventive replacement and maintenance.

Before we can quantify the impact of new materials, construction methods and manufacturing processes, and optimize the engine to reduce fuel consumption, pollutant emissions and weight, we have to determine all parameters in the virtual engine model. Of course, this always includes extending components' service life, ensuring maximum robustness and reliability, and containing costs. We have a lot on our agenda, given that our industry has set some very ambitious requirements for new engines.

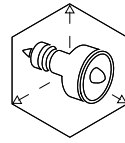
What are we doing now?

Let me preface this by saying that much development work remains to be done before we can map an entire engine to a virtual model and make the most of the intended benefits. What matters now is getting from here to there in a way that lets us take advantage of some of the aspects early on. Let me give you the specifics of what we have been up to so far.

We have been using the eProtas platform for quite some time now to develop products. It provides most of our aerodynamic and structural/mechanical computational tools in standard formats. eProtas serves to digitally document the variants of a component's design, be it a low-pressure turbine or a high-pressure compressor, and their configurations in a transparent way.

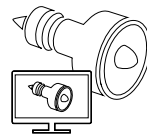
Throughout the design phase, we use extensive simulations in a multidisciplinary approach to ensure that all (virtual) engine functions comply with specifications and meet approval requirements. MTU's Technology 4.0 strategy centers on simulations in materials and manufacturing, the virtual engine and the digital twin. The latter is an exact replica of a real component in the digital realm. This can be anything up to an entire engine. The virtual engine serves to define the project twin; the actual twin reflects the reality of the manufactured and operated product. This is where all data on the component and engine life come together.

TECHNOLOGY 4.0



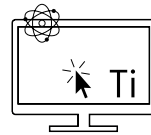
Virtual engine

The complete virtual representation of an engine opens up new possibilities for engine optimization—thus eliminating costly certification tests.



Digital twin

The 1:1 digital representation of an engine component serves as a powerful data backbone for end-to-end product lifecycle management.



Material and manufacturing simulation

MTU is banking on digitalization and aims to connect its entire value chain—from development and manufacturing to maintenance.

What's next?

The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) is pushing hard to promote digitalization in Germany. It set up four new research institutes last year. One is the DLR Institute for Test and Simulation for Gas Turbines (SG) in Augsburg, which focuses on the virtual engine. MTU contributed ideas and was deeply involved in the conceptual design. On board as a partner, we share our expertise and experience in developing and operating engines. In return, we can ask for research support and use the testing infrastructure. This affords us many opportunities to advance our cause. We are already tackling some clearly defined issues. 



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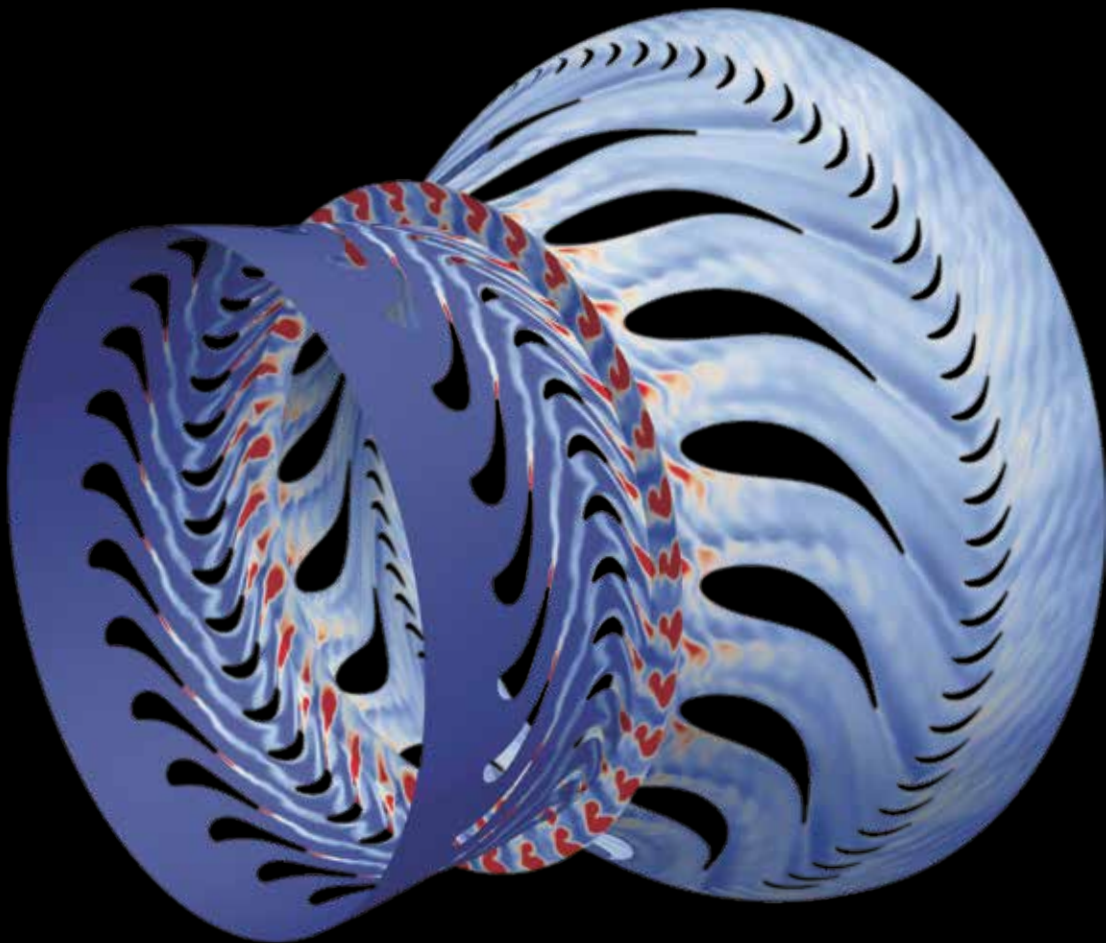
More on this topic: www.aeroreport.de



Text:
Martina Vollmuth holds a degree in journalism and trained as a copy editor for daily newspapers. She is the official spokeswoman for technology at MTU.

“Through our close exchange with MTU, we have access to industrial aerospace programs and receive constant feedback from the field.”

Dr. Edmund Kügeler,
DLR Institute of Propulsion Technology



Engine optimization ——— TRACE maps flow processes and their effects. With the Harmonic Balance method, calculations are one hundred times faster than before.

Awe-inspiring aerodynamics

Engines should be quiet, fuel-efficient, low-emission, and safe—and come to market faster. Accelerating the simulation of aerodynamic flows should help.

Text: *Monika Weiner*

No air, no propulsion. The highly complex design of an engine is ultimately intended to direct air into the right channels: to take it in, compress it, and then combine it with fuel and ignite it in the core engine. In the final step, energy is extracted from this highly energized air in the low-pressure turbine, thus giving the fan the necessary power to generate thrust. In designing these engines, developers aim to optimize the flow of air because this one factor determines the engine's efficiency and noise output as well as key constraints on the components' service life.

On-screen engine development

The development engineers at MTU Aero Engines can evaluate these interrelationships even before a single component is manufactured and tested: they have a simulation program that provides all the information they need. Any change to the shape of the turbine or compressor blades is reflected on the screen in a 3D image of the flow lines representing the movement of the air. A keyboard command is all it takes to call up the temperature of the blades, as well as the pressure acting on the front and back side. Using this information, the program calculates the design's efficiency. At the same time, it determines which vibrations the components are exposed to during operation and whether acoustic waves are generated that cause prohibited noise pollution.

The simulation software that makes all this possible was developed by MTU engineers together with researchers from the Institute of Propulsion Technology at the German Aerospace Center (DLR). "DLR, one of our most important technology partners, is a leader in propulsion technology and contributes the latest findings in aerodynamics, aeroacoustics and aeroelastics research," explains Dr. Edgar Merkl, who is responsible for technology partnerships at MTU. For more than 20 years, the teams have been working together on TRACE—Turbomachinery Research Aerodynamic Computational Environment. "This simulation tool allows us to very quickly map and evaluate flow processes and their effects on the overall system in detail. This helps us to develop products with aerodynamically optimized designs."

Tailored solutions

Manufacturers of gas turbines and engines worldwide use simulation programs. They are called "flow solvers" because they calculate solutions for complicated flow fields. "However, the commercially available programs usually offer only standardized solutions. TRACE, on the other hand, is tailored to our very special requirements and is constantly being refined. Thanks to our strategic collaboration with DLR, we have unrestricted rights of use—a real competitive advantage," Merkl says.



A faster result — At MTU, Dr. Nina Wolfrum and Bertram Stubert work on simulation techniques that perform flow model calculations within a very short period of time.

DLR benefits from the cooperation, too: “Through our close exchange with MTU, we have access to industrial aerospace programs and receive constant feedback from the field,” explains Dr. Edmund Kügeler of the DLR Institute of Propulsion Technology. “The test results and user validations help us refine the models further.”

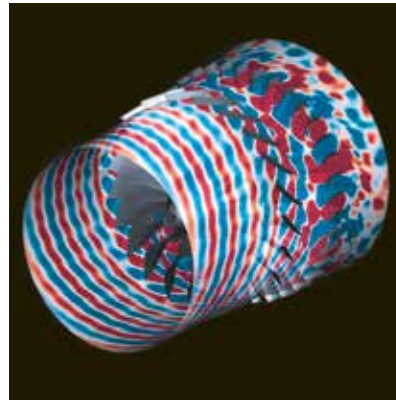
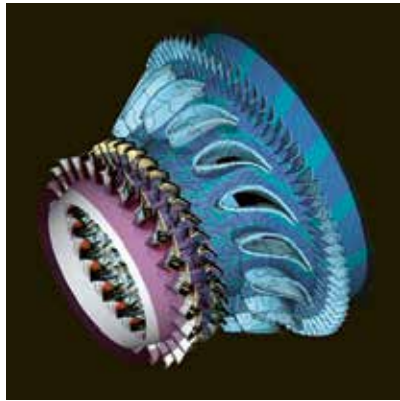
Calculations that go beyond classical mathematics

Year after year, TRACE became increasingly effective. Today, the simulation tool helps map both laminar and turbulent air flows as well as their temporal progression, i.e., the fourth dimension. “The calculations are extremely complex. They are based on nonlinear equations that cannot be solved with pencil and paper. You need to use numerical methods that gradually approach the answer following a long series of calculation steps,” explains Dr. Nina Wolfrum. She is the engineer heading the aero-CFD meth-

ods team at MTU. CFD stands for Computational Fluid Dynamics. To simulate the flow ratios in turbines or compressors, the simulation program has to carry out numerical calculations for millions of points.

TRACE can provide aerodynamics designers with a four-dimensional flow model within a matter of hours. A mathematical trick helps here: flows in the engine change periodically. For example, rotating and stationary components in the turbine and compressor move relative to each other, but always the same way in a circle. This periodicity is exploited by the “harmonic balance (HB) method.” As Wolfrum explains: “The flow solution is represented by overlapping waves. The time course of the flow in an engine can usually be described with just a few of these waves,” she says. “As a result, the program can calculate flow models a hundred times faster than with classical temporal resolution methods.”

The HB method makes it possible to carry out the complex full wheel calculations with the time domain solver for verification up to 2 orders of magnitude faster.



The harmonic balance process can predict the tonal noise generated by the UHBR fan on the approach.

Long-term goal: Virtual test stand @ DLR-SG

The new, fast simulation methods are already helping aerodynamics designers optimize turbine and compressor blades. For MTU's strategists, however, this also marks a further step towards their long-term goal of simulating the entire engine. "A virtual test stand like this would help us make engines as a

whole even more efficient, reliable and economical, with lower emissions," Merkl summarizes. MTU is pursuing this goal in cooperation with the DLR Institute of Test and Simulation for Gas Turbines (see also "Virtual Engine" on page 16 of this issue), which was founded in 2018. "TRACE plays a key role in this." 🌐



GERMAN AEROSPACE CENTER (DLR)

The German Aerospace Center (DLR) researches and develops solutions for aeronautics, space, energy, transport, digitalization and security. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space program.

DLR's mission comprises the exploration of Earth and the solar system and research for protecting the environment. This includes the development of environmentally friendly technologies for the energy supply and mobility of tomorrow as well as for communications and security. DLR's research portfolio ranges from basic research to product development. In this way, it contributes its scientific and technical expertise to strengthening Germany as a location for industry and technology.



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Text:
Monika Weiner has been working as a science journalist since 1985. A geology graduate, she is especially interested in new developments in research and technology, and in their impact on society.



Highly complex _____ Even conventional 3D printing is barely capable of producing some components of the Ariane rocket. MTU adapted the brush seals it uses in engines and in steam and industrial gas turbines to solve a fundamental challenge in the 3D printing process.

Sturdy brushes

After transferring its brush seal technology to an additive manufacturing application, MTU is enabling components for space applications to be produced with wafer-thin walls.

Text: Thorsten Rienth





“The flexible brush coater is extremely durable. Using a rigid coating blade, by comparison, would limit the extent to which we could produce the components and we’d be looking at high process development costs.”

Dominik Scherer,
 Engineer at ArianeGroup GmbH

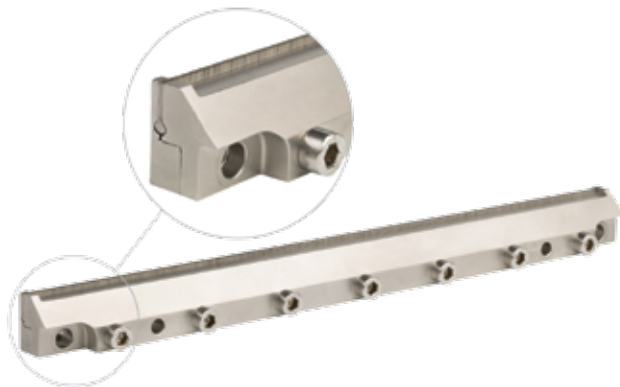
Every last gram counts for the components that Munich-based ArianeGroup GmbH sends up into space. For that reason, they are designed to have wafer-thin walls, often with a sophisticated internal structure. Their design has become so complex, in fact, that conventional processes are barely capable of producing them. For production engineers Dr. Fabian Riss and Dominik Scherer from ArianeGroup, it’s cases like these where 3D printing is the only way forward. This approach is known as design-driven manufacturing.

In this case, the technology involved is a three-dimensional welding process. Rather than milling components from a solid work-

piece, additive manufacturing is used to construct them layer by layer using metal, plastic or composite materials in powder form. Coaters deposit extremely thin layers of the powder onto a build platform and a powerful laser then selectively welds the powdered material together at the exact locations specified by the computer-generated component design data. In this way, the component is built upwards layer by layer just a few micrometers at a time, depending on the application.

But even this ingenious technology has its limitations when it comes to thin-walled components for space applications. “With conventional, rigid coaters, contact between the component and

CLEVERLY ADAPTED



Ingenious _____ *Highly robust and composed of thousands of wires each just fractions of a millimeter across that have been wound and cut into brushes, MTU brush seals adapt almost perfectly to the surfaces to be sealed. This technology has long since spread beyond engines. Instead of being round, the brush coaters used in industrial 3D printing are long and thin.*

Customized _____ *Because the sealing element and housing are designed separately, they can be optimally adapted to any seal environment. Compared to conventional seals, they reduce leakages by as much as 80 percent.*


the blade often resulted in us having to abort the process,” Riss explains. “Each time that happened meant a scrap part and the loss of valuable production time.”

This is where MTU and its brush seals come in. Composed of thousands of wires measuring just fractions of a millimeter across that have been wound and cut into brushes, they form highly flexible seals for engines as well as steam and industrial gas turbines. Shaped as required, they adapt almost perfectly to the surfaces to be sealed, and yet are extremely robust.

Dr. Stephan Pröstler, Project Manager for Brush Seals at MTU, had an idea: “If we could apply our brush seal technology to the coaters in 3D printing machines,” he thought, “then we might be able to solve the issue we have with the coating blade disrupting production of thin-walled aerospace components.”

It would not be the first time that Germany’s leading engine manufacturer has adapted its sealing expertise for applications in general mechanical engineering, including pumps, machine tools and special machines, the automotive industry, shipbuilding applications or coal mills. MTU has a dedicated development and production department for additive manufacturing, where it produces borescope bosses for the Pratt & Whitney GTF™ Engine Family, for example.

Pröstler, an expert in his field, decided to team up with his colleagues from additive manufacturing and a few months later, their joint efforts resulted in a shiny silver component that resembles a flat metal broom without a handle. They took a strip originally intended as a brush seal and turned it into a long, thin coater for 3D printers, including compatible interfaces for installation in ArianeGroup’s machines.

Now, it’s a permanent fixture in production at the company. “The flexible brush coater is extremely durable,” Scherer says. “Using a rigid coating blade, by comparison, would limit the extent to which we could produce the components and we’d be looking at high process development costs.” 



Pioneers _____ MTU began experimenting with brush seals in 1983; two years later, it successfully filed a patent for its new technology. The brush seal team is now a highly specialized center of excellence.

Sturdy and flexible _____ What started out as a way to improve engine efficiency also performs very well as a brush coater in 3D printing machines.



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Text:

Thorsten Rienth writes as a freelance journalist for **AEROREPORT**. In addition to the aerospace industry, his technical writing focuses on rail traffic and the transportation industry.

ASME TURBO EXPO 2019

**“Turbomachinery
will continue to
play a major role
in aviation”**



Dr. Harald Schöenborn

Technical Program Chair on the Organizing Committee of ASME Turbo Expo 2019 and compressor aeroelasticity specialist at MTU Aero Engines.

*MTU engineer Harald Schöenborn was on the organizing committee for ASME Turbo Expo 2019. He talks to **AEROREPORT** about what's going on in the global turbomachinery industry.*

Text: Eleonore Fähling

***Dr. Schöenborn, what is ASME?
Who's involved and why?***

ASME stands for American Society of Mechanical Engineers and is the U.S. and international counterpart to the Association of German Engineers (VDI). Once a year, ASME organizes ASME Turbo Expo, the largest conference of the turbomachinery industry. The location switches back and forth between the U.S. and Europe. The conference brings together companies and institutions involved in the development, manufacture or operation of aircraft engines, stationary gas turbines or wind turbines, providing an opportunity to exchange information on new developments in thermodynamics, combustion, structural mechanics and more. This year, the five-day conference took place in Phoenix, Arizona.

How did you first get involved?

Every university researcher who works on these topics dreams of presenting their work at ASME Turbo Expo. All papers are examined by at least three reviewers, so the quality of the publications is very high. It was the same with me when I did my doctorate at RWTH Aachen University. Later, I organized sessions and spent six years on a committee leadership team. Last year, I was appointed Technical Program Chair of the ASME organizing team.

“Turbomachinery will continue to play a major role in aviation and power generation“

Dr. Harald Schöenborn,

Compressor aeroelasticity specialist at MTU Aero Engines

The ASME Turbo Expo 2019 conference covers a wide range of topics—the program is 240 pages thick! Where do you even start?

Most people come to the conference with a specific focus already in mind—for example, blade vibration—and seek out related events in advance. There is a conference app that you can use to plan your visit, which will replace the printed program in the future.

You were one of the curators of the conference. What were some of the main considerations in selecting the topics?

The conference chair and the organizing committee decide on a key topic that will be discussed in greater depth in the keynote speeches and panels. This time the key topic covered clean propulsion for gas turbine engines and clean energy for stationary turbomachinery. These were discussed in a keynote panel and in two plenary discussions.

How do you decide what topics to propose for the conference? Are you overwhelmed with papers or do you have to actively seek them out?

No, we really don't have to search actively. We receive about 2,000 abstracts each year, resulting in some 1,000 papers that get presented at the conference.

Were you also a speaker at ASME Turbo Expo? What was your topic?

Not this time, but two years ago I spoke there on my area of expertise, aeroelasticity, which deals with the interaction between aerodynamic forces and flexible (elastic) structures in the engine. Other MTU colleagues attended this year, giving presentations on probabilistic methods, combustion and performance, and MTU Aero Engines North America and the brush seal team were represented at the exhibition.

In the internet age, you can put all this information online and access it there. So why host or attend a live conference?

The papers go online one week before the conference, but they can be looked at in more depth and discussed at the event itself.



The American Society of Mechanical Engineers, ASME for short, has set itself the goal of promoting cooperation and development across all engineering disciplines through a worldwide network. The not-for-profit organization was founded in 1880 by several U.S. industrialists and today has more than 100,000 members in over 140 countries, including around 32,000 students.

ASME organizes more than 30 conferences annually, among them ASME Turbo Expo, which focuses on the development and manufacture of turbomachinery and takes place alternately in North America and Europe. In June 2019, around 2,500 engineers, scientists and students from many companies and institutes worldwide gathered in Phoenix, Arizona. The program included more than 1,000 discussions, lectures, workshops and presentations over five conference days.



Added value for personal exchange — MTU engineer Harald Schöenborn was a regular participant and speaker at ASME Turbo Expo before he was appointed to the organizing committee.

And you get so much more out of it by talking to people face to face and networking, including in the breaks.


Turbomachinery for environmentally friendly power generation and drive systems was the focus in 2019. What does that mean exactly?

In my view, we must move towards renewable liquid fuels, because batteries will be too heavy for scheduled passenger flights for the foreseeable future. The general feeling at the conference was that turbomachinery will continue to play a major role in aviation and power generation.

What's the latest regarding digitalization in development simulation?

Simulations, especially their computing times, are becoming increasingly important and more and more complex. However, they won't replace practical tests, as there was also consensus at the conference that safety is the top priority. NASA, for example, is planning its own test facility for a hybrid aircraft engine.

And what happens now in the run-up to the next ASME Turbo Expo 2020 in London?

The organizing committee for 2020 already met for the first time in Phoenix. This time I will be the Vice Review Chair; that means I'll help ensure that the time-consuming reviews of the papers we receive are carried out properly. Abstracts for 2020 can be submitted until early October 2019, when the review process begins. 



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Text:
Eleonore Fähling has been on the AEROREPORT editorial team since 2014 and in charge of the MTU employee magazine since 1999. As an aerospace journalist, she specializes in aviation history and market topics.

Knights in shining armor _____ *The Bavarian police helicopter squadron and mountain rescue service use rescue winches in the Alps to bring injured hikers or those in dangerous situations to safety.*

Aerial search and surveillance

Police task forces rely one hundred percent on their aircraft: H135/EC135 helicopters equipped with powerful and robust PW200 engines.

Text: *Nicole Geffert*

It is the end of the line. On the climb up to the summit of Zugspitze, Germany's highest mountain, a hiker shows signs of fatigue, having overestimated his strength. A steep slope forces him to admit defeat. His mobile phone fails to pick up a signal. Anxiously waiting for news at home, his family eventually reports him missing.

An aerial search and rescue operation is launched and an Airbus H135 helicopter from the Bavarian Police Helicopter Squadron takes off from Munich Airport, where the unit is stationed. Alongside the pilot and the flight technician, two members of the

mountain rescue team are on board. The experienced crew locates the missing hiker at the edge of a snowfield and one of the rescuers is lowered down to him with a winch operated by the flight technician. Fortunately, the climber is not injured, merely exhausted. If he were badly injured, the task force would immediately alert the rescue coordination center to request a rescue helicopter with an emergency doctor on board. In this case, the man can be winched aboard, given first aid and airlifted away.

Peter Hauschild, technical operations manager in the Police Tactical Unit of the Bavarian Police Helicopter Squadron since 2008,



reads the mission report the next morning. He and his team—a total of 14 members responsible for the airframe, engines and avionics—take care of the squadron’s eight H135 helicopters and 16 PW200 engines in the maintenance facilities in hangar 3, which have been certified by the German Federal Aviation Office (Luftfahrtbundesamt, LBA).

“The hiker had a lucky escape,” says Hauschild. He has also seen more critical missions, in thunderstorms with hail, for example, poor visibility because of fog or where the helicopter had to take off and land on a sloping mass of sand, gravel and stones. “In conditions like these, there is a risk of foreign objects getting into the engine and damaging the compressor blades, for example,” he says. As the squadron is forced to land off-piste now and then, the PW200 engines were fitted with an inlet barrier filter, or sand filter, as protection against erosion.

Detecting smoldering fires with a thermal imaging camera

Missions in alpine terrain are not on the agenda for Marvin Gereke, technical operations manager of the Lower Saxony Police Helicopter Squadron, stationed at Hannover-Langenhagen Airport, since 2017. Instead, he and his colleagues face very different challenges on the ground and in the air. In 2018, when a peat fire had to be controlled and extinguished on a Bundeswehr military site near Meppen, the EC135 P2 helicopters powered by PW200 engines were deployed to detect smoldering fires on the vast terrain from the air, to assist the fire departments.

“To this end, a gyro-stabilized thermal imaging camera is mounted on the outside of the helicopter, the Electro Optical System, or EOS for short,” Gereke explains. An EOS operator on board controls the complex device. While the pilot is responsible for flying

the helicopter and communicating with air traffic control, the flight technician next to them in the cockpit heads the police operation. It's their responsibility to take care of navigation, maintain radio contact with other police units and coordinate the collaboration between ground forces, the EOS operator and the pilot.

Gereke and his team ensure that the two EC135 P2 helicopters and the two McDonnell Douglas (MD) 902 Explorers, all equipped with PW200 engines and based in Hannover, are ready for service 24 hours a day, seven days a week: to locate missing or wanted persons, fly reconnaissance missions, provide support at large-scale events, or for training and advanced training flights. In the LBA-certified repair facility, they also carry out maintenance work on engines, such as repairs or the replacement of parts such as fuel injectors.


Whenever the PW200 engines need a complete overhaul, the police helicopter squadrons in Lower Saxony and Bavaria entrust their equipment to the Pratt & Whitney Canada Customer Service Centre Europe, or CSC for short, in Ludwigsfelde—a joint venture company between MTU Maintenance Berlin-Brandenburg and Pratt & Whitney Canada.

Long-standing collaboration of over 20 years

"We know that helicopter availability and around the clock operational readiness are crucial for our customers, especially those who fly on police operations or special missions," says Ismael

Rhissa Zakary, as of July 1, 2019 the CSC's new Managing Director. "We offer them tailored, comprehensive long-term service solutions, including not just maintenance and overhaul, but also fast on-wing service and spare engines for accelerated return to service. The Bavarian and Lower Saxony police forces are long-standing customers of our fleet management service program."

Some of the contracts have been in place since the late 1990s. "Our collaboration has grown over the last 20 years," says Dr. Philipp Schumacher, Fleet Management Program Manager at the CSC. "We provide a reliable repair service for all PW200 engines powering helicopters operated by regional police forces in Germany. For example, during the 2015 G7 Summit in Bavaria, we provided important spare parts and engines in the vicinity of the police operation."

The CSC performs overhaul of PW200 engines, which involves disassembling them in full and repairing them. Engines operate for approximately 500 flight hours per year. A major overhaul is due after around 4,000 flight hours, which equates to roughly every eight years. "We are extremely satisfied with the service—and with the PW200," says Hauschild. "It's robust, powerful and reliable." Despite their obvious enthusiasm for helicopters and technology, Gereke und Hauschild both agree that their favorite part of the job is helping people. For them, to find a missing person safe and sound, whether that's a child, somebody who is confused or a hiker, is always a good feeling. 

Three questions for Ismael Rhissa Zakary, *Managing Director of Pratt & Whitney Canada Customer Service Centre Europe (CSC)*

What are the main tasks of the CSC?

Our principal task is to offer our customers on- and off-wing solutions to get their aircraft off the ground. Thanks to our mobile repair teams, including the MTU MRT team, we provide AOG services in 120 countries in Europe, Africa, and the Middle East.

Founded in 1992, the CSC recently celebrated its 25th anniversary. What would you say is the company's greatest achievement to date?

We have loyal customers in more than 120 countries, who come back time and again. This loyalty is evidence that we must be doing a good job. We have established a sound enterprise with a pleas-

ant working atmosphere, where staff from all over the world work together as a team. My priority is making this atmosphere even better, thereby ensuring that we retain our talented employees and attract new skilled personnel. I firmly believe that we will continue to grow and impress our customers with this team.

You have lived in ten different countries and worked with teams from a variety of cultures. Are there any aspects of your work in Germany that you consider to be unique?

Perhaps that people readily accept a significant degree of clarity and direction. Above all, however, I have learned that there is a very strong aviation culture in Germany. People are passionately committed to quality and take safety extremely seriously.



Bavarian Police Helicopter Squadron

In total, the Bavarian Police Helicopter Squadron operates a fleet of eight Airbus H135 helicopters powered by PW200 engines. Established in 1970, the unit is based at Munich Airport. Three helicopters are stationed at its Roth site. The squadron works closely with the rescue and civil protection services. As the only helicopter squadron of all regional police forces in Germany, it locates missing persons in alpine terrain and provides mountain rescue and emergency transport, day or night. Its equipment includes a winch with a 50-meter steel cable and a lifting capacity of 230 kilos, a tracking device to detect avalanche victims, and a double hoist hook to transport external loads or external water tanks (Bambi buckets), used to suppress forest fires in remote locations. In 2010, the squadron began replacing its Eurocopter EC135 P2s with eight H135 (formerly EC135 P3) helicopters, which offer an increased take-off weight and a greater range. In 2018, the squadron completed 2,925 missions, 953 of which were at night. It celebrates its 50th anniversary in 2020.



Lower Saxony Police Helicopter Squadron

The Lower Saxony Police's helicopter squadron commenced operations at Hannover-Langenhagen Airport in 1971. Its sub-squadron in Rastede was founded almost four years later. At present, the fleet comprises two EC135 P2 helicopters, acquired in 2015, and two MD 902 Explorers, all powered by PW200 engines. The Langenhagen-based aircraft are on call 24 hours a day. Under normal circumstances, the helicopter in Rastede operates daily from 6 a.m. to 10 p.m. In 2017, the squadron completed more than 1,600 missions with over 1,150 flight hours.



Kirsten Böning _____ *The Lower Saxony Police's first female helicopter pilot.*



Dutch Police Aviation Branch

Along with other aircraft, the aviation branch of the Dutch Police operates six EC135 P2 helicopters. In total, the PW200 engines of the EC135 P2 fleet have clocked up around 70,000 operating engine hours since 2009.

The helicopters are mainly deployed to help in the prevention of high impact crime and search for missing persons.

Their PW200 engines are maintained by the Dutch Police Maintenance department and repaired and overhauled by the Pratt & Whitney Canada Customer Service Centre Europe (CSC) at MTU Maintenance Berlin-Brandenburg.

"Over the last ten years, the PW200 has achieved outstanding performance data and proven to be highly reliable," says Ronald Uittenbogaard, Technical Manager of the Aviation Engineering team at the Dutch Police.



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Text:
Nicole Geffert has been working as a freelance journalist covering topics such as research and science, money and taxes, and education and careers since 1999.





China's regional market takes off

Demand for flights between secondary destinations in China is increasing. Up-and-coming provider China Express Airlines benefits from MTU's on-site services.

Text: *Andreas Spaeth*



Fleet _____ *China Express Airlines operates Airbus A320 and Bombardier CRJ900 aircraft.*

Great class _____ *MTU Maintenance stepped in at short notice to perform unplanned repairs on two CF34 engines that had been damaged during flight operations.*



Growth _____ *The expanding Chinese aviation market holds particular promise for regional air traffic.*



Since April 2019, China's first private regional airline has been flying from metropolis of Zhengzhou, the capital of Henan Province with a population of ten million, to Mandalay in Myanmar, a popular tourist destination. "China Express Airlines is capitalizing on niche markets, where the demand is huge in China. Although flying is still something of a novelty, it is really on the rise," says Daniel Hummel from MTU Maintenance Berlin-Brandenburg in Ludwigsfelde.

Hummel is in charge of Sales Support for MRO services for CF34 engines, which power various regional jet models. From their Brandenburg base, Hummel and his colleagues also manage the on-site service in China, assisted on the ground by a Chinese colleague from MTU Maintenance Zhuhai. MTU's joint venture with China Southern Airlines, one of the country's largest carriers, is a resounding success.

First impressions count

With the support of MTU Maintenance Zhuhai, Hummel and his colleagues recently succeeded in helping China Express solve a problem, thereby "presenting a highly impressive business card", as Hummel puts it. Until then, the Chinese regional airline had not been a regular MTU customer, but had its engines maintained by a Japanese competitor. "However, only six shops in the world are able to maintain the CF34; like the entire MRO sector, they are working at maximum capacity," Hummel says. "We helped the airline after two CF34 aircraft were damaged in operation and had to undergo unplanned engine disassembly."

Thanks to the MTU experts who flew in from Germany and their back-up from the Zhuhai site, the on-site service team was able to save the day. In October 2018, the modules of both high-pressure turbines were removed in situ and flown to Berlin. Here, they were expertly overhauled in MTU's Ludwigsfelde shop, which specializes in CF34 engines. "Shipping the components rather than the entire engines meant the costs of the repair were considerably lower," Hummel explains. However: "Getting the licenses needed for on-site work involves many links, sometimes taking months. The tools we needed for the job in China were stuck in customs for two and a half weeks while we waited for the import license," the MTU manager adds.

However, there is no doubt in his mind that it is worth the effort. "Our colleagues from Zhuhai are fantastic at interpreting and opening doors in China. Over there, everyone in the aviation sector graduated from one of just four universities and is therefore part of a tight network," Hummel says. In MTU Maintenance Zhuhai's portfolio are also CFM56 engines that power Airbus A320 family aircraft, which China Express operates, too. This opens up other potential lines of business.



14 million
seats/week
domestic flight market



7x more
domestic flights
than international




+14%
growth in
international air traffic

Growth off the beaten track

In particular, traffic between airports that are not on the main routes, which is China Express's niche, looks set to skyrocket. Today, China is the world's second largest domestic aviation market after India, almost triple the size of the US market. According to CAPA, with 14 million seats per week, China currently has seven times more capacity on domestic flights than on cross-border connections. However, international traffic is growing even faster, by some 14 percent in the past twelve months, and doubling over the last five years.

As the major international hubs in China are often overloaded, a dynamic market is rapidly developing between secondary desti-

nations, of which there are more than in any other country. At the last census in 2010, 85 cities in China had more than one million inhabitants. "The country has a terrific market with plenty of opportunities for growth in regional air traffic," says Professor Li Guijin from the Chinese Civil Aviation Management Institute. He continues: "Smaller regional companies would be advised to join forces with the big airlines; the collaboration between Air China and China Express Airlines is a shining example."

Hummel is confident that MTU is in pole position, particularly with regard to private airlines such as China Express. "We were able to put in a tailored, flexible bid. Good communication can open a lot of doors." 



Do you have any questions, requests or suggestions?
Contact the editors here: aeroreport@mtu.de



More on this topic: www.aeroreport.de



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Andreas Spaeth has been traveling the world as a freelance aviation journalist for over 25 years, visiting and writing about airlines and airports. He is frequently invited to appear on radio and TV programs.

On an equal footing

Interview with Uwe Böhm, Head of Purchasing at MTU Aero Engines, on the supplier base for the engine industry and its special features.

Text: Eleonore Fähling





Uwe Böhm — Materials scientist Uwe Böhm heads up purchasing and logistics at MTU Aero Engines.

Since the start of 2019, Uwe Böhm has headed up purchasing and logistics at MTU Aero Engines. He became familiar with the perspectives of his internal “customers” in his three years working as Head of Programs for military transport aircraft engines. Prior to that, he gathered 13 years’ purchasing experience as a team leader and later as a department leader. Born in Bayreuth, Böhm started his career at MTU in 1994 when he joined the company as a quality assurance engineer for deliveries immediately after graduating from the renowned Friedrich-Alexander University Erlangen with a degree in materials science.

Mr. Böhm, how many suppliers work for MTU worldwide? And where are they based?

We work with about 500 companies that supply production materials for our engine components. When it comes to individual components, the number of suppliers we use varies greatly. In some cases, only very few specialists worldwide are able to supply the parts we need to the standard of quality required in the aviation industry. Of course, there are more suppliers for the less sophisticated components, such as basic standard parts. We work with companies across the world, primarily in North America, Europe and the Middle East, but also in Mexico and Asia.

What kinds of companies are they?

They range from highly specialized, family-owned medium-sized companies with an annual turnover of a few million euros to groups that are considerably bigger than MTU. Many specialist engine suppliers have based themselves in close proximity to the OEMs GE Aviation and Pratt & Whitney, which explains why many of the companies we work with are in the U.S. and indeed on the East Coast. You find the whole spectrum of suppliers there, from inventors who simply buy some land and set up a finishing workshop to highly specialized corporate groups.

How many suppliers for specific product groups are there worldwide?

There are actually very few in the engine industry. This is due to the high complexity of our components and above all to the strict safety requirements in aviation.

What does a supplier to the aviation industry have to be able to do?

For a start, it has to have been awarded all the licenses required in the aviation sector. Getting them can take up to two years. And whenever an aviation company expands its capacities, then any new facilities must first be licensed before components destined for use in the aviation industry can be manufactured there. That’s what makes it difficult to simply increase the production rate. Aviation suppliers also have to guarantee extremely high quality standards and undergo regular inspections. One particularly important aspect is their ability and willingness to continuously invest in technology developments. Our suppliers know that they have to constantly develop at this high level. And last, but not least, our suppliers have to be able to produce at a competitive cost.

How do you ensure that suppliers deliver to the right quality on a long-term basis?

“Quality first” is our top priority. We always work closely in interdisciplinary teams with the relevant departments to select appropriate suppliers. We conduct audits on site and have permanent representatives at key suppliers in the U.S. and Asia. But, most of all, we work together as partners on an equal footing—maybe that’s what’s special about MTU. And this has proven beneficial over the years.

When the launch of the A400M military transport was pushed back, several smaller suppliers faced financial difficulty, meaning that Airbus had to save them. Is that something that MTU would consider doing?

Of course we would consider it, but in fact our active supplier risk management prevents such situations from developing in the first place—and so far, it’s always been a great success.

What happens when a supplier can no longer deliver?

In that case, we send out a crisis intervention team to work with the supplier to analyze the causes and find solutions. Like I said before: we prefer to work as partners on an equal footing and in the common interest. When it comes to critical components, we don’t rely on just a single supplier; rather, we usually have two sources or more.

The aviation market—and, with it, demand for aircraft—has been continuously growing for 20 years. Until now, the aviation industry has always gradually adjusted its capacities in line with that growth. Is that still enough?

In all of aviation history, there’s never been a ramp-up like the one we’re seeing at present. You’re right, we won’t be able to keep pace just by optimizing current capacities. The entire avi-


ation industry supply chain has to make huge investments to cope with this expansion. Another key to our success is our integrated product development teams, in which our suppliers work hand in hand with MTU’s developers and design engineers to improve the manufacturability of components.

Surely suppliers to aircraft manufacturers, including engine manufacturers, will be delighted if Airbus steps up deliveries of the A320 to 70 aircraft per month. Where’s the problem?

Our supplier base’s capacity situation is extremely strained, especially when it comes to high-tech components like monocrystalline turbine blades. All manufacturers go to the same few suppliers for these. Delivery times for certain forged parts have almost doubled in the past few years. For many of our deliveries, we have a procurement time of more than a year. This means there isn’t a lot of scope for short-term changes. Naturally, we also have concepts such as consignment warehouses at suppliers in order to increase flexibility. These are warehouses that store finished components until we retrieve them. This gives us some breathing space. In addition, stable predictions of the amounts needed in the next few years help to prevent bottlenecks in the future.

On top of that, we and our suppliers now also need to take the next step technologically, as Pratt & Whitney GTF™ Engine Family components, for example for the high-speed low-pressure turbines, are considerably more complex than those for older engines such as the V2500. The production ramp-up for them wasn’t nearly as steep as now.

Over the next few years, MTU will invest around one billion euros in the expansion of existing and new locations. Is insourcing the answer?

This isn’t about insourcing at all, but about MTU’s organic growth. The mix of in-house and external production is determined beforehand in a common manufacturing strategy and is incorporated into location planning. 



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Eleonore Föhling has been on the AEROREPORT editorial team since 2014 and in charge of the MTU employee magazine since 1999. As an aerospace journalist, she specializes in aviation history and market topics.

The digital director

Advanced engine control and monitoring systems ensure that military engines do exactly what the pilot wants them to do. This component monitors the status of the entire assembly and is essential to keeping flight operations safe.

**HIGH PROCESSING CAPACITY,
LOW USE OF SPACE**

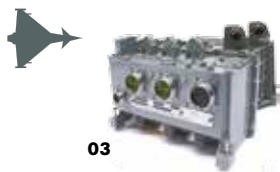
The design of the computer technology for these applications must be as compact and at the same time as fail-safe as possible.



01

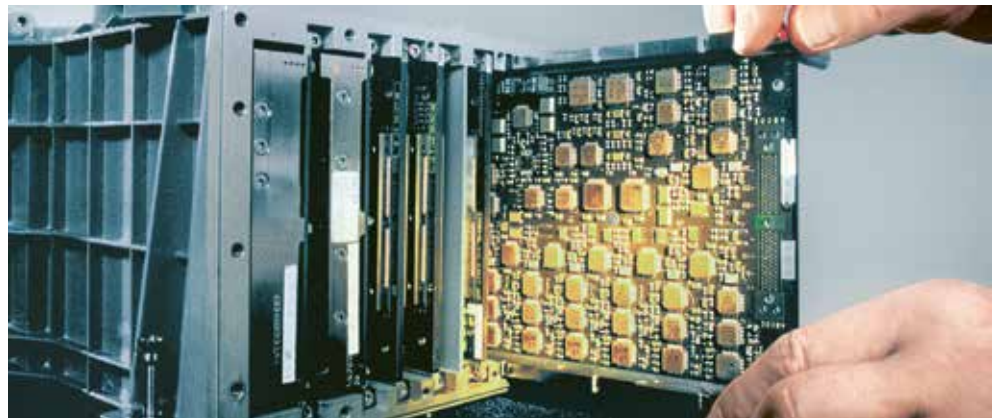


02



03

MTU has developed control and monitoring systems for engines powering a wide variety of military aircraft, including helicopters (01: Tiger combat helicopter), cargo aircraft (02: Airbus A400M transporter) and combat jets (03: Eurofighter).



The engine control and monitoring system, or ECMS for short, ensures that a fighter jet pilot always gets exactly what they want: thrust. And at the precise level indicated by the position of the thrust lever: sometimes more, for example during takeoff or aerial combat, other times less, such as during a monitoring mission or when landing. "The control and monitoring system is rather like the brain of an engine, where all the information is collected and evaluated. It uses this knowledge to make sure the aircraft can be operated safely and in line with the pilot's requirements," says Christian Rausch, Senior Manager, System Design and Accessories at MTU Aero Engines in Munich. To this end, the ECMS continuously measures factors such as temperature, speed and pressure in addition to adjusting the flow rates of fuel pumps and geometries of stators, and opening and closing nozzle areas on the engines.

Safe component, safe operation

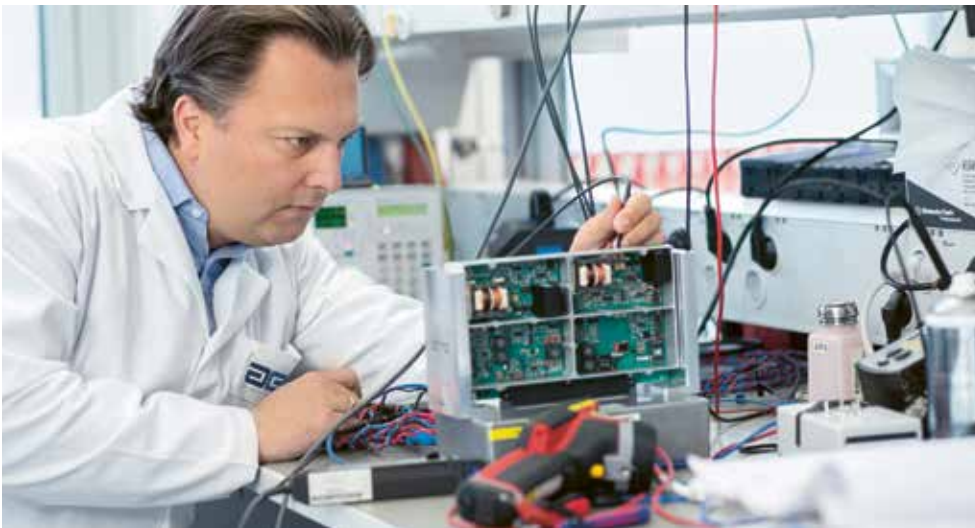
The control and monitoring system also performs another vital task: by drawing on the engine data, it calculates the remaining service life of the engine and its components. This helps the ground crew schedule and prepare for any maintenance work or components that might need replacing. If engine damage or faults occur during the flight phase, for example if contradictory sensor data is flagged up, the monitoring system can also limit the aircraft's operating range for safety reasons. In this case, the pilot would be notified that they are no longer operating with the full aircraft performance and dynamics. Due to its safety-critical function, the ECMS is engineered and programmed to be extremely reliable. "Moreover, the components go through a series of highly sophisticated and rigorous mandatory tests before they reach the customer," Rausch says.

Four decades of experience

MTU's expertise in designing and building this complex component is vast: over the past four decades, the company's engineers have been involved in engine control and monitoring systems for the RB199 Tornado engine, the EJ200 Eurofighter engine, the TP400-D6 for the Airbus A400M and the MTR390 Tiger engine. Rausch and his colleagues are also working on a new concept for the control and monitoring unit to be installed in the Next European Fighter Engine (NEFE), the development of which is being led by MTU and French aviation group Safran. Due to the increasing complexity of engine sensors and actuators, the central processing unit will have to be replaced with distributed, intelligent systems in the future. "We are already working on the requisite technology," says Rausch.



In the lab ——— Once the electronic components have been produced, they are meticulously measured in the lab.



Perfect functionality

————— Only when all the measurements are correct and the technology has demonstrated that it functions perfectly in complex tests and simulations is it delivered to the customer.



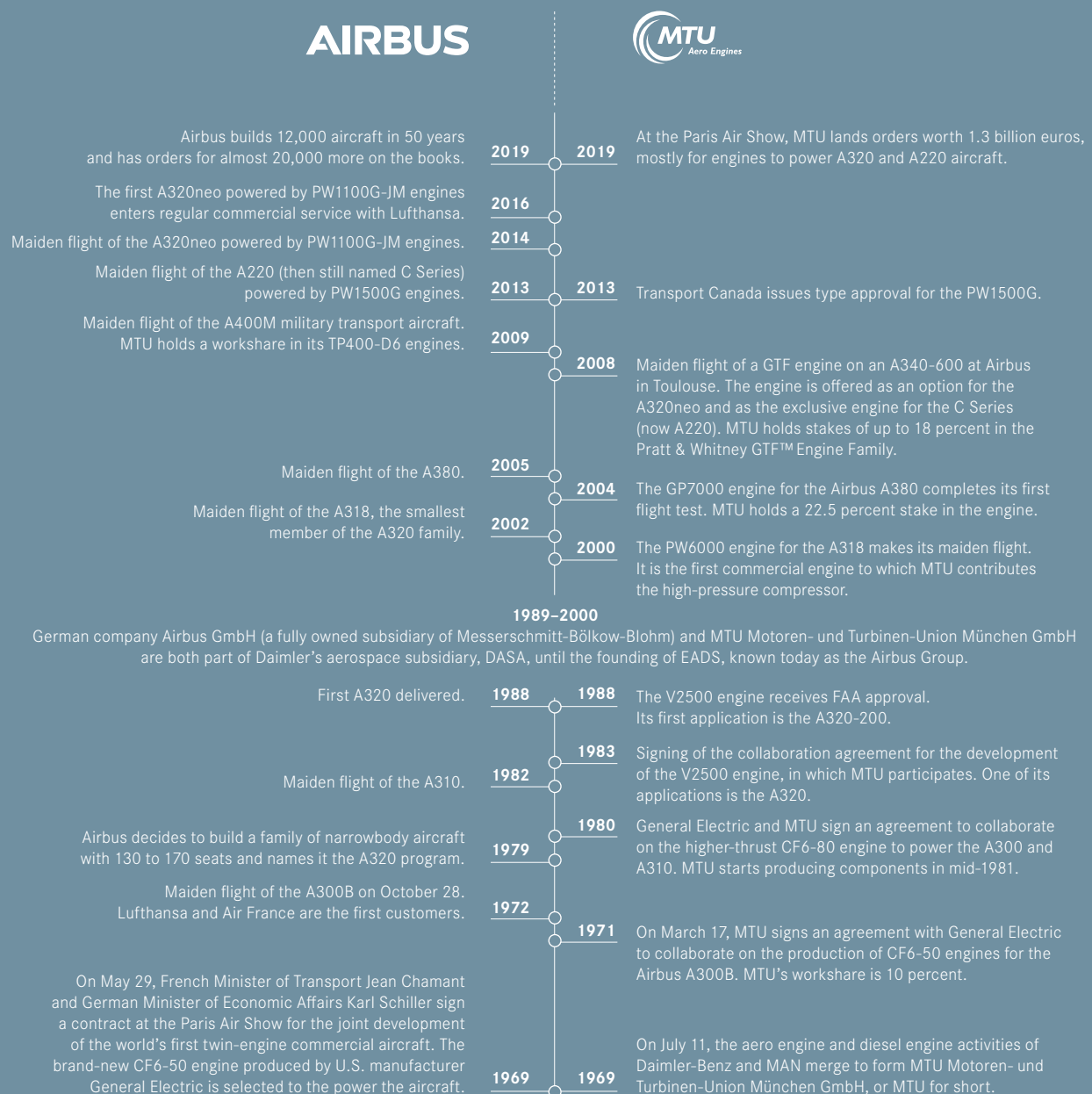
"The control and monitoring system is rather like the brain of an engine, where all the information is collected and evaluated."

Christian Rausch, Senior Manager, System Design and Accessories at MTU Aero Engines

50 years of Airbus and MTU

Milestones of two successful companies

Aircraft manufacturer Airbus is celebrating its 50th anniversary this year. Together, Airbus and MTU Aero Engines have shaped the aviation industry. Here are some milestones of their shared history:



The nine freedoms of the air

It often seems as though the freedom above the clouds knows no bounds. Yet cross-border air traffic is carefully regulated.

Nowadays, international flights are nothing out of the ordinary. Yet ensuring that airlines can fly into the sovereign airspace of other countries requires international agreements. The first binding international accord to secure air travel rights was signed in 1944: the Convention on International Civil Aviation, or the Chicago Convention for short. Its first article states that every state

has complete and exclusive sovereignty over airspace above its territory. Should an airline wish to offer a route from its home country to another country, it requires further authorizations from the states concerned. To make sure international air traffic proceeds smoothly in such cases, there are nine “freedoms of the air”:

Home country Foreign country 1 Foreign country 2



Freedom 01 The airline is allowed to fly from its home country across another country without landing.

Freedom 02 The airline is allowed to make a technical landing in a third country for non-traffic purposes.

Freedom 03 The airline has the right to transport passengers or freight from its home country to another country.

Freedom 04 The airline has the right to take on passengers or freight from abroad destined for the carrier's home country.

Freedom 05 Passengers or freight can be transported between two foreign countries if the starting or the end point of the journey lies in the airline's home country.

Freedom 06 The airline is allowed to transport freight or passengers between two foreign countries via its home country.

Freedom 07 The airline is allowed to transport freight or passengers between two foreign countries without touching down in its home country.

Freedom 08 The airline is allowed to transport passengers or freight within another country on a flight that has originated or will terminate in its home country.

Freedom 09 The airline is allowed to transport passengers or freight within another country without touching down in its home country.

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