An engine trio with a common core

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Dear Readers:

The global climate debate essentially revolves around two issues: fuel consumption and carbon dioxide emission. The latter is directly related to the fuel burn, and we are challenged to reduce both. In view especially of current oil price trends, public opinion and airlines are urging for fuel-thriftier and hence cleaner engines. There’s still another type of emission, though, that must not be neglected in the environmental protection effort, and that is aircraft noise. It’s a quality-of-life nuisance and, too, needs cutting drastically.

The Advisory Council for Aeronautics Research in Europe (ACARE) isn’t the only voice demanding aircraft noise to be cut in half by 2020. For local residents and airport operators, for instance, aircraft noise is the clincher in airport expansion plans. It is a perennial theme also in nighttime curfew discussions. Concepts for future aircraft engines, therefore, must necessarily focus on lower fuel burn and associated carbon dioxide emission in conjunction with massive noise reductions.

At MTU and our partner Pratt & Whitney, we’re betting on an engine concept that in our estimation best satisfies those needs: the geared turbofan engine. Development of this engine is in full swing. Its priceless advantage is that the enabling technologies are already on hand, so that a full-fledged demonstrator engine was built and put to flight testing at very short notice.

Sincerely yours,

Egon Behle
Chief Executive Officer

Ground and flight testing leave little doubt we’re on the right track. The test output makes the targets—15 to 20 percent less fuel burn and carbon dioxide emission, and half the perceived noise—appear realistic enough. The data won over launch customers Mitsubishi and Bombardier. Their new regional jets will fly in 2013, when the geared turboshaft engine will be able to demonstrate its excellence also in revenue service. Airbus, too, is impressed with it and currently conducting flight tests of the PW1100G on the wing of one of its A340s.

MTU and Pratt & Whitney are united in the view that the geared turbofan is the only engine concept that promises appreciable fuel burn and carbon dioxide reductions and at the same time meets the widespread requirement for low engine noise levels. It is going to win the battle and prove us right.

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By Patrick Hoeveler

It was with obvious pride that Steve Finger, Pratt & Whitney President, announced the launch of a new generation of engines at the 2008 Farnborough Airshow: “Airlines and business aircraft customers want pure engine solutions that deliver economic and environmental benefits without compromises. Pratt & Whitney PurePower™ engines employ game-changing technologies to deliver step-change improvements.” All of which is going to happen not sometime in 2016 or 2020, but now.

Pure power, low fuel burn and less noise is what the new engine trio from the United States intends to deliver. MTU Aero Engines holds a 15 percent stake in each of the three engines. Front and center is the geared turbofan engine concept. Two members of the new engine family are to enter service in 2013, the PW1217G on the Mitsubishi Regional Jet (MRJ), and the PW1524G on the Bombardier CSeries. They are geared turbofan configurations, as indicated by the letter G adjunct. Completing the trio is the ungeared PW810C to power the Cessna Citation Columbus business jet.

For the PW810 and PW1217G, MTU has already inked 15-percent-workshare contracts. Germany’s leading engine manufacturer will provide the first four stages of the high-pressure compressor, plus the turbine, which is high-speed for the MRJ and CSeries and conventional speed for the Citation. Production of first long-lead items like the castings for the low-pressure turbine nozzle vanes and the blanks for the integrally bladed rotors has already been initiated. The two engines are scheduled to make their first run next year.
For interesting multimedia services associated with this article, go to: www.mtu.de/208PW1000G

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Cover Story

The nod for the new Bombardier business jet was given also at the Farnborough Airshow: after Lufthansa had issued a letter of intent for a 30-aircraft buy, Bombardier announced the long-awaited launch of the CSeries and green-lighted detailed development work to begin on the engine worldwide. MTU will start parts production for the PW1524G in early 2009.

“For the CSeries, we’re looking to participate on about the same scale as for the other two programs, and we expect to wrap up negotiations with Pratt & Whitney before the year is out,” explains Dr. Christian Winkler, who heads new business development at MTU.

“With that, we’re steadfastly continuing our strategy, which focuses on the turbine and high-pressure compressor areas.” Taken over the life of the program, he is figuring on 2,800 engines worth six billion euros in revenues to MTU.

The rising price of oil attracts the growing interest of airlines in the geared turbofan configuration. That’s where the promising results of flight tests on a geared turbofan demonstrator based on a PW6000 core engine (that is, using a PW6000 high-pressure compressor, combustor and high-pressure turbine) come in handy. The tests on the wing of a Pratt & Whitney-owned Boeing 747SP began on July 11, 2008, out of Plattsburgh, New York. By August, 12 flights had been completed and a total of 43 flight hours were logged. The test schedule included maximum power takeoffs, flights above an altitude of 12 kilometers, relighting in flight, rapid load alternations and extreme flight maneuvers, as at high angles of attack. Winkler said: “During the trials, efficiency and noise targets were hit.” The 12 to 15 percent fuel burn reduction eyed for production geared turbofans appears feasible.

The engine also seeks to reduce noise levels by 24 decibels. “That item has been the subject of several discussions we’ve had with representatives from Frankfurt and Munich airports, who took a great interest in the geared turbofan,” said Winkler. Pratt & Whitney experts issued impressive projections of the noise footprint of an Airbus A319 and Boeing 737 class aircraft: when fitted with a geared turbofan, the 75-decibel footprint at takeoff from Munich decreases 72 percent. This helps mitigate the noise perceived by local residents and moreover cuts climb time and, hence, costs. The noise issue also is the focus of the flight trials Airbus started in September in Toulouse, France. They are made on the wing of an A340 and scheduled to last 75 hours.

The salient feature of the new PurePower™ engine family is the common core its members share, the core consisting of high-pressure compressor, combustor, and high-pressure turbine.

The heart of the engine beats in its eight-stage high-pressure compressor, which sports several innovations: this is the first time a compressor is a 100 percent blisk construction. Its designers used 3D aerodynamic code and replaced conventional bolted rotor connections with interlocking joints. For the rear compressor stages, novel materials were used, such as powdered metals. In the first stage, additionally, they fitted MTU-patented brush seals for better sealing integrity and hence improved efficiency.

Dr. Christian Winkler, who heads new business development at MTU, notes: “On the engines for the MRJ and Citation Columbus, the compressors are essentially the same, also in size, except that inlet and outlet conditions and rotary speeds vary. The compressors are designed to make these variations negligible in terms of efficiency, so what you’ve got here is a trade-off between production and development costs on the one hand and efficiency on the other.” High-pressure turbine and combustor, too, are essentially similar types. The core engine for the CSeries uses upscaled hardware. “Put in a nutshell, you blow up the blueprints and then figure whether the design is feasible from the structural mechanical aspect or needs tweaking a little. Development characteristics remain unchanged, nonetheless,” assures Winkler.

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Welcome aboard: MTU Aero Engines has taken a stake in Pratt & Whitney Canada’s upcoming PW810 engine program and secured a role also in Pratt & Whitney’s new PW1000G geared turbofan engine. “The selection of MTU Aero Engines for these key technologies demonstrates our commitment to bringing world-class partners to the geared turbofan and PW810 engine programs,” emphasized Robert J. Keady, Pratt & Whitney Senior Vice President of Sales & Marketing, as he inked the contract at the ILA International Aerospace Exhibition in late May.

By Silke Hansen

MTU’s low-pressure turbines and high-pressure compressors have for years been among the finest in the global market. On the PW810, MTU brings its specific expertise to the table, being responsible for the development, production and assembly of the low-pressure turbine; the development and production of four high-pressure compressor stages, plus a share in the engine’s after sales services. That adds up to a 15 percent aggregate stake in the program. “We figure on sales of five billion euros over the life of the program, based on about 5,000 engines sold,” explains MTU’s Program Manager Martin Wiedra.

The PW810 engine is scheduled for its first ground test in mid-2009 and for certification two years after. Development is in full swing on either side of the Atlantic. Designed to deliver about 10,000 pounds of thrust, the engine is targeted at the top end of the business jet market. Already it has been selected by Cessna for its new model, the Citation Columbus. As the only jet in its class this intercontinental long-haul aircraft is to have a range of 7,400 kilometers at Mach 0.8 and be the largest ever made in the U.S. company’s annals. Cessna is positive the Columbus is one of the most advanced, thriftiest and cleanest business jets ever conceived. The aircraft will be the baseline of an entirely new aircraft family and is slated for first delivery in early 2014.

So far, Cessna has been serving the lower and middle segments of the business jet market only. With tremendous success: in 2007, at 1,272 deliveries, of which 387 were Citations—40 percent of them boasted MTU content—, Cessna posted a record year. The Citations are among the world’s hottest selling business jets.

Excelling in various areas at once, the PW810, too, has what it takes to become a very popular item. “We’re coming up with a completely novel design. Apart from advanced weight and fuel saving technologies, the focus is primarily on low manufacturing and life-cycle costs,” Wiedra says. That approach pays dividends: up later in operations, “taking time and cost out of engine maintenance” and resulting in an especially robust and long-lived engine. The PW810 scores big also in terms of noise and emission reductions. In oxides of nitrogen, it comes in fully 50 percent below International Civil Aviation Organization (ICAO) standards, and up to 35 percent in carbon dioxide. On top of that, it is quieter than the noise level limit for this category.

The PW810 and the new PW1000G geared turbofan make up an expanded product family. Pratt & Whitney and MTU are producing two versions of the PW1000G to power the Mitsubishi Regional Jet and Bombardier CSeries. In all three engines, the core engine is much the same. The Common Scalable Core, as it is called, includes the combustor, high-pressure compressor and high-pressure turbine. Says Wiedra: “Business jets are flying higher and faster than commercial airliners, and that’s the reason why geared turbofans presently are not the engines of choice in that application. Preference accordingly still goes to conventional turbofans like the PW810. That engine, however, will set new benchmarks in its class.” It is a likely candidate, therefore, to power further new business jets.

Engines that have got what it takes

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For further information on this article go to:
www.mtu.de/208PW810

The PW810 will power heavy business jets, such as the Cessna Citation Columbus.
What the European Commission hopes to achieve through its initiative primarily is speed things up. That makes sense: aircraft normally are in revenue service for 30 years and developing new technologies usually takes longer than ten. The integrated approach of Clean Sky and the 800 million euro grants from the European Union are to hasten technological development. “More development funds will help us implement our ideas and bring products to market that much faster,” explains Dr. Hermann Scheugenpflug, Director Technology Management at MTU. That would benefit not only the environment.

Against the background of rising fuel prices and the global climate debate, thrifter and quieter aircraft would additionally give European manufacturers a competitive edge. This in turn is supposed to have also non-European manufacturers jump on the bandwagon and develop cleaner technologies. Clean Sky takes its cue from the mandates of the Advisory Council for Aeronautical Research in Europe (ACARE), which demands that aircraft carbon dioxide emission and noise levels be halved by 2020 and oxides of nitrogen emissions be reduced fully 80 percent. While engines hold the most promise of emission reduction, other areas, too, can and will have to contribute their bit. Accordingly, Clean Sky focuses on six different research domains, so-called integrated technology demonstrators (ITD): SMART fixed wing aircraft, green regional aircraft, green rotorcraft, systems for green operation, eco-design, and sustainable and green engines.

Ultimately, one or more demonstrators will be tested in each ITD domain for maximum benefit for a string of products. Clean Sky is to provide a package of innovative technologies covering all aspects of commercial aviation.

Following two years of laborious negotiations, MTU in May 2008 became an associate member in the engine domain (Sustainable And Green Engines – SAGE), in the fall, the contracts were inked and project work was officially launched in Munich. The engine manufacturer is responsible for a demonstrator of its own, with Avio and Volvo Aero coming along as partners. “First, we’ll develop conceivable concepts for our demonstrator,” says Scheugenpflug. “Then in the fall of 2009, we’ll tackle the design of specifically the compressor and low-pressure turbine.”

Plans are for the continued enhancement of the geared turbofan (GTF) engine, where fan and turbine are decoupled from one another to run at their respective optimum speeds. The first-generation GTF demonstrator in mid-August successfully completed flight testing at Pratt & Whitney and is now undergoing testing under the wing of an A340 at Airbus. The second-generation GTF demonstrator to be developed under Clean Sky is specifically targeted to power the successors to the Airbus A320 and Boeing 737 family aircraft.

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First-generation GTF demonstrator.

“By 2012, we want our demonstrator to be on the test stand. So from the time aspect, our project share fits in nicely with our Claire roadmap.” The latter, the Clean Air Engine program, is MTU’s long-term pilot concept for the development of commercial aircraft engines to reduce, by 2030, carbon dioxide emissions by as much as 30 percent in a three-phase effort.

Clean Sky

The 1.6 billion euro, seven-year Clean Sky research project ranks among Europe’s largest concerted research undertakings. Participating in it are 86 partners from 16 countries, with more to join down the road. One half of the budget is funded by industry, the other by the European Commission. The moneys are used to fund six different research domains.
About 30 times a year, the mobile repair experts leave home, traveling the continents to fix damaged engines wherever they happen to be. These experts are dedicated to providing the finest of workmanship soonest possible, aware that aircraft squatting on the tarmac with engine damage cost their operators a bundle. So the minute a damage report reaches Ludwigsfelde, the MRT mechanics gather whatever spare parts and tools they need and hop on the next plane out. The MTU mechanics are posed for action 24/7 all year round. For CF34™ duty, a team includes four people, all specifically trained and skilled for the job. To be eligible, for instance, they must have prior exposure to work on diverse engine assemblies and modules, giving them full engine competence.

“We do the smaller and bigger repair jobs during aircraft C-checks, which occur at 12- to 18-months intervals. That way we don’t interfere with revenue operations between shop overhauls,” explains Katharina Meister. On-site jobs range from smaller boroscope inspections to module replacement. “Aircraft On Ground (AOG) jobs are few and far between, though,” says the customer support representative at MTU Maintenance Berlin-Brandenburg.

General Electric’s CF34™ engine is a natural for on-wing repairs. Being the commercial cousin of the TF34™ powering the A-10 Thunderbolt ground attack aircraft, the engine offers the ready accessibility mandatory for military engines. “That makes it easier for us and we pass the savings on to our customers,” emphasizes André Sinanian, who supervises the CF34™ product line at Ludwigsfelde, adding: “That’s why practically all airlines on our maintenance list are appreciating our mobile services.”

A textbook case for MTU’s mobile repair capability came during the C-check of a Bombardier Canadair Regional Jet 200 (CRJ200) operated by Cimber Air, a Danish regional airline; that was when in early August, in a Flybe maintenance hangar in England’s Exeter, a complete low-pressure turbine module and fan rotor module were replaced.

Preparations for such repair missions are the responsibility of customer support representatives like Katharina Meister: “It takes a tremendous amount of organizing and paperwork to make sure parts and technicians arrive on-site at the exact time agreed on with the airline and airframe MRO provider.” In these preparations, swift and smooth action again is of the essence, as it is for the actual work in the field.

Customers appreciate MTU’s flexible service. “As an aircraft operator, the on-site services are a very important element of our maintenance strategy. MTU is not only a reliable and quick-responding partner when it comes to AOG, the scheduled on-site maintenance supports optimal on-wing times for our aircraft engines,” says Swen Intemann, Chief Engineering CRJ Fleet at Cimber Air.

For more complex work, like the replacement of modules, the engine is taken off the wing.

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For interesting multimedia services associated with this article, go to www.mtu.de/208MRT
GE38 breakthrough

At this year’s Farnborough Airshow, MTU CEO Egon Behle inked a contract that ushers in a new era for Germany’s leading engine manufacturer. With that contract, the company takes an 18 percent stake in the GE38 helicopter engine. “For the first time, MTU acts as a development participant in a U.S. military engine program,” enthuses Behle.

While the German engine manufacturer has been a production partner of General Electric in the U.S. military programs F404 and F414, it will now bring its development savvy to the table as well, designing and building the three-stage power turbine for the GE38 turboshaft engine to power heavy-lift helicopters. Additionally, the German engine builder has obtained licenses for maintaining, final assembling and testing GE38 models on the proposed European heavy transport helicopter (HTH).

By Martina Vollmuth
MTU Aero Engines has a broad background of experience with helicopter engines. Over 100 years ago, already, its predecessor companies equipped the first powered aircraft, fixed and rotary wing alike. In 1937, the Focke-Achgelis FW61 took to the air, powered by a Siemens-Halske SH14B. The Berlin-based company later was absorbed by BMW, MTU’s ancestor.

After World War II, Daimler-Benz and BMW focused more closely on this type of engine, with Daimler developing the DB720, which was tested on a Bell UH1 but never went into production. The BMW6002 was doomed similarly. In 1957, it indeed took off on the German Siemetzki helicopter, but likewise failed to make it into production. Nor did the two successor models, the BMW6012 and MAN Turbo 6022, make the grade, vanishing into limbo after their first flights.

And so it went until 1970 when MTU began building the T64 under license from General Electric. That engine powers the German armed services’ Sikorsky CH-53G transport helicopter. Those helicopters are still in service, their engines being repaired by MTU. For missions in hot, dusty and high regions like Afghanistan, the Munich engine experts in 2003 developed an update kit to qualify the engines for such rough service. The last engines will be retrofitted before year-end.

In 1979, MTU began manufacturing the 250-C20 engine—formerly Allison, now Rolls-Royce—for the PAH-1 antitank helicopter operated by the German army.

The first application of the new GE38 helicopter engine will naturally be a U.S. model, the triple-engine heavy-lift CH-53K of Sikorsky. It is intended to replace, beginning in 2013, the 156 CH-53E SUPER STALLION™ helicopters of the U.S. Marine Corps. The two partners in the engine, GE and MTU, assume there will be further export orders. The engine may find a home also on other military aircraft. In all, taken across the diverse helicopters and turboprops in question, the market is expected to potentially absorb 6,000 copies. Says Behle: “For MTU, this means revenues of about two billion euros over the life of the program of about 30 years.”

The GE38 engine delivers more than 7,500 shaft horsepower and bases on the U.S. services’ GE97 Modern Technology Demonstrator Engine program and the U.S. Navy’s T407 turboprop engine. First component tests have already been made and given good results. “Its foray into this program has positioned MTU ideally for future growth and put it in pretty good shape also for the demands of the European market,” says MTU’s Program Director Rainer Becker. The engine is scheduled to make its first run in early 2009.

The MTR390 was the first helicopter engine MTU co-developed and co-produced on its own responsibility. Preceding this engine for the Tiger were versions MTM380 and MTM385, which had been developed in a cooperative effort with France’s Turbo-meca. When Rolls-Royce joined in, the engine was re-designated MTR390. It completed its first run in 1991. Meanwhile, it gave rise to an enhanced version, the MTR390E, with Spain’s ITP coming in as a further partner. The Tiger helicopter is currently being phased in with the German armed forces.

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50 years, and counting: the familiar roar of Phantom engines will remain with us on many military airfields for many years to come. In Turkey, for instance, plans are to fly the McDonnell Douglas F-4 Phantom II through 2020, and the German F-4F jets will probably keep flying through 2012, when they’re replaced by the Eurofighter. Until then, MTU Aero Engines will continue to take care of the Luftwaffe’s J79 engines, the first large engine program in its corporate history.

Looking at the Phantom’s longevity and robustness, it appears that McDonnell Aircraft Company’s design engineers, headed by Herman Barkey, five decades ago did a very neat job. In late summer 1954, they showed the U.S. Navy first blueprints of a F3H Demon upgraded into a twin-engine fighter bomber. The Navy brass was impressed with the jet and ordered two prototypes dubbed Phantom II, a name picked by the company’s chief executive James McDonnell in memory of his first production aircraft, the FH-1, which in 1946 was the first American jet aircraft to operate off the deck of an aircraft carrier.

With a crew of two, and armed with Sparrow III missiles, the aircraft was to achieve mach 2. For its final version, the designers were unable to arrange the elevator horizontally. After much fiddling about in the wind tunnel, they found that a 23-degree downward slant was what they needed, since it provided the necessary stability and yet kept the tail unit out of the engines’ exhaust jet. In their trials, however, they encountered instability in the wing area, and not wanting to develop an entirely new wing, the engineers bent the wing tips up through 12 degrees. That gave the Phantom its characteristic shape and “Double Ugly” nickname.
**J79—a milestone in MTU’s history**

"Today’s company basically dates back to the J79 license manufacturing program. The J79 marked the day engine manufacturing began at MTU," says Karlheinz Koch, a former commander of reconnaissance wing AG 51 and Managing Director of Turbo-Union. "MTU remains a reliable partner of the industry-military cooperative model of engine maintenance. "We’re assisting our customers in the phase-out of the Phantom weapon system and will be sure to keep the repair line intact."

MTU’s Munich location has ceased manufacturing J79 parts. If parts are needed, salvaged parts are taken, repaired items or new parts are purchased. "MTU’s J79 expertise is in demand also outside Germany. Greece, for instance, is mulling adopting a modification MTU developed to prevent cracks from occurring in the compressor case. Turkey, too, is in dire need of repaired spare parts. The J79 still is a long ways from being retired for good."

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**The jet made its maiden flight on May 27, 1958, at St. Louis, Missouri, with Robert Little at the controls. Barely two years later, the Phantom bested several world records, setting the absolute speed mark at 2,585.086 kilometers per hour. People took notice. The U.S. Marine Corps had the F-4’s highly promising fighter bomber capabilities in its sights, and also the U.S. Air Force took notice. The U.S. Marine Corps had the F-4’s highly promising fighter bomber capabilities in its sights, and also the U.S. Air Force took notice. The U.S. Marine Corps had the F-4’s highly promising fighter bomber capabilities in its sights, and also the U.S. Air Force took notice.**

**Customers + Partners**

"Job well done": specially painted Phantom of fighter wing 74 based in Neuburg on the Danube.
Engineering art in the best of all possible test environments

By Denis Dilba

Test, evaluate, rebuild in three shifts around the clock, “that’s what you do operating one of the world’s largest, most advanced compressor test stands,” claims Dr. Armin Michel of MTU Aero Engines’ Munich location, adding that the superlatives are not just hype. The high-tech facility indeed makes sure that development pursued by the company is as fine as it gets. Word leaks out beyond company boundaries, and already third-party companies have signaled interest in the formidable test facility.

MTU has been running its Munich compressor test stand practically uninterruptedly since early 2007, using advanced and continuously enhanced data acquisition techniques. This is the crystal ball the company uses to gaze into the future of engines, running component tests to check out advanced technology programs based on newly designed and engineered compressors and turbines. “Feeding into that effort are the insights gained in our analysis departments,” MTU’s Senior Manager Rig Testing, explains. Tests on the compressor stand are telling “if novel compressor technologies indeed deliver what on paper they promise to do.” On the other hand, the highly advanced test engineering pursued at the compressor test stand serves to steer current engine programs through extensive certification processes. Says Michel: “That’s where we demonstrate what our components are worth.”
On the average, a test takes about 100 running hours, or 20 working days. During the test, as many as 15 specialists throng into the test facility to measure, evaluate, modify and assess things around the clock. Often, up to five such test suites are necessary to help in the development of a single engine component. Often, in the course of testing, the compressor is literally maltreated and pushed to the limits of its capacity to "obtain reliable vibration and surge data, exactly validate the component design and early identify, interpret and quantify deficiencies," explains Gerhard Heider, Director Technology Programs and Core Functions at the MTU test center.

Just like aircraft engines, the test stand must be able to ingest air and duct it into the compressor, lots of it. The PW6000, for instance, guzzles about 300 kilograms of air per second equating a cube 6.6 meters in edge length. 20 percent of that flows into the core engine (high-pressure compressor, combustor, and high-pressure turbine), and the remainder is ducted around it to generate main thrust.

Apart from its hardware, there’s yet another attraction that puts the test stand in the crosshairs of third-party customers: testing is a family affair at MTU, from the planning of the test stands and design of the test items, the manufacturing, instrumentation and assembly of components, and all the way through to the test runs proper and evaluation of the test data. Says Heider: “The short lines of communication save us a lot of time. In this ideal environment, there’s hardly a problem we wouldn’t be able to resolve during the work shift to a point where the test can be continued that same shift or the day after. In situations like these, test stands elsewhere will often be stuck with waits running into weeks.” MTU brings the expertise of its people to the table also when turbine test runs are conducted at the altitude test facility of Stuttgart University, with which MTU has been closely partnering for years.

At the Munich test facility, operations will likely be running at full throttle until at least mid-2010. The MTU expert enthuses that the facility will be pretty much sold out. "There’re the three new commercial programs coming up—the PW106 and the PW1000G geared turbofan engine–plus our participation in Germany’s aviation research program, LuFo IV, which will extend into 2010."

Data Acquisition System (proDAS), visualises 95 percent of the test results on about eight screens right at the test stand. Trends, stationary data and efficiencies are shown for the various compressor stages. "When problems surface, technicians at the test stand can immediately intervene. proDAS is an invaluable help to us. At test stands elsewhere, people may be toiling through their test schedules for a couple of weeks before they really know if everything went right. If it didn’t, maybe the test was for the birds," he explains.

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Bird versus aircraft

By Andreas Spaeth

In the sky, peaceful co-existence between birds and flying machines is rare. Aircraft are mostly disrespectful of birds’ natural right of way, and collision between them happens. Instances of such collision, called bird strikes, are mostly fatal for the birds and often enough hazardous for the aircraft. Even the tiniest of the fine feathered friends, if occurring in flocks, may cause big trouble for aircraft.

Bird strikes are the engines. Among the 198 incidents involving German aircraft, 95 entailed engine damage. DAVVL and related international organizations, jointly with the airports’ bird strike officials, are pursuing numerous investigations, in part scientifically supported, in an effort to minimize bird strike exposure. According to DAVVL, the list of preventive measures is headed by habitat management, specifically long grass management where mowed the grass outside safety areas is allowed to stand at least 25 centimeters high to make the surface unattractive to potentially dangerous birds. Where bird populations are massive, airports also resort to birds of prey for additional deterrence, as is the case in Düsseldorf and Barcelona. These predators are the natural enemies of many species of birds. Officials at Barcelona airport claim their falcons are teaching other birds in a quite natural fashion to please not settle down at the airport.

Airport authorities are trying to prevent such dangerous encounters, and aircraft designers are trying to alleviate their impact.

Airports are the most likely meeting places of birds and aircraft; their vast green and open spaces offer resting and feeding opportunities for local and migratory bird populations. The International Civil Aviation Organization (ICAO) reported that 90 percent of all bird strikes occur at or near airports. The International Civil Aviation Organization (ICAO) reported that 90 percent of all bird strikes occur at or near airports.

Most of the unfriendly encounters between birds and aircraft occur during aircraft takeoff and landing. In practice flights of military aircraft, bird strikes may occur at altitudes of up to 1,000 meters. The faster the aircraft flies, the more dangerous the impact is. If a combat jet flying at 1,000 kilometers per hour hits a stork, the bird’s momentum equates 40 metric tons.

In these encounters, aircraft don’t always get off lightly. The Federal Aviation Administration (FAA) of the U.S. estimates that since 1988, bird strikes have accounted for over 200 aviation fatalities worldwide. Material damage incurred in bird strikes is figured at up to three billion U.S. dollars annually. The latest number of bird strikes globally, as reported by ICAO for 1999, was in excess of 7,200. “The actual number probably is a multiple of that,” suspects Dr. Christoph Morgenroth-Branczyk of the German Bird Strike Committee (DAVVL). The reason is that only few countries bother to compile bird strike statistics.

To be reported to the DAVVL are all incidents involving German commercial aircraft. In 2006, 1,087 bird strikes were recorded, and in 174 of these, aircraft damage occurred. In 2007, at about 1,000, the number of bird strikes was a little lower. Suffering most from bird strikes are the engines. Among the 198 incidents involving German aircraft, 95 entailed engine damage.

As a consequence, all engine manufacturers, together with the European Aviation Safety Agency (EASA), have established a bird strike program. As part of engine development, bird strike load testing is conducted to ensure the engines, in particular the blades, can withstand the forces caused by bird strikes. Certification requirements demand that strikes of small and medium-size birds shall not cause excessive power loss. “So we often make the blades thicker so they survive such incidences,” says Dr. Jörg Frischbier, a stress engineer at MTU’s Munich facility. All components designed at MTU to ensure they withstand stresses from potential bird strikes are undergoing a special development process: their design bases on analytic simulation, and to validate design methods, resort is made to preliminary testing during which synthetic dummy masses (gelatine or plasticine) are catapulted onto the components. Invariably, for certification, proof is required by flinging previously euthanized genuine birds into the engine.

In engine development, bird strike is a serious consideration. Especially the blades of the forward engine stage must be designed to withstand bird impact without fracturing or suffering excessive damage. Certification requirements demand that strikes of small and medium-size birds shall not cause excessive power loss. “So we often make the blades thicker so they survive such incidences,” says Dr. Jörg Frischbier, a stress engineer at MTU’s Munich facility. All components designed at MTU to ensure they withstand stresses from potential bird strikes are undergoing a special development process: their design bases on analytic simulation, and to validate design methods, resort is made to preliminary testing during which synthetic dummy masses (gelatine or plasticine) are catapulted onto the components. Invariably, for certification, proof is required by flinging previously euthanized genuine birds into the engine.

For additional information, contact
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For interesting multimedia services associated with this article, go to: www.mtu.de/208BirdControl
The stage is set in the American Southwest, Nevada, near Las Vegas: ten times a year a desert area sprawling over several thousands square kilometer goes live with a frenzy of activity on the ground and in the air. That’s when the U.S. Air Force is conducting its aerial warfare exercises there, some of the biggest the world has ever seen. Taking part in them for the first time in June this year were modified Eurofighter Typhoons of the United Kingdom’s Royal Air Force (RAF). With notable success: the European fighter aircraft excelled in all missions they flew.

The availability of the European aircraft came close to 100 percent, which did not fail to impress the hosts of the exercises. “I’d expect a higher [sortie] cancellation rate, but they’ve done very well,” admits commander Lieutenant Colonel Ron Hanselman. “The RAF came here prepared. They’re thinking not just about the aircraft, but the tactics,” lauded the Senior U.S. Officer running the exercises.

Reporting for Green Flag West was No. 11 Squadron RAF. Wing Commander Gavin Parker had deployed seven aircraft, additionally equipped with laser target marking capability, of his squadron to Nellis Air Force Base near Las Vegas, Nevada. Completing them were three No. 17 Squadron Eurofighter Typhoons. All in all, 20 British pilots and 150 technical and logistic staff were to demonstrate under the U.S. Air Force and Army’s Green Flag West exercises the Typhoon’s operational multi-role capability and its ability to cover the mission spectrum assigned to it. From the fighters’ showing over the desert grounds, this much was clear: these aircraft are capable of defending or gaining a favorable air situation and moreover repulsing attacks and precisely engaging all targets day and night, in any weather and at any distance.
The Green Flag desert exercises prepare air and ground forces for combat missions in a realistic approximation of war scenarios. Taking part in the exercises are several thousand U.S. troops, as well as troops of varying coalition partners, plus several thousand civilians. Mock-up villages, air field complexes and surface-to-air missile sites make up the scenery in the desert.

Ever since the Iraq war, the exercises have invariably followed the same pattern, with the role of escorting convoys of coalition ground troops being added to that of attack and destruction of targets from the air. A typical scenario has two dozen friendly vehicles moving through the desert and charges pilots with the task of locating and tracking nearby hostile activities and buzzing to deter and disperse enemy combatants.

Notes Wing Commander Gavin Parker: “The complexity of the exercise is astonishing. This is the best preparation for contemporary operations that money can buy.” In the European airspace, the practicing of tactical close air support by airborne weapon systems is subject to tight constraints through noise control legislation, low-altitude flight bans and regulations governing the onboard carriage of live weapons. Not so in the American desert, where several thousand square kilometers of nothing but sand and mountain terrain around Nellis Air Force Base provide optimum conditions for complex, large-scale aerial warfare exercises.

The Green Flag operations on any one day involved as many as two dozen aircraft over a continuous nine-hour period. Simulated were multiple threats from, for instance, air defense missiles, unmanned combat air vehicles (UCAV) and enemy aircraft. Practiced also was the relief of besieged ground troops through airborne sorties. Hanselman, who ran the exercises, explains that Green Flag is “a very important exercise, because these [army] guys are going into combat.” The USAF’s 14th Fighter Squadron based at Misawa Air Base in Japan, for one, will be re-deployed to Iraq before the year is out.

The RAF Typhoons were able to make several sorties a day for durations of up to 120 minutes each. In this, they were supported by technical staff on the ground, working two shifts. The armament they carried was that intended for war emergency, that is guided short-range ASRAAM, IRIS-T or AIM-9L Sidewinder missiles for air-to-air combat, the AIM-120 AMRAAM for the intermediate range, depending on the nation, and the laser-guided Paveway II and GBU-16 for air-to-surface environments. At this loading status, the Typhoon is cleared for loads up to nine times the gravitational force of the earth in extreme flight maneuvers. And that’s about the limit to which the pilots actually pushed their combat jets over Nevada’s desert, exploiting the full power of their two high-thrust EJ200 engines.

Developed by the Eurojet consortium, the EJ200 delivers 60 kilonewtons of thrust, or 90 kilonewtons reheated. At full combat load, that takes the Typhoon to one-and-a-half time sonic speed and an altitude of 11,582 meters within less than two and a half minutes. All of which not only takes the pilots’ honed flying skills but moreover perfectly coordinated support from the maintenance crews on the ground.

The 11th Squadron’s aircraft were deployed to the U.S. along with a primary equipment pack permitting eight fighters to operate on a four-week first line spares allowance. The full hardware complement is carried on a C-130J Hercules, so it isn’t overwhelmingly voluminous. Which pleases Aloysius Rauen, Eurofighter GmbH Chief Executive Officer: “The Typhoon has been developed for cost-efficient operation at low operating costs. An appreciably reduced amount of infrastructure, engineering and not least manpower, ease of maintenance and intelligent logistic concepts permit the aircraft to swiftly adapt to diverse challenges, such as the instant shift from air-to-air to air-to-surface assignments.”

That capability was much in demand also during Green Flag: “We’re getting into the era of digital close air support,” was how Wing Commander Gavin Parker summed it up at Nellis Air Force Base. The Link-16-equipped Typhoons can pool situational awareness data with other weapon systems. What’s more, Parker’s team includes four forward air controllers plus a liaison officer on the ground to connect with the 4th Battalion, The Yorkshire Regiment.

The Royal Air Force considers its Green Flag participation a full success. So it hopes to be in on the exercises in 2009 as well.
The Red Bull flies Alpha Jet

By Martina Vollmuth

Red Bull gives you wings. That goes for the Austrian energy drink on its triumphant progress around the world and moreover its creator. In flying circles, Dietrich Mateschitz is a well-known aviation enthusiast with diverse links to flying. He is, for instance, the owner of the Flying Bulls. That legendary private aircraft fleet is based in Salzburg, Austria. Among other aircraft it also operates a number of Alpha Jets from former German military inventory.
The Alpha Jets used to be German Bundeswehr property, flying from the early 1970s to the mid-1990s under the German national emblem. Upon their retirement, 168 of the aircraft remained available and found new owners, such as museums, flying squadrons of foreign nations like the United Kingdom, Portugal and Thailand, private patrons and companies like that with the Red Bull in its logo, established in 1999. That company was formed by a group of enthusiastic pilots, technicians, and helpers brought together by their love of flying machines. Their assortment of aircraft ultimately outgrew the capacity of the Innsbruck Airport, its original base. In the spring of 2000, they decided to move to Salzburg and build two hangars there, which were Hangar-7 and a maintenance hangar.

Salzburg then became home also to the German Alpha Jets. This agile aircraft resulted from a binational joint project, with the French conceiving it as a trainer and the Germans as a light fighter bomber. It was built by Dassault and Dornier and made its first flight in 1973, powered by two Larzac04 engines that to this day survive in MTU Aero Engines’ portfolio.

Totally, over 500 aircraft were fitted with the Larzac engines. In 1975, MTU, the French companies of Snecma Moteurs and Turbo-mecas, plus Klockner-Humboldt-Deutz (KHD), today’s Rolls-Royce Deutschland, launched production of the engine. MTU holds a 25 percent stake in the powerplant, being responsible for its combustor, high-pressure turbine and casing parts. Most of these engines are still flying in countries such as Egypt, Cameroon, Qatar, Morocco, Nigeria, Togo, Portugal, and Ivory Coast. France and Belgium late in May celebrated its one-millionth flying hour, together still logging 45,000 flying hours annually in training practice. “With our partners, we’re still supplying spare parts to all user nations, reliably contributing to keeping the Alpha Jets flying smoothly,” explains MTU’s Senior Program Manager Uwe Feyler. MTU no longer performs repairs on the two-shaft bypass engine, that work having been shifted entirely to Snecma Moteurs.

The Flying Bulls veteran aircraft are kept in good shape locally, at Salzburg. The work is performed in maintenance hangar number 8, opposite Hangar-7. The impressive architecture of the two buildings has since made them a landmark of Salzburg Airport.

Hangar-7

The Flying Bulls are known not only by the rare aircraft found in their historic collection but also by the building in which they are accommodated at Salzburg Airport. Opened in 2003, Hangar-7 impresses with its spectacular construction. Enveloping a volume of 64,300 cubic meters, partly with 380 tons of specialty glass, it is shaped like an airy shell spanning over the various aircraft under it. Weighing 1,500 tons overall, it is designed to house aircraft like the DC-6B that sports a vertical fin nine meters high.

But it’s not merely a repository of aircraft. It features a restaurant, a coffee shop, two bars and several lounges that have since turned it into a favorite meeting place. It also accommodates exhibitions and company events.

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For further information on this article go to: www.mtu.de/208FlyingBull

The DC-6B was converted into a luxury VIP aircraft by former Yugoslavian President Tito. The Alpha Jet is powered by two Larzac04 engines.
MTU and Lufthansa Technik cooperate

MTU Maintenance Berlin-Brandenburg at Ludwigsfelden has broadened its service offerings in partnership with Lufthansa Bombardier Aviation Services GmbH at Schroidorf, a subsidiary of the Lufthansa Technik Group, the engine specialists are now offering complete maintenance packages for Bombardier Learjet 60 business aircraft and their PW305A engines.

Dr. Wolfgang Konrad, President and CEO of MTU Maintenance Berlin-Brandenburg, emphasized that the two parties teaming up here, both of them established players in the aviation industry, showed that “in the service sector, Berlin-Brandenburg is catching up with other European centers of excellence in the dynamically growing corporate excellence market.”

Certification received

MTU Maintenance Berlin-Brandenburg has added another engine to its portfolio: the company has expanded its services as an Authorized GE CF34™ Service Provider to include the CF34™-10E engine. Certification covering support for the GE powerplant was awarded by EASA/FAA. Overall, the MRO experts now have the entire in-service CF34™ family in their portfolio.

André Sinanian, Vice President CF34™ Program at Ludwigsfelden, is enthused with the latest addition: “We’ve extensively prepared for the CF34™-10E version and will be sure to offer our clients custom-made solutions same as we do elsewhere.”

The first -10E engines are expected to make their shop visits still before year-end. A re- cent newcomer to the market, the CF34™-10E powers 100 to 120 passenger Embraer 190/195 airliners.

In late October, MTU Aero Engines reported positive results. In the first nine months of 2008 revenues and EBITDA increased five percent each. At the end of September, revenues amounted to over 1.9 billion euros and adjusted EBITDA reached 295 million euros. After adjustments for the U.S. dollar exchange rate, revenues even increased by 17 percent. The EBITDA margin at the end of September came to 14.9 percent, as in the previous year. Net income has remained stable at 118.6 million euros.

“MTU has had a particularly successful third quarter and is making good headway towards its targets,” MTU CEO Egon Behle in late October explained to journalists and analysts. And he continued to add: “On the basis of these results, we are today able to revise our forecast for 2008 upwards. We now expect to close the year with revenues of 2.65 billion euros and anticipate an EBITDA of at least 400 million euros.” This is at least ten million euros higher than the previously estimated EBITDA, despite an increasing level of capital expenditure. The original forecast for revenues has been increased by 50 million euros.

The greatest contributors to revenues in the commercial OEM engine business were the V2500 engine that powers the Airbus A320 family and the PW3000 engine for the Boeing C-17 transport aircraft. The programs generating the highest revenues in the military engine sector were the EJ200 for the Eurofighter Typhoon and the RB199 for the Tornado. The primary sources of revenue in the commercial MRO business were the V2500, and the CFM engine power wide-body jets such as the Airbus A330 and Boeing 747.

MTU’s capital expenditure in the first nine months of 2008 amounted to 97.6 million euros. This represents an increase of 76 percent over the same period in 2007. A major portion of this sum concerns investments in the development program for the GE38 engine, destined to power the CH-53K heavy-lift helicopter, and the construction of the new test cell at MTU Maintenance Hannover in Langenhagen.

Research and development expenses in the first nine months of 2008 amounted to 120.1 million euros. “This shows that MTU attributes a central importance to research and development activities—especially with a view to further expanding our innovative lead. It is an arena in which we intend to make growing investments,” said Behle.

Strong nine-month performance

MTU Aero Engines – Key financial data for January through September 2008

<table>
<thead>
<tr>
<th>MTU Aero Engines</th>
<th>End Sept. 2008</th>
<th>End Sept. 2007</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>1,982.9</td>
<td>1,888.8</td>
<td>+ 5.1%</td>
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<tr>
<td>of which OEM business</td>
<td>1,196.3</td>
<td>1,153.8</td>
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<tr>
<td>of which commercial engine business</td>
<td>841.4</td>
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<td>of which military engine business</td>
<td>354.9</td>
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<td>of which commercial MRO business</td>
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<td>815.2</td>
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<td>EBITDA (calculated on a comparable basis)</td>
<td>295.0</td>
<td>280.8</td>
<td>+ 5.1%</td>
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<td>of which OEM business</td>
<td>246.9</td>
<td>210.5</td>
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<tr>
<td>of which commercial MRO business</td>
<td>50.2</td>
<td>70.3</td>
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<tr>
<td>EBITDA margin</td>
<td>14.9%</td>
<td>14.9%</td>
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<tr>
<td>in the OEM business</td>
<td>20.6%</td>
<td>18.2%</td>
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<td>6.2%</td>
<td>9.3%</td>
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<td>Net income (IFRS)</td>
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<td>117.0</td>
<td>+ 1.4%</td>
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<td>Earnings per share (adjusted)</td>
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<tr>
<td>Free cash flow</td>
<td>124.5</td>
<td>121.7</td>
<td>+ 2.3%</td>
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<tr>
<td>Research and development expenses</td>
<td>120.1</td>
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<td>of which company-funded R&amp;D</td>
<td>59.9</td>
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<td>of which outside-funded R&amp;D</td>
<td>60.2</td>
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<td>Capital expenditure</td>
<td>97.5</td>
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<td>Sept. 30, 08</td>
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<tr>
<td>Change</td>
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<td>Order backlog</td>
<td>3,227.9</td>
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<td>3,132.3</td>
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<td>of which commercial MRO business</td>
<td>95.6</td>
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<tr>
<td>Employees</td>
<td>2,327</td>
<td>2,130</td>
<td>+ 2.8%</td>
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( Figures quoted in € million, calculated on a comparable basis, statements prepared in accordance with IFRS. Figures calculated on a comparable basis apply adjustments to the IFRS consolidated results to exclude restructuring and transaction costs, capitalized R&D costs, and the effects of IFRS purchase accounting.)
Stake in LM6000™

MTU Aero Engines, Germany’s leading engine manufacturer, is a risk-and-revenue sharing partner of GE with a 13 percent share in the LM6000™ program and the new derivative models. “Including spare part sales, that adds up to sales of 1.2 billion euros through the life of the contract,” explained Dr. Anton Binder, Senior Vice President Commercial Programs at MTU.

New chief executive in China

Holger Sindermann on July 1, 2009, took the position of President and CEO of MTU Maintenance Zhuhai, a joint venture of MTU Aero Engines and China Southern Airlines. He succeeds Walter Strakosch, who upon his return to Germany in the summer of 2008 died unexpectedly. Sindermann had held the position of Senior Vice President Corporate Development at MTU Aero Engines since early 2006.

With its roughly 400 employees, MTU Maintenance Zhuhai is China’s largest engine MRO provider. Its portfolio includes V2500 and CFM56 series engines. The shop caters mostly to customers from the Chinese and Southeast Asian region.

In Brief

Inauguration of the new test cell with Dr. Uwe Blöcker, President and CEO of MTU-Maintenance Hannover, Dr. Stefan Wengenrther, President and CEO Commercial Maintenance, Christian Wulff, Lower Saxony’s Minister President, and Egon Behle, MTU CEO (from left).

The aircraft is powered by four GP7200 engines manufactured by Engine Alliance. In this program, pursued jointly by General Electric and Pratt & Whitney, MTU has a 22.5 percent role. The engine delivers 72,000 pounds of thrust and thanks to its efficiency, the wide-body aircraft consumes less than three liters of fuel per passenger per 100 kilometers.

Ceremony for the mega-transport: in July 2008, at the Hamburg Airbus facility, Emirates took delivery of its first A380. With 58 of the aircraft on order, the Dubai-based airline is the largest A380 customer.

“With its very low fuel burn and quietness, the A380 also sets new standards in environmental performance. It will definitely help air transport and Emirates grow, while reducing the impact on the environment,” declared Emirates Chairman and Chief Executive Officer Sheikh Ahmed bin Saeed Al-Maktoum.

Emirates special delivery of its first A380 was powered by GP7200 engines in a celebration held at Airbus’s Hamburg facility.

Emirates receives A380

96 meters long and 35 meters high: that’s about the size of the new test cell at MTU Maintenance Hannover, which is worth around 24 million euros. The high tech facility was inaugurated in September 2008 by Lower Saxony’s Minister President Christian Wulff and MTU CEO Egon Behle. Over 150 guests from industry, politics and science attended the ceremony.

Behle noted: “This test cell adds a new dimension to our work, accommodating engines no matter how high their thrust rating. It points the way to the future and opens a new chapter in the annals of MTU.”