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F.l.t.r.:
Nicolas Bonleux,
Francis Carla,
Heiko Lütjens,
Josef Gropper

Dear Reader,

The aeronautical sector has been enjoying substantial growth for several years now with aircraft manufacturers steadily increasing their production rates of commercial aircraft and airlines showing profitable operation. Also, there is a promising outlook for the coming years.

Liebherr-Aerospace has an integral part in these successful developments: in 2014, we were entrusted with major contracts from our customers illustrating their level of confidence in us. These contracts included, for example, components of the folding wing tip system for the Boeing 777X and the bleed air system for the Airbus A330neo.

Moreover, we have substantially supported our customers in achieving key milestones in the development of their new aircraft. The entry into service of the Airbus A350 XWB and the AgustaWestland AW189, the certification of the COMAC ARJ21 or the first flight of Dassault's Falcon 8X are examples underlining our performance and contribution.

Sustained investment in our production facilities as well as in our service network worldwide has meant that we have been able to ensure deliveries to the final assembly lines of our customers producing aircraft and to support the profitable and reliable operations of our customers operating aircraft.

We are also strongly committed to the development of technologies that will make air transport of the future greener, safer, more comfortable for passengers and crew, and the system and components of all our product lines – flight control and actuation, landing gear, air management, gears and gearboxes – more energy-efficient.

Making our company future-proof so that we can continue offering our customers innovative and competitive solutions is a priority for us. We can count on the outstanding commitment, the broad expertise and the remarkable professionalism of all members of our staff at Liebherr-Aerospace, and therefore we would like to warmly thank them for their joint performance.

The latest issue of our magazine contains recent success stories and an overview of several exciting projects that we thought may be of interest to you. We hope you enjoy reading this magazine!

Best regards,

Nicolas Bonleux
Managing Director and
Chief Sales Officer

Francis Carla
Managing Director and
Chief Technology Officer
Air Management Systems

Josef Gropper
Managing Director and
Chief Operating Officer,
Production, Purchasing
and Asset Investments

Heiko Lütjens
Managing Director and
Chief Technical Officer, Flight Control
and Actuation Systems, Landing Gear
Systems and Hydraulics

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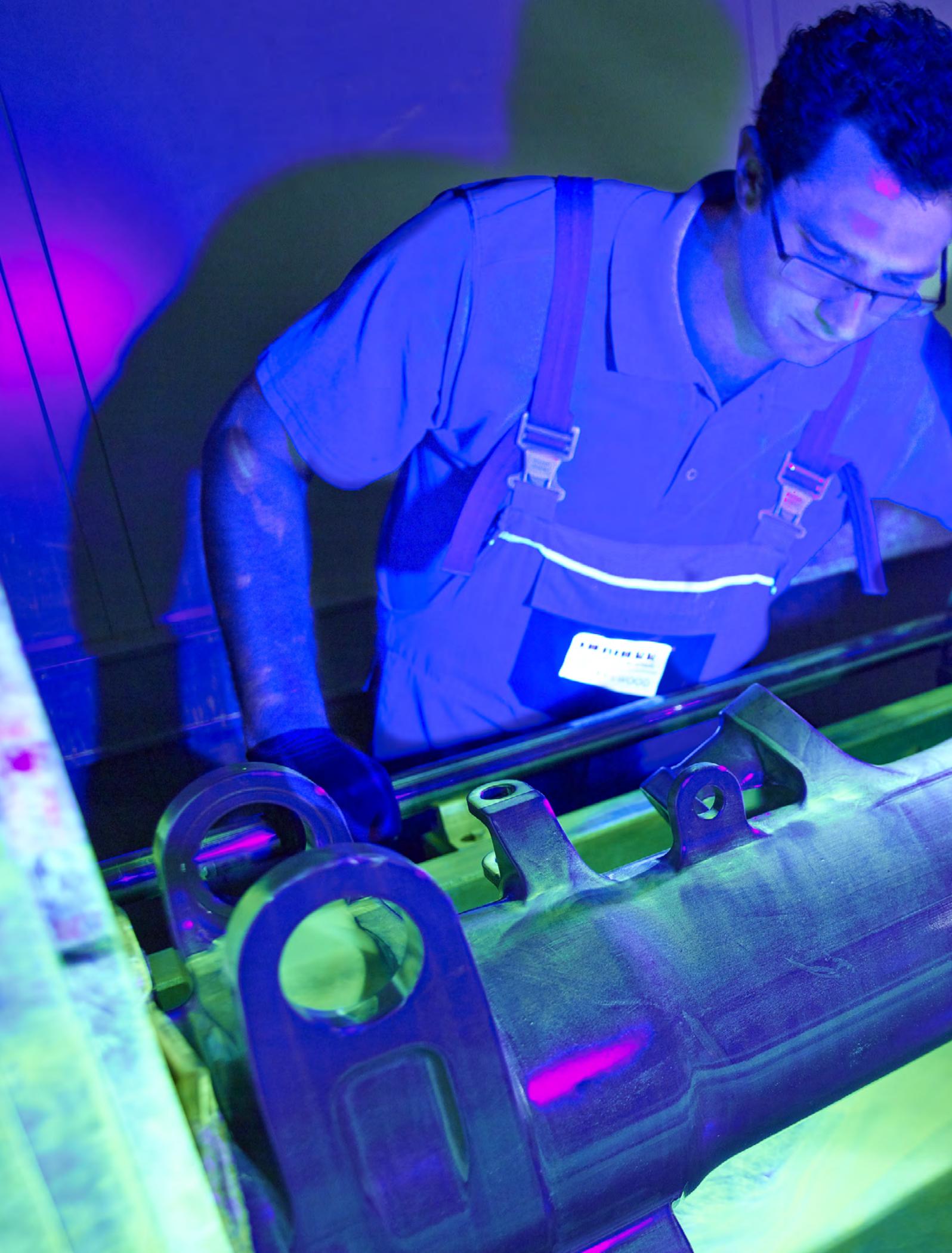
Impressions

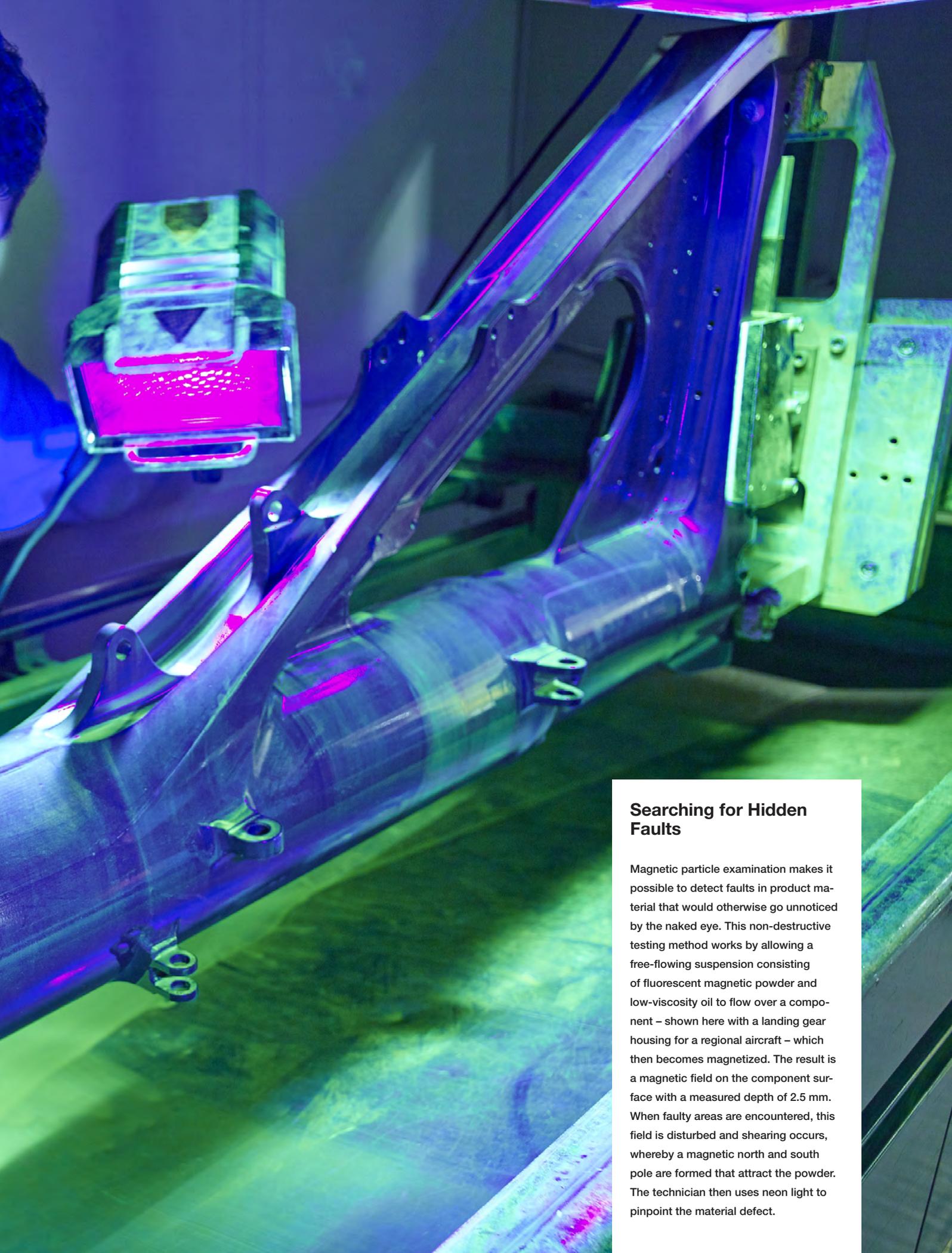
Non-destructive testing, high-precision balancing or the simulation of extreme pressure conditions – these and other production and testing processes ensure that Liebherr-Aerospace's systems and components are highly reliable.



Until Sparks Fly

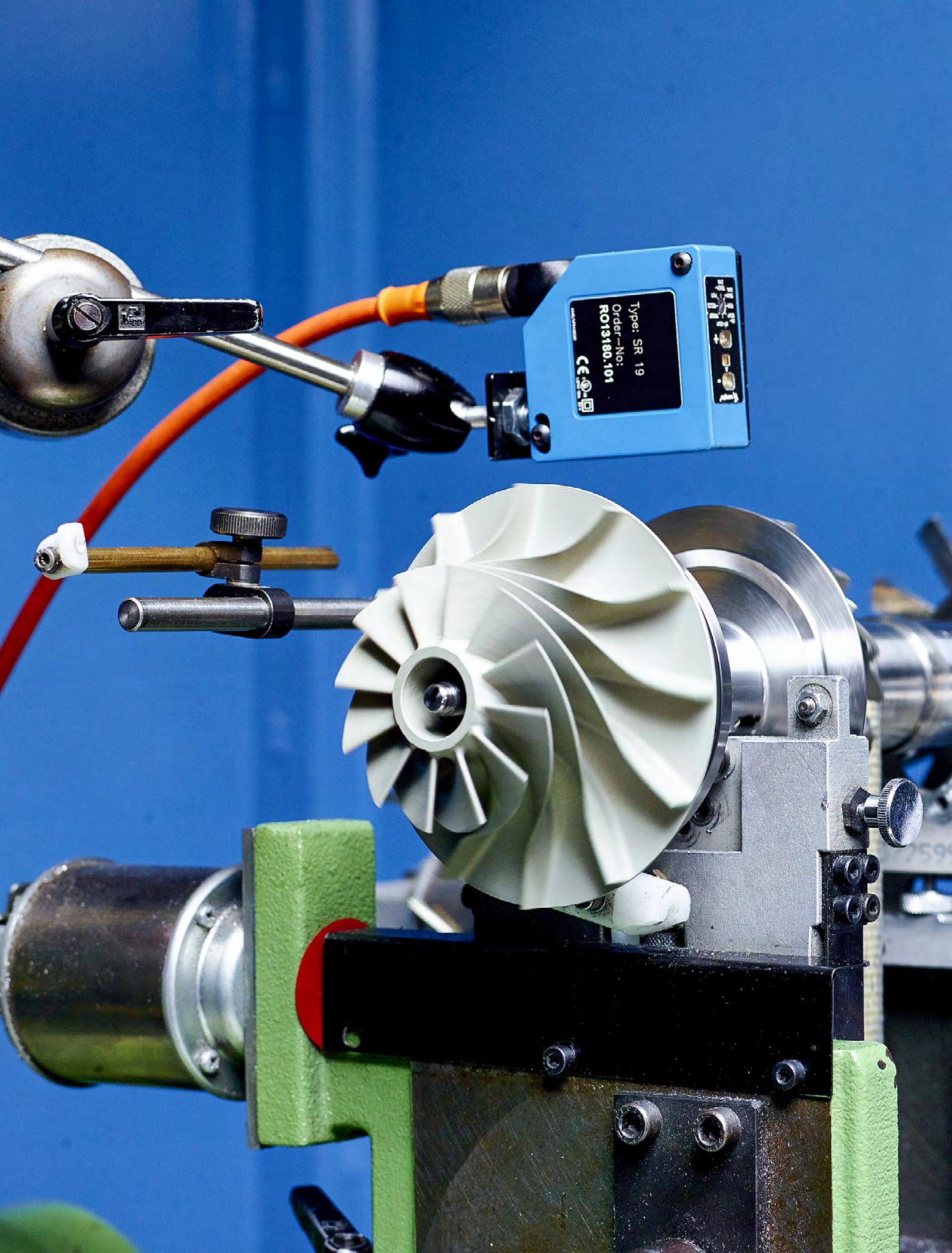
When structural components are manufactured for landing gear systems, up to 85% of the material is removed during the machining process. Steel components, for example, are processed in highly dynamic machining centers that operate at such high speeds that sparks literally fly. This is because all of the energy generated during the cutting operation is dissipated into the steel chips, which start to glow.





Searching for Hidden Faults

Magnetic particle examination makes it possible to detect faults in product material that would otherwise go unnoticed by the naked eye. This non-destructive testing method works by allowing a free-flowing suspension consisting of fluorescent magnetic powder and low-viscosity oil to flow over a component – shown here with a landing gear housing for a regional aircraft – which then becomes magnetized. The result is a magnetic field on the component surface with a measured depth of 2.5 mm. When faulty areas are encountered, this field is disturbed and shearing occurs, whereby a magnetic north and south pole are formed that attract the powder. The technician then uses neon light to pinpoint the material defect.



Type: SR 19
Order-No: RO13180.101
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Smaller than One Quarter of a Micrometer

The rotor of a three-wheel cooling turbine as installed in the air conditioning system of a regional jet is balanced. First any potential imbalance of the rotor is measured as it spins at a given speed. If the measuring instrument detects imbalanced operation, a technician corrects the imbalance by removing material until the required quality is achieved. The gap between the balance point and the axis of rotation for such a high-speed rotor supported by aerodynamic bearings must be smaller than one quarter of a micrometer.





Pressurizing to the Max

Liebherr-Aerospace has two large altitude chambers at its site in Toulouse (France) that are used to test air management systems and their components. With a volume of 70 m³ and 120 m³ and a weight of 20 tons and 48 tons, respectively, the chambers are connected to a high-performance compressed air and vacuum circuit, which is used to simulate pressure conditions that prevail at high altitudes.



© Embraer

Programs and New Contracts

Brazil – a Site in Motion

Much has changed at Liebherr Aerospace Brasil Ltda., since the production facility in Brazil opened its doors in 2006. Equipped with state-of-the-art technologies, Liebherr can manufacture more than 250 different components for landing gear, flight controls and air management systems on site in Guaratinguetá. Recently, the

company reached yet another milestone as the production of complex "make-to-print" parts was successfully launched. Liebherr will deliver these structural parts – which include brackets for wings, struts as well as swing arms for landing gear systems – directly to aircraft manufacturer Embraer in nearby São José dos Campos. In so

doing, the company continues to pursue the strategic objective of expanding its production know-how and becoming a key player in the supply chain for the Brazilian aerospace industry.

But this is not the only positive development in the history of the production facility located in the federal state of São Paulo. 2014 saw the company introduce an environmental management system and have it certified to the ISO 14001 quality standard. In a move to expand its range of services for precision machining, surface treatment, and assembling high-tech parts, Liebherr Aerospace Brasil Ltda. also integrated new processes for assembling electronic sub-assemblies as well as assembling and painting structural parts.

The site in Brazil now employs some 280 members of staff, who play a key role in advancing and furthering the company. In 2014, Liebherr Aerospace Brasil Ltda. was able to increase its turnover by approximately 30% compared to the previous year.



Liebherr-Aerospace manufactures a wide range of components in Brazil.

Boeing 777X: Components for the Wing Tip Folding System

Boeing Commercial Airplanes has selected Liebherr-Aerospace to supply three components for the folding wing tip system of the Boeing 777X. “We are very proud to develop, manufacture and also service the fold subsystem, the latch pin actuator and the secondary lock actuator for the Boeing 777X folding wing tip system,” said Heiko Lütjens, Managing Director and CTO, Liebherr-Aerospace & Transportation SAS. “This contract is a historic milestone in our company’s collaboration with Boeing.”

Relying on its experience in high-lift systems, gears, torque tubes and hydraulic power drive units, Liebherr-Aerospace will design a compact, extremely reliable and powerful fold subsystem. With its motor and rotating actuator, this system will fold the wing tip after landing, thus reducing the wingspan of the new widebody aircraft by 7 m (3.5 m on each side) from 71.8 m to 64.8 m. For take-off, the system will extend the wing tips back into the horizontal position.

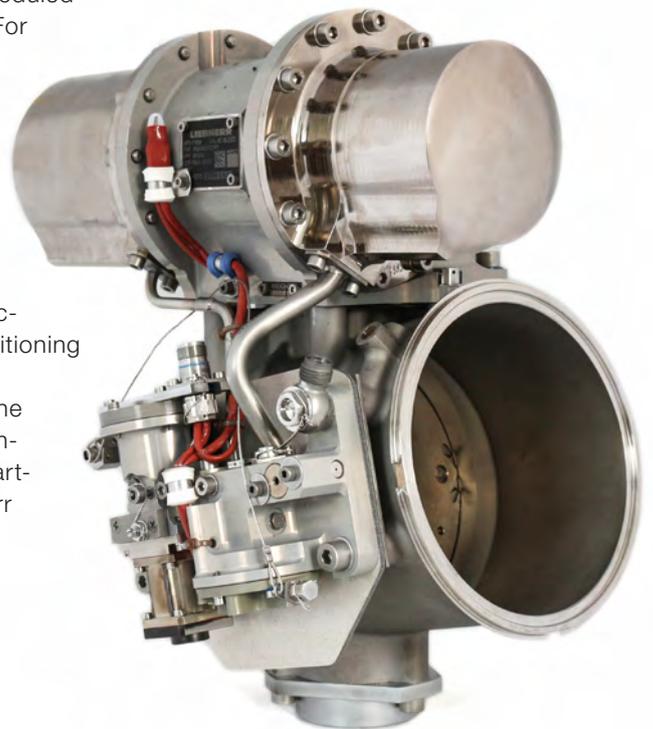
The extremely large wingspan is one of the factors defining the Boeing 777X. It allows increased fuel efficiency, but it would normally exclude the new aircraft from using the same airport gates as the current Boeing 777 model. Thanks to its special wing tips, the 777X will, however, be in the same wingspan category as the 777. “This contract awarded to Liebherr-Aerospace illustrates the shared commitment to quality and innovation of Boeing and Germany’s aerospace manufacturing industry,” said Matthew Ganz, President, Boeing Germany and Northern Europe.

Innovative Bleed Air Technology for the A330neo

The order: To deliver a bleed air system employing innovative electro-pneumatic technology for the A330neo, a wide-body aircraft that features state-of-the-art engines. The client: Airbus. The system supplier: Liebherr-Aerospace. The result: Greater reliability and considerably lower operating costs.

The electro-pneumatic bleed air system is developed, tested, and manufactured by Liebherr-Aerospace Toulouse SAS in Toulouse (France) and comprises compact, light-weight, and highly reliable bleed air valves as well as a pre-cooler with integrated control elements. This new system generation is a product of the comprehensive experience that the company has acquired in developing the bleed air systems for the A320neo, the A380 and a variety of other commercial airplanes. This new technology not only contributes to the improvement of the reliability of the system, but also to a considerable reduction of operating costs.

The first A330neo is scheduled to be delivered in 2017. For the current long-range Airbus, which is also now known as the A330ceo, Liebherr supplies several key systems and components such as the high-lift system, the spoiler and rudder actuation, and the air conditioning system. The contract for the bleed air system of the A330neo further strengthens the decades-long partnership between Liebherr and Airbus.



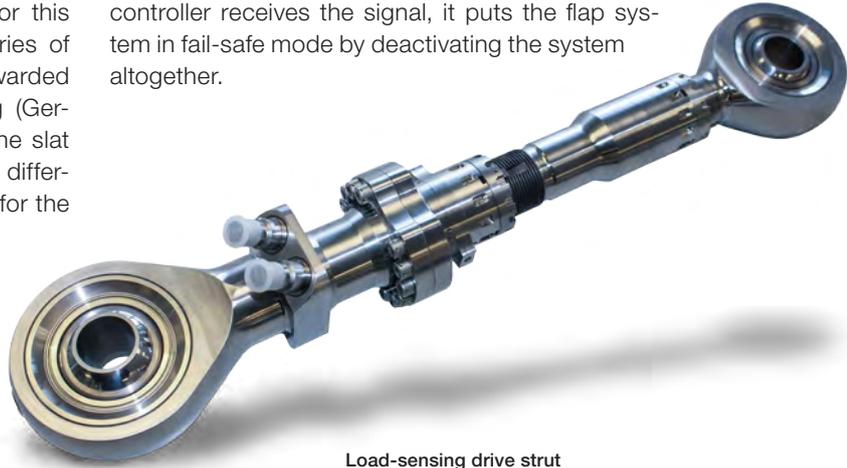
Liebherr-Aerospace’s bleed air valve for the A330neo is both compact and highly reliable.

Another Contract for the A350-1000

The latest wide-body aircraft from Airbus, the A350-1000, will have another product from Liebherr-Aerospace on board: the load-sensing drive strut. The contract for this electro-pneumatic component is the latest in a series of orders that aircraft manufacturer Airbus has awarded Liebherr-Aerospace Lindenberg GmbH, Lindenberg (Germany). The system supplier already manufactures the slat actuation system, the nose landing gear, the active differential gearbox for the flaps, and the moving damper for the A350-1000.

Four of the struts are installed in every aircraft and send a signal to the high-lift controller if the

loads between the actuation system and the flaps exceed a defined threshold due to a malfunction. When the controller receives the signal, it puts the flap system in fail-safe mode by deactivating the system altogether.



Load-sensing drive strut

Gearbox for the H160 Tail Rotor

At this year's Heli-Expo, which took place in Orlando, Florida (USA) in March, Airbus Helicopters debuted its H160. This new civilian helicopter features rotor blades that have been contoured specifically to make the new member of the H gen-

eration quieter. The tail rotor of the H160 also contributes to lower noise levels and is slightly canted and also shrouded to increase performance and flight stability. The gearbox for the tail rotor is manufactured at the Friedrichshafen plant of Liebherr-Aerospace Lindenberg GmbH, where specialists build and assemble precision gearbox units.

Their know-how is based on the many years of collaboration between Liebherr-Aerospace and Airbus Helicopters; Liebherr provides not only the tail rotor gearbox for the H145, but also other systems and components for numerous models from Airbus Helicopters. The contract for the tail rotor gearbox is already the third the system supplier received within the H160 program. Other equipment Liebherr provides for the new helicopter includes the actuators for the main rotor and components of the environmental control system.



© Airbus Helicopters

The gearbox for the H160 tail rotor is manufactured in Friedrichshafen.



Barbara Aichele makes sure that the systems produced at Liebherr-Aerospace Lindenberg GmbH, Lindenberg (Germany), meet the highest reliability requirements.

Barbara Aichele, Team Leader Safety and Reliability

Safety Down to the Smallest Detail

It sounds paradox, but to ensure that technical systems are as reliable as they can possibly be, Barbara Aichele first devotes her time to the exact opposite: the worst case scenario. To this end, the leader of the team that is in charge of safety and reliability at Liebherr-Aerospace Lindenberg GmbH asks herself three main questions: What malfunction could occur with landing gear and flight control systems, what is the probability of the malfunction occurring, and what would the consequences be? "Every design engineer needs to know exactly how a device or system is supposed to function. The employees who work to ensure the safety and reliability of these systems must also understand why something does not operate as intended", explains Barbara Aichele. Together with her team of six, she is responsible for meeting the safety requirements for newly developed and modified systems as well as providing technical verification documents for certification. Typically, their work involves complex interactions of devices that fulfill specific mechanical or hydraulic

functions, computers that carry out control tasks via software, equipment used by pilots to enter control signals, and the sensor system for the equipment. These functional interconnections make it so difficult to detect every conceivable source of error and map it out in a structured fashion. "Of key importance is that you do not focus too quickly on any one particular factor as being the cause, but instead carefully consider every detail", comments Barbara Aichele.

A High Level of Trust in Reliability

Safety is a very demanding area to be working in. While the engineering and development divisions for landing gear and flight control systems focus on one type of product, the safety department must cover the entire product portfolio from a technical perspective. But this is not the only thing that is special about working in this department. The other thing is that the team, which Barbara Aichele has been leading for three years now, also includes another female employee. This

is a relatively high percentage of women for a technical field. "When I was studying mechanical engineering, our class of 44 had only two women. And during my first seven years working in the design department at Liebherr, I was the only female member of staff", the engineer recalls. This changed when she moved to safety and reliability 13 years ago, where more women are active, in general. Barbara Aichele can only guess as to the reason for this. "The straight career path of the classic mechanical engineer points directly to the field of technical design, while safety is something of a niche that has more to do with the layout and configuration of systems and their interrelationships." This is exactly what draws her to her work. Whenever Barbara Aichele is on a plane, she thinks about the systems and components supplied by Liebherr. The engineer is also not afraid to fly as she trusts the work performed in the safety departments.

The Embraer KC-390 Takes to the Skies

The new KC-390 military transporter from Embraer took off for the first time from Gavião Peixoto Airport in Brazil in February 2015. On board the aircraft were flight-critical systems and components that Liebherr-Aerospace developed and manufactured applying its extensive experience in the field of military airlifters.

Experts at Liebherr-Aerospace Toulouse SAS developed both an air-conditioning system and a cabin pressure control system of the latest generation for the KC-390. Even when operated under the most extreme conditions, both systems help to ensure the safety and comfort of the troops and the crew on board.



Liebherr also put its know-how to work by designing the components of the air management system, the bleed air system and the anti-ice system for the wings to optimize efficiency, durability, operating costs and reliability. The state-of-the-art bleed air valves,

for example, incorporate innovative electro-pneumatic bleed air technology – a key feature of the high-wing, twin-engine model, which can be refueled in the air or be used as a tanker plane to refuel other aircraft.

Maiden Flight of the Falcon 8X a Success

Dassault Aviation has developed a new business jet, the Falcon 8X, designed to carry up to eight passengers. With a range of almost 12,000 km, this aircraft is capable of flying non-stop to destina-

tions such as Beijing from Los Angeles and Singapore from Paris, for example. Liebherr provides two critical systems for the plane: the pre-cooling system for the bleed air and the humidification

system for the cabin air. Outfitted with this equipment, the latest business jet from the French manufacturer completed its maiden flight in February 2015 with flying colors.



The technologies for the three-engine aircraft are provided by Liebherr-Aerospace Toulouse SAS, the center of excellence for air management systems of the Liebherr Group based in Toulouse (France) and feature reliable, lightweight components that the system supplier developed leveraging its many years of experience. For over 50 years, Liebherr has been manufacturing critical flight systems for all aircraft from Dassault Aviation, including for the other members of the Falcon family such as the Falcon 5X, Falcon 7X, Falcon 900, Falcon 2000, and Falcon 50 models.



Thiago Silva works for Liebherr Aerospace Brasil Ltda., Guaratinguetá (Brazil), in the on-site support team at Embraer's headquarters.

Thiago Silva, Technical Support Specialist

Flying High

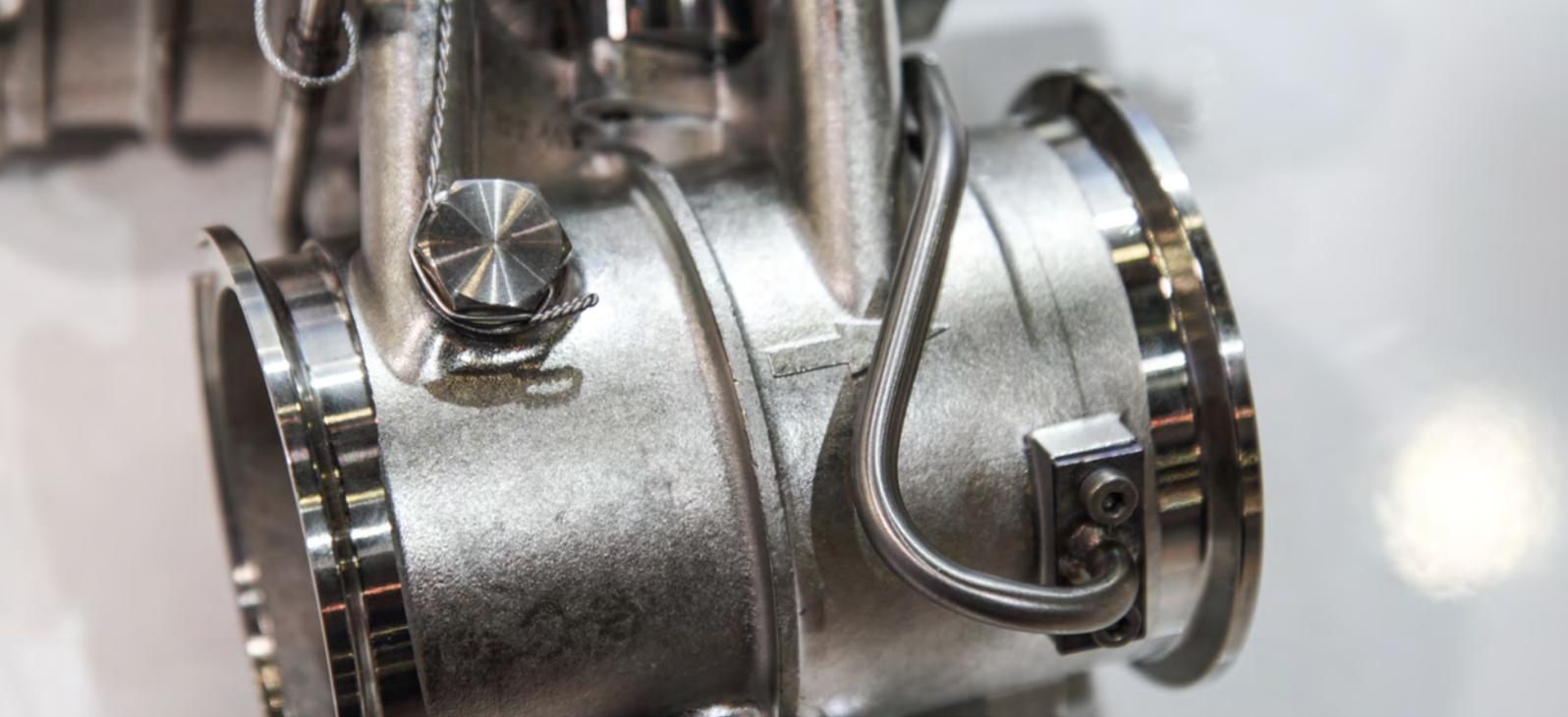
A passion for technology and a keen awareness of product quality and service are just some of the things that make Thiago Silva a very special service technician. Since 2011 the 27-year-old has been working for Liebherr Aerospace Brasil Ltda. in the on-site support team that provides assistance to customer Embraer at the aircraft company's headquarters in São José dos Campos (Brazil). Located approximately 80 km northeast of São Paulo, this is where the world's third largest manufacturer builds business jets, small and mid-sized passenger airplanes for regional routes and transport links, as well as other aircraft. Embraer has continued to grow steadily over the past few years and currently counts 70 international airlines among its customers, including United Airlines, British Airways and Lufthansa.

Liebherr-Aerospace has also noticed the increase in business activity as the number of aircraft rolling out of the assembly halls in São José dos Campos with Liebherr technology on board is on the rise. "Whenever technical questions arise concerning our systems and components, we work hand in hand with the engineers at Embraer", explains Silva.

Most Demanding Career Challenge to Date

Before Thiago Silva switched to his current position as a customer-facing technician for Embraer, he worked in the production facility of Liebherr Aerospace Brasil Ltda. in Guaratinguetá for four years. There, the mechanical technician became familiar with the product range and gained a great deal of practical experience that helps him in his present job.

Nevertheless, Silva still considers working as an on-site service technician for Embraer as the most demanding challenge in his career to date – not so much because of the technologies involved, which he is very adept at handling due to his expert skills. Even traveling 90 km to São José dos Campos each day is not a problem for him. Being required to speak English – this is what makes his job so demanding. Silva never had the chance to learn this language before joining Liebherr-Aerospace. So the company gave him the opportunity to acquire English language skills as well as to develop and grow further. "I have learned a tremendous amount over the last few years, and every day brings with it new challenges that I look forward to facing. For me, a dream has come true. I am proud to be part of the Liebherr family."



Technology

The More Electric Aircraft: Highly Energized

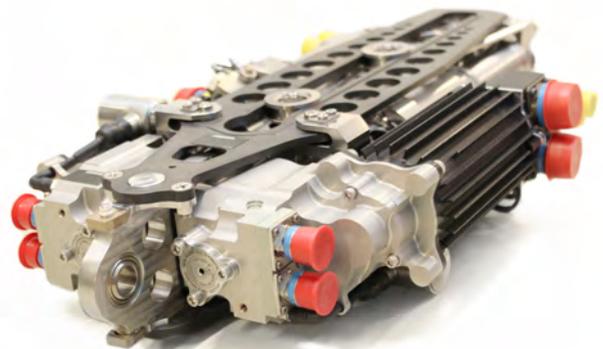
Electrical systems will play a key role in next-generation aircraft as they aim to replace the hydraulic systems used at present. The intention is to provide lighter, more efficient and lower-maintenance aircraft for cheaper, more environmentally friendly air transport. Liebherr-Aerospace is working hard to produce reliable, highly efficient electrical systems that will help get the More Electric Aircraft off the ground.

"Our objective is to find new system architectures for power generation and distribution on board an aircraft, and to develop on-board systems that use as little energy as possible," says Jan Uhlig, Director Electronic Products at Liebherr-Aerospace Lindenberg GmbH, Lindenberg (Germany). Hydraulic systems can already be replaced by electrical systems today, for example, for actuating landing gear systems, flight control surfaces or cargo doors.

These kinds of electro-mechanical actuators work extremely effectively because the electric motor's level of efficiency allows it to convert the electrical energy into more than 90% shaft power with minimum effort, which no other machine can achieve. Furthermore, electrical systems only require power whenever they are operated.

Levers for Greater Efficiency

To really take full advantage of the increased efficiency, the costs, weight and reliability of the electrical systems must also be optimized. At Liebherr, therefore, they have an ambitious plan to halve the current figures in terms of weight, volume and costs. The engineers are also placing high demands on the stability of the systems. Their aim is to double



Electro-mechanical actuator

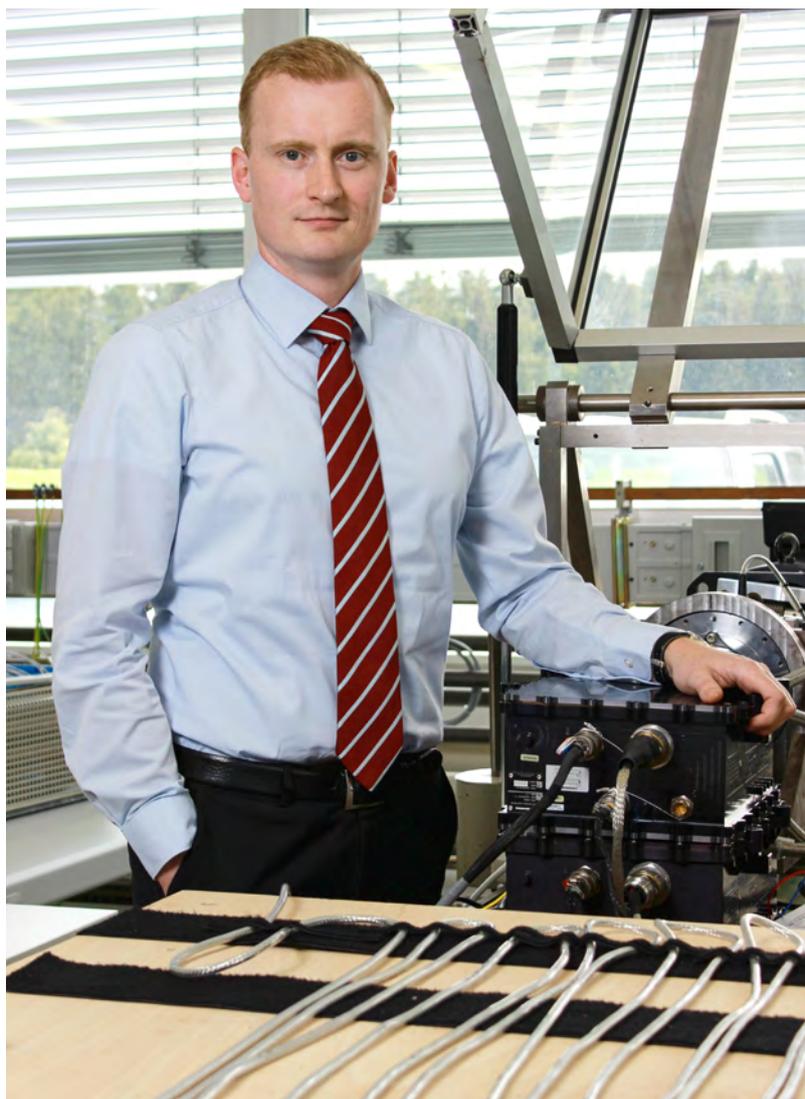
the average period of time between two potential failures – the so-called “meantime between failure”. There is also some leeway – although not much – concerning the efficiency of the electric motor and of the power electronics. Increased modularization, which allows individual components to be used for many different aircraft models, should help to halve development time.

“With regard to increased reliability and improved efficiency, we’re making excellent progress,” says Jan Uhlig. In a direct comparison of the costs involved, however, electro-mechanical actuators are still losing out against hydraulic ones. In a similar way to the combustion engine in cars, decades have been spent optimizing the hydraulics used in aircraft, whereas electrical systems are still in their infancy and incur high development outlay. “To reduce the costs, the market needs to be penetrated more deeply,” explains Uhlig. “So far, mainly small aircraft or helicopters have been fitted with electro-mechanical actuators.” The fact that electrical components are used to some extent, such as for actuating the spoilers on wings or for opening and closing cargo doors, is a start, but this also has its drawbacks: The hydraulic system still being on board, there are more electrical devices now. So the hybrid solution deployed in aircraft requires a more efficient power supply. Initially, therefore, the dual installation results in increased weight and higher maintenance.

Detailed Views and Overview Ensure Success

The specialists at Liebherr are taking a broadly based approach to optimizing individual system components. Uhlig and his colleagues are currently working on a “power core module” – the control center for the power electronics in an electric motor. To reduce their weight, the electrical components are made progressively lighter. However, the electronics themselves account for only half the weight; the other 50 % are in the housing that protects against vibrations and environmental impact. For that reason, the engineers are experimenting with carbon fibers and other alternative materials to provide the power core module with a cover that is light yet robust as possible.

The strategic aim of the More Electric Aircraft has long since gone beyond constantly improving individual components. The main challenge lies in identifying their dependencies and either utilizing or eliminating them. As they work, therefore, the engineers at Liebherr always keep a close eye on how individual subsystems interact. The electrical drive system includes the power electronics and the software that controls it, as well as the electric motor and the mechanics that convert the rotary motion of the electric motor into motion that operates an actuator. All this must dovetail harmoniously to ensure that optimization takes place not only at component level but also at system level. Consequently, a change may result, for example, in the motor weighing a couple of grams more, but on the upside, the power electronics are made considerably lighter. “That’s what makes this topic so interesting for us as a system supplier. It’s not just about the efficiency of individual components such as the electric motor or the power electronics, but also optimizing the entire electrical drive system,” says Jan Uhlig.



Jan Uhlig, Director Electronic Products at Liebherr-Aerospace Lindenberg GmbH, and his team are working on electrical systems for the next generation of aircraft.

The Liquid Skin Heat Exchanger in Flight Test

Engineers of Liebherr-Aerospace, Airbus and the National Aeronautics and Space Research Center of the Federal Republic of Germany (DLR) are cooperating in the European research program "Clean Sky" to find solutions to counteract the significantly increasing thermal loads and heat density in aircraft. The idea: Dissipate the heat through a so-called liquid skin heat exchanger developed by Liebherr-Aerospace with the help of liquid coolants.

Liebherr's specialists for air management systems have designed a liquid loop system to simulate thermal loads in the aircraft and to feed the liquid skin heat exchanger with coolant. Both, the liquid skin heat exchanger and the liquid loop system operate completely independent of other systems in the aircraft. For a practical test, both elements were integrated into a test aircraft of the type A320 provided by DLR.

Test Results Confirm Calculations

When integrating the aluminum heat exchanger prototype into the test aircraft, a number of parameters had to be taken into consideration – for example, the compatibility of interfaces and existing structures as well as flight safety. The engineers identified a panel of the fairing – which is also called skin – on the belly of the aircraft to be the best position for the liquid heat exchanger. This is how the liquid "skin" heat exchanger finally got its name.

The aim of the flight test taking place in September 2014, was to find out how



The innovative heat exchanger was tested on board DLR's A320.

the liquid skin heat exchanger would act under different real aerodynamic and thermodynamic conditions which appear through altitude and speed. The test results confirmed the pre-calculated performances.

Currently, Airbus, DLR and Liebherr-Aerospace experts are working on the report of the flight test. They can illustrate how the liquid skin heat exchanger can be further improved by using the data from the test flights. The prototype itself is used in a test rig for optimizing the electrical and thermal control. Moreover, Liebherr-Aerospace is working to improve the production process in order to enable serial production of the heat exchanger, and to reduce the weight of the system using composite materials.

Developed by Liebherr-Aerospace, the liquid skin heat exchanger completed two test flights with a duration of five hours each in September 2014. A maximal altitude of around 11,900 m was reached during the flights. The practical test was part of the European research program "Clean Sky". In this project, Airbus and the DLR were partners of Liebherr and were responsible for the integration of the prototype on board as well as the monitoring and evaluation of flight test data.

Guillaume Galzin, Expert for Air Management Systems

What Moves... Guillaume Galzin

How do you explain to your friends what you do?

It's not as difficult as you might think. I work on electric air management systems for the next generation of aircraft, the so-called "More Electric Aircraft", in a Research and Technology environment. For this field we develop new architectures and control solutions and specify new products in order to optimize energy consumption and reduce fuel burn. I work as a GETI project manager and system architect expert. GETI is a French abbreviation and actually stands for "electric and thermal power management".

Have you always had a passion for airplanes?

Yes, I've been interested in aviation for a long time. For example, I enjoyed building radio control gliders and piloting them during mountain hikes in the past.

More and more electric systems are being used in planes. What do you think the greatest achievement is here?

Electric systems, which are more flexible, allow a great optimization of energy along mission profile of the aircraft. They also enable efficient monitoring and a large reconfiguration capability ensuring the safety and availability of aircraft.

What do you think are the greatest challenges in your department right now or in the near future?

First, studies on aircraft architectures have to be conducted to identify the key technologies that need to be developed for next-generation aircraft, especially in terms of electrical power conversion, cooling systems and cabin air quality.

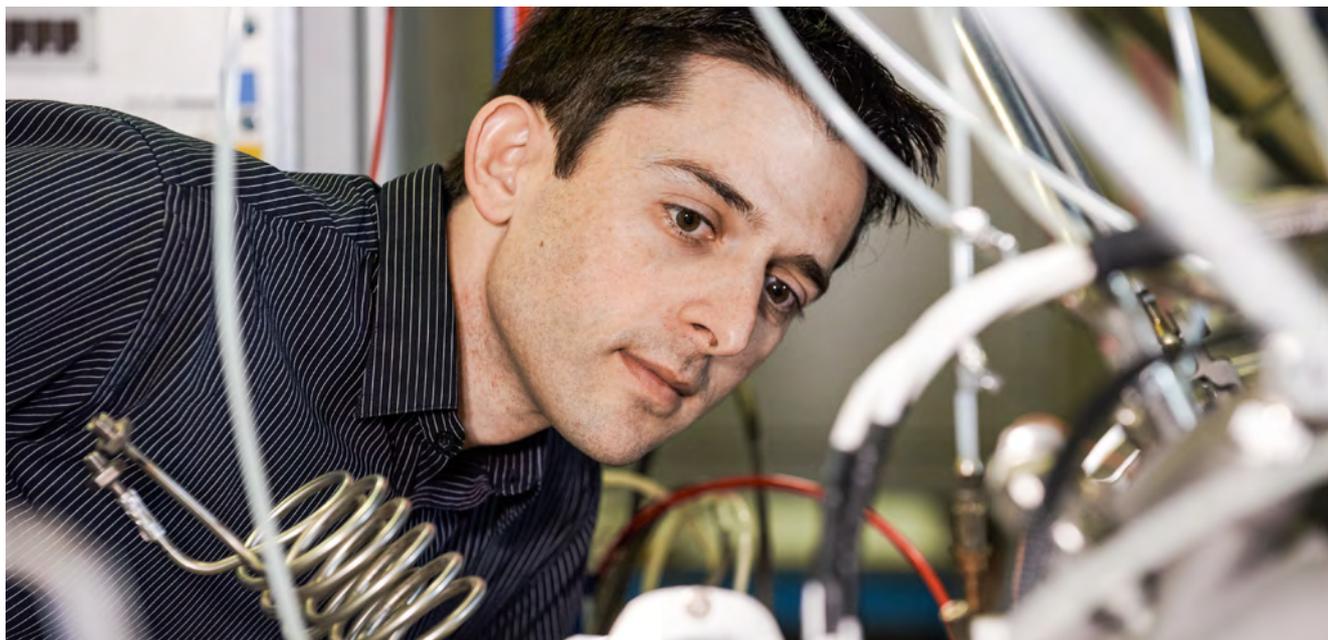
Also, in the next months electrical air conditioning demonstrators on A320 and ATR72 aircraft are planned to be tested in flight for the European project "Clean Sky". These will be key milestones demonstrating the maturity of electrical technology.

What is special about your job? What motivates you?

The system approach enables me to interact with experts from several fields including performance calculations, safety analysis, product design and others. Our aim is to find the best solution for aircraft.

Another motivation is that we are able to validate specifically by testing what we previously designed, therefore being able to follow all system development phases.

Finally, developing new technology for next-generation aircraft generally is a very motivating framework, where innovation sources often originate from crossroads between several technical domains, such as electric and thermal for instance. For this reason, working together as a team is essential!



Guillaume Galzin is pushing the development of electric air management systems at Liebherr-Aerospace Toulouse SAS, Toulouse (France).



Sites

The Gearbox Specialists at Lake Constance

High-performance gearboxes and components for flight control and actuation systems as used in helicopters and aircraft are the core competencies of Liebherr-Aerospace's German production facility in Friedrichshafen. The site at Lake Constance has been part of Liebherr-Aerospace Lindenberg GmbH since 1999, which is headquartered in nearby Lindenberg. It was at this place steeped in the history of German aviation – where the legendary zeppelin airship was unveiled – that the company began to manufacture bevel gears and precision gear wheels and to develop helicopter gearboxes.

The significance that the Friedrichshafen production facility has for Liebherr-Aerospace is reflected by the system supplier's high commitment. Over the past 26 years, more than 50 million € have been invested in the plant and its machinery and equipment. In the first two years alone, an additional 100 employees were brought on staff to assist the 130 individuals originally hired. Currently, the site employs more than 350 women and

men in the production, planning, quality assurance, development and technology divisions. All of them work on a number of systems and components for programs of aircraft manufacturers from all around the world, including the high-lift system used in the Airbus A330, the gearbox for the auxiliary power unit of the NH90 helicopter, the gearbox used in the flap actuation systems of the Embraer E-Jet family, the gearing for the gearbox fitted to the H135 helicopter and the tail rotor gearboxes for the H145 and H160 helicopters, to name just a few examples.

To this end, the production facility collaborates closely with the plant in Lindenberg, especially when it comes to the work processes associated with technical gearing systems. When the production ramp-up for new programs starts in Lindenberg, the colleagues in Friedrichshafen are also required to stretch their limits further, at least when it comes to manufacturing flight control and actuation systems.

The Friedrichshafen plant, which has a production floorspace of approximately 6,000 m², is also a direct supplier to Airbus Helicopters, ZF Luftfahrttechnik, and Rolls-Royce Germany, for it disposes of all core technologies required and can manufacture many of the products it offers – from the smallest gear to complete gearboxes – entirely in house.

A Monumental Task

Labor-intensive – that is how the next years at Liebherr-Aerospace Lindenberg GmbH in Lindenberg (Germany) will definitely be. The reason is that, in addition to the numerous existing programs, production of the new landing gear and flight control programs is now also being gradually ramped up. A major challenge for production and development alike.

But the production ramp-up is also a monumental task for the company as a whole because it needs to be accomplished at the same time as the site's extensive expansion work. Planning began at a very early stage, even when the system supplier had contracts in prospect for new aircraft programs, which the manufacturers have just started to ramp up. In 2011, the decision was taken to expand the plant with the aim of increasing the long-term production capacity and meeting the growing customer demand.

Confidence is high in Lindenberg. Work is progressing as scheduled, so the team responsible for the plant expansion is always one step ahead of the ramp-up phase. Internal processes are also being continuously optimized to ensure that the individual workflows run smoothly. In the new assembly hall, for example, the aisles are so wide that all large components can be transported easily.

From A as in Airbus and AgustaWestland, through B as in Boeing and Bombardier, to S as in Sukhoi – Liebherr-Aerospace

Lindenberg GmbH delivers its systems and components to aircraft manufacturers throughout the world. Its portfolio includes landing gear as well as flight control and actuation systems for all kinds of aircraft. It has been manufacturing some products, such as the landing gear system for the Embraer E170 and E190, for more than 10 years, and others, like the high-lift system used in the Airbus A320, for over 20 years. New additions that are now “ready for take-off” include the landing gear for the Airbus A350, the COMAC C919 and the Bombardier CSeries, as well as the high-lift system for the Embraer E2.

Comprising some 2,500 individual parts, the 4.5-meter-high nose landing gear of the A350 was one of the new products to go into manufacture at the Lindenberg plant. It is the largest ever landing gear to be produced there. Progress is also being made in terms of flight controls. The first systems have already been produced for the new Embraer E2 and are currently undergoing tests and qualification. And the machines are running round the clock not only for these two programs.

The next production ramp-up coming up is that of the C919 landing gear system. The Lindenberg employees are currently working hard to manufacture and assemble the parts that are now coming out of development, because the first delivery to the customer COMAC in China is planned for summer 2015.



A landing gear system is getting ready to be tested at Liebherr-Aerospace's site in Lindenberg.

Set for the Future: the Infrastructure in Lindenberg

Work on expanding Liebherr-Aerospace's Lindenberg location in the south of Germany is progressing steadily and on schedule. The project numbers speak for themselves: The plant's area will be enlarged gradually from its original 127,000 m² to around 160,000 m² in 2018. The production floorspace, which has already been increased by 10,000 m² after initial construction work and now totals 65,000 m², will ultimately cover 75,000 m². Creating space and new buildings is one part of the project. The other involves structuring this expansion. To ensure that absolutely nothing is left to chance here either, the plant planning and infrastructure division at Liebherr-Aerospace Lindenberg GmbH has simulated and assessed various versions of the expansion. An essential requirement of this was that the work should not impede ongoing operations.

The first buildings were already completed by late 2013. One of the two halls now houses the logistics division and flight control system assembly. The other hall accommodates the landing gear assembly and the on-site fire department. Relocating the assembly workstations from the old premises to the new ones presented a major challenge. Production had to continue uninterrupted, but the company wanted to use this opportunity to optimize the individual assembly lines while they were being dismantled and reassembled.

The project was completed on schedule, thus ensuring that the infrastructure is now perfectly geared to handling the forthcoming ramp-ups in the production of flight control and actuation systems as well as landing gear.

The plant planning and infrastructure division employees also developed a new logistics concept. In view of the increasing order volumes and growing customer demands regarding delivery times, some 1,230 containers per hour can now be loaded into and out of the new small parts warehouse, which provides space for up to 45,000 containers, using four fully automated rack operators. In the adjacent large parts warehouse, which offers space for 7,000 Euro pallets, around 230 pallets per hour can be transferred using three rack operators.

However, the expansion project at Liebherr-Aerospace Lindenberg GmbH does not end there. The new parking facility is due for completion in summer 2015 and will provide space for over 1,400 cars. The old production halls are also being renovated and converted so that they can also be used for production in the future. And last but not least, the surface treatment division will undergo expansion. Naturally, this will all be achieved with minimum impact on ongoing production.



The new assembly hall for flight control systems at Liebherr-Aerospace Lindenberg GmbH



Well Prepared from a Logistics Perspective

The new logistics center of Liebherr-Aerospace Toulouse SAS celebrated its grand opening in mid-September, 2014. The infrastructure at the site in Toulouse (France) was expanded primarily to keep pace with market growth and increasing customer expectations of the system supplier's performance.

Liebherr invested a total of around 11.5 Mio. € in the building, which boasts 6,300 m² of floor space and houses all

functions of the supply chain – from incoming goods receipt and inspection, to storage and warehousing, through to outgoing goods inspection and shipping. Offices for the purchasing department, supplier quality control and other logistical support functions are also accommodated in the new facility.

Leveraging state-of-the-art technology, the logistics center can process approximately 130,000 components and several hundred thousand spare parts

every year, whereby quality, tracking and traceability, and on-time delivery are key.

As environmental compatibility also played a role in the construction, special materials were used for insulation and solar panels installed to heat the water used on a daily basis.

Keeping the Environment in Mind

As a supplier of highly sophisticated technical systems, Liebherr-Aerospace continually invests not only in research and development, but also in production engineering. For this reason, the company has set up a new, state-of-the-art surface treatment installation in its plant in Toulouse (France). As a result, Liebherr-Aerospace Toulouse SAS

is now ideally prepared to meet future production requirements.

The facility was designed to serve future orders while at the same time conserving resources and maximizing environmental compatibility. The new surface treatment techniques employed therefore reduce process water requirements by up to 70%.

Solvents are no longer used to wash the components treated as they have been replaced with cleansing agents. Moreover, the surface treatment installation is connected to an innovative water treatment facility installed in the basement of the production building. The new surface treatment facility is verifiable proof that Liebherr takes its obligation to improve the eco balance of its operations seriously.



Customer Service

Liebherr-Aerospace Extends Its Range of Services in Dubai and Shanghai

Aircraft belong in the air and not on the ground, which is why expediting spare parts, components, and tools to airlines is one of the key challenges in supporting airlines. In pursuit of extending its range of customer services and further improving support for carriers, Liebherr-Aerospace has expanded its service network by adding a logistics center in Dubai (UAE) and a maintenance facility in Shanghai (China).



Blessed with sunny weather and a balmy 24 °C, Liebherr-Aerospace celebrated the opening of its new logistics center at the Liebherr Middle East FZE site in the Jebel Ali Free Zone in Dubai

F.I.t.r.:
D. Seksaoui (General Manager, Liebherr-Aerospace Dubai), R. Russier (Managing Director Material Management, Qatar Airways), C. Thoyer-Rozat (Executive Vice President Customer Services, Liebherr-Aerospace), A. Osman (Senior Vice President Material Management, Emirates Airlines), M. Al Sirhan (Vice President Engineering Technical Services, Emirates Airlines), and D. Granger (CEO OEMServices)

on February 3, 2015. The center offers over 1,000 m² to accommodate several storage facilities, a goods receipt and delivery area, and offices for logging and administering parts and replacement equipment. All storage and logistics activities carried out at the Dubai site are managed by OEMServices, which was jointly founded by suppliers Diehl Aerospace, Liebherr-Aerospace, Thales Avionics, and Zodiac Aerospace to provide aircraft operators with component services.

The Middle East is among the regions where airlines are undergoing particularly rapid growth. Reason enough for Liebherr-Aerospace to make a lasting impression in the aviation service industry there by exploiting the possibilities of its new logistics center.

Certified: ARJ21 Regional Jet Equipped with Technology from Liebherr

The Civil Aviation Administration of China (CAAC) certified the ARJ21 regional jet from Chinese aircraft manufacturer COMAC at the beginning of this year. This certification also testifies to Liebherr-Aerospace's high-quality work as the system supplier is responsible for several of the components and systems installed in the airplane.

The integrated air management system and the high and low-pressure ducting are provided by Liebherr-Aerospace Toulouse SAS, the center of excellence for air management systems of the Liebherr Group based in Toulouse (France). The landing gear system – including the brake system, wheels, and tires – was developed by the specialists at Liebherr-Aerospace Lindenberg GmbH. The center of excellence for flight control and actuation systems as well as landing gear systems, which is based in Lindenberg in southern Germany, also manufactures these products.

Services for Aircraft Manufacturers and Operators

The ARJ21 regional jet will be used to transport passengers for Chengdu Airlines and other carriers in China. Liebherr-Aerospace will provide manufacturer COMAC and airlines with parts and a range of services from the maintenance facility it opened in Shanghai in 2014. This includes technical support for the Liebherr systems and components fitted in the airplane during the entire life cycle of the ARJ21.

Service in No Time in Shanghai

Just a few weeks earlier, in November 2014, the new Liebherr-Aerospace China maintenance facility began operations in Shanghai. Strategically located in the vicinity of the Shanghai Pudong Airport, the service center not only offers maintenance services, but also OEM-quality components to airlines operating from mainland China. The employees of Liebherr-Aerospace China were recruited locally and received training at the OEM production centers of Liebherr-Aerospace Toulouse SAS in Toulouse (France) as well as Liebherr-Aerospace Lindenberg GmbH in Lindenberg (Germany).

Moreover, Liebherr-Aerospace will offer the airlines maintenance training courses for their employees.



© COMAC

Airbus 350 XWB Flies with Liebherr-Aerospace Technology on Board

December 2014 marked the delivery of the first Airbus 350 XWB long-range aircraft to Qatar Airways headquartered in Doha in the Emirate of Qatar. One month later, the twin-engine commercial jet entered service. On board the aircraft are many components and systems from Liebherr-Aerospace, including the nose landing gear, the slat actuation system and various key elements of the flaps.

All of this equipment was developed and manufactured by the specialists at Liebherr-Aerospace Lindenberg GmbH. The systems and components incorporate state-of-the-art technology for the next generation of long-range aircraft; they are

characterized by lightweight materials and coatings as well as a high level of integration of power electronics with precision mechanicals and high-pressure hydraulics. In this project, the engineers at Liebherr-Aerospace leveraged the vast experience the company had gained by participating in all Airbus programs.

The system supplier also offers support for its components and systems installed in the Airbus A350 WXB across the entire life cycle of the aircraft. At several locations around the world, customer service representatives from Liebherr-Aerospace assist aircraft manufacturer Airbus and operators alike by ensuring that parts, services, and technical support are available at all times.



© Airbus

GoJet Airlines Extends Contract

GoJet Airlines has extended its maintenance contract with Liebherr-Aerospace for an additional five years. The agreement covers the components of the integrated air management systems on board its Bombardier CRJ700 and CRJ900 regional jets. The carrier headquartered in Bridgeton, Missouri (USA) has been working with the system supplier since 2005. "We are pleased that GoJet values the service Liebherr-Aerospace has offered for the aircraft over the last ten years", affirms Alex Vlieland, President of Liebherr Aerospace Saline, Inc. in Michigan (USA). "What's even more important, however, is that the airline decided to extend its contract with us."

The repair work will be carried out by service technicians at Liebherr Aerospace Saline, Inc. and Liebherr-Aerospace Toulouse SAS. The company based in Toulouse (France) also manufactures the air management systems for the CRJ700 and CRJ900. The contract not only encompasses comprehensive service and support warranties, but also ensures access to a managed supply of exchange components, which the airline requires in its daily operations.

Lindenberg and Saline Chosen to Overhaul E-Jet Landing Gear

Two airlines, one job: Estonian Air and TAME Línea Aérea del Ecuador have commissioned Liebherr-Aerospace to overhaul the landing gear systems of their Embraer E-Jets.

Estonian Air, the flagship airline of Estonia, currently operates four Embraer E170 aircraft, each of which must be overhauled every 30,000 flight cycles, or 12 years, according to the requirements defined by the Maintenance Review Board. The Embraer E190 aircraft operated by Ecuador's TAME airline, on the other hand, must be serviced after 20,000 cycles, or 10 years. What both airlines have in common is their decision to commission Liebherr-Aerospace to overhaul the nose and main landing gear systems of their E-Jets. And for good reason, since the entire landing gear system including the braking system for the E170, E175, E190 and E195 jets were designed and manufactured by Liebherr-Aerospace Lindenberg GmbH in Lindenberg (Germany). Liebherr can therefore fully leverage its comprehensive know-how as a system developer to meet the exact requirements for carrying out the service work defined in these orders.

The landing gear systems of the E170 jets are maintained by specialists in Lindenberg, while work on the E190 landing

gear is performed in the Liebherr-Aerospace service center located in Saline, Michigan (USA). To ensure that the airlines can continue using their E-Jets while the maintenance work is in progress, Liebherr-Aerospace – being the OEM and system integrator – provides them with exchange systems. These landing gear systems are then installed and used on the airplanes until the next overhaul operation is scheduled to be carried out. Once all overhaul activities are completed for the landing gear, the systems will be stored in the Global Access Pool. Liebherr-Aerospace will then also offer these systems as exchange units to other customers that select the company to overhaul their E-Jet landing gear systems.

The work on the E170 and E190 landing gear systems will allow the engineers and technicians at Liebherr-Aerospace to gain valuable insight into the operative performance of the system. Orders such as those from Estonian Air and TAME also help the company further optimize the engineering that goes into the landing gear and the logistics behind maintenance operations, whereby the primary objective is to be well prepared to handle the large number of E-Jet overhauls the future has in store.

Embraer Honors the "Supplier of the Year"

Liebherr-Aerospace not only developed the entire landing gear system for Embraer's E-Jet family, but also manufactures the system and offers comprehensive customer service to carriers operating these aircraft. In recognition of Liebherr-Aerospace's exceptional performance with respect to delivery, quality and flexibility, the Brazilian aircraft manufacturer presented its longstanding partner with the "Supplier of the Year" award in the category of "Mechanical Systems".



© Embraer

Greg Hoevermeyer, Quality Supervisor

Proven Quality

As Quality Supervisor at Liebherr Aerospace Saline, Inc. in Michigan, USA, you and your team work to ensure that repair and maintenance work is carried out correctly...

...and that all materials and parts pass final inspection. What may initially seem to be a somewhat uneventful task actually forms a key component of our customer service philosophy. It goes without saying that one of the main factors driving the success of any airline is that of aircraft maintenance. Because only a fleet that is properly serviced can ensure safe, punctual, and cost-efficient operation. This, in turn, means that the services offered by Liebherr-Aerospace need to meet the highest possible standards of quality and performance.

As an "aviation guy", you are the one who must know about that...

Correct. I have worked in the aviation industry for my entire professional career. Right after I graduated from high school, I enlisted in the U.S. Marine Corps and served the organization for four years by maintaining and repairing their airplanes. I then attended Northrup University to acquire my license as a certified aviation mechanic and moved on to work at three different airlines. You can definitely say that I've been around...

What brought you to Liebherr-Aerospace in Saline?

I was born and raised in Dundee, a town that is right down the road from Saline. When I was serving in the military, I had the opportunity to see the world and was stationed in Japan, Korea, and in the Philippines. In 2011, when the Quality Manager employed by Liebherr Aerospace Saline, Inc. at the time presented me with an offer to become the new Quality Supervisor, I didn't waste any time in accepting. This decision was what allowed me to go back to my professional roots, so to speak, as well as remain with my family.

Would it be going too far to say that flying is not just your job, but your passion?

Absolutely, without question. I obtained my pilot's license at the tender age of 17 and am still fascinated when I see an aircraft taking off or landing. And I also feel right at home on an airplane, especially if I know that Liebherr components are on board.

Saline maintains an active city partnership program with Lindenberg in Germany's Allgäu region. Have you ever had the opportunity to visit Liebherr-Aerospace in Germany?

No, not yet, but I will certainly do so at some point. After all, my father is originally from Dettingen an der Erms in Baden-Württemberg.



Greg Hoevermeyer makes sure that maintenance work carried out at Liebherr Aerospace Saline, Inc., Saline, Michigan (USA), meets the highest quality standards.

Service Center in Singapore Recognized for Commitment

Education is a very valuable commodity, and specialists play a key role in the success of international companies such as Liebherr. The managers at Liebherr-Aerospace Singapore know this all too well, which is why the service center in Singapore has been supporting the internship program of the engineering department at Republic Polytechnic, the technical college of the island country, since April 2012. In January 2015, this commitment was honored by the director of the department, Dr. Wang Jianguo, who presented an award.

The program reaches out to aerospace technology students, whose curriculum requires them to complete a five-month internship to get an idea of what working in the sector is like. The internship should also make it easier for students to be hired after they finish their degree at Republic Polytechnic.

Insights into Jobs and the Industry

At Liebherr-Aerospace Singapore, future engineers gain comprehensive insights into potential career paths and the

industry at large. The service center is the second customer service facility managed by the system supplier in the Asia-Pacific besides Liebherr-Aerospace China. Operating from Singapore, Liebherr provides carriers in the region with a wide variety of customer services for products that are manufactured by Liebherr-Aerospace Lindenberg GmbH and Liebherr-Aerospace Toulouse SAS. Actuators for flight control systems, landing gear components, air conditioning systems, cabin pressure control systems, bleed air systems and many more systems and components are not only repaired and overhauled in the service facility, but also tested and certified. All services rendered are adapted to meet the specific needs and requirements of customers. Liebherr-Aerospace Singapore also sells, leases, and exchanges equipment and also offers training courses for service technicians.



The team of Liebherr-Aerospace Singapore

Participation in Programs

Airbus

Airbus A300-600

- Cabin Pressure Control System
- High-Lift System
- Krüger Actuator
- Latching Actuator
- Landing Gear Door Actuators
- Nose Landing Gear
- Upper Cargo Door Actuator

Airbus A310

- Cabin Pressure Control System
- High-Lift System
- Krüger Actuator
- Nose Landing Gear

Airbus Single Aisle Family ceo/neo

- Air Chillers
- Air Conditioning System
- Avionics Cooling System
- Cargo Heating System
- Engine Bleed Air System
- Fuel Tank Inerting System – CSAS (except A319CJ)
- High-Lift System
- High Pressure/Power Transfer Unit Manifolds
- Rudder Servo Control
- Safety Valve

Airbus Long Range Family ceo/neo

- Air Chillers
- Air Conditioning System
- Auxiliary Power Unit Gearbox (Long Range)
- Avionics Cooling System
- Engine Bleed Air System
- Cargo Heating System
- Cargo Door Actuator
- Crew Rest Humidification System
- Fuel Tank Inerting System – CSAS
- High-Lift System
- Landing Gear Door Actuation
- Rudder Servo Control (Airbus A340 Enhanced)
- Spoiler Actuation
- Spring Strut

Airbus A350 XWB

- Flap Active Differential Gearbox
- Load Sensing Drive Strut
- Moving Damper
- Nose Landing Gear
- Slat Actuation

Airbus A380

- Air/Hydraulics Cooling System
- Cargo Heating System
- Engine Bleed Air System
- High-Lift System
- Pneumatic Distribution System
- Reservoir Air Supply Cooler
- Spoiler Actuation
- Supplemental Cooling System

Airbus Defence and Space

A400M

- Aileron, Elevator, Rudder Servo Control
- Air Conditioning System
- Cabin Pressure Control System
- Door Ramp Actuation System
- Engine Bleed Air System
- Fuel Tank Inerting System – CSAS Components
- Nacelle Anti-Ice System
- Power Control Unit
- Spoiler Servo Control
- Ventilation Control System
- Wing Anti-Ice Valves
- Wing Tip Brake

Eurofighter/Typhoon

- Airbrake Actuator Servo Control
- AMAD Gearbox
- Engine Driven Hydraulic Pump
- Filter Package Units
- Nose Landing Gear
- Nose Landing Gear Retraction Actuator
- Main Landing Gear Side Stays
- Primary Flight Control Actuators – Fly-by-Wire Technology

MRTT ARBS

- Ruddervator Control System

Cobham

Cobham Mission Equipment

Pod

- Hose Drum Drive System

Airbus Helicopters

AS350/355 Ecureuil

- Environmental Control System Components
- Gears for Main Gearbox

AS365

- Environmental Control System

BK117

- Gears for Power Transmission Gearboxes (ZFL)
- Hydraulic Power Supply
- Main- and Tail Rotor Servo Controls

H120

- Environmental Control System Components

H130

- Air Conditioning System

H135 / H135M

- Gears for Power Transmission Gearboxes (ZFL)
- Hydraulic Power Supply
- Main- and Tail Rotor Servo Controls

H145

- Gears for Power Transmission Gearboxes (ZFL)
- Hydraulic Power Supply
- Main and Tail Rotor Servo Controls
- Tail Gearbox

H160

- Environmental Control System Components
- Main- and Tail Rotor Servo Controls
- Tail Rotor Gearbox

H175

- Environmental Control System Components

H225 / H225M

- Environmental Control System Components
- Heating System

Airbus Helicopters

NH90

- Auxiliary Power Unit Gearbox
- Fly-by-Wire Main- and Tail Rotor Servo Controls
- Environmental Control System Components

Tiger

- Gears for Tail Gearbox (ZFL)
- Air Conditioning System
- Main- and Tail Rotor Servo Controls
- Tail Landing Gear

UH-72A Lakota LUH

- Gears for Power Transmission Gearboxes (ZFL)
- Hydraulic Valveblock/Reservoir
- Main- and Tail Rotor Servo Controls

Alenia

C27-J

- MELTEM III-MMI Auxiliary Cooling System
- MELTEM III-MMI Environmental Control Unit

M-346

- Main Landing Gear System
- Nose Landing Gear System
- Nose Wheel Steering System

Antonov

AN-74 / AN-140

- Cabin Pressure Control System

AN-148 / AN-158

- Integrated Air Management System

AN-178 Prototype

- Integrated Air Management System

ATR

ATR 42/72

- Cabin Pressure Control System
- Anti-Ice Valves

AgustaWestland

AW109

- Environmental Control System

AW139

- Environmental Control System
- Landing Gear System

AW149

- Environmental Control System
- Fly-by-Wire Main and Tail Rotor Actuators
- Landing Gear System

AW169

- Environmental Control System

AW189

- Environmental Control System
- Fly-by-Wire Main and Tail Rotor Actuators
- Landing Gear System

T129

- Environmental Control System

AVIC HAIG

AC 312

- Air Conditioning System

Boeing

B747-8

- Air Conditioning System
- Engine Bleed Air System

B767 Tanker

- Fuel Tank Inerting Valves

B777-200LR

- Auxiliary Tank Pressurization System

B777X

- Folding Wing Tip Actuation

Bombardier Aerospace

Challenger 300/350

- Flap System
- High and Low Pressure Ducting
- Integrated Air Management System

CRJ700/900

- Integrated Air Management System
- Low Pressure Ducting

CRJ1000

- Command-by-Wire Rudder Control System
- Integrated Air Management System
- Low Pressure Ducting

CSeries

- Integrated Air Management System
- Landing Gear System

Dash8-400

- Cabin Pressure Control System

Global Express

- Cabin Air Humidification System
- Integrated Air Management System
- Nose Landing Gear Shock Strut

G5000

- Cabin Air Humidification System
- Integrated Air Management System
- Nose Landing Gear Shock Strut

G6000 / G7000 / G8000

- Integrated Air Management System

Learjet85

- Flap System
- Integrated Air Management System

COMAC

ARJ21

- Integrated Air Management System
- Landing Gear System incl. Braking System, Wheels and Tires
- High and Low Pressure Ducting

C919

- Integrated Air Management System
- Landing Gear System
- High and Low Pressure Ducting

Daher-Socata

TBM850/900

- Air Conditioning System
- Cabin Pressure Control System
- Engine Bleed Air System

Dassault Aviation

Falcon 50EX/900/2000/2000EX

- Air Conditioning System
- Cabin Pressure Control System
- Engine Bleed Air System

Falcon 5X

- Integrated Air Management System
- Cabin Air Humidification System

Falcon 7X / 8X

- Cabin Air Humidification System
- Engine Bleed Air System

Mirage 2000

- Air Conditioning System
- Cabin Pressure Control System
- Engine Bleed Air System

Rafale

- Air Conditioning Components
- Cabin Pressure Control System
- Engine Bleed Air System

Embraer

ALX

- Cabin Pressure Control System

E1

- Landing Gear System incl. Braking System, Wheels and Tires

E2

- Nose Wheel Steering Control Module
- High-Lift System
- Integrated Air Management System

Embraer 135/145/Legacy 650

- Cabin Pressure Control System
- Flap System
- Nose Landing Gear

Embraer Lineage

- Landing Gear System incl. Braking System, Wheels and Tires

KC-390

- Air Conditioning System
- Cabin Pressure Control System
- Engine Bleed Air Valves
- Wing Anti Ice Valves

FAdeA

IA-63 Pampa III

- Air Conditioning-, Heating- and Ventilation Components
- High-Lift Actuation Components
- Primary Flight Control Components
- Landing Gear Components

HAL

ALH

- Heating and Ventilation Systems

Dornier 228

- Flap System
- Landing Gear Actuators
- Nose Wheel Steering System

HJT 36

- Cabin Pressure Control System

Jaguar

- Cabin Pressure Control System

LCA

- Cabin Pressure Control System

Hawker Beechcraft

750/850XP/900XP

- Cabin Pressure Control System

IAI

Elta

- Environmental Control Unit

G200

- Cabin Pressure Control System Components
- High-Lift System

Korean Aerospace Industries

KHP

- Cabin Pressure Control System Components

KT-1

- Cabin Pressure Control System
- Engine Bleed Air System
- Ventilation Control System

Northrop Grumman

Litening

- Environmental Control Unit for POD

Rafael

Litening

- Environmental Control Unit for POD

RUAG Aerospace

Dornier 228 New Generation

- Flap System
- Landing Gear Actuators
- Nose Wheel Steering System

Snecma

Silvercrest

- Engine Bleed Air System

Sukhoi Civil Aircraft Company

SuperJet 100

- Fly-by-Wire Flight Control System
- Fuel Tank Inerting System – CSAS
- Integrated Air Management System

Thales

Damocles

- Environmental Control Unit for POD

RECO NG

- Environmental Control Unit for POD

MELTEM II

- Environmental Control Unit



Liebherr-Transportation Systems

“Cool” Batteries for Nanjing’s Trams

The Chinese metropolis of Nanjing with its subtropical climate as well as Wuhan and Chongqing are collectively known as the “Three Furnaces” along the Yangtze river. With average temperatures of 28 °C during the summer months, the eco balance of public transport in the densely populated city plays a critical role.

This is why Nanjing increasingly relies on trams that operate without using overhead power lines. The new vehicles that are to operate in the city’s rail network will feature PRIMOVE® inductive battery systems from Bombardier. These systems allow the trams to largely run without overhead power lines as the lithium-ion batteries integrated in the vehicles are charged during normal operation, that is when the vehicles accelerate or stop at the stations.

Bombardier commissioned Liebherr-Transportation Systems to supply reliable cooling systems for the PRIMOVE® drives. These systems ensure that the lithium-ion batteries always operate within an optimal temperature range. This not only increases the service life of the batteries, but also their efficiency. For this reason, both Bombardier and Liebherr play a key role in substantially improving the eco balance of Nanjing.

Liebherr manufactures the cooling systems in its plant in Korneuburg (Austria). Together with Bombardier’s drive units, the systems are then shipped to rail vehicle manufacturer China South Locomotive and Rolling Stock Corporation Limited in Puzhen, (China) for final assembly.

CSR Orders HVAC Systems from Liebherr

Chinese train manufacturer CSR Sifang Locomotive & Rolling Stock has decided to outfit the passenger compartments and driver cabins of its trains with HVAC (heating, ventilation and air conditioning) systems from Zhejiang Liebherr Zhongche Transportation Systems Co., Ltd. Hence, the joint venture of Liebherr-Transportation Systems GmbH & Co. KG and Guangzhou Zhongche Railway Vehicles Equipment Joint-Stock Co., Ltd., which is based in Zhejiang (China), will supply CSR with a total of 540 HVAC systems to be installed on train roofs. By the end of 2015, 28 new subway trains will have been

equipped with the units, and another 17 trains, which will serve metro line 6 in the city of Tianjin, will be outfitted with HVACs from 2018 onwards. This line will link the Dabizhuang and Liqizhuang stations.

Zhejiang Liebherr Zhongche Transportation Systems Co., Ltd. has already provided air conditioning systems for the subways operating in seven Chinese cities, and the new order strengthens the company’s position as a supplier of air conditioning systems in the Chinese market.

New Service for Split Systems

Rhein-Neckar-Verkehr (RNV) GmbH, headquartered in Mannheim (Germany), has selected Liebherr-Transportation Systems to modernize 70 split systems. These systems are fitted to the driver's cabins of the GTN 6/8 trams the transportation company uses to serve its rail network in the Rhein-Neckar metropolitan area. A split system comprises an air treatment unit and an air conditioning unit. The order not only encompasses modernizing the split systems, but also cleaning the ventilation ducts and aluminum flex pipes –

a new service Liebherr offered for the first time. All work to this end is carried out by the specialists at Liebherr's plant in Korneuburg (Austria).

The contract from RNV has subsequently led to Liebherr-Transportation Systems expanding its portfolio for the aftermarket. So now, the company is able to also offer other customers professional duct cleaning services in addition to overhauling and modernizing their air conditioning systems.

Environmentally Friendly Air Conditioning Systems for the First Series of the ICE 3

Liebherr's air cycle air conditioning systems have proven themselves many times over in the second series of ICE 3 trains operated by Deutsche Bahn (DB). At the end of 2014, Liebherr-Transportation Systems was selected by DB Fernverkehr AG to equip a multiple-unit train of the first series of ICE 3 trains with air cycle systems of the latest design.

Specialists at Liebherr-Transportation Systems developed this system in close collaboration with DB experts. By the end of February 2015, the jointly designed system successfully passed the first article inspection. In March, Liebherr delivered its first air cycle system on time for an eight-car test train. The new system was installed by DB in Nuremberg (Germany), and the prototype is undergoing a 12-month testing phase. DB will then decide on converting all 53 ICE 3 trains of the first series as part of a redesign program scheduled for 2016.

This recent order from DB confirms the company's confidence in the cold-air systems from Liebherr, which are based on absolutely environmentally friendly technology: process air is drawn in from the surroundings and expanded with an electrically powered cooling turbine. The resulting reduction in pressure effects a simultaneous reduction in temperature. An air heat exchanger is used to draw energy from the inflowing air, which is then fed into the passenger

compartment. In the next step, the process air in the open circuit of the cold-air system is re-compressed to ambient pressure and then released to the outside. The inherent benefits of this air conditioning system are that it consists of few components and is therefore light in weight as well as easy and inexpensive to maintain. Moreover, the air cycle system features low operating costs and energy consumption.



F.l.t.r.: A. Busemann (Managing Director DB Fernverkehr AG), D. Junghans (Managing Director Sales, Marketing and Customer Service) and A. Buhl (Managing Director Research and Technology, both Liebherr-Transportation Systems GmbH & Co KG) signed the contract at InnoTrans 2014.

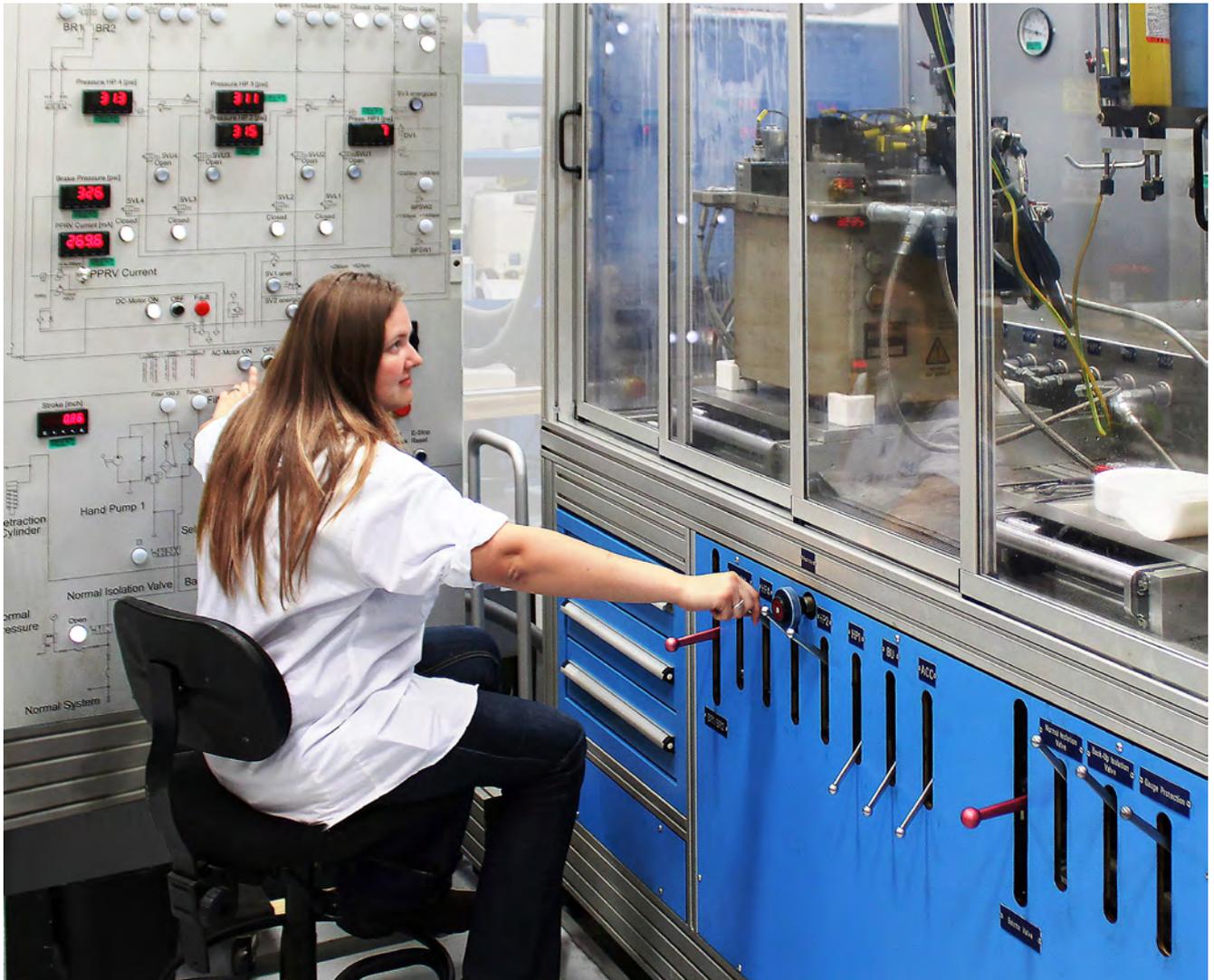
Service Network Expanded

Liebherr's site in Saline, Michigan (USA) has been the place of work to specialists who maintain aircraft systems for many years. Only recently, a team of technicians servicing rail engineering products joined them as Liebherr-Transportation Systems opened a new workshop there to expand its global service network.

The workshop is dedicated to repairing, overhauling, and testing the hydraulic components installed in the leveling systems of rail vehicles. In so doing, the facility offers vehicle manufacturers and operators in North America, who are making increased use of these hydraulic applications, a broad range of targeted services. An additional benefit for Liebherr's customers is the close proximity of the location,

which minimizes product transit and turnaround times. The service technicians in Saline are currently supporting the leveling systems for the rail vehicles operated by the Chicago Transit Authority (CTA) in Chicago, Illinois (USA) and the Metropolitan Transit Authority (Metro) in Houston, Texas (USA).

The customer service workshop is located at the site of Liebherr Aerospace Saline, Inc. Established as a service center of Liebherr-Aerospace, the company has been maintaining and repairing air management systems, flight control and actuation systems and landing gear systems for aircraft and helicopters since 1991. Liebherr-Transportation Systems decided to profit from the existing infrastructure on site and set up its own service facility there.



Testing a hydraulic component that is to be integrated into a leveling system.

Easy Access

Trams featuring Liebherr technology will not only run in the Houston, Texas metropolitan area, but also in two other US cities. This is because Spanish rail vehicle manufacturer Construcciones y Auxiliar de Ferrocarriles, S.A. (CAF) has commissioned Liebherr-Transportation Systems to develop and manufacture actuators to be incorporated in leveling systems for the new vehicles that will be used in Cincinnati, Ohio and Kansas City, Missouri.

The leveling technology allows the boarding height of the vehicles to be adapted to the exact height of the platform. A total of 48 hydraulic ac-

tuators will be installed in the vehicles that are to serve the new Cincinnati tram network, and the contract includes the option on 250 additional actuators. CAF also commissioned 32 actuators for four low-floor vehicles that will bring passengers to their destinations in Kansas City. The units will be shipped by Liebherr to the CAF plant in Elmira, New York, where final assembly work for the vehicles is carried out. The main benefit of low-floor trams with leveling technology is that they make it very easy for passengers with restricted mobility and customers with baby carriages or bicycles to enter and exit the vehicle.

CAF started collaborating with Liebherr-Transportation Systems in 2013, when ordering hydraulic actuators for the leveling systems for the trams in the Houston, Texas, area. The new orders placed for the Cincinnati and Kansas City-based trams are a direct outcome of the good results CAF has had since using Liebherr technology. Moreover, they strengthen the position of the system supplier as a leading manufacturer of hydraulic actuators for leveling systems in the North American market.

Checked from A to Z

The Transdev operating company has placed an order with Liebherr-Transportation Systems to carry out a full-service check of the air conditioning units installed in the 27 low-floor trams it uses to serve the rail network in Rouen (France).

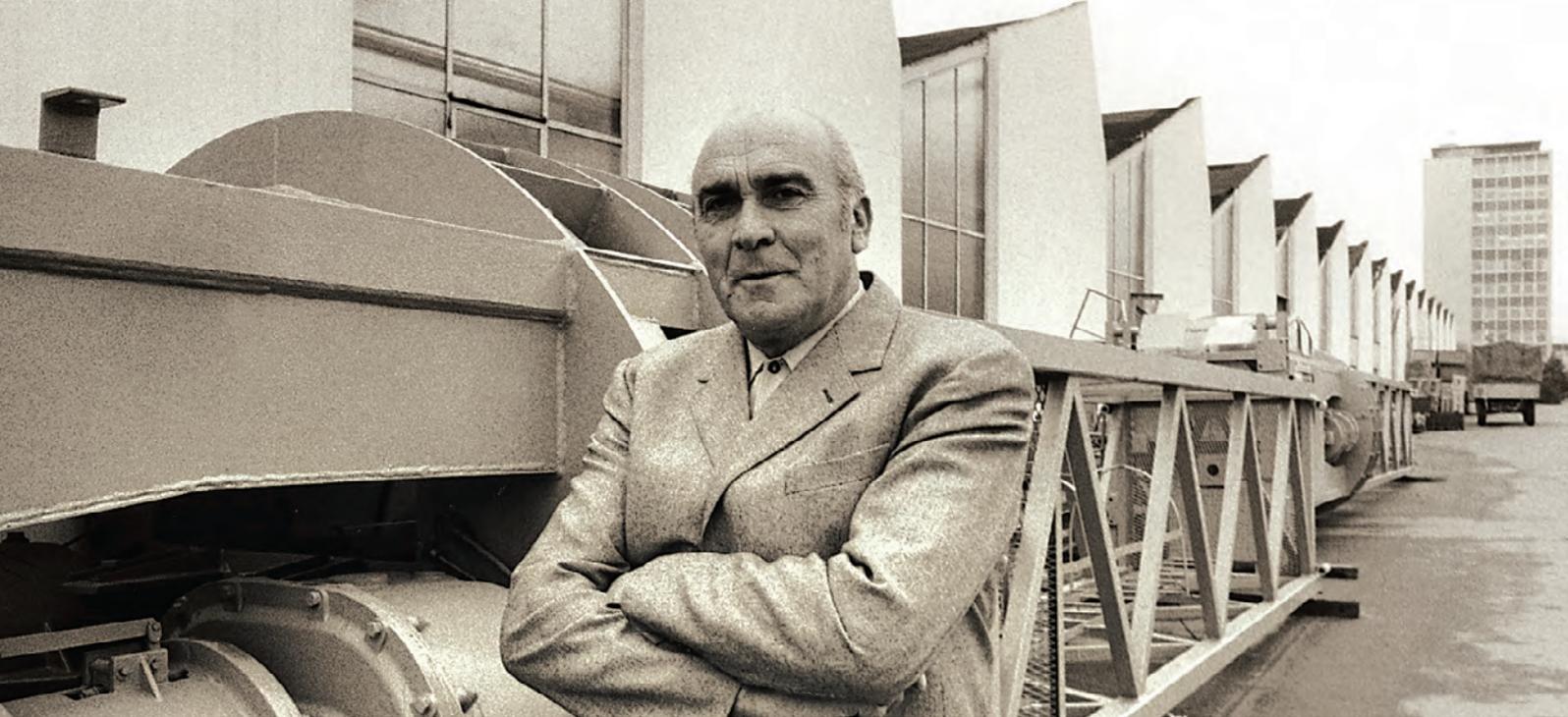
The two-year contract awarded encompasses a range of inspection and maintenance services for the air conditioning systems used to cool the driver's cabins and passenger compartments of these trams. To this end, Liebherr-Transportation Systems' certified service technicians work on site to perform the inspections mandated by law as well as make repairs to the refrigeration circuit of the air conditioning units, if required, to further improve their safety, availability, and reliability. This also ensures that Transdev stays compliant with the certification requirements imposed by Afnor NF Services for tramway operation.

Headquartered in Issy-les-Moulineaux near Paris, Transdev S.A. operates the vehicles that serve the Astuce transport network of the Rouen metropolitan region via its local subsidiary company "Transports en Commun de l'Agglomération de

Rouen" (TCAR) and is also responsible for the maintenance work required for them. The order placed by the operator underscores the know-how and capability of the service team at Liebherr-Transportation Systems in France.



The trams operated in Rouen (France) will be maintained by Liebherr-Transportation Systems.



The Liebherr Group

Hans Liebherr – Entrepreneur, Inventor, Visionary

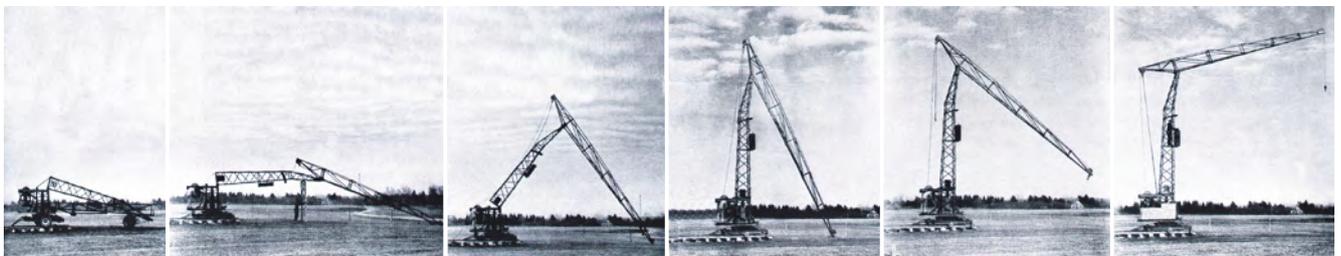
His groundbreaking inventions include the mobile tower crane and the first hydraulic excavator in Europe. He was one of the great pioneers of the German post-war economy: Hans Liebherr. He would have celebrated his 100th birthday on 1st April 2015.

The history of the Liebherr Group is inextricably linked to its founder – a qualified master builder, a tireless tinkerer, a pragmatic businessman and a successful pioneering entrepreneur. Hans Liebherr, born on 1st April 1915 in Kaufbeuren (Germany), had many talents. One of these was his keen instinct for promising products and emerging markets.

When large parts of Germany were being reconstructed after the Second World War, Hans Liebherr recognized the demand for tools and machinery for the building industry and domestic construction. Together with draughtsmen and craftsmen, he developed the first mobile tower crane in 1949. The TK 10 could be easily transported and assembled

at construction sites. It accelerated and simplified the reconstruction of Germany after 1949 and laid the foundation for the present group of companies. This success could not initially be foreseen, as the presentation of the product at the Frankfurter Herbstmesse trade fair in 1949 was a disappointment. Hans Liebherr would later recall that “after the trade fair, I actually could have given up on producing cranes.” Instead, he displayed perseverance and worked with determination to realize his plans – until the first commissions finally came in and production began.

As an entrepreneur, Hans Liebherr banked on step-by-step expansion. In doing so he financed all of his enterprises primarily with his own capital. The profits were mainly put back into the business, in order to further optimize research, development, production and distribution. By the middle of the 1960s he had long since established this once-small construction firm as one of the leading manufacturers of construction machines worldwide.



Transportation and erection of TK 3.6. The successor model of the first Liebherr tower crane was introduced in 1950.

Hans Liebherr was among the greatest German entrepreneur personalities – and yet he always remained humble. “You know, I’m actually just a master builder,” he said upon the conferment of an honorary doctorate by the technical university Aachen in 1964. He still oversaw his works himself and, in his down-to-earth manner, paid close attention to the needs of his customers.

After his death in 1993, three of the five children of Hans Liebherr, who was a family-business entrepreneur through and through, took over the management of the company. To this day, the shareholders of the Group are all family members – by now into the third generation.

Hans Liebherr built up the Liebherr Group and made a lasting impression in the building industry with his inventions. His work still earns him accolades today; the Handelsblatt, a significant German economic publication, has included him posthumously in the Family Business Hall of Fame at the beginning of 2015.

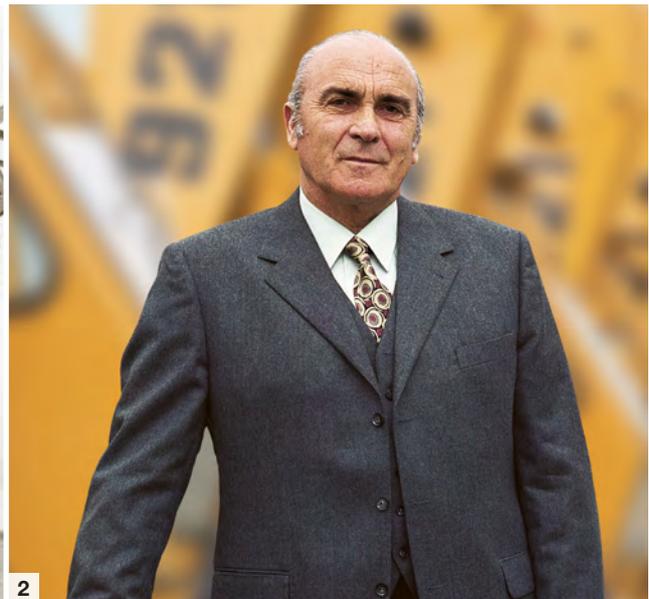
Abridged Biography of Hans Liebherr

- 1915** Born on 1st April in Kaufbeuren (South Germany)
- 1938** From his exams as master builder, Hans Liebherr turns his attention to managing his parents' building firm
- 1949** Patent submitted for "mobile tower crane" and formation of Hans Liebherr Maschinenfabrik
- 1964** Presented an honorary doctorate in engineering by the deacon of the technical university in Aachen, Prof. Dr. Weyres
- 1974** Honorary senator of the University of Karlsruhe in recognition of his "groundbreaking technical developments"
- 1986** Grand Cross of the Order of Merit of the Federal Republic of Germany, awarded by Prime Minister Lothar Späth
- 1993** Died on 7th October in La-Tour-de-Peilz, Kanton Waadt (Switzerland)

1. Hans Liebherr in Kirchdorf/ Iller (Germany), winter 1953
2. Family-business entrepreneur Hans Liebherr, around 1970
3. Conferment of an honorary doctorate, 1964



1



2



3

Tower Cranes

Liebherr Cranes Build One of the Biggest Buildings in Paris



It's difficult to say which landmark Paris is more famous for: the Champs-Élysées with the Arc de Triomphe at the top? The Louvre with its glass pyramid? Or the Eiffel Tower? Without doubt, though, since the start of 2015 the French capital has been enriched by a building worth seeing. In the business

area called La Défense, the new Tour D2, which had its opening ceremony at the end of January, reaches up to the clouds and stands out with its striking architecture. Particularly unusual is the skyscraper's rounded dome. Also involved in the three year building project were two tower cranes from Liebherr –

the two 355 HC-L 16 Litronic cranes helped, among other ways, to mount the Tour D2's characteristic dome. Even the figures of the office complex are impressive: 37 floors, a height of 171 m and an overall surface area of approx. 50,000 m².

Domestic Appliances

BlackSteel Side-by-Side Receives Interior Innovation Award 2015



The Liebherr BlackSteel Side-by-Side SBSbs 7263 cooling device has received the Interior Innovation Award 2015. The jury praised above all the innovative material of the Liebherr combination: BlackSteel is an optically appealing black stainless steel. An additional SmartSteel treatment reduces the visibility of fingerprints, is easy to clean and is resistant to scratches. The so-called BioFresh safes ensure freshness and a longer shelf life of the food products stored within. Furthermore, the BlackSteel Side-by-Side combination features two removable VarioBoxes, a practical bottle storage area and a NoFrost freezer compartment with IceMaker.

The Interior Innovation Award is an independent, industry-orientated prize that was first introduced in 2002 by the "Rat für Formgebung" (German Design Council). It is still acknowledged today as one of the world's most renowned design prizes for the furnishing industry and distinguishes innovative ideas and outstanding performance in all product areas.

Hotels

New Event Location at the InterAlpen Hotel Tyrol

In 2014, a modern event location became a feature of the InterAlpen Hotel Tyrol by Seefeld in Tyrol (Austria). The "Hofburg – meet & eat" is a venue for parties and cooking events, lectures or concerts. Under the leadership of head chef, Mario Döring, the young catering crew in this 5 star superior house also recently received 16 points in the gourmet guide, Gault Millau, along with two chef hats. A current overview of everything that the hotel has to offer can be found on the new website www.interalpen.com.

Another Liebherr hotel, The Europe in Killarney (Ireland), with 5 stars has been crowned Hotel Spa of the Year in the

World Spa & Wellness Awards 2014 in the Western Europe and Scandinavia category.

Further information on www.theeurope.com



Maritime Cranes

Spectacular Lift of RL-K 7500



The Liebherr site in Rostock (Germany) was the scene of a spectacular lift in autumn 2014. The RL-K 7500 – the largest subsea crane that Liebherr has so far built and developed – had to be maneuvered near the quay wall and then onto a sea transportation device. The huge crane had previously completed numerous tests on land. The 670-ton RL-K 7500 was then loaded

onto a transport ship as a completely assembled crane and delivered to Asia.

A special lift of this kind using four cranes – two heavy duty LG 1750 truck-mounted cranes as well as two LHM 600 mobile harbor cranes – was executed for the first time on the Rostock test stand. Equally as long was the planning that was needed, along with

accurate and precise preparation. Assembly of the two mobile cranes alone took two entire days. The actual lift from the test stand to the specially built maritime transporter required 90 minutes for a distance of 25 m. A 4-axle industrial transporter bridged the final meters to the water.

Further information on www.youtube.com/liebherr

Automation Systems

New Gear Hobbing Machine Combines High Chamfering Quality with One-Cut Machining



The new Liebherr gear hobbing machine LC 180 with integrated chamfer cut unit for chamfering the front edges of gears combines two tried and tested technologies: After gear hobbing with the familiar one-cut machining method, further chamfering is achieved by respective chamfer cutting tools for precision and high repetition accuracy.

Until now it took a lot of time to incorporate these two stages – hobbing and

chamfering – in one set-up. With the new method of “two machines in one”, the components are now deburred in a separate unit within the machine while the next workpiece is being hobbled at the same time. This shortens the processing time notably. With this new feature, the gear hobbing machine LC 180 combines the high chamfering quality of the tried and tested chamfer cutting method with cycle times as required by the automotive industry.

Crawler Cranes

LR 11000 Crawler Crane in Operation for the First Time with PowerBoom

PowerBoom is a parallel boom that Liebherr has employed for three years on its large crawler cranes. The lattice sections are mounted parallel to each other in the lower part of the crane, the double jib at the top is joined to form a simple jib. With this unique design, the lifting capacity is increased by up to 50%. This value is made possible by the increased lateral rigidity as well as the higher torsional torque.

The PowerBoom is now being used for the first time in the latest Liebherr crawler crane of the 1,000-ton category: On the test field for offshore wind energy plant about 20 km south of Cuxhaven (Germany), Senvion, the German wind energy plant manufacturer, has installed a 6.2 MW pilot system. The Liebherr LR 11000 crawler crane placed a 19 m long and 9 m high machine house on the tower of a wind turbine. The overall load of the house together with the load cross member and hook block was 220 tons, the hook height reached an incredible 147 m. Thanks to the design of the parallel booms, the LR 11000 lifted the machine house to 130 m in height with a reach of 30 m. Without

the PowerBoom, only about 160 tons could have been lifted with the same hook height. Previously, the LR 11000 had been shipped from its maiden deployment in a refinery near Bucharest (Romania) to Bremerhaven (Germany) and transported from there to the construction site. After just seven days of setting up time, the crawler crane was equipped with the P-boom and ready to lift.

The LR 11000 also fulfilled another central task on the Senvion test field: The pilot system was fitted with one of the biggest wind turbines in the world with a rotor star diameter of 152 m. The propeller had been preassembled on the ground and then subsequently installed as a complete unit.



LIEBHERR

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