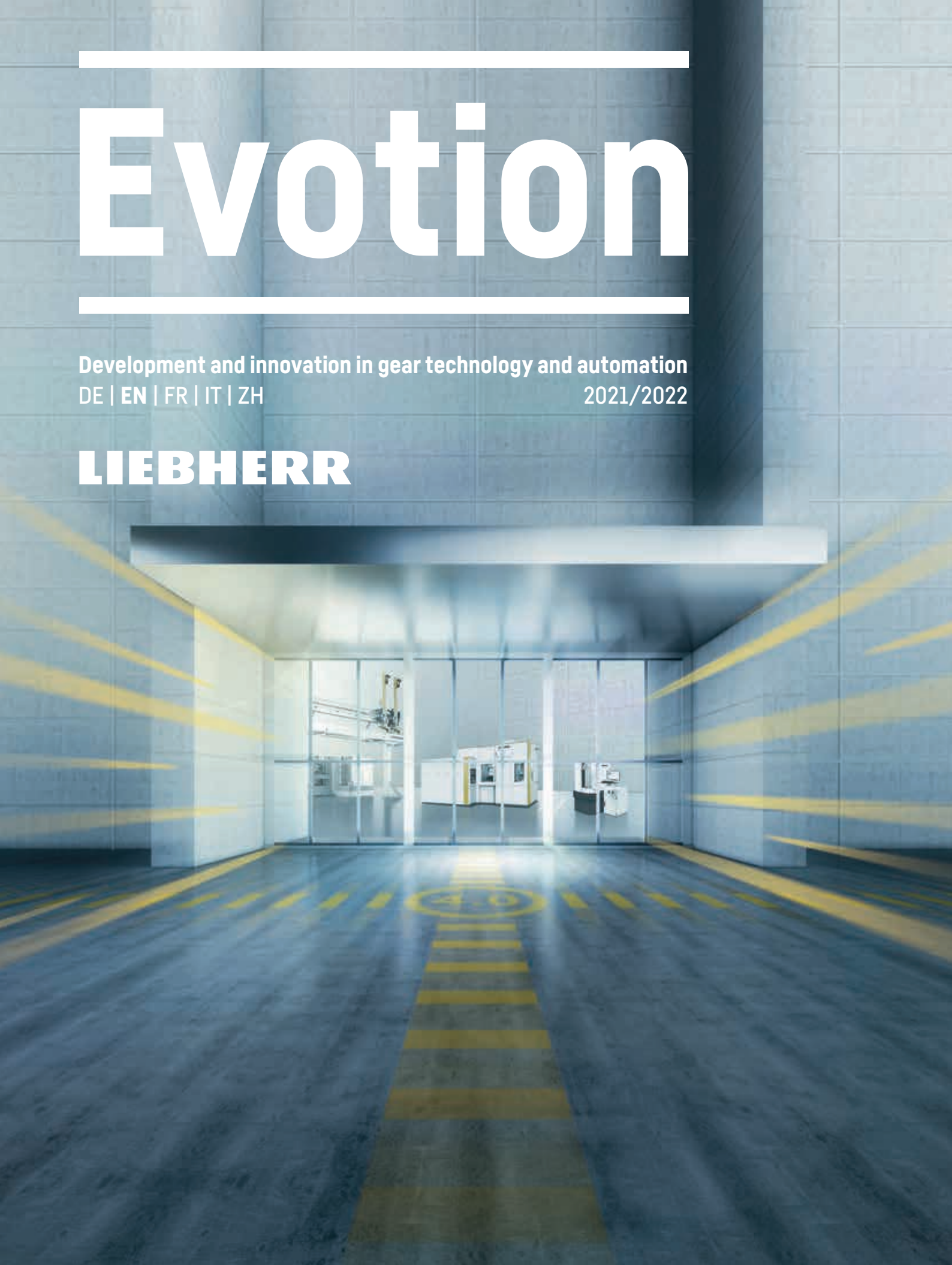
Evotion

Development and innovation in gear technology and automation

DE | **EN** | FR | IT | ZH

2021/2022

LIEBHERR



The Managing Directors of Liebherr-Verzahntechnik GmbH (from left to right): Peter Wiedemann, Dr. Hans Gronbach, Michael Messer and Michael Schuster

Consciously shaping the digital transformation

Dear readers,

We are pleased to present the topics of the current issue to you in a fresh, new layout and with the new name of Evotion.

This is a combination of two terms. “Evolution” represents the constant development of our products and solutions. “Devotion” reflects the great passion of our developers for pioneering technologies.

But things have changed in the last few months, and not just for our magazine. The pandemic demanded a lot of us and, at the same time, has given great impetus to the digital transformation. But what is this exactly about? Is it about communication, process optimization, added value through the digitalization of products and services? We at Liebherr have looked closely at this question and Evotion provides some answers.

We want to shape digitalization consciously in line with our company’s philosophy. The focus of our activity is always on customer benefit and on developing individual, tailor-made solutions in dialog with our customers and business partners. Whether communication takes place virtually or in real life is ultimately secondary – what is key is its targeted and economical implementation.

In our virtual in-house trade fair, the Liebherr Performance Days, we have created a digital platform for a virtual experience of our new innovations and technologies. However, all of this cannot, and should not, replace face-to-face meetings and the exchange of views. Our future goal is to unite the best of the real and the virtual world.

We hope you enjoy your read!

Dr. Hans Gronbach | Michael Messer | Michael Schuster | Peter Wiedemann

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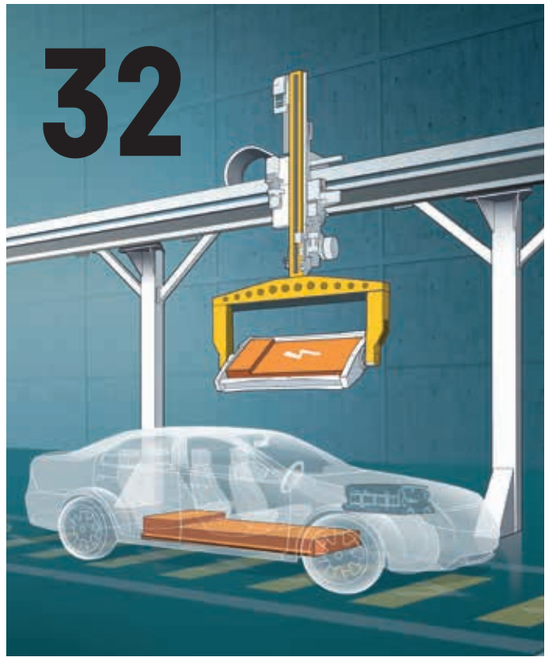


Interview

Gear Technology

Automation Systems

In Focus

Michael Messer (right) and Peter Wiedemann (center), General Managers for Production and Sales, Liebherr Verzahntechnik GmbH

„Data protection is a sensitive topic.“

Peter Wiedemann
General Manager for Sales
Liebherr-Verzahntechnik GmbH

Structured, sustainable and benefit-oriented

Digitalization with sense of proportion

The digital transformation, with its opportunities and risks, is a ubiquitous topic which is also being intensively addressed by Liebherr-Verzahntechnik GmbH. Michael Messer and Peter Wiedemann, General Managers for Production and Sales, view digitalization as a strategic challenge which must be implemented with sense of proportion and with a focus on customer benefit.

How is Liebherr-Verzahntechnik GmbH approaching the topic of digitalization, and where do you see the greatest potential for the company?

Michael Messer: We want to place the topic in the areas where we can best promote it. The questions we are asking ourselves in relation to this are: How do we integrate our products into digital worlds? Which virtual solutions can we implement in service and communications? And to what extent are we promoting the idea of Industry 4.0 in our own company landscapes as well? One thing, at any rate, is clear: Digitalization is not an end in itself and must fit in with our philosophy. The focus is on customer benefit.

Peter Wiedemann: I see a lot of potential in the area of research and development, and in after-sales service. Here, we are intensively addressing topics such as predictive maintenance and predictive service. We are tackling them purposefully and with dynamic ambition, but we are also remaining realistic, because we are reliant on data which have to be gathered in a cooperative dialog with the customer.

Talking of data protection, how do you get customers on board with this and gain their trust?

Peter Wiedemann: Data protection is a sensitive topic. In order to benefit from digital solutions, you have to let the other party view their own data. Customer acceptance of this has grown considerably in the last few months. A good example of this are remote services: Customers have experienced benefits from the fast and uncomplicated processes. We are able to score here because we are perceived as a reliable partner, and customers trust us – particularly for more complex topics which require a lot of expertise and experience.

Michael Messer: We supply highly specialized solutions for our customers' individual requirements. That's why we are always reliant on intensive dialog. This goes far beyond what you can offer with a standardized app, for example. Formats such as our Live Online Training or live-streamed machine pre-acceptances combine the virtual and real world and are far more able to serve this purpose.

Liebherr Performance Days have taken place in Europe, America and Asia under the motto “Real life meets virtual Tech Arena”. How do you assess the success of the virtual trade fairs?

Peter Wiedemann: In virtual exhibition rooms and video talks with chats and workshops, visitors were able to experience the technologies of gear technology and automation virtually and to interact with us. This was very popular: We had a similar number of contacts to the EMO 2019, for example. Further events are planned. We aim to offer even more live and interactive formats to continue to improve our availability.

Michael Messer: An advantage of the virtual trade show is that we are not tied to show dates to introduce our new products and can therefore present our solutions to customers and interested parties when they appear.

Has digitalization also had an effect on communication?

Michael Messer: Definitely! We were very quick to react and efficient in organizing our digital structures. This meant that our availability, particularly in the area of service, was continuously guaranteed even during the pandemic. However, informal communication has suffered. The usual, important conversations between colleagues “in passing” have not yet arrived in the virtual space.

Peter Wiedemann: From a sales point of view, I can confirm that. Certainly, the use of virtual possibilities here can also, in the future, remove the need for some journeys which previously involved a considerable outlay of money and time. Despite this, employees, customers and business partners are longing for a meaningful combination of personal and virtual contact. It is also still extremely difficult to build new relationships and the trust needed for these using purely virtual media.

What are the future challenges of digitalization for Liebherr-Verzahntechnik GmbH

Michael Messer: Developments so far confirm that we should carry on the path we have taken: solution-oriented and not influenced by buzzwords. Basically, Liebherr-Verzahntechnik GmbH has already been focusing on many topics of Industry 4.0 for a long time. Digital information about the machine status is not really new for us. We are continually monitoring the potential for further digital solutions in our portfolio. In doing so, we are not always the first to bring new hypes onto the market, but when we do take something up, we also implement it lastingly.

Peter Wiedemann: Digitalization helps us to focus, but also makes us more flexible. It is important to check carefully how to combine the best of both worlds in our business relationships: efficiency and personal interaction.

Gear Technology

Mastering challenges together with the customer

Gear solutions for e-mobility

New drive technologies in electric mobility are changing the requirements for gears and therefore also for the quality of the tooth flank surfaces. Manufacturers of gears have to adapt their manufacturing process accordingly. It's good to be able to rely on a technology partner with expertise covering the entire range of production processes and technologies, which enables them to find suitable solutions even for special challenges.

E-mobility is changing the entire drivetrain in cars, which also changes the demands made of gear components. One of the most important topics is the reduction of noise emissions from the drivetrain while driving. In order to minimize installation space, many parts of the gearbox are manufactured using a lightweight or compact design. At the same time, gear components must become increasingly robust and long-lasting in order to withstand the considerable stress caused by the higher engine RPM.

Process and technology expertise from Liebherr

This results in high quality demands on the tooth flank surfaces, which in turn brings about growing demands on the gear cutting process. Liebherr-Verzahntechnik GmbH has addressed this issue and refined and optimized various technological solutions for e-gearboxes. "We know about the challenges that manufacturers and suppliers must master in terms of quality and process reliability", explains Dr. Andreas Mehr, who is responsible for the technology applications of gear grinding and shaping. "We apply our expertise both in the process depth and in the range of technologies. This means that we can advise and assist customers comprehensively in order to find the optimal solution for them and their application."

Processes and methods

On the process side, generating grinding with dressing-free CBN grinding worms, for example, ensures a high degree of process reliability. During the hard gear finishing, the gears can be precision-ground and polished, which further improves the surface roughness. Tools with small outside diameters machine collision-critical gears with limited tool overrun.

Methods for tooth lead modification are available for the tooth flank topology. For example, topologically error-free grinding with targeted end relief (GER) optimizes the load-bearing capacity. In order to reduce noise emissions, a targeted waviness can be applied to the tooth flank (Noise Excitation Optimization), or the diagonal amount during finishing can be increased in order to distribute the ghost line structure stochastically (Silent Shift Grinding).

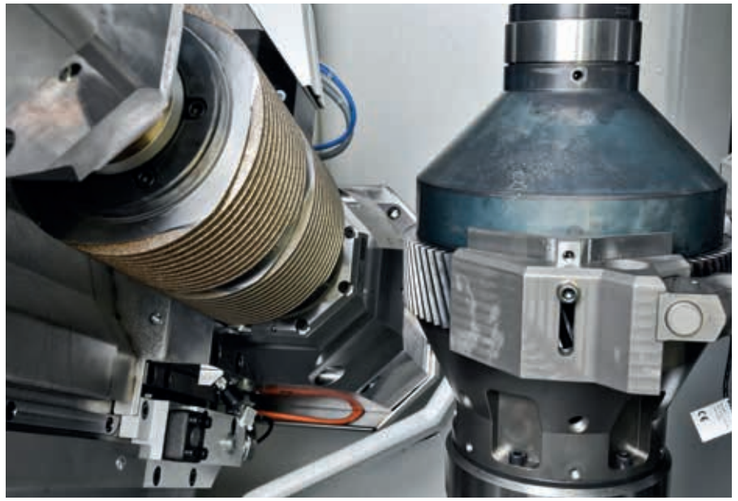
Tool material: CBN grinding worms

The more topological modifications are necessary, the more it pays off to think about the tool material: CBN tools can be an economical alternative here. For many applications, grinding with corundum grinding worms is a good solution which, however, reaches its limits when grinding with high topological demands because of the dressing effort required. Dressing-free CBN grinding worms from Liebherr's own production offer a number of advantages: high process reliability due to the long tool life, the avoidance of error sources during dressing, easy tool handling, and considerably reduced measurement and testing effort. For a topology with GER modification, for example, CBN

grinding performs much better than corundum grinding with regard to the unit costs. Extremely fine surfaces with an Rz roughness factor of under three micrometers can also be achieved in this way.

Clamping solutions for small components

The challenge when producing gear parts for e-bikes is often in the intricate measurements and small modules. To manufacture these components in a high quality, the grinding process and clamping technology must be fast and extremely precise. Special clamping solutions ensure that even small and collision-critical components, such as drive shafts with a module of 0.6 in a gear quality of DIN 1-4, can be machined without difficulty.



Example of use
Generating grinding of a drive gear for an e-drive with dressing-free CBN

Machine concept: economic efficiency and reproducibility

The exclusive Liebherr machine concept provides optimal concentricity and the highest possible reproducibility with a one-table solution – for the controlled and continual manufacturing of parts with quality requirements in the micrometer range, this is a technologically indispensable advantage. Particularly for smaller and medium batch sizes, which frequently occur in manufacturing for e-mobility, this concept is also particularly economical, since the short setup times enable a fast production start.

At eye level with the customer

“We see ourselves not only as product providers but as partners and solution providers”, Dr. Andreas Mehr emphasizes. “We take the customer with us on the journey by offering advice and pointing out plausible alternatives so that he can finally make the decision that is best for him.” For this purpose, Liebherr has a number of test machines on which all the process parameters for the production of specific parts can be tested and designed, including the tool, the design or measuring software, grinding methods or process parameters, tooth flank modifications or other settings.

The only limits are those set by physics

For example, in one customer’s gearbox, noise was emitted despite adherence to the required specifications. Liebherr addressed this issue in an intensive discussion with the customer under strict time pressure. On the test machines, a number of variants for the corresponding component were ground and tested. It was revealed that the cause lay in further parameters outside the grinding process and that the gearbox had to be designed differently. On the basis of these results, the customer was able to optimize its processes accordingly. Noise emissions were significantly reduced, achieving a satisfactory solution within the limits of what is physically possible.

“It was possible to maintain the narrow timeframe because Liebherr has bundled the complete technology and expertise”, recalls Dr. Andreas Mehr, who explains further: “Often, there is no ‘right or wrong’. Rather, the choice of the optimal process depends on the specific requirements and parameters. At this point, we want to support our customers by honestly weighing up the pros and cons of one method or another.”

„We see ourselves not only as product providers but as partners and solution providers.“

Dr. Andreas Mehr
Technology Development and
Consultancy for Grinding and Shaping

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The ideal process for every need

CNC chamfering with ChamferCut or FlexChamfer

Chamfering processes at Liebherr

Chamfering gears prevents the edges of the teeth from becoming brittle during heat treatment and reduces transportation and installation damage. Multiple processes can be chosen for this. Classic technology such as press deburring or chamfering with end mills are increasingly being superseded by CNC controlled processes such as ChamferCut and FlexChamfer. These are extraordinarily economical and guarantee an excellent chamfer quality which can be reproduced very precisely. CNC controlled processes are easy to operate and minimize set up cost.

Liebherr knows the advantages and the limits for the various processes and individually advises customers with their selection. Requirements for an optimal chamfering process can be individually arranged by batch size, chamfer shape, subsequent machining or component geometry. Liebherr specializes in particular in the ChamferCut technology from LMT-Fette. As a pioneer in introducing this process and its development to being production-ready, Liebherr is determined to take this further in the future: By consulting with clients, both companies are working to improve precision, productivity and usability.

ChamferCut

ChamferCut-CG (collision gear)

„Precise, economic and flexible – ChamferCut is the future of chamfering.”

Dr. Oliver Winkel
Head of Technology Application

FlexChamfer

ChamferCut-IG (internal gear)

ChamferCut – precise, quick and reliable

- Precise chamfering geometry and quality, no material deformation
- Can be reproduced very precisely
- Easy operation, short setup times due to CNC control system
- Single-cut strategy: No additional finishing cut required to remove bulging on the lead
- Low investment cost and long tool life
- Ideal for subsequent finish machining
- Integrated chamfering device or standalone machines from Liebherr enable parallel machining
- **Application range** module 0.5 - 36

ChamferCut-CG (Collision Gear) – Chamfering despite interfering contour

- Chamfering including the root, even for collision critical gears
- More degrees of freedom with the chamfer divided between the left and right profile
- Can be implemented on Liebherr machines with a simple software update
- Batch sizes: Suitable for medium and large-scale production
- **Application examples:** Truck shafts, passenger vehicle idle gears and ring gears, industrial gearboxes

FlexChamfer – maximum flexibility for external and internal gears

- CNC controlled advanced development of chamfering with end mills
- Development of variable chamfering forms with standard catalog tools
- Particularly suitable for external gears with or without interfering contours as well as shafts and internal gears
- Use in hobbing, shaping and gear skiving machines
- Parallel to machining (depending on the main machining time)
- Ideal for small and medium batch sizes
- **Examples of use:** Stage planetary gears, double internal gears

ChamferCut-IG (Internal Gear) – Chamfering of internal gears

- Chamfering of internal gears on both flanks in one cut
- Machining on compact standalone machine, e.g. LD 180 C
- **Application examples:** Internal gears of plantenary and e-motive gearboxes

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Head of Technology Application

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Clamping solution for very diverse requirements with special customer service

SECLA – one for (almost) all

Easy operation combined with maximum flexibility and short setup times – these are the features of the clamping arbor SECLA, which Liebherr has been successfully using in its own gear cutting machines for many years. Anyone who buys a SECLA from Liebherr also benefits from the company being a solution provider: from manufacturing to after-sales service, Liebherr offers everything from one source.

Customer feedback was so positive that, in 2019, Liebherr decided to offer the clamping fixture as a separately available component. The clamping arbor manufactured by Liebherr impresses with its modular construction, which enables a clamping fixture exchange in next to no time.

Short delivery times

As well as its diverse variety and its robustness (see illustration), which make it suitable for different workpieces, the SECLA also impresses with its fast availability. A complete clamping device can be delivered within ten weeks, while individual components such as the clamping arbor, clamping base and the mounting for the counter column are in stock and thus immediately available. Liebherr even goes one step further and provides customers with the interface geometry of individual, workpiece-touching components – for example, the workpiece support, the centering tip or the clamping top – for their own production.

Work area and collision monitoring in advance

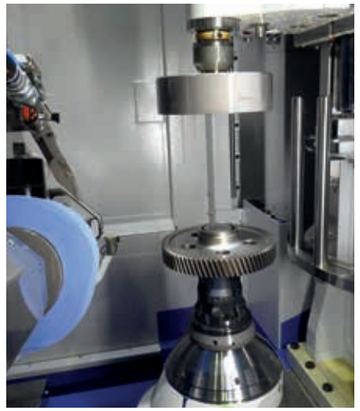
Liebherr offers a special peripheral service for the clamping fixture: in case of possible interfering contours, Liebherr conducts advance collision monitoring in the work area as an engineering service. This ensures that production can start immediately after installing the clamping device.

SECLA service help desk

Liebherr has set up a help desk for any questions concerning SECLA. The employees can be reached by telephone or email and will answer any questions about technology, delivery times or commercial handling, or will connect you with the right person.

Gear hobbing:
Single-cut strategy for larger modules as well, thanks to high clamping force

ChamferCut:
Also suitable for use with interfering contours



Generating grinding:
Frequently used clamping solution for generating grinding

SECLA helpdesk

Liebherr-Verzahntechnik GmbH
Phone: +49 831 786-1050
tooling.lvt@liebherr.com


1


2


3


4

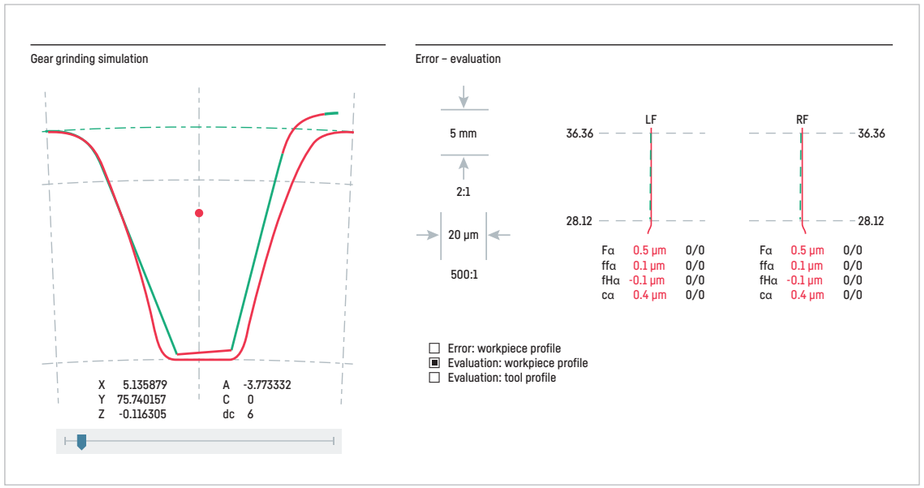

5

1 Put workpiece support on clamping attachment and screw tight
2 Screw in clamping unit
3 Screw in torsion protection
4 Put on test workpiece or workpiece
5 Optional: additional workpiece clamping from above

Comprehensive technological competence with skiving³

Gear skiving tools: a question of trust

Gear skiving is considerably more productive than gear shaping and more flexible than broaching, but it also has its pitfalls. Minimal errors in tool design can be decisive for the success or failure of the manufacturing process. Comprehensive competence is required here, so that the user can be confident that his processes will work and that highest-quality components will be produced.



The simulation software depicts the expected profile quality on the workpiece

The success of gear skiving lies in the significantly higher efficiency and productivity of this process compared with shaping and the considerably higher flexibility and lower investment compared with broaching. However the requirements for the tools are extremely high. Excellent quality is a must, since minimal details in tool design can be decisive as to whether machining will work successfully.

Trusting the tool manufacturer is key

Practical experience has shown that the mathematical mastery of the process and its coordination with the tool and machine is the key to success. It's a good thing, then, if you can trust the expertise of your tool supplier. Liebherr knows the entire process of gear skiving intimately. With the Skiving³ technology package, the gear specialist is combining its expertise with regard to the tool design, machines and technology of gear skiving. "We have a holistic view of the process and know exactly which adjustments we have to perform in order to make it work", says Haider Arroum, Sales Team Leader for Gear Cutting Tools at Liebherr.

Simulation software for optimal tool design

Liebherr's gear skiving tools are available in conical and cylindrical form and can be optionally manufactured from powder-metallurgical high speed steel (PM-HSS) or full carbide. For process-optimized tool design, Liebherr uses specially developed software, which simulates the manufacturing process, calculates the required tool profile and then controls the gear grinding machine in order to generate the desired profile characteristics on the gear skiving tools. The software detects the profile, taking into account the crossed-axis angle and rake face offset, collision avoidance and the optimum rake and clearance angle for the entire process. This enables optimum quality and process reliability to be achieved for all gears.

"First time right" instead of "Trial and error"

Whether it is for large-volume production or smaller batch sizes, this means more safety and reliability for the user's manufacturing process from the very first minute – at competitive prices. Perfect coordination between simulation and production technology ensures short delivery times. "Liebherr continually invests in the optimization of quality, tool life and process reliability. Our customers value us as a reliable partner that can also implement individual special features", Arroum emphasizes.

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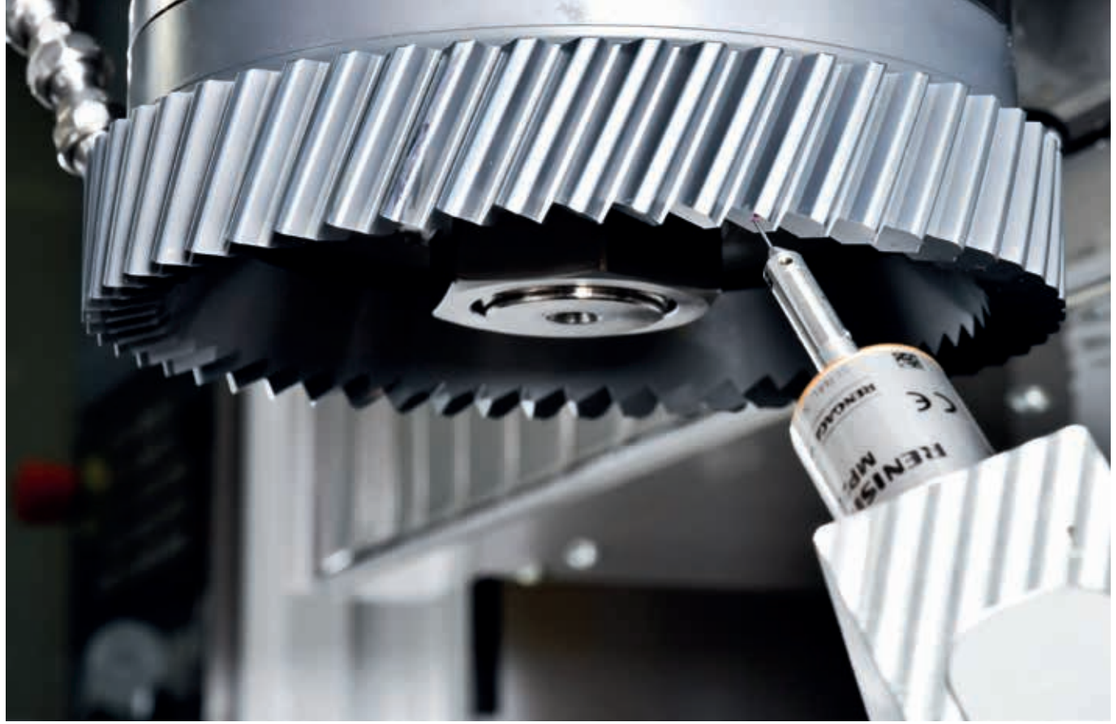

Skiving³: Gear skiving technology successfully introduced at gearbox manufacturer Allison

Making mistakes is not an option

For the serial production of planet carriers for gearboxes for commercial vehicles, the American gearbox manufacturer Allison Transmission has shifted to the gear skiving method. With Skiving³, Liebherr was able to implement several special requests within a short time due to good coordination between machine, tool and technology, significantly increasing the tool life and productivity.

Allison Transmission Holdings, Inc, based in Indianapolis, is a US manufacturer of automatic gearboxes with integrated braking systems and hybrid drives for commercial vehicles. The company's drive systems are in use in trucks, buses, off-road and military vehicles all over the world.

Allison Transmission – a traditional company with a commitment to quality

Founded in 1915 by James Allison, the company initially built race cars and airplane engines. Further milestones in manufacturing were, for example, the first powershift transmission for the navy, the angle drive for track vehicles, integrated hydraulic retarders, fully automatic truck gearboxes, and gearboxes equipped with double turbines for transport vehicles. Today, Allison Transmission is the world's largest developer, manufacturer and distributer of fully automatic gearboxes for medium-duty and heavy-duty commercial vehicles and hybrid drive systems.

Allison's demands of the quality and service life of their fully automatic gearboxes are high. From the beginning, the company's philosophy was based on quality and workmanship. "Whatever leaves this shop under my name must be of the finest work possible", states the inscription on a sign in the company which its founder, James Allison, put up. Today, customers still value the reliability and economic efficiency of Allison gearboxes, which ensure low downtimes and maintenance cost with minimum maintenance requirements.

Investment in gear skiving technology

In the course of a substantial machine investment in 2017, the company was searching for productive and economically efficient alternatives for the manufacturing of planet carriers – sophisticated components with an interfering contour, which had previously been shaped. At this point, Liebherr was able to convince the company's management that these components could be ideally manufactured using gear skiving technology. Furthermore, the Liebherr machine can combine two gear manufacturing machining tasks into one single machine, significantly reducing the overall cycle time.

Gear skiving is significantly faster than shaping and more economical than broaching, but it is also a demanding process which relies on perfect coordination between machine, tool and technology. "For successful gear skiving, users need more than just a good machine", explains John Hartford, Regional Sales Manager at Liebherr. "With our Skiving³ design, we offer a

Liebherr LK 300:
innovative and productive

Top: tandem machining of a planet carrier.
Bottom: tool loading device for particularly heavy tools

complete customer solution, which includes not only the actual gear skiving machines but also the matching tools and technology for the process."

Liebherr LK 300:
innovative and productive

With the LK 300 gear skiving machine, Liebherr had the ideal machine for Allison's requirements. It is characterized by high machine rigidity with directly powered tool and table spindles. Additional functions such as a tool loading device for particularly heavy tools and an adaptable deburring steel on the gear skiving head extend the application possibilities. Optionally, a fully automatic tool changing system for up to twelve tools can be integrated. It is operated via the LHGearTec control software, which also includes the mathematical formulas for tooth thickness, lead and profile angle modifications. This means that quality improvements can be easily achieved via the kinematics of the machine.

Specialist for special requests

However, for the machining of the planet carriers, special features had to be realized, which are not included in the machine as a standard. Until now, both gears of the component had been manufactured using different methods on two different machines: The outer gear of the component was hobbed, while the spline was shaped. This meant that, on the LK 300, tandem machining of both gears had to be realized in one workpiece clamping. The customer also requested integrated tool measurement in the machine. "Liebherr's strength lies precisely in implementing individual customer requests", says John Hartford. "Our customers come to us because they know that we can do better than the standard."

Despite the implementation of the desired special features, Liebherr was able to deliver the machines within the usual timeframe. During commissioning, the service team supported the customer on site. "We have optimized the process and tool conditioning together. The result was a significant improvement to the tool life and a threefold increase in productivity compared to the previous process", explains Philipp Kohler, responsible for technology application for gear skiving at Liebherr.

Investment that paid off

In this case, two gear skiving machines were able to replace four shaping machines – an investment that paid off. After the successful commissioning of the first two gear skiving machines, Allison decided to purchase a third machine. There is even a further integrated option: A tool changing system, which can also change large tandem tools. "More than anything, Liebherr rises to the individual challenges and is also able to react flexibly and at short notice and implement special requests as part of a machine delivery", emphasizes John Hartford.

Allison Transmission

Allison Transmission Inc.

Industries:
Automatic transmissions for medium- and heavy-duty commercial vehicles

Company size:
2,700 employees

Founded:
1915

Headquarters:
Indianapolis, Indiana
(United States)

Website:
www.allisontransmission.com

Distinguished in the "User Experience" category

Design award for LHStation and LHMobile

Award for Liebherr-Verzahntechnik GmbH: The operating concept of LHStation and LHMobile won over the international jury in the "User Experience (UX)" category at the iF Design Awards 2021. Having nearly 10,000 entries from 52 countries to choose from, the jurors awarded this sought-after hallmark of excellence.

About iF:
iF International Forum Design GmbH is one of the oldest independent design institutes in the world and has been awarding industrial products of particularly high-quality design since 1953.

"User Experience" focuses on the user experience in regards to digital application design. This is exactly what Liebherr has achieved with the new control panel for gear cutting machines, which intelligently distributes the programming and operation of the machine over a two part system: The fixed monitor unit "LHStation" for data input and process monitoring, and the mobile handheld terminal "LHMobile" with context-sensitive user guidance during set-up. The combination of the multi-touch surface and tactile elements on both devices ensure the utmost user friendliness. The control panel is designed for all gear technologies. With the LHGearTec controller interface, Liebherr makes the complete machining of gears at the highest level of precision possible (more on pages 24/25).

Highlights

- 24" main screen with Multi-Touch
- Mobile handheld terminal with 10" multi-touch screen
- Tactile numeric keypad
- Context-sensitive views
- Wired signal transmission for maximum security
- Standardized operating mode selector with RFID-based user recognition
- 8 freely-configurable buttons or key switches
- 2 USB ports for flexible data import/export

LHGearTec closes a technology gap

From gear cutting to complete machining

Conventional turning and milling machines can perform gear cutting, albeit with limited productivity and accuracy. But are gear cutting machines also able to turn and mill? With Liebherr machines, upstream and downstream processes can be integrated. The LHGearTec programming and user interface, together with the Siemens control system, enables a continuous simulation and programming of all machining steps.

The gear cutting process is always at the center of machining. Before a gear is machined, however, process steps are required which are normally achieved by upstream turning machines or machining centers. For example, the blank is first turned on the shell surface, bores are applied to the front side or slots are milled. Frequently, the gear or spline to be subsequently generated must be aligned with these features.

Turning, milling, drilling

Although gear cutting is always at the focus of machining, Liebherr gear cutting machines can integrate upstream process steps such as turning, milling and drilling. To do this, first the necessary turning tool, mill tool or drill is loaded into the main spindle using a tool changing system and the corresponding machining is carried out. At the same time, the reference contours of the workpiece can already be created for later gear cutting, thus omitting the measurement of the externally prepared partly-machined workpiece using a measuring probe or inductive sensor. This saves time since the gear machining can begin without further intermediate steps.

Deburring and chamfering

Downstream processes can also be realized in the gear cutting machine. For less accessible gears, the FlexChamfer unit is recommended, which with simple shank cutters can not only deburr a workpiece in parallel with the machining of another workpiece, but can also chamfer with a targeted profile. This means that the chamfer can be both freely programmed and automatically generated from the data of the defined gear geometry. For complex, collision-prone workpieces, Liebherr offers an engineering service of calculating the specific chamfer program. As well as chamfering, the FlexChamfer unit can also carry out final engravings or markings.

User-friendly programming and simulation

All additional machining is programmed in a user-friendly way on the basis of the downstream Siemens control system (SINUMERIK 840Dsl/ONE) in DIN/ISO G-Code with the available cycles, graphically supported by the Siemens programming system programGUIDE on the HMI Operate.

The LHGearTec control system, in connection with the Siemens center, offers a unique simulation chain for upstream or downstream secondary processes: already during the work preparation, gear cutting can be parametrized on an office PC in one programming station version – exactly as at the machine. This means that the programs can be developed at leisure, which enables a more precise adjustment of the individual, geometry-determining parameters than in the generally more hectic machine environment. The result of the gear cutting can be checked using a 3D model, which can subsequently be further observed in the emulated Siemens control center. All additional operations can be carried out virtually and the gearing situation can be checked using this model.

With the aid of continuous simulation, Liebherr is closing the gap between gearing and “non-gearing” and enabling not only a combination of both worlds but also an efficient work preparation and quick retraction of complex workpieces.

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Consulting offer for product optimization

Added value from data using LHOpenConnect

With its portfolio of gear cutting machines, automation systems and tools, Liebherr-Verzahntechnik GmbH has always been a full-range supplier for gear manufacturing. The service campaign LHOpenConnect is strengthening its offerings with consultation and networking services for product optimization.

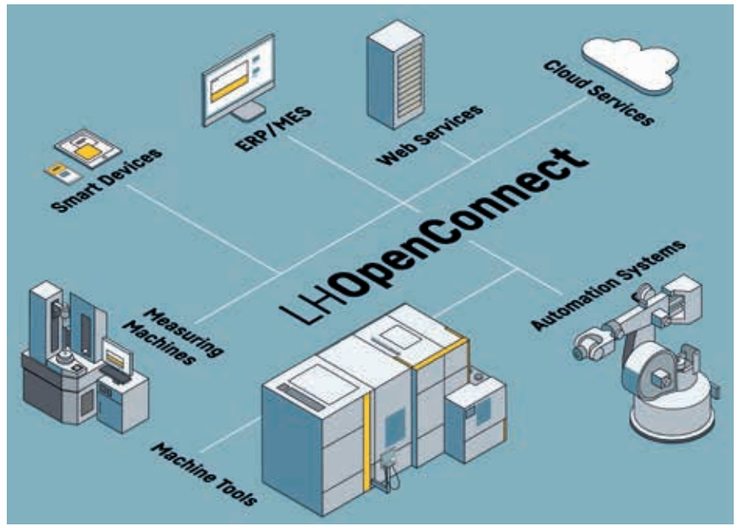
Liebherr is the specialist for gear cutting machines, automation systems, gear inspection machines as well as tool design and manufacturing. This not only applies to mechanical engineering, but also to the software relating to the entire gear cutting process; in particular our own programming systems LHGearTec and LH90. This combined know-how lets our company have a complete overview of the production process; both of our own manufacturing and that of the customer.

A view of all data in the manufacturing line

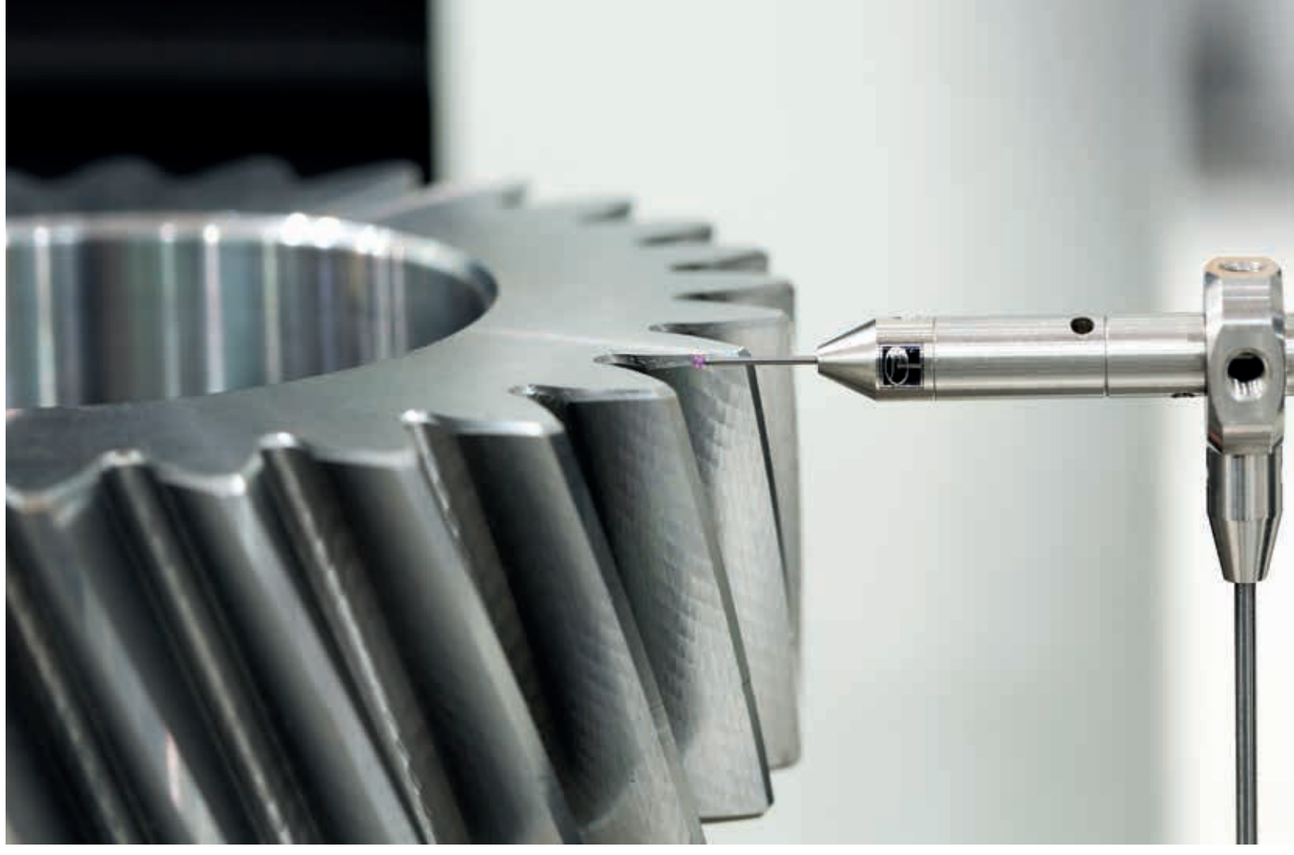
The web-based application of the manufacturing monitoring system, LHWebPlatform enables a detailed view of all data along the entire manufacturing line from the incoming order to manufacturing to quality control. For this reason, Liebherr implements standard interfaces so that, in addition to gear cutting and gear inspection machines, also existing machines and machines made by other manufacturers can be connected via standard protocols such as MQTT, MTConnect, OPC-UA and UMATI.

Individual optimization via LHWebPlatform

Even more is possible based on the interfaces and collected data: With LHOpenConnect Liebherr offers on-site analysis of optimization requirements and the network environment directly at the customer. Using this as a basis, targeted networking can be planned – whether it's for order management systems such as ERP or MES up to the machine, or the exchange of inspection and quality data via the GDE interface between gear cutting and inspection machines. With this methodology of service, Liebherr can contribute to creating real added value for the machine operator based on pure data which arises during digitalization.



LHOpenConnect: networked manufacturing and consultation for optimized production



The new software ensures even greater precision during the measuring process

Chamfer measurement integrated into gear measurement

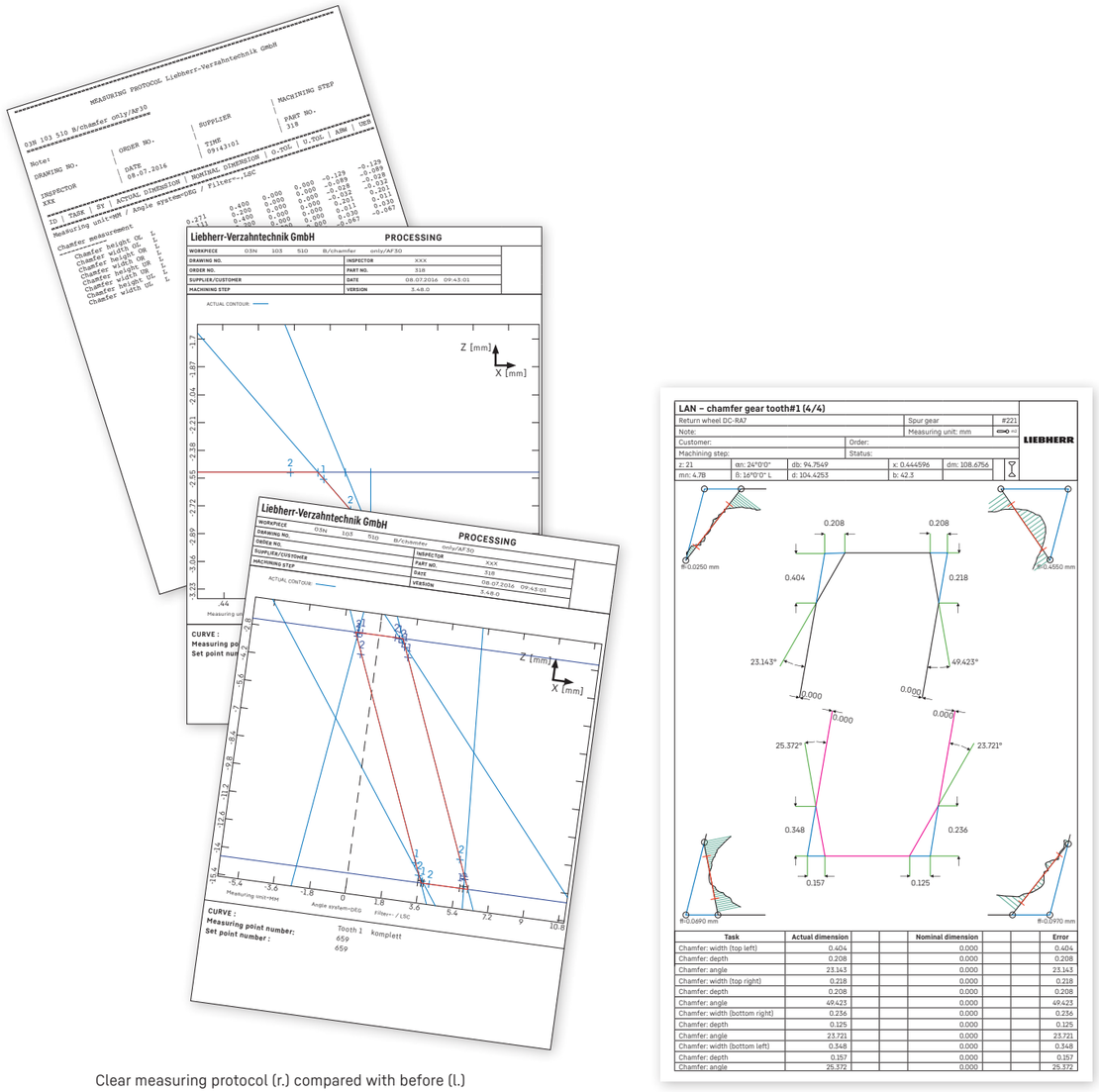
Two become one

Liebherr-Verzahntechnik GmbH has refined its inspection software for gears and combined two steps into one: Chamfer measurement is now integrated into gear measurement. Initial default evaluation ranges ensure process reliability and maximum precision of the measurement results. In addition, the simplified data input and improved layout representation of the measuring protocol ensure usability.

Gears and chamfers were previously measured in two steps using different measurement software modules: First, the entire face width of a gear was captured by continuous scanning. Based on this, the operator then manually defined in the measurement software module the evaluation limits for the chamfer, which was subsequently measured in a further step. This was problematic because, on the one hand, specific areas could only be unaccuratly defined: The evaluation limits and the number of detected points for the chamfer within these set limits were theoretically calculated and not actually measured on the chamfer. Potential position deviations of the actual chamfer could not always be exactly determined. In addition, manual, user-dependent data input was time-consuming and could falsify the measurement results.

New: automated chamfer measurement

Liebherr has now succeeded in integrating chamfer measurement into the standard gear inspection software. The determination of the evaluation ranges and the definition of points to be scanned are now automated. This means that the measurement and evaluation parameters only have to be entered once at the beginning, while the determining of the evaluation ranges for the chamfer and the definition of the points to be scanned are carried out automatically. “The software detects where the chamfer begins and measures the actual chamfer”, explains Matthias Brüderle, Product Manager for Gear Measuring Machines at Liebherr. “This results in a high repeatability, and therefore even more precise measuring results.”



Clear measuring protocol (r.) compared with before (l.)

Task	Actual dimension	Nominal dimension	Error
Chamfer: width (top left)	0.404	0.000	0.404
Chamfer: depth	0.208	0.000	0.208
Chamfer: angle	23.143	0.000	23.143
Chamfer: width (top right)	0.218	0.000	0.218
Chamfer: depth	0.208	0.000	0.208
Chamfer: angle	49.423	0.000	49.423
Chamfer: width (bottom right)	0.236	0.000	0.236
Chamfer: depth	0.125	0.000	0.125
Chamfer: angle	23.721	0.000	23.721
Chamfer: width (bottom left)	0.348	0.000	0.348
Chamfer: depth	0.157	0.000	0.157
Chamfer: angle	25.372	0.000	25.372

Simple and clear

Liebherr’s measurement software has always been user friendly. With this development, data input and output has been optimized and simplified, specifically for chamfer measurement: Each chamfer can be exactly defined with the numerical input of the evaluation limits. For both a single chamfer and for all four chamfers on a gear tooth, the nominal values for chamfer width, depth and angle can thus be input and scanned during the first measurement. In addition, the operator can set parameters such as the stock for grinding or the number of gear teeth to be measured. The output of the measurement results was modified to include the chamfer measurement. The inspection protocol is easy to read and is displayed in graphic and tabular form (see image on page 28).

Increasing demands on the measuring technology

The requirements for gears with regard to power density, gear efficiency, service life and noise emissions are continually rising in all application areas for gearboxes. Particularly for applications in e-mobility, gear measurement technology is an important component of quality assurance and production process control. With the automation of chamfer measurement, Liebherr is therefore taking a logical step which will ensure the highest accuracy and high process reliability with simplified and time-saving operation.

Available separately and as a retrofit

The software that Liebherr has developed in an exclusive cooperation with Metrotek GmbH is installed as a standard on Liebherr’s high-precision WGT measuring machines; these are equipped with Renishaw probe systems, granite guides and air bearing technology. However, the software can also be acquired separately as a basic package with individual extensions – depending on the workpiece – and can be retrofitted at any time. It measures gears from a module of > 0.12. The evaluations comply with common gear norms. Thanks to a manufacturer-neutral GDE interface for the exchange of geometry and measurement data, the setting data can be automatically corrected at the gear cutting machines. If solutions are required which go beyond the standard, Liebherr is available as an experienced development partner. “If the customer has further needs, the software can be individually adapted and updated”, says Matthias Brüderle.

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Gear Measurement Instruments

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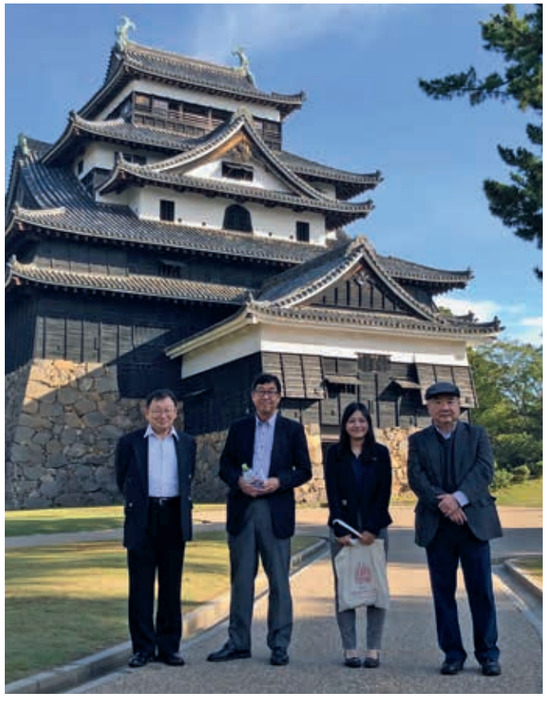
Strategic partnership with Japanese tool grinding machine manufacturer

Seiwa backs Liebherr's measuring technology

The Japanese Seiwa Corporation has recently started using the WGT 400 gear inspection machine by Liebherr to measure the tools that are used for its customers. The manufacturer of machine tools for the gear industry has confidence in the measuring instrument's excellent precision. Liebherr is now offering tool grinding machines made by Seiwa, in order to expand the product portfolio for customers.



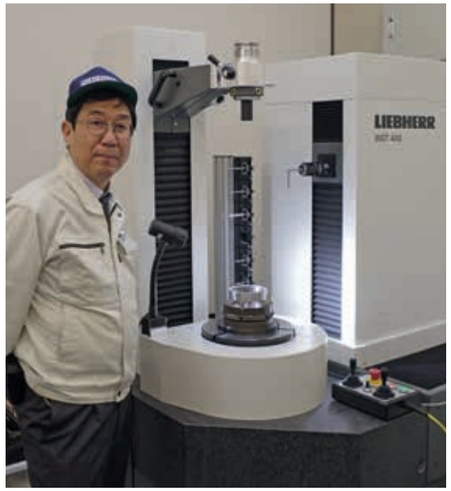
From left to right: Yoshio Itoh (President, L+M Corporation), Toshihiko Tatsu (President, Seiwa Corporation), Kana Nakayama (Sales, Liebherr Japan) and Kiyoshi Iguchi (Branch Director, Liebherr Japan) during a visit to the Shinto shrine Izumo Taisha

In south-west Japan, situated by the Sea of Japan and Lake Shinji, one of the country's largest inland lakes, lies the picturesque coastal town of Izumo. It is famous, among other things, for one of the oldest and most significant Shinto shrines in Japan: Izumo Taisha. Not far from there is the headquarters of Seiwa Corporation, a leading manufacturer of machine tools for gear manufacturing in Japan. For Toshihiko Tatsu, the president and majority shareholder of Seiwa since 1994, this location has a special significance: "In Japanese mythology, Izumo is the country's birthplace. The art of forging and steel processing also have a long tradition here, which continues to inspire us as a mechanical engineering company."

International sales partnership

Seiwa, which celebrated its 100th anniversary in 2020, is proud of its tradition as a customer-oriented solution provider: "With just under 100 employees, we supply leading companies of the Asian automotive industry and gear manufacturers worldwide", president Tatsu explains. "We place great significance on innovation and technological progress and have been involved in research cooperation with universities and research centers for a long time."

Liebherr has opened its own sales office in Japan in 2015. The contact between the two companies was brought about by Kiyoshi Iguchi, Director Sales & Service at Liebherr in Japan. Ultimately, Toshihiko Tatsu was won over by Liebherr's presence as a complete provider of tools, machines and technology. This gives him confidence in the quality and precision of Liebherr's measuring technology.



President Toshihiko Tatsu puts the WGT 400 into operation

Peter Wiedemann, General Manager for Sales of Liebherr-Verzahntechnik GmbH, expects new impulses for international business to result from the sales partnership: "For us, the strategic partnership with Seiwa is a springboard into new markets, which we are happy to use."

The WGT 400 – universal and accurate

The company is well-known in the Asian market for the high quality of its products. Since March 2021, quality control of the tools used by Seiwa has been carried out on the WGT 400 gear inspection machine by Liebherr. It is also available there for tests and customer presentations.

The WGT 400 is a universal gear inspection machine which is suitable both for gear and for tool measurement and which provides a high-quality alternative to other common inspection machines. Lapped granite guides, air bearings, precision rotary tables and Renishaw probe systems ensure the mechanical precision of the machine. On the WGT, any type of gears, shaft geometries, gear cutting tools and other rotation-symmetrical workpieces can be measured – individually configured by Liebherr according to user requirements. Each model fulfills the quality standard of group 1 according to VDI/VDE 2612/2613 and measures gears from a module of > 0.12.

The machines are installed and commissioned on site by Liebherr service specialists. In addition, training is provided which is adapted to the specific customer, as well as service support packages. The WGT is equipped with an extensive software package, which includes not only gear and tool measurement but also integrated chamfer measurement. The measuring results can be evaluated according to the different country-specific norms – for example, according to JIS in Japan or AGMA in the USA.

Customer benefit for both sides

Toshihiko Tatsu expects, in particular, that the Liebherr gear inspection device will optimize the precision and quality of the measurement of tools used to machine very small parts: "We are currently putting a lot of work into machines for the production of internal gears and gears with very small modules. We are also hoping for an increase in efficiency due to the WGT 400's high measuring speed. The supply of data in real time is a real advantage: Since our largest customer, Honda, also uses a WGT 400, this will make exchange of data a lot easier."

Liebherr, in turn, is expanding its product portfolio with tool grinding machines: The grinding machine from Seiwa's FABRIS product line sharpens the hobs for the machining of straight and helical gears. Until now, Seiwa machines have been well-known in the Asian market, where their stability and precision are valued by manufacturers and users. Liebherr customers will now also benefit from this: "We are taking this step because we are convinced of the quality of Seiwa's machines", says Kiyoshi Iguchi.

Two companies, one philosophy

Iguchi also has confidence in the company: "Seiwa is an agile, pragmatic company with a hands-on mentality, close customer contact and lots of experience – small but fine, and well connected in the Japanese gear world." Both Liebherr and Seiwa view themselves as innovative solution providers focusing on the customer and their individual requirements. When asked what he particularly values about Liebherr, Toshihiko Tatsu says: "The foreman system in Germany stands for the craftsmanship which is greatly valued in Japan. I am impressed by the quality awareness of the Liebherr technicians and always have the feeling that one can learn a lot from them. This is probably the factor that makes Liebherr a top brand." Both companies are convinced that the consensus between the companies' philosophies is a good basis for a partnership and that customers on both sides will benefit from the expanded product portfolio and technological expertise.

Seiwa Corporation

Company size:
100 employees

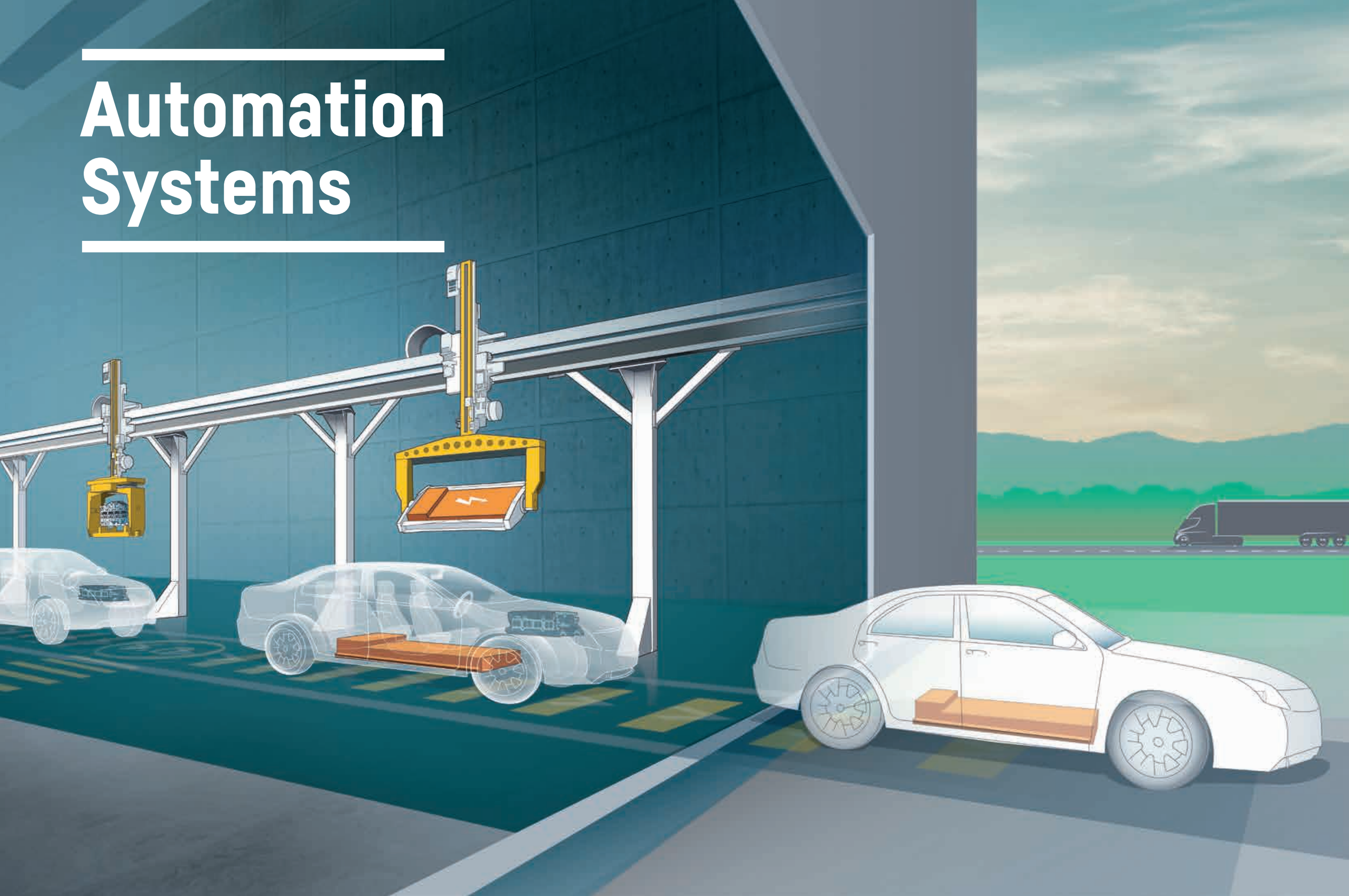
Founded:
1920

Headquarters:
Izumo, Japan

Locations:
Izumo, Osaka, Tokyo

Website:
www.segtec.jp/english/

Automation Systems



System supplier with process competence

Innovative automation solutions for e-mobility

In the course of the mobility transition, electric and hybrid drives will gradually replace the traditional combustion engine. The battery is a key element in electrification: More and more manufacturers are starting their own production of battery systems and are looking for suitable solutions to do so. Liebherr has looked into the processes extensively and offers system-capable, modular concepts for the automated assembly of battery packs.

The requirements for the production of combustion engines are generally known and exactly defined. However, the production of e-mobility components is still new territory for many users. Systems for battery pack assembly are mostly not yet designed to deal with large batch sizes and are therefore only partially automated, because complete automation is not yet economically viable for smaller and medium batch sizes. When batch sizes increase, however, partially automated production is no longer efficient or economical. In order to be able to keep pace in growing markets, fully automated assembly lines are increasingly in demand by vehicle manufacturers and suppliers.

Automation provider with system capability

Liebherr has integrated this technological transition into the further development of its automation solutions and built up corresponding expertise in order to support its customers in the design of new manufacturing processes. The company designs manufacturing lines for both conventional and electrified drive systems and, with its modular automation solutions, covers all requirement profiles from individual stations to turnkey systems – whether it is for combustion engines or for e-mobility.

“We have always considered ourselves to be solution providers and a point of contact for all customer concerns”, explains Viktor Bayrhof, Market Sales & Product Management for Automation Systems at Liebherr, describing the company’s aims. “Because of the changed requirements made of automation in e-mobility, we are currently changing from being an automation specialist with a focus on material flow technology to a system supplier with process competence.”

Core processes in battery assembly: dosing and screwing

With regard to these requirements, various subprocesses in battery pack assembly play a decisive role. These are mainly dosing and screwing processes:

- The dosing and application of the heat-conducting and electrically insulating gap filler, a heat-conducting paste for the thermal connection and cooling of the electrical components
- Inserting and screwing the modules into the battery pack
- Applying and screwing on the battery lid, and applying the sealant so that no gases can escape or moisture enter the battery

Other important modules are critical and safety-relevant processes at the end of the manufacturing line, such as the leak test and the end-of-line test (high-voltage electricity test), as well as the integration of the associated test benches into the manufacturing line. Here, solutions are being developed for how to transfer a battery pack from the manufacturing line to the test bench. But extreme scenarios, such as the case of fire, are also being considered and emergency strategies developed.

Automated plugging of module connectors

Liebherr pays special attention to the electrical contacting of high-voltage module connectors (busbars). These can be plugged, screwed or welded. Pluggable module connectors present significant advantages compared with screw connections. For this, Liebherr has developed an innovative and unique automation process with which this type of plug connection can also be plugged with process reliability (more on pages 37/38).

From subprocesses to a complete system

The components for the individual processes are supplied by specialist suppliers; for dosing processes, for example, the dosing equipment, including the pump, metering unit and process monitoring system, are bought. Liebherr integrates these into its own robot cells and supplies a turnkey automation solution for the customer-specific process. This may mean integrating process stations into a complete system conceived by Liebherr; however, if required, Liebherr can also offer a single station. “We consider the process from inside out – from the individual process in detail to the individual robot cell, right up to the complete system. We can test and validate all this on our own test systems under real

Test the core processes of the battery-pack assembly at Liebherr's Tech-Center

conditions", explains Jan Pollmann, development engineer for automation systems. "If we imagine the individual components of automation as being like a Lego building block, here in the Tech-Center we have already built a small Lego city and got it up and running."

Unique possibilities in the Tech-Center

Over 700 m² of testing space, Liebherr carries out feasibility studies and preliminary tests in its own Tech-Center. Subassembly lines with technology modules for the automatic production of battery packs (screwing, plugging, dosing, bonding, gripping, positioning) are available there for tests and quality control of components and processes.

Liebherr thus offers the possibility of testing and validating processes under real conditions. Tests can be presented to customers on site but also virtually using cameras. With test series commissioned by customers, Liebherr is flexible and quick to respond: "If the customer wishes to test a process directly on the workpiece, we can build a test line for this within a very short time", explains Jan Pollmann. "These core processes can then be scaled up to the series system for volume production." In order to fulfill as many customer requirements as possible, the individual process stations are equipped with different robot types from Kuka, Fanuc or ABB.

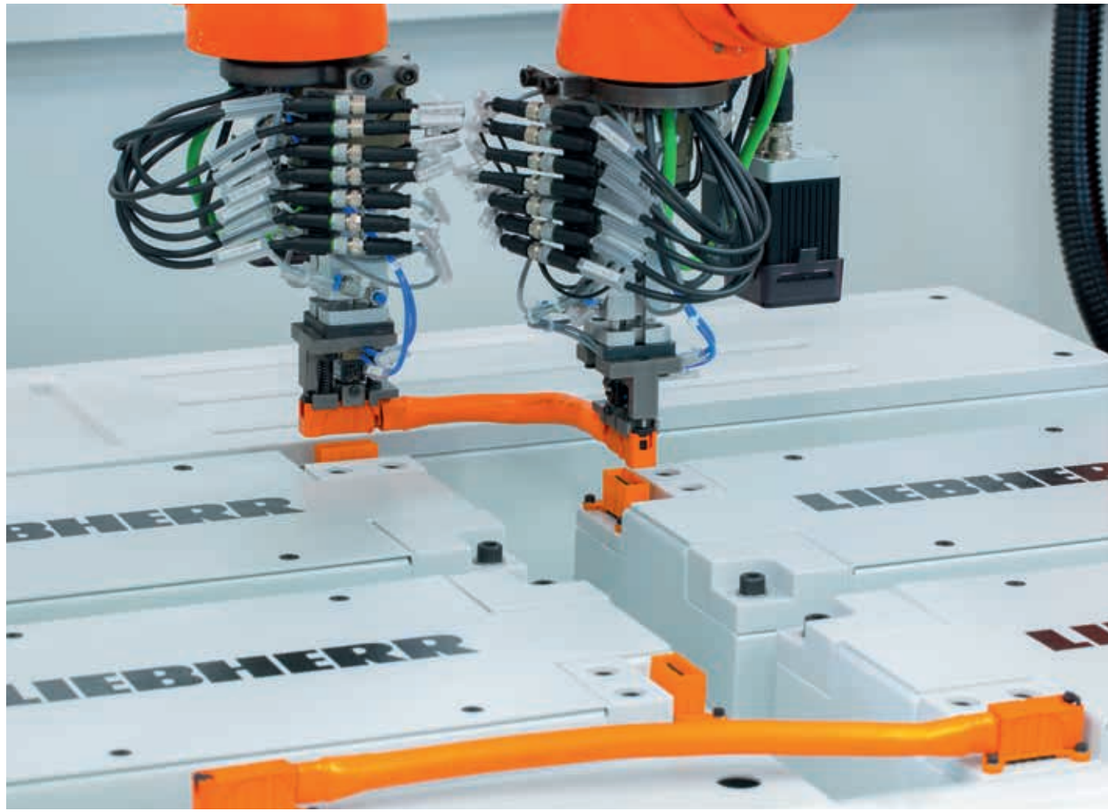
Competence center for e-mobility

This enables Liebherr to advise customers comprehensively on the design of new processes, thus preparing them for the forthcoming technology transition, whether it is for subprocesses or for the entire assembly line. The modular approach offers the greatest possible flexibility, whether it is in the integration of manual workstations or the subsequent retrofitting of automation processes due to rising batch sizes. "This means that the degree of automation can 'grow with the company' according to individual customer requirements. System capability means that we can combine all the process modules into a complete system", says Viktor Bayrhof in summary.

Innovative and safe method for battery pack assembly

Liebherr automates the assembly of pluggable module connectors

Plug connections for electrical contacting of modules in the battery pack offer several advantages. However, until now it was only possible to assemble them manually – an obstacle for large batch sizes. Liebherr, together with KOSTAL Kontakt Systeme GmbH, has developed an innovative solution for the automation of the plugging process.



KOSTAL

KOSTAL Kontakt Systeme GmbH

Sector:
Development, production and distribution of plug systems for the automotive industry

Company size:
1,400 employees

Founded:
1993

Company headquarters:
Lüdenscheid, Germany

Sites:
9 sites on three continents: Dresden (Germany), Goldthorpe (Rotherham, Great Britain), Gyancourt (France), Jince (Czech Republic), Turin (Italy), Rochester Hills (Michigan, USA), Shanghai (China), Seoul (Korea)

Turnover:
approx. €3 billion

Website:
www.kostal-kontakt-systeme.com/en-us/

The modules installed in the high-voltage battery must be electrically contacted with each other. Currently, screw connections with busbars made of copper material are predominantly used for this. It is also possible to use plug connections with flexible cables or busbars.

Advantages of plug connections

Compared with screwed and rigid busbars, plug connections with flexible cables offer a number of advantages:

- **Easy assembly:** Only the plug and counterpart have to be connected. This also facilitates the disassembly of the modules in the battery pack during later servicing, for a second life or for battery recycling. The flexible cables can also compensate positioning tolerances in the battery modules of several millimeters.
- **Safety:** Normed, touch-protected contact parts mean that no danger is presented by exposed electrical high-volt contacts.
- **Robustness in practice:** If there are strong vibrations in the vehicle, screwed busbars can detach themselves. The flexible cables with the plug connections are able to compensate for these vibrations.

Challenge: the automation of limp parts

For these reasons, there is growing interest from manufacturers in pluggable connections. However, since the automated assembly of soft components presents an engineering challenge, this has till now still been carried out manually. This can cause a bottleneck in production if batch sizes increase. The problem is that the parts have low resistance against shape changes. They already become very highly deformed as a result of even small stresses, such as their own weight. These changes in shape are often a rejection criterion for the automation of handling or assembly processes.

Innovative automation solution by Liebherr

Liebherr has developed a unique solution for this to enable the automated, process reliable, plugging of module connections. Two cooperating robots each grip one end of the cable and carry out the plugging process synchronously with temporally and geometrically coordinated movements. Using a 2D camera, the robot detects the real position of the slots, thus enabling positioning tolerances to be compensated. The actual, mechanical plugging process is performed using a pneumatic cylinder. A spring assembly limits the force transfer to the module, plug and plug lock to secure the position (CPA). Finally, process reliable monitoring is performed by a stop position sensor. Liebherr can also solve the laying of the cables in the desired position and geometry using suitable cable bend grips.

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AI-based enhancement of bin picking software LHRobotics.Vision

Bin picking made easy

“Bin picking” is among the most difficult disciplines in automation. Adjusting the parameters for reliable recognition and gripping of complex objects is demanding and requires expertise. LHRobotics.Vision, a software by Liebherr-Verzahntechnik GmbH from Kempten, now makes bin picking much easier for users through Artificial Intelligence (AI).

Bin picking is playing an increasingly large role in automation and is one of the most difficult tasks. The robot must recognize different objects chaotically arranged and, in some cases, with complex geometries. It must remove the object from the container without collision, bring it into an orientated position and transfer it to the machine. Setting up the interaction between the components, bin and gripper requires experience and expertise from the operator.

The challenge of bin picking

This is why implementing bin picking solutions presents a great technological challenge for users. In most cases, it is not possible without support by the system manufacturer or integrator. But what if the system was able to learn and could adjust the parameters autonomously during setup or even during operation? Liebherr-Verzahntechnik GmbH, a leading manufacturer of automation solutions, has been addressing this question and is refining its own software, LHRobotics.Vision. This software greatly simplifies parametrization for the user through Artificial Intelligence (AI). “We want to enable ‘bin picking for everyone’”, says Jürgen Groß, Sales Director for Cells & Flexible Manufacturing Systems and Automation Systems at Liebherr, summing up the aim of the project.

Liebherr is well-known as a manufacturer of complete robot cells with integrated bin picking software. In 2020, the Kempten based company decided to offer this software as an independent product. This means that it can also be used in plants with lines made by other manufacturers – which makes it attractive both for end users and for integrators.

„We want to enable ‘bin picking for everyone’.“

Jürgen Groß
Sales Director for Cells & Flexible Manufacturing Systems, Automation Systems

LHRobotics.Vision technology package

Alongside the graphically led, intuitive software, the technology package also includes a projector-based 3D camera system. This enables an object-oriented image recognition system by evaluating a 3D stereo vision recording. From the components' 3D data and the interfering contours of the real bins, a point cloud is generated which serves as the basis for path planning for collision-free component picking. The desired picking positions on the component can be easily set graphically in the software, thus omitting the expensive teaching for the robot.

A special feature is the optional simulation tool, LHRobotics.Vision Sim. Using a physics engine, bin filling is simulated, after which a virtual point cloud is generated and evaluated. This enables the user to adjust the gripper geometry and optimize sequences purely virtually in order to achieve an improved emptying rate of even deeper bins – without risk and without expensive investment in test hardware.

AI enters the system

A new release of the LHRobotics-Vision software is planned for September 2021. Artificial intelligence and machine learning enable the automatic setup of new components in the bin picking process – a quantum leap in this technology. To achieve this, the system calculates the geometrical parameters of the components on the basis of real scan data and analyzes the resolution and the noise behavior of the sensor. Subsequently, test measurements are generated from these scan data, which are then used to determine the optimal setting parameters. This simplifies processes and saves time and costs. Since the system trains itself at each scan during setup and it creates the basis for the next step: Machine learning during operation.

Physics engine

A physics engine is a simulation program which models object interactions and collisions in a virtual world. It takes into account parameters such as gravity, elasticity, friction and conservation of momentum between colliding objects.

Predestined for e-mobility applications

"Many users still shy away from bin picking, because it is apparently so complex and they don't want to have to deal with this problem. With the new software release, we are now able to take these fears from our users and integrators", says Jürgen Groß, who goes on to explain: "We see the paradigm shift in the entire industry as an opportunity as well; because of the upheaval in the automotive sector and the transition to e-mobility applications, we have to face the new challenges."

Thus, Liebherr is now already using Vision systems with Artificial Intelligence for the process-reliable, automatic plugging of limp cable connections – for example, the module connectors of battery packs for e-vehicles. The changes brought about by e-mobility affect not only the drive train, but also body components, which are increasingly being manufactured in lightweight construction. Here too, Liebherr successfully uses LHRobotics.Vision for picking and removing metal components.

"In the future, increasingly complex part geometries and properties will present great challenges to bin picking. AI is a key technology, without which it will be almost impossible to meet these requirements", says Jürgen Groß. "We at Liebherr are familiar with the user side and contribute our expertise to the entire process. This makes us a genuine partner to the industry, and also well equipped for future developments", he summarizes.

Jürgen Groß
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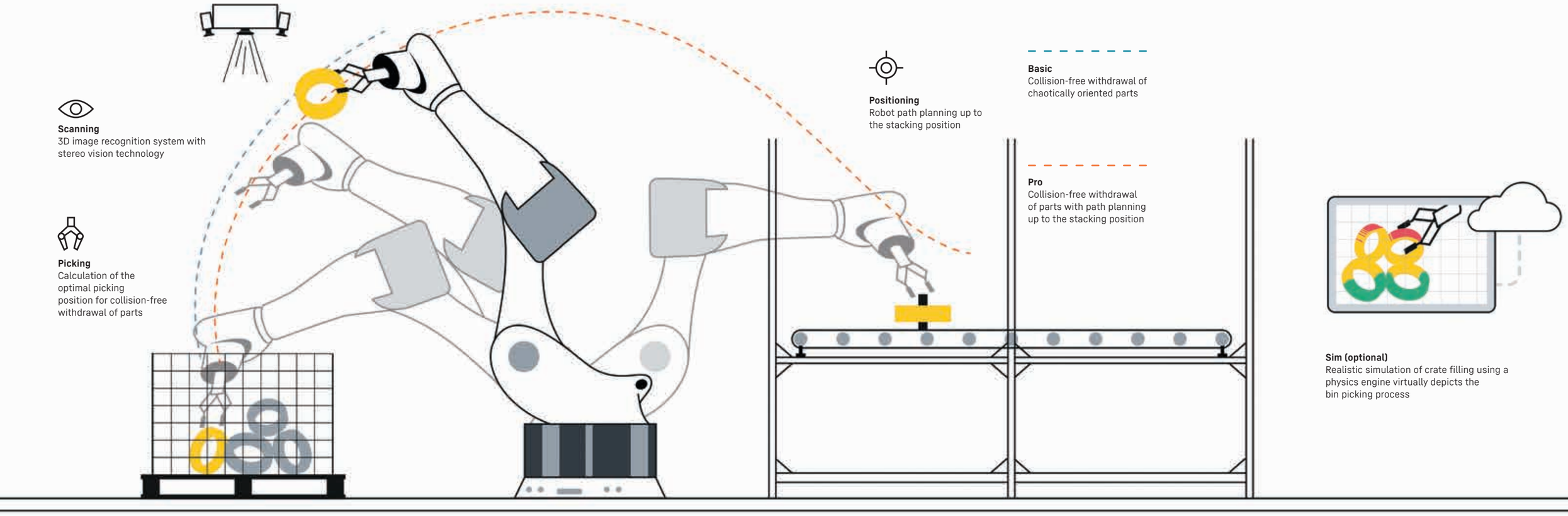

PHS 1500 Allround enables flexible individual part manufacturing

From a pencil sketch to high-tech automation

Hetec GmbH, the Hessian machining technology specialist and supplier for tool, mold, and machine construction, has automated its production using the pallet handling system PHS 1500 Allround. The company almost exclusively manufactures individual parts and small series with long spindle running times and does not seem like a typical automation customer at first glance. Nonetheless, a flexible automation system was the right solution. In this case, the secret to the system's success is its integration into a well-thought-out system layout with three identical Grob G751 5-axis machining centers and the powerful Procam master computer. This combination enables the company to achieve optimal machining flexibility.

Everything started with a piece of paper, a pencil sketch of four rectangles, the idea of a system with three Grob G751 5-axis machining centers, and a linear memory was born. The general managers of Hetec GmbH – Friedhelm, Günter, and Tom Herhaus – had given intensive thought to the requirements and layout of such a system and were prepared to create the necessary peripheral conditions for it. The aim is maximum flexibility in order processing for just-in-time production.

Modern company with digital processes

Founded in 1998, Hetec specializes in the sophisticated 5-axis milling of components, in particular complex components for tool and mold construction, as well as general machine construction. Hetec almost exclusively machines individual parts and small series and adherence to tight delivery deadlines is key. A modern machine park consisting of 5-axis machining centers guarantees the utmost precision right down to the smallest tolerances in micrometers.

The workflows in the modern production hall have been thought through to the last detail. Every tool is electronically monitored and can be used in every machine, which ensures minimal retooling times. Order management for the individual workpieces is digitalized. Each component receives a material routing slip with a bar code containing all the stored information, which can be updated in real-time if changes are made. An app produced by the machine supplier reduces standstill times by allowing users to check the current status of the system at any time, even outside the factory, and to respond immediately to warnings.

Desire for more flexibility

Given the great diversity of parts, absolutely precise just-in-time manufacturing of complex components is a basic prerequisite for sustainable success and customer satisfaction. This only succeeds with perfect order management and optimal flexibility. The path to automation as a solution to this challenge was developed step by step. First, the company invested in a zero-point clamping system which was later supplemented with a Grob G551 with a pallet changing system to be able to manufacture continually at weekends as well.

However, the general managers continued to think about the idea of further flexibility. The solution of attaching three identical Grob G751 5-axis machining centers to a linear feed system to be able to apply the pallets flexibly in any machine seemed perfect – however, for a small contract manufacturer, this didn't exist in this form yet except as a pencil sketch. "Hetec approached me with this request and commissioned me to search for suitable project partners", explains Hans-Hermann Rink, head of Rink Werkzeugmaschinen in Hesse. After a benchmark comparison, the decision was made quickly in favor of the PHS 1500 Allround from Liebherr, and the master computer system Procam was selected soon after that. Decisive factors were the modular concept that enabled machines to be connected successively, and the possibility of adapting the system layout individually to Hetec's spatial conditions and needs. Rink continues: "The providers understood Hetec's programming and manufacturing philosophy and were able to implement it with absolute flexibility".

From left to right: Tom and Friedhelm Herhaus, General Managers of Hetec GmbH; Agnes Schauppel, Product Manager for Automation Systems at Liebherr; Hans-Hermann Rink, Rink Werkzeugmaschinen

„What impressed me was the great flexibility of our project partners and the way in which they catered to our requests and ideas as a matter of course.“

Tom Herhaus,
General Manager Hetec GmbH

PHS 1500 Allround optimizes machine utilization and part availability

“Many components that we machine are only produced once. The PHS Allround expands part availability and storage capacity, while the linear memory ensures maximum flexibility. We can always decide completely freely, and without a machine standstill during reclamping, on which of the three Grob G751s a part is to be machined. This has significantly improved the utilization of our machines. The operator uses the Procam master computer to link the NC programs with the pallets and organize the workflows. Updates or change requests at short notice are also no problem”, explains general manager Tom Herhaus.

Further plus points for the system are its space-saving, compact layout with two frontal setup stations and the front access with the possibility of decoupling individual machines from the operation. Since the operator performs the component check directly in the work area, machine accessibility is a key point. A well-thought-out integration of the ERP system with the Procam master computer enables continuous digital order management. Hetec has developed its order management system, which is tailored to the company. “We felt that we were in very good hands with Procam and Liebherr”, says Tom Herhaus. “Both of them catered to our wishes one hundred percent. Even with special requests, they said - we can do it.” This included, for example, a setup station with hydraulic clamping and the possibility of weight-optimized machine calibration.

Thought through from start to finish

In spring 2017, the project partners sat around a table together for the first time and began planning. This required a lot of coordination and agreement concerning data security, interfaces, and machine conformity. To create the environmental conditions for maximum precision, Hetec had left nothing to chance and had ensured a temperature-stable environment prior to investment.

In December 2018, everything was ready. The first Grob G751 was connected to the PHS 1500 Allround, and in February 2021, the third Grob G751 completed the system. “The PHS 1500 Allround had only just come onto the market and, because of its weight class, matched our components perfectly”, Tom Herhaus recalls, “What impressed me was the great flexibility of our project partners and the way in which they catered to our requests and ideas as a matter of course.”

Were there any difficulties during the project? Tom Herhaus laughs. “It would be incredible if no difficulties arose in such a complex project. We were impressed by the competent problem-solving and the quick response times. Liebherr was exemplary in this respect. The remote support worked excellently. The service was always manned and responded within a very brief time – which was extremely important to us in order to minimize standstill times.”

Impressive Liebherr quality

Herhaus cited quality, flexibility and the individual addressing of customer requests as the particular strengths of all the companies participating in the project. “The robust, solid workmanship and absolute reliability of the system won us over. Liebherr was even flexible enough to take into account our design wishes with regard to color schemes”, he adds with a wink. “The system is our ‘showcase’.”

HETEC.

HETEC GmbH

Sector:
Machining technology

Company size:
20 employees

Founded:
1998

Company headquarters:
Breidenbach, Deutschland

Website:
www.hetec-cnc.de

Thanks to its overlaid turning and swiveling movements, the storage and retrieval unit enables loading of the machines at an incline

Liebherr automates heavy loads safely and efficiently

PHS 3000 Allround: The family is complete

With the successful launch of the PHS 3000 Allround pallet handling system, Liebherr's PHS family is now complete. It enables the handling of large and heavy parts weighing up to three tons. Particularly in this area, automation can achieve a high degree of efficiency and cost-effectiveness.

The PHS 3000 Allround contains all the proven qualities of the PHS family, just like its smaller siblings the PHS 800 and PHS 1500, the system automatically supplies machine tools with machine pallets. A flexible combination of standardized modules enables the user to uniquely configure their systems and allow for machine tools, setup stations, pallet storage and further modules to be added for expansion and scalability in all directions.

Large telescopic stroke for heavy parts

In the new weight class, large and heavy parts weighing up to three tons of transport load can be automated – for example, valves for pipelines, axle components for heavy commercial vehicles or structural parts for the aerospace industry. For the PHS 3000 Allround, a particularly robust telescoping stroke was developed. This also retains the special advantage of frontal access; the operator is able to access the machine at all times through a door between the PHS and the machine. This ensures minimal downtime and high productivity, since the system continues to run when decoupling individual machines for manual activities or maintenance work. The shelf magazine on the PHS 3000 Allround also offers pallet storage for up to three levels.

Particularly economical for heavy loads

The intelligent software makes automation profitable even with low batch sizes: "The cell control follows the material flow and manages orders so intelligently that even small batch sizes can be elegantly conveyed through the system", explains Agnes Schauppel, Product Manager of Automation Systems at Liebherr.

Heavyweight: The Liebherr service bus has an extraordinary task

The possibility of setup during the machining process and unmanned manufacturing in multi-shift operation increases the machine runtime by up to 90 percent and reduces the unit costs by up to 40 percent; overall, increasing the capacity by two and a half times. Because of the higher machine investment when machining large components, the automated handling is particularly profitable for parts with a high volume or weight. A pallet handling automation system increases the manufacturing capacity without additional machines and can therefore even cut investment costs.

PHS 3000 Allround	Technical Data
Max. transport weight	3,000 kg
Max. collision circle diameter*	Ø1,400 mm / Ø1,700 mm
Max. machine pallet size	800 x 800 / 1,000 x 1,000 mm
Shelf levels	2 to 3
Max. workpiece height (including pallet)	1,600 mm (2 shelf levels)

*The collision circle diameter designates the maximum permitted deviations of the machine pallet, including workpiece clamping and workpiece.

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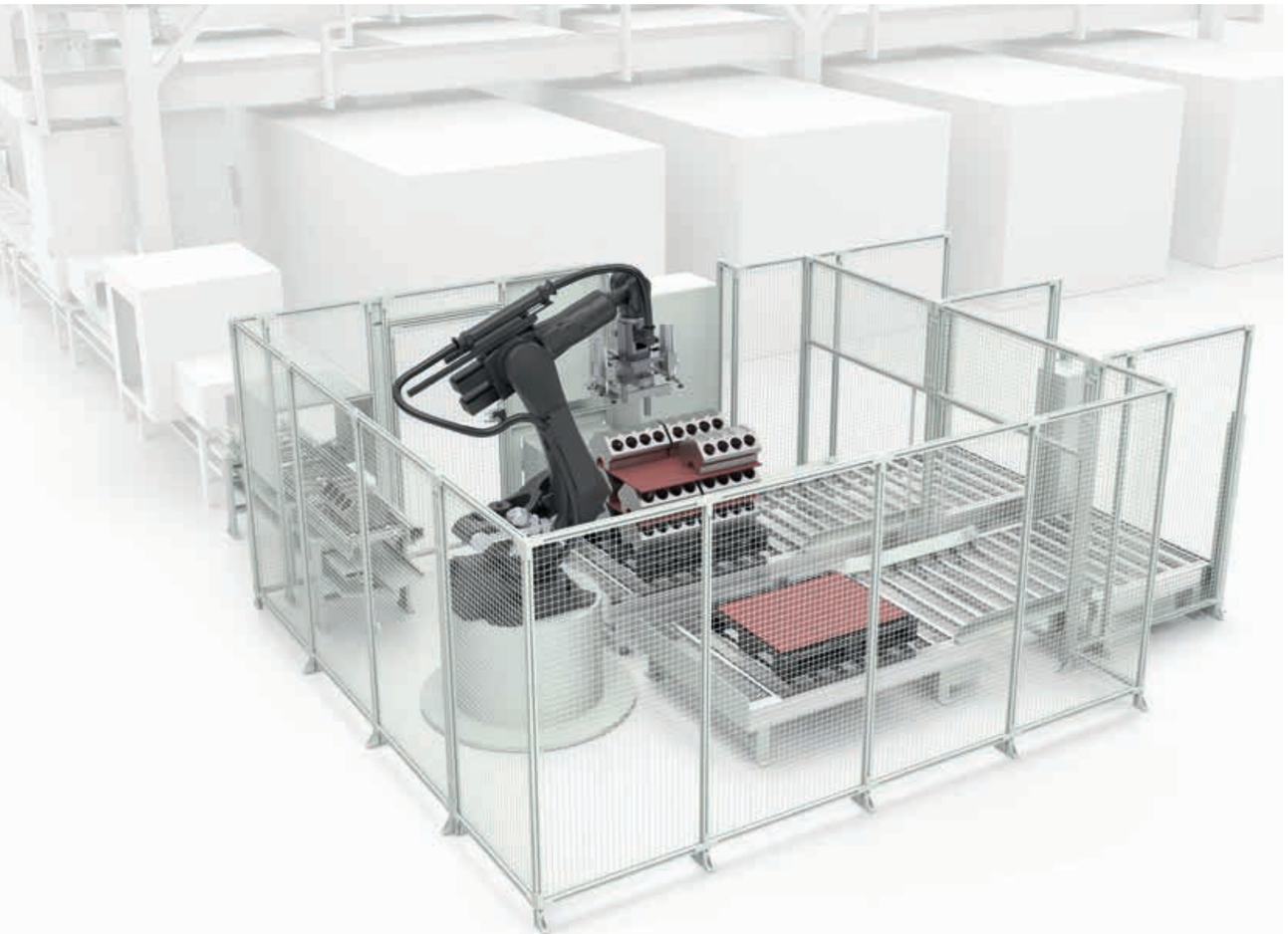
Productivity reserves in the manufacturing of vehicle parts

Automated line inputs and outputs



Due to the electrification of automotive fleets, there is no doubt among experts that growth in combustion technology will come to a halt. This will result in increased cost pressure on the current production capacities. A simple retrofitting solution by Liebherr for automated raw part input and finished part removal helps to make full use of productivity reserves.

The manufacturing lines for components of combustion engines, such as engine block, cylinder head and gearbox housing, are usually fully automated. However, a number of manufacturers worldwide continue to load and unload material or parts manually. For the operators, this is monotonous and heavy work.

Efficient pick-and-place solution by Liebherr

Particularly in high-wage countries, automation in this area would quickly pay off, but automated machine loading is also an interesting option in low-wage countries. In the inexpensive and space-saving Pick-and-Place solution by Liebherr, components are added to the line in blisters or on pallets. A robot then grips the parts and feeds them into the line. At the end of line, the process takes place in the opposite order. In the case of simple applications – for example, for pre-sorted workpieces in blisters or frameworks – such a solution can be designed with process reliability without the use of vision systems. Liebherr solves more complex depalletization tasks in which, for example, the orientation of the workpiece varies due to tilting, using 2D or 3D robot vision systems. To evaluate 3D images, the proven Liebherr software LHRobotics.Vision is used in a reduced variant (more on page 39).

Easy retrofitting for lines by other manufacturers as well

This means that highly-qualified employees can be used for value-creating tasks, while unproductive process idle times are eliminated and lightly-manned manufacturing can be expanded. Further-reaching solutions, right up to completely unmanned manufacturing (“lights-out production”) are also possible. The use of transverse shuttles to optimize the loading cycle or the connection of an automated guided vehicle (AGV) are also conceivable. Since the robot cells are a closed unit, Liebherr’s solution can also be applied to manufacturing lines by other manufacturers.

Concept also suitable for e-mobility parts

The concept can also be applied to manufacturing lines for e-mobility. Particularly in battery pack assembly, large, heavy workpieces such as battery trays or modules are processed. Viktor Bayrhof, Market Sales and Product Management for automation systems at Liebherr, sees future application potential here: “„In existing production facilities, space is usually very limited. Liebherr has developed a simple, inexpensive, custom-fit retrofitting solution which is also suitable for further automation in e-mobility.”

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In Focus

The Liebherr team at the Guaratinguetà site

Liebherr's used equipment program goes international

Reman starts in Brazil

The Reman used equipment program provides a second lease of life for older, high-quality machines. Since 2016, older machines have been refurbished at locations in Germany and the USA. Now the Reman program is also being launched at the Liebherr site in Brazil.

The Reman program is a cost-effective alternative to purchasing a new grinding, shaping or hobbing machine. Depending on technology, age or residual value, customers can choose between a reconditioned used machine, a general overhaul, or repair of their own machine to original manufacturer quality at attractive conditions. After the general overhaul, a used machine from the Reman program looks like new, is up to date with the latest technology, and comes with a new warranty.

Reman: Used machine, overhaul or repair

If the customer orders a new or a reconditioned used machine, Liebherr offers to buy back the customer's used machine, provided it is suitable for this. If the customer has their machine overhauled, Liebherr provides a rental machine to minimize downtime.

The scope of a machine overhaul depends on the customer's requirements or wishes regarding the machine and workpiece qualities. Liebherr replaces the respective components in several steps:

- **Step I**
  ensures that the existing machine quality is maintained.
- **Step II**
  restores the machine to the quality on delivery.
- **Step III**
  contains additional upgrades for the controls to latest version.

Individual assemblies can also be overhauled and come with a warranty. Maintenance and service, as well as repair and spare parts services, are also part of the program. Ralf Glatzeder, head of the Reman program at Liebherr, is well aware that experience counts. "In Brazil, just as in Kempten, we have experienced and qualified employees who have worked for many years in the assembly and servicing of machines, and are also very familiar with older models."

Market entry strategy for smaller companies

So far, the Reman program has been offered at the Kempten (Germany) and Saline (USA) sites. By offering the service at the Guaratinguetá site in Brazil, Liebherr is a pioneer in the South American market. "We are expanding the program worldwide in order to reduce the transport and handling expenditure of the machines for our customers," explains Glatzeder.

Small and medium-sized companies in South America are the main beneficiaries of the program. In the local industry, the production facilities are often not fully utilized in three-shift operation, so that the acquisition of a new machine would often not be profitable for a company. The comparatively inexpensive Reman machines are also affordable for small and medium-sized companies. "With our low-cost solution, we are making it easier for smaller suppliers and job shops in particular to enter the market. None of our competitors offer this," says Claudio Mota, After Sales Manager at Liebherr, Brazil.

Economical and sustainable

Liebherr's used equipment program is not only efficient in terms of economics but it also contributes to sustainability and the conservation of resources. The refurbishment of an existing machine requires significantly fewer raw materials than the production of a new machine, reduces material and energy consumption, and cuts greenhouse gas emissions. Liebherr is committed to this goal as a partner in the VDMA's Blue Competence initiative, which promotes sustainability in the machine tool industry.

Before

After

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Expansion of Liebherr's service portfolio

Industrial services of the future

Liebherr is expanding its service portfolio and entering the digital future with extended support solutions. This enables customers to save time and money while increasing their system availability through fast response times and an effortless ordering process. Seminars and training courses are now also being offered in an interactive online format.

Special circumstances require special solutions: The operational readiness of machines and systems must be guaranteed, even if on-site customer service is not possible, or only to a limited extent, because of social distancing. Liebherr has adapted its service portfolio and is supporting its customers worldwide with various services: Expert support by remote service ensures fast response times for troubleshooting. Retrofitting solutions for machine control systems enable remote access even for older existing machines. The Liebherr Academy conveys application and maintenance knowledge in interactive Live Online Training courses with up-to-date media technology (more on pages 56/57), the Reman program extends the economic working life of older machines if required (more on pages 52/53).

Efficient processes using remote service

The advantages of remote service are obvious. Fast response times ensure minimized standstills and higher system availability while reducing travel and downtime costs. In the case of mechanical or electrical problems, the service specialists give unbureaucratic remote support with the involvement of all the required departments. For software problems, after authorization by the customer, they dial in directly to the machine control system, analyze machine and process data and error messages, and carry out the troubleshooting online together with maintenance.

Liebherr makes this as easy as possible for their customers: Efficient and inexpensive service packages ensure a fast and seamless process. Flat rate packages reduce the order times and simplify the processing effort on both sides: In urgent cases, the maintenance staff can request support directly from Liebherr, without going via their own purchasing department, thanks to the remote packages. For special topics or special requirements, further technical specialists can be involved by Liebherr quickly and easily. This facilitates the customer's access to manufacturer expertise and know-how.

Remote service creates the basis for digitalization

Liebherr guarantees a secured infrastructure and an established remote support connection, thus creating the basic prerequisites for further digitalization solutions. Upgrades and updates to the machine software can be installed quickly and cheaply. Even older existing machines with an LH90 control system can be retrofitted for remote service access. "We have noticed that openness to digital services has grown considerably in the course of the pandemic", explains Maximilian Hofmann, Global Industrial Services Manager at Liebherr. "The readiness to face the challenges of digital solutions and support is increasing – although many people also still see risks."

Sensitive handling of data security

For many customers, the security of their machine data is a very sensitive topic. "Many customers have reservations concerning the security of their production data", explains Maximilian Hofmann. For this reason, the standards for data protection at Liebherr are high: State-of-the-art technology and encryption algorithms guarantee maximum data security. "We assure our customers that their data is secure and that we will only intervene in the operation of the system if requested to do so", Hofmann continues.

Liebherr Industrial Services portfolio

- **Remote service:**
  Quick troubleshooting in the form of offline and online support
- **Retrofitting solutions:**
  Retrofitting of the LH90 control system on existing machines
- **Live Online Training:**
  Interactive training courses with state-of-the-art media technology
- **Reman program:**
  Second life-cycle for older machines

Coronavirus will pass, digitalization will remain

Liebherr has expanded its service portfolio for the time after the pandemic as well. "We have adapted our support to the changed general conditions and offer it in attractive packages which optimally supplement the different maintenance strategies of our customers. This enables us to be available for our customers remotely as well, as quickly and personally as possible. Remote service will also be a permanent component of our portfolio in the future", Hofmann summarizes.

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Fully equipped, interactive, practical

Liebherr Academy goes digital

Everyone's talking about digital learning – Liebherr shows how it's done: Training courses on all topics connected with gear technology are now taking place in the form of interactive Live Online Training. Participants can tune in from anywhere and can also be trained virtually on the modern, fully equipped machines in Liebherr's new Machine Training Center (MTC) if required. The new training catalog provides a comprehensive overview of all the training courses offered.

With Live Online Training, Liebherr has expanded its proven, practical on-site training format to include a digital format. Elaborate media technology depicts the processes on the machines in the brand-new Machine Training Center (MTC): Here, grinding, hobbing and gear inspection machines with state-of-the-art technology, are available for the participants and offer ideal training conditions for on-site training and – thanks to up-to-date camera equipment – also for Live Online Training. During the training session, the trainer can superimpose the control system and work area of the machines accordingly using several cameras. Small learning groups with a maximum of six participants enable an interactive learning dialog with the trainer, therefore increasing the learning value.

The Machine Training Center (MTC): Ideal training conditions for on-site and online training courses

MTC

Machine Training Center (MTC)

- On-site or online training in dedicated rooms in the Liebherr factory under ideal training conditions
- Equipment: gear hobbing machine, generating gear grinding machine, and gear inspection machine, all with state-of-the-art technology
- Programming and simulation stations to deepen understanding of the learning subject
- Introduction to new software products
- Motivated trainers from the field
- Very high-level training
- Inexpensive and targeted employee training; individual participation is also possible

LOT

Live Online Training (LOT)

- Digital, interactive "live" learning using the latest media technology
- Travel time and costs are omitted; participation is possible from anywhere with the appropriate equipment and technical prerequisites
- Integration of machines from the MTC using elaborate camera technology
- Standard training courses possible with short preliminary planning
- Training is individual to the customer and their requirements, with a question and answer session
- Small groups with max. 6 participants
- Didactic concept: interactive learning dialog
- Languages: German and English

"We wanted to offer more than just web seminars. It was quite an effort to implement the Live Online Training, but we wanted to offer our customers the modular and topic-based training program online, as much as possible, in the same scope and quality that they are used to from our on-site training. Thanks to the technical equipment and our didactic concept, high training level is also guaranteed in the digital format", says Markus Bahsler, head of the Liebherr Academy. The whole program is capped by comprehensive training documents.

New possibilities in a digital format

Travel time and costs are omitted, and participation is possible from practically anywhere around the globe. The format even opens up additional flexibility: Product-related training can also be implemented, and companies can register their employees individually for this. Individual sequences of a training course can also be combined logically. An additional benefit: For specific questions, there is the possibility of individual question and answer sessions after the seminar.

Full catalog of all the training courses

The new catalog on the Liebherr website provides an overview of the entire training program. Prepared in a graphically appealing way, it makes the structure and logical sequence of the training units transparent and offers the possibility of configuring employee qualification yourself.

Contact the Academy team and order the current training program!

Contact and individual customer advice:
Vanessa Gräßle
Phone: +49 831 786-1010
training.lvt@liebherr.com

MuT project: Liebherr encourages young women to go into technical professions

Girls and technology – that's a match!

Even though the proportion of women in technical professions is increasing, they are still under-represented in many companies. That's not the case within Liebherr: for over 30 years, the company has been cooperating with the Maria Ward girls' secondary school in Kempten. The vocational orientation project "MuT – Mädchen und Technik [Girls and Technology]" aims to increase interest of young women in technical professions at an early stage. We discussed this project from different perspectives.

Michael Messer, Wolfgang Kern and Walter Ferstl visit Sabine Fetzer at her workplace

The MuT project is now an indispensable institution for vocational orientation and work experience to introduce young girls to technical professions. How did it all start?

Walter Ferstl: My colleague at the time, Siegfried Nußmann, and I were convinced that it doesn't matter who assembles or commissions a machine – whether it's a boy or a girl. In 1990, I approached the vice principal at the time of the Maria Ward girls' secondary school. Together, we organized information evenings and factory tours, which were intensified with his successor Wolfgang Kern and the school principal at the time, in order to increase girls' interest and to convey to them that technical professions are not just for boys.

Wolfgang Kern: I remember it well! Above all, the parents were very skeptical. They thought that the operation of machines was heavy manual labor and only for boys. At one of our information evenings, a Liebherr trainee got on the podium and talked with enthusiasm about her work. She was around 5 foot three and very petite – which really shook the image of a strenuous male profession!

Ms Fetzer, you completed the MuT project a few years ago and then started training to become an electrician for industrial engineering at Liebherr. What made you decide to take on a technical profession?

Sabine Fetzer: I was always interested in technology. My favorite subjects at school were physics and technical drawing. I was therefore certain that I wanted to participate in the MuT project, and this definitely reinforced my career choice.

What made you decide to do your training at Liebherr, and what did you particularly like about it?

Sabine Fetzer: I have always been aware of Liebherr, and the MuT project certainly contributed to my decision. What I liked about the training was that it is so modern and multi-layered, you experience a lot of departments and you get close to technical developments. The trips abroad are definitely a special highlight: I took part in an exchange project in Norway and in installation assignments in India and China. The impressions from different cultures were incredibly exciting.

How would you describe the atmosphere between colleagues at Liebherr?

Sabine Fetzer: Very good! Social interaction with each other is completely natural. You are judged by your work, whether you are a man or a woman. It is perfectly normal here for women to work in commissioning.

Michael Messer: We experience the young women as very determined, ambitious and an enrichment to the working atmosphere. We foster interaction with each other on equal terms and it is our constant experience that this mix produces good, high-performance teams. Our high proportion of women in the industrial and technical fields always makes a very positive impression on our customers as well as our visitors.

Walter Ferstl: So far, we have hired all the female trainees and, in the electrician apprenticeship in the second year, the proportion of women is now 50 percent.

What prospects can you offer to young women who want to take on a technical profession?

Michael Messer: As a highly specialized machine-builder, Liebherr relies on lifelong learning and the transfer of experience, because the job description does not end with training. Flexible conditions such as part-time contracts and job sharing enable continual further development, whatever your life circumstances. For us, learning also means intercultural exchange: We want to expand horizons, both technically and culturally.

What is "MuT – girls and technology"?

An initiative by the Maria Ward secondary school in Kempten and Liebherr together with the state employment agency, the district of Oberallgäu and the city of Kempten. It gives schoolgirls in Years 8 and 9 the chance to try out a technical profession practically and in detail, in three successive modules.

School

Module 1
Foundations of tool and material science, manufacture of simple workpieces and assemblies
(5 x 3 hours per week)

Module 2
Production of more complex workpiece groups, insight into work organization and carrying out complex workflows
(5 x 3 hours per week)

Liebherr

Module 3
Connecting mechanical and electronic basics in Liebherr's training department
(one week, afternoons)

Sabine Fetzer: I can confirm that. I experience my work as very varied and have also been able to pass on a lot of this to interns and trainees. And the stays abroad are definitely among the best and most exciting experiences.

In conclusion: what else would you perhaps like to say?

Sabine Fetzer: I can only advise young women who are interested in technical professions to do as many internships as possible in order to get to know the different occupations and companies!

Walter Ferstl: We have even developed a creative solution in the current situation and continue to offer young women the possibility of gaining practical experience with our “internship to go”.

Wolfgang Kern: The MuT project has a large reach in this region: Liebherr was a pioneer here, and many other companies are now interested in it. This is a huge achievement by Mr Ferstl, and I would hope that this great partnership between Liebherr and the Maria Ward school will remain in place even when Mr Ferstl and I eventually retire.

Michael Messer: I am happy to agree with that! Liebherr is absolutely convinced by this project as a contribution to knowledge transfer and personal development. We’ll keep at it!

„Social interaction with each other is completely natural. You are judged by your work, whether you are a man or a woman. “

Sabine Fetzer
Electronics Technician for Industrial Engineering,
Liebherr-Verzahntechnik GmbH

Sabine Fetzer
Electronics Technician for Industrial Engineering, Liebherr-Verzahntechnik GmbH

Walter Ferstl
Industrial Head of Training, Liebherr-Verzahntechnik GmbH

Our discussion round

Wolfgang Kern
Principal of the Maria Ward girls’ secondary school in Kempten

Michael Messer
General Manager Production, Liebherr-Verzahntechnik GmbH

Positive response to virtual in-house trade show

Liebherr Performance Days

Innovative product developments connected with gear technology and solutions for industrial automation systems – Liebherr-Verzahntechnik GmbH presented its product portfolio at the first virtual in-house trade show of the year.

In virtual exhibition rooms, visitors were able to experience the exhibits and simultaneously obtain detailed information about the product technologies by videos, talks and live chats. Liebherr is one of the first companies in the industry to offer this holistic and interactive approach, which was very well received by visitors.

In late 2021, the event will take place again with even more interactive formats and live presentations. In the future, the virtual trade show will take place in parallel with the customer day in the company’s Kempten factory – a platform that combines both worlds.

Would you like to receive current information on the Liebherr Performance Days? Please send an e-mail to:
lvt.marketing@liebherr.com

3
Continents
Europe, America, Asia

12
Exhibits in
gear technology, gear cutting tools, automation

52
Talks in 4 languages
German, English, Japanese, Chinese

Visitors from

39 countries

Around the world with Liebherr

The highlights of the group

Concrete technology

All-electric transport

Emission-free, virtually noiseless concrete transport and a battery that is simply charged overnight: Liebherr develops the first fully electric truck mixer in cooperation with Designwerk. Available in two versions, with 10 and 12 cubic metres drums, the ETM 1005 and ETM 1205 set a milestone in environmentally friendly concrete transport.

Material handling technology, construction machines, mobile and crawler cranes

Around the world and back

Day after day, the S-Bahn trains in Munich (Germany) cover a distance equivalent to a journey around the globe and back. On the Marienhof construction site in the heart of the city, six Liebherr machines play a major role in the construction of one of the central access structures to the second main line. In addition to two cable excavators with slurry wall cutters and -grabs, the LB 24 and LB 44 drilling rigs are being used in the extension of the S-Bahn. An LR 1250 crawler crane lifts the reinforcement cages, which weigh up to 55 tonnes and are 55 metre high, into position.

Mobile and crawler cranes

The world‘s first battery-powered crawler crane

Ending the year on a high note: with the LR 1250.1 unplugged, Liebherr presents the world‘s first battery-powered crawler crane in a brand new design. Model number one goes to Kynningsrud Nordic Crane AS in Norway, which uses the crane in Oslo. An investment for the future, considering the Norwegian capital’s goal to be independent from fossil energy by 2030.

Aerospace

Supersonic air conditioning

Liebherr-Aerospace will develop and supply the air management system for Aerion‘s new supersonic business jet AS2. One of the core components of the system will be an electric air conditioning unit, which enables more efficient and environmentally friendly aircraft operation. The air required by the system will be drawn in from the outside and not from the engines, as is usually the case.

Aerospace, Components

To the airport with hydrogen

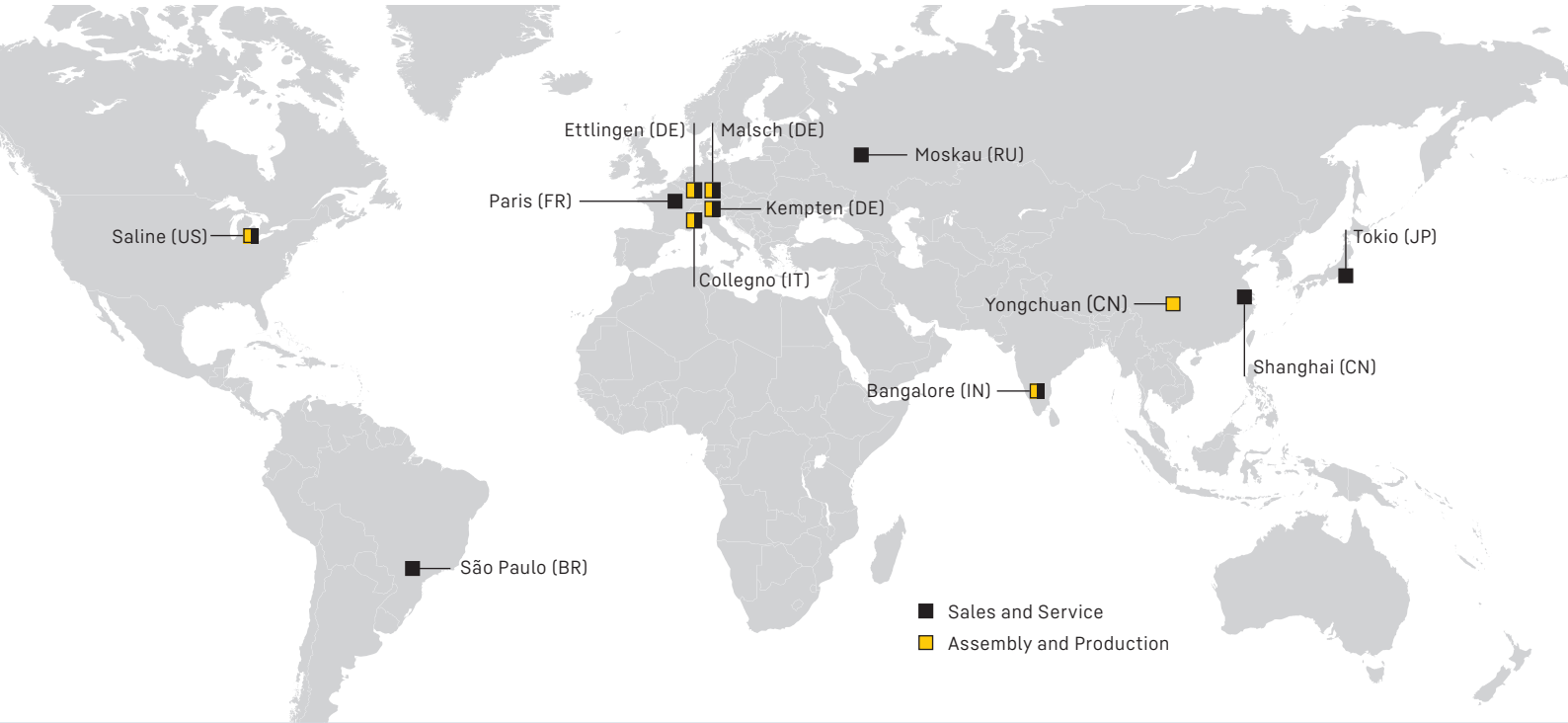
Success for Liebherr’s developers: Liebherr technology is now on board the hydrogen-powered shuttle buses manufactured by Shanghai Automobile Group Co, Ltd, which shuttle between Hongqiao and Pudong airports in Shanghai. The integrated electric compressor is a crucial component of the PROME P390 fuel cell system on board the buses. The system received the mandatory Chinese certification (CCC) at the beginning of 2020.

Domestic appliances

„Digital Hub“ in a prime location

One year after construction started, Liebherr-Hausgeräte GmbH moves into its new premises in Science Park III in Ulm (Germany). In addition to sales and services, the new building also houses the digitalisation department. This is the ideal prerequisite for future-oriented digital work. The proximity of the innovation centre to Ulm University makes Liebherr an attractive employer for students and junior staff.

Your solution provider



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