LIEBHERR

Gear Technology and Automation Systems 2020/2021

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

Dear readers,

The current Liebherr magazine was created during an exceptional global situation: Our world is facing an unprecedented challenge due to the new Coronavirus. During this time, we have succeeded in protecting the health and safety of our employees as well as possible while continuing to support our customers and partners.

But what will the future look like? It is uncertain whether, and by when, the level of economic performance from the pre-Corona era can be reached again. However, one thing is more true than ever: The manufacturing industry worldwide will be determined by increasing demands for flexibility and productivity in networked production.

This is the basis for our various offers for the world of gear technology and industrial automation systems: Based on our modular product portfolio, we develop optimized processes and economical solutions, always oriented toward the customer and his individual requirements.

Accordingly, the topics of flexibility, productivity and customer orientation are a common thread running through this magazine. Find out more about Liebherr as a comprehensive solution provider in the two major areas of industrial automation systems and gear cutting technology.

Together, we want to look positively into the future and shape it – as a partner in dialog with you.

We hope you enjoy your read!

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

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In Focus

Imprint

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Gear Technology

The new series of generating and profile grinding machines

Compact and powerful all-rounders

Liebherr presents the new series of generating and profile grinding machines for hard machining of external and internal gears on workpieces with diameters of up to 500 millimeters. The LGG series follows the successful Liebherr LCS 300 to 500 series. With an impressive range of added features, they offer more flexibility and grinding performance with a significantly reduced footprint.

The LGG 500 and its sister models the LGG 300, LGG 380 and the manual solution LGG 700 M are Liebherr's new series to succeed the LCS 300 to 500 generating and profile grinding machines that have been popular all over the world. The machines are suitable for generating grinding, profile grinding and both processes combined. The new series also retains essential features such as maximum precision, robust machine design and high flexibility. Corundum and CBN tools are available, the latter from Liebherr's own production. The high level of performance and versatility now also extends to hard machining of internal gears: changing from external to internal profile grinding is possible in less than 30 minutes. There are also newly developed grinding heads and even more machine options.

New features: slim design and higher grinding performance
On the outside, the first thing that catches the eye is the machine's new, compact monolith design. With the footprint reduced by a third, the work area is just as big as the one of the previous model, ensuring maximum ease of use even with manual loading. With an axial travel range of up to 1,000 millimeters, the machine column allows the machining of long shafts, for example for commercial vehicles.

Three different directly driven grinding heads with optimized rigidity are available for the new series, and can be configured precisely as the customer requires. The grinding heads have a large effective speed range, which allows the use of large and small grinding worms at optimal cutting speed. Liebherr is a pioneer when it comes to machining collision gears with dressable and dressing-free grinding worms: the compact counter bearing ensures the highest grinding and polishing quality for critical components. Optionally, the grinding heads can be equipped or retrofitted with an auxiliary spindle or an internal grinding arm (see also page 10).

Highlights of the LGG 500

- Small footprint: 30 percent space saving
- Large work area: large grinding stroke and machine column with 1,000 millimeters travel range
- Choice of three grinding heads:
  - Grinding performance: up to module 14
  - Grinding worm volume: up to 320 x 250 millimeters
  - Grinding speed: up to 80 meters per second
- Table: workpieces up to 500 millimeters diameter, up to 100 kilograms weight, speeds up to 2,000 revolutions per minute
- Uniform interfaces: upward and downward compatibility
- Integrated automation system: flexible loading of workpieces up to 100 kilograms
- Peripherals: individual storage solutions
- Optional: swivel-out tailstock on the counter column, measuring probe for integrated gear check, auxiliary spindle

Universal concept
LGG 500 – Maximum flexibility with regard to:

- **Geometry:** internal or external gears with an expanded range of workpieces
- **Technology:** generating or profile grinding for external gears or profile grinding for internal gears
- **Batch sizes:** from prototypes or small series up to large series with integrated automation system

The most powerful grinding head, the GH 320 CB, can easily handle generating grinding jobs up to module 14. Grinding worms with a volume of up to 320 millimeters in diameter and 250 millimeters in length are used. Cutting speeds of up to 80 meters per second achieve high grinding performance for dimensionally critical components at much shorter grinding times, especially for workpieces with long face widths.

Flexibility and open structures
The selection of direct drive tables is tailored to the specific component range with regard to the component weight (up to 100 kilograms), required machining speed and optimum pitch quality. The robustly built table allows speeds of up to 2,000 revolutions per minute for generating grinding and highly accurate positioning for profile grinding.

The new LGG machine generation offers the best possible compatibility with the available clamping fixtures, so that the existing equipment can be used or inexpensively modified. The Liebherr OpenConnect concept allows GDE data to be imported and exported which, together with the gear check integrated in the machine, ensures short setup times for heavy components (see also page 28).

One platform – plenty of options
"With the new generation of machines, the customer is not buying a specialist machine, but an all-rounder that embodies maximum flexibility combined with optimum grinding performance and quality," explains Martin Schwarzmann, Product Manager for Gear Cutting Machines at Liebherr. "A fully equipped grinding machine for external and internal gears with immense grinding performance as well as an automation system – that's a very versatile combination and pretty unique in the market."

The machine offers flexibility for small and medium batch sizes. With its integrated ringloader automation system and configurable Liebherr storage systems, it creates a unique basis for highly efficient large-scale production, for example of complete planetary gears, including ring gears. The huge scope of possibilities allows companies, and in particular small businesses, to carry out a wider range of processing so that they can respond much more flexibly to future market requirements.


Interior of the machine

Before its official market launch this year, the LGG 500 had already gone through an intensive, highly demanding test phase: several prototypes have already been successfully used at Liebherr and are continuously being improved.

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Accessories for external profile grinding of multi-stage gears with an interfering contour on aerospace parts

Auxiliary spindle for challenging grinding

The machining of gears with interfering contours for the aerospace industry places the highest demands on the grinding tool and often cannot be carried out with standard grinding heads due to the small tool diameters. Liebherr has developed an auxiliary spindle for these applications which can be retrofitted. This enables the production of challenging aerospace components on existing LGG gear grinding machines.

The greatest possible flexibility, even for special applications, by means of simple conversion or retrofitting of the necessary tools: Liebherr has been successfully pursuing this approach for several years with its adaptable internal grinding arms. With the existing range of internal grinding arms, a machine can be converted from external grinding to profile grinding of internal gears in a very short time. Why shouldn't this proven concept also work for the external grinding of special aerospace components? Following this thought, Liebherr developed an auxiliary spindle as an optional accessory that can be offered for LGG gear and profile grinding machines and can be retrofitted to existing machines.

A further option for special applications

The newly developed auxiliary spindle is part of a machine purchase and will be handed over to production at the sister company, Liebherr-Aerospace Lindenberg GmbH, at the end of 2020. This sophisticated new development is designed in close cooperation with the user so that the practical needs of machine operators can be incorporated into the design at an early stage. This applies to setup procedures and service tasks, in particular. A typical aerospace application is profile grinding of what is known as a 3-stage planetary gear, which is required for the wing flap adjustment. Due to the weight-optimized, compact component geometry, only small CBN grinding wheels are technically possible for final hard gear finishing.

With the auxiliary spindle, the user can use the LGG gear grinding machine to produce aerospace components with interference contours, along with their special technical challenges, in small batch sizes without having to invest in an expensive, possibly under-utilized, special machine. The geometrically demanding components can thus be manufactured with high gear quality and surface quality. This expands the range of LGG grinding applications to include an additional option for critical, very small and high-quality components.

> "We view our standard products as the basis for flexible solutions that are always geared to our customers and their requirements."
>
> Thomas Breith, Head of Product Management Gear Cutting Machines

The auxiliary spindle – just like the internal grinding arm – can be mounted on all new Liebherr grinding heads with counter bearings via a changeover interface, which ensures short setup times. The additional functions of the grinding heads, such as an inductive meshing sensor, a movable cooling lubricant nozzle and a swiveling measuring probe, can also be used in combination with the auxiliary spindle.

Spindle and matching CBN grinding wheels from Liebherr

Machining parts with very small grinding discs requires high spindle speeds to ensure the required cutting speeds of at least 30 meters per second. At speeds of up to 30,000 revolutions per minute, the auxiliary spindle must meet the highest requirements in terms of vibration behavior and temperature resistance. A bearing on both sides ensures high rigidity, a stable concen-

Very small grinding discs for critical component geometries

The auxiliary spindle ensures short setup times

tricity and additionally allows the use of a longer grinding arbor, which is the technical prerequisite for the safe mounting of several grinding discs. This enables up to two duo roughing discs and two finishing discs with increased feed rates to be used, significantly reducing machining times.

Liebherr now has over 30 years of CBN expertise for its globally successful gear grinding machines. For this reason, a sophisticated development project was started for the extremely small CBN profile grinding discs, in order to galvanize the extremely fine CBN grains (grain size ~ 25 to 35 micrometers) onto the high-precision main bodies, so that the narrow gear tolerances and high surface qualities can be ensured with the finest CBN coatings.

Core competence: grinding process

Liebherr aims to be able to supply all the key components from a single source in order to offer customers the best possible solution:

- Gear grinding machines with accessories
- Technological expertise
- Tool design and production

“We view our standard products as the basis for flexible solutions that are always geared to our customers and their requirements,” says Thomas Breith, Head of Product Management Gear Cutting Machines at Liebherr, summarizing the philosophy.

Liebherr machines provide complete machining of the gear

One tool for everything: flexible machining from A to Z

Anyone who manufactures small batch sizes of complex components wants to perform as many work steps as possible with a single machine. This not only saves time and equipment costs but also increases the quality, provided that the clamping fixture does not have to be changed. Liebherr-Verzahntechnik GmbH offers a comprehensive solution for complete machining by integrating a tool changing system and a chamfering device while using the turning, drilling and gear cutting functions of the latest generation of Siemens controls.

Machining a workpiece completely with a gear cutting machine necessitates four key elements:

1. Flexible programming which enables a combination of gear cutting processes with turning, drilling or hobbing operations
2. A tool changing system which accelerates the workflow over various sub-processes
3. Automated tool check and workflow correction
4. An intelligent distribution of primary and secondary processes

Flexible programming with LHGearTec and programGUIDE

With the programming system LHGearTec and the new control panel LHStation, Liebherr offers a comprehensive operating concept to define gears with optimum efficiency and precision. When combined with the Siemens programming system programGUIDE, further contours can be programmed. Bores, slots, levelings, engravings and threads become a standard.

Deburring during the machining process saves time

Tool changing system with standard hollow shank taper

The Liebherr tool changing system can be used in various ways. Firstly, it makes the process more flexible and more efficient. This is because it can incorporate different gear cutting tools, even those specifically intended for roughing and finishing processes. This means that more expensive tools are only used where they are really necessary, thus saving money and extending tool life. Secondly, sister tools can also be accommodated to increase productivity. The remaining magazine stations accommodate up to twelve tools, allowing additional operations such as drilling, hobbing or turning in the same clamping fixture used for gear cutting processes. “This enables us to achieve maximum flexibility at the same time as maximum precision, because the reference surfaces remain the same through all the machining steps,” summarizes Dr. Peter Pruschek, Head of Electrical Design and Machine Control Development. “For specific application cases, this removes the need for an upstream turning machine or a downstream machining center.”

Deburring at the additional machining station

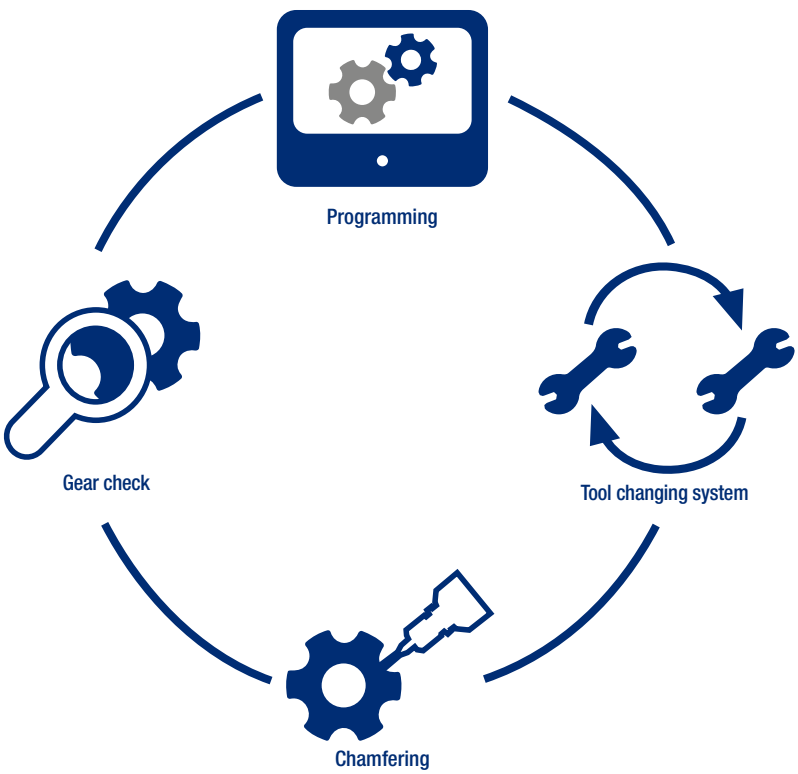
Flexible chamfering is a major topic, particularly for precision gears for e-mobility. However, comprehensive technological solutions enabling flexible chamfering are increasingly in demand for gears with interfering contours such as in the aerospace industry, as well. “Deburring gears is now pretty much the norm,” says Dr. Gerd Kotthoff, Head of Technology Gear Cutting. “However, many customers are now also demanding pre-defined chamfers on the front sides. That’s why, with ChamferCut and FlexChamfer, we offer the option of integrated chamfering units which deburr a second workpiece during the machining process, so that no time is lost.” Like the tool changing system, the chamfering device reduces the intralogistics to other machining processes and saves setup time. In the case of the new FlexChamfer unit, simple shank milling tools can be used here as well, replacing special deburring tools. “This enables us to obtain stable processes with optimum accuracy and minimal tool costs.”

Measuring and correcting inside and outside the machine

For extremely precise manufacturing, continuous quality control is indispensable. At Liebherr, the customer can select a number of different methods for this. While the gear cutting machines

themselves perform a gear check on the basis of a measuring probe, complete measurement can also be carried out on a separate gear inspection machine. This is connected to the control system by the network (see also page 28). If errors should occur, the overall system can optimally support the user and can also activate corrections itself, depending on the configuration. “Until now, we have always spoken of a ‘closed loop’,” Peter Pruschek explains. “However, with the LHOpenConnect service portfolio, we can go beyond the closed loop to connect both our own products and measuring systems and control station solutions by other manufacturers via open interfaces. Measuring data only constitute a small part of the process data which we connect and use to optimize the entire process.” The services bundled within LHOpenConnect, as well as the associated Industry 4.0 software products summarized by the term LH-WebPlatform, are presented in detail on pages 28 to 30.

The system can accommodate twelve tools



Flexible and accurate: An overview
Gear cutting in combination with chamfering, additional machining options and tool changing system in a closed quality loop

- **LHGearTec with Siemens programGUIDE:** Flexible programming of complete machining processes
- **Tool changing system:** Roughing and finishing, sister tools for longer tool life and unsupervised manufacturing, and additional machining such as turning, drilling or hobbing using a hollow shank taper
- **FlexChamfer and ChamferCut:** Very high quality deburring and chamfering during the machining process
- **Gear check:** Measuring during the machining process with the possibility of correction

SECLA: Liebherr develops its own clamping concept

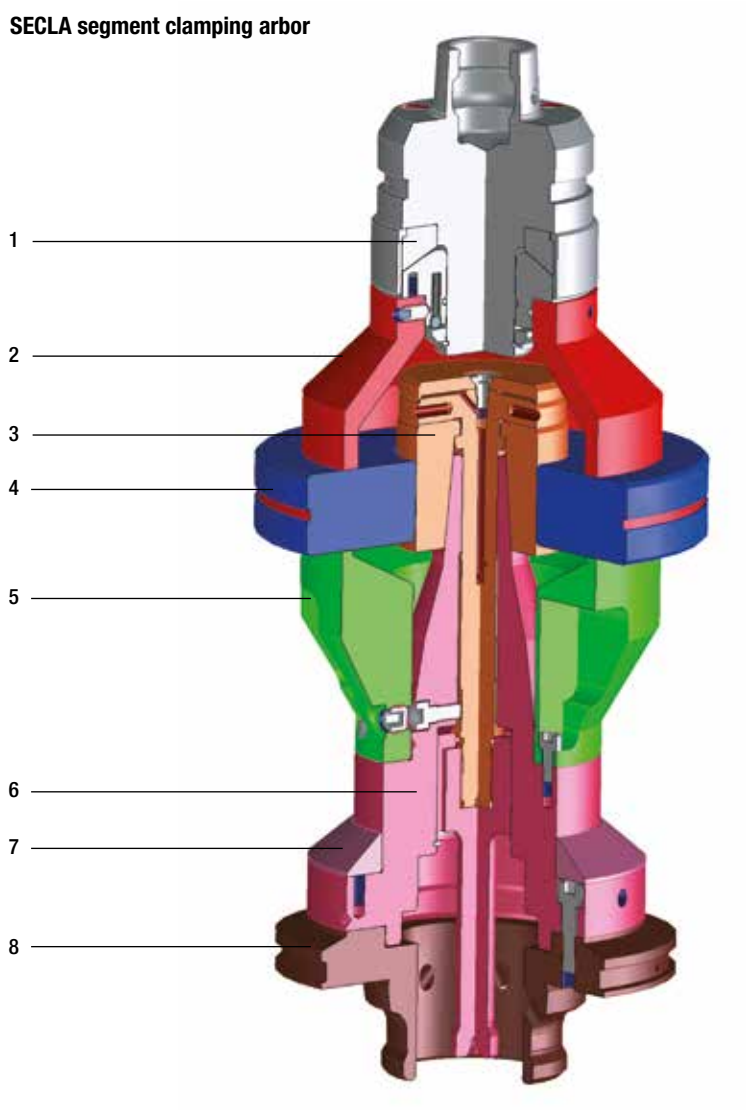
Let's get clamping!

Clamping units for gears with short delivery times at low costs – due to the high level of individualization of clamping devices, these demands were often difficult to reconcile. That's now a thing of the past. The segment clamping arbor SECLA from Liebherr is an innovative, inexpensive standard solution with short delivery times for a maximum application range in gear manufacturing machining.

With SECLA, Liebherr is setting a new standard in clamping technology

Until a few years ago, clamping devices for gear manufacturing machining were manufactured individually. This meant that if anything broke, the machine stood still for a long time – depending on the supplier's capacity – since there were no standardized spare parts. For the team led by Dieter Lange, Head of Order Construction, this was an untenable situation: "We wanted

SECLA segment clamping arbor



1. Optional: upper mounting for counter column
2. Optional: clamping cone
3. Clamping element (segment clamping bushing and tension adapter)
4. Test workpiece
5. Workpiece support
6. Segment clamping arbor (clamping support)
7. Protective cover
8. Clamping base for table interface

Your advantages

- Short delivery times
- Independent of all gear cutting processes
- Suitable for hard and soft machining
- Dry and wet use possible
- Simple and fast retooling
- Large clamping area
- Excellent machining quality
- Integrated rinsing solution

SECLA segment clamping arbor in figures

- Ten sizes for 20 to 200 millimeters bore diameter
- Rinsing channels from size 3
- Concentricity up to 5 micrometers
- At least 250,000 clamping cycles

a solution which would reduce customer downtimes as far as possible. With SECLA, we have developed a solution with defined interfaces which is always available in stock at a consistent quality, and can be delivered correspondingly quickly, and which is suitable for all Liebherr technologies." The greatest challenge for development was the large range of technologies: the clamping arbor supports dry and wet machining, permits every conceivable interfering contour and nonetheless demonstrates very high rigidity.

High quality and service life

The project began four years ago with the initial desire for a standardized main body. However, in the course of development, an even greater amount of standardization was achieved. Defined interfaces simplify tooling and retooling. Numerous experiments, from material analyses to strain and endurance tests, successfully proved the quality and durability of the clamping unit. "A very high concentricity enables us to achieve a new dimension of gear quality," reports project manager Florian Schmölz. Older machines and machines made by other manufacturers can also be equipped with the new SECLA. "This innovation can therefore be deployed very flexibly."

Well thought-out details

"Then there are a number of functionalities which we have developed over the years in various special solutions," adds Stefan Breyer, a member of the clamping device development team. The constructive details include the perfected integrated rinsing solution (from size 3). This enables the clamping device to be permanently cooled by air or oil and cleaned at the same time. Both these things ensure that it will work well over a longer service life. The slender design and intelligent geometry make SECLA suitable for a maximum range of applications, without any loss of rigidity. It enables hobbing, shaping, skiving, grinding and ChamferCut processes in one clamping fixture – and for a majority of common gear sizes.

Concepts for the present and the future

Product highlights of EMO 2019

Liebherr-Verzahntechnik GmbH presented four machine concepts at EMO 2019. These were characterized above all by their versatility. With technologies such as shaping, worm milling, grinding and skiving, the exhibited products offered a wide range of options for every requirement in gear technology. Here is a review of the trends at the leading trade fair for metal machining.

LS 180 E

Shaping machine with electronic shaping head

The electronic shaping head provides maximum flexibility, allowing the LS 180 E to shape straight and helical gears in one clamping. The easy-to-use control system means that lead modifications with different crowning are no problem. These features make the machine as interesting for the supplier industry as it is for prototype development. Gear shaping is still vital, especially for workpieces without sufficient tool overrun, and will not be replaced by other processes such as the new gear skiving in the future. On the same platform, Liebherr also offers the LS 400 EM, which is ideal for manually loaded workpieces with a diameter of up to 400 millimeters.

Highlights

- Electronic shaping head with up to 1,500 double strokes per minute
  - Minimal setup times
  - No mechanical helical guides required
  - Setting of various helix angles and modification via NC control
- Different gears and splines in one clamping
- NC stroke position adjustment

Options

- Automatic loading unit with plastic chain conveyor and chain storage for flexible workpiece feed

LC 80 WD

Worm milling

Thanks to high machine rigidity and fast automation, the LC 80 WD is ideal for milling steering worms and for industrial worm applications. The highly rigid tool and workpiece clamping gives it a long tool life and excellent workpiece quality. It also comes with an optional additional station for a dedicated chamfering or brushing unit. The strength of the machine lies in the quality, cycle time and value-adding additional operations for economical serial worm production.

Highlights

- Optimized static and dynamic rigidity
  - High process capability
  - Long tool life thanks to additional counter bearings on the worm milling head
- Ring loader for rapid loading and unloading
- Robust tool holding

Options

- Chamfering or brushing during the machining process
- Various automation options, such as belt conveyors and robot automation

LGG 180/280

Something neat: generating grinding in the age of the clean factory

In order to avoid waste and make efficient use of resources such as service fluids and expensive grinding coolants, the LGG generating grinding machine has an integrated centrifugal unit. This cleans the gears by throwing off chips and coolant, so that they are transferred from the machining station in a clean condition. The centrifugal unit is decoupled from the machine tool so that no vibrations are transmitted to the process. The direct return of the grinding oil significantly reduces operating costs, and no oil ends up outside the machine. This contributes significantly to sustainable production in a clean factory.

Highlights

- Topological generating grinding
- Direct data exchange with the gear inspection machine via LHOpenConnect (see also page 28)
- High technological flexibility
  - Hard fine machining of internal and external gears
  - Generating, profile and combination grinding
  - Different cutting materials (corundum, CBN, ceramic CBN)

Centrifugal unit options

- Decoupled centrifugal station for transferring clean, drip-free workpieces to the automation system
- Freely configurable centrifuging time and speed
- Easy access for setup through a separate door

LK 180/280 DC

From Skiving³ to Skiving^Plus

The new-generation LK 180/280 comes with a wide range of options: the machine-integrated tool changer with up to twelve storage spaces has room for roughing and finishing tools, but can also be used for other tools, such as for turning, drilling or hobbing. An additional chamfering device with the new FlexChamfer method ensures deburring during the machining process. An integrated tool measuring device for skiving wheels shortens setup times and simplifies operation.

Highlights

- Compact footprint
- Short machining times
- Integrated workpiece automation
- High-performance spindle with internal cooling lubricant return
- Fast tool change

Options

- Tool changer
  - For roughing and finishing tools
  - For additional functions such as turning, drilling, milling and measuring
- Chamfering during the machining process
  - Drawing-compliant chamfer geometries possible
  - Maximum reproductive accuracy and precision

The LC 4000 for HMC Gears is capable of gear hobbing, form and 4-axis milling

A unique machine

A visit to the HMC Gears plant in Indiana kicked off an extensive project which resulted in the creation of a unique solution for exceptional demands: With the LC 4000, Liebherr forges new paths in large-scale gear cutting production and unites diverse machining methods in one highly efficient machine for the American gear specialist.

The HMC Gears plant is located south of the small town of Princeton, Indiana surrounded by fields and broad plains. For around 100 years the company has been a well-known specialist for gears and gearboxes for various industries. They are one of the few manufacturers in the world to produce gears with a diameter of up to eight meters. HMC is proud of its many years of expertise, fast delivery times, and excellent service. Always placing the highest quality demands on both itself and its suppliers.

As a supplier for the coal and steel industry the company also specializes in spare parts for large equipment for deep and open-cast mining. Every day counts: If the giant machines are idle, the operator of the mine or conveyor system incurs losses which can quickly go into six figures, but a planned part exchange is not always easy either, since the machines and equipment often run for decades. This means that the design drawings may be old or no longer available. Almost every part is therefore critical. It is a matter of custom-made devices and very small batch sizes, often in massive dimensions and with highly demanding geometries.

Giant dimensions for giant gears


Interior of the LC 4000

A case for Liebherr

Gears with herringbone or double helical gears are often used in mines and conveyor systems. These particularly quiet-running gears are used when large forces have to be transferred. The special arrangement of the gear prevents the occurrence of axial forces, which minimizes bearing wear. However, herringbone gears are complicated and expensive to produce. HMC needed to acquire an efficient machine with the latest technology. This machine would need to replace several planing machines and be able to manufacture spur, helical, double helical, or herringbone gears, handling diameters between two and a half to four meters. This was an investment decision which would require great trust in the supplier and its expertise.

A case for Liebherr: Although they did not have such a machine in their portfolio, Liebherr was happy to design and manufacture a prototype for this specific customer requirement. Liebherr was familiar

with the desired specifications but had not yet united them all together in one machine of this size. Until now: The LC 4000 can machine gears with a diameter of up to four and a half meters and a weight of up to 36 tons.

A project driven by team spirit and the will to succeed

Robert "Bob" Smith III, HMC's CEO, explains how HMC came to take on this complex project together with Liebherr: "We were looking for a gear cutting center where we could carry out every stage of production, from rough-cutting to internal machining. During a visit to our plant, Liebherr demonstrated their profound expertise and attention to detail and, ultimately, they were the only supplier prepared to take on this challenge." This was the prelude to a long and constructive development phase, during which the specific requirements were defined. "HMC is a demanding customer in the best sense. It has high quality standards and expects a first-class product. In this sense, our two company philosophies fit together perfectly. This was reflected in the very fair negotiations and the consistently positive and constructive discussions." says Dr. Oliver Winkel, Head of Technology Application at Liebherr, describing the cooperation between the two companies. Robert J. Smith confirms: "We have been extremely satisfied with Liebherr's service, their quick response times and the technical support they have provided."

In December 2015, following intensive preliminary discussions, a detailed kick-off took place in Princeton, resulting in a specifications sheet containing over 100 points. A great deal had to be constructed from scratch. Examples of this would be an over four-meter long finger milling head for external gears, a second main column, and not least a special machining unit for internal finger milling. The project was characterized by great transparency and open discussions. Liebherr provided HMC with all the provisional results in the form of drawings, photos, videos, and measurement results. Setbacks were also communicated: "Both parties wanted success and at Liebherr everyone really pulled together." recalls Peter Wiedemann, Managing Director of Liebherr-Verzahntechnik GmbH. The pre-acceptance of the machine finally took place in October 2017 in Kempten. During the spring of 2018 it was shipped and put into operation on site. The install was handled by a team of service technicians from Kempten (Germany) and the USA.

Innovative gear cutting center for gear hobbing, form and 4-axis milling

The machine offers great flexibility within its components. It contains an innovative direct drive hob head and an additional finger milling head. The additional head machines external and internal

"We have been extremely satisfied with Liebherr's service, their quick response times and the technical support they have provided."

Robert J. Smith, HMC's CEO

gears from its own main column opposite the hobbing head. This enables machining with gear hobbing, form and 4-axis milling methods on a single machine. Creating the optimal setup for the manufacture of herringbone and double helical gears. The technology was specially customized to the requirements and dimensions of this application. The head has a very long Y axis in order to minimize the thermal influences on the machining results and therefore optimizing the component quality. Another advantage is offered by targeted chamfering with a ball nose end mill. The process design software, Euklid GearCAM, contains data management for workpieces, tools for 4-axis milling, and can simulate the process. It calculates the required hobbing paths, feed strategies, and the tool changes.

An integrated tool changing system with up to 60 storage locations enables the different gear cutting tools to be automatically changed. A scanning probe for gear inspection is also integrated. The machine is capable of achieving accuracies of 12 to 15 according to the quality standard of the American Gear Manufacturers Association (AGMA), which corresponds to the German DIN standard of 3-6. And which module sizes can be produced by this machine? “There is no upper limit. In principle, it could easily achieve module 100!” says Dr. Oliver Winkel.

The HMC Gears factory in southern Indiana (USA)

Productivity of single and double helical gearing considerably increased

The decisive factor for HMC was the efficiency of the machine in the production of herringbone, double helical gears and in that of conventional helical gears. On the LC 4000 a double helical gear with a diameter of four meters can be manufactured within one to two days. The manufacturing duration using traditional planing machines is more like one to two weeks – which means a three- to fivefold productivity increase! A traditional helical gear can be manufactured on the machine just as efficiently. In this case taking only approx. four hours of machining time for a workpiece diameter of four meters.

By also adding an additional internal milling head to the second tool stand, Liebherr has added a massive value for HMC. This head is able to machine internal keyways or splines. The giant gear, which weighs several tons, does not have to be re-clamped to finish the bore. “Sometimes it’s the little things that make the difference to a purchase,” says Peter Wiedemann with a grin. The investment and long planning time were worth it for HMC: “We have been manufacturing gears since 1921. For us, the acquisition of the LC 4000 signifies a quantum leap with regard to our efficiency and delivery times for large gearboxes, as well as the security of having a powerful machine for future requirements,” says Robert J. Smith about the machine’s added value.

HMC Gears

Industries:	Gear manufacturing for the following industries: mining, steel and aluminum, mineral processing, marine, defense and sugar
Founded:	1921
Headquarters:	Princeton, Indiana, USA
Website:	www.hmcgears.com

Precision gears for robotics and other special applications

A flexible solution for everything

From the manufacture of satellite antenna systems to medical technology and automation: Precision gears are at the heart of many applications in industrial production. The automation industry is booming, and with it demands on both quality and productivity are increasing, creating a challenge for many suppliers. The wide range of machines, processes and expertise at Liebherr offers the optimum solution for every application.

Precision gears for industrial applications have to deliver a top-class performance. In order for a robotic arm to achieve precise gripping movements, for example, extremely small and light-weight components are required that must also provide enormous transmission ratios. Cycloidal drives or Harmonic Drive® gearboxes are used in particular. These simply constructed gearboxes are characterized by their precise transmission of motion, zero backlash and high transmission ratios, and they are also free from wear and tear. Furthermore, they are very compact in size. In order to manufacture these demanding parts, Liebherr has developed solutions and made its range of processes more flexible.

Generating grinding of cam discs with double clamping

The challenge of cycloidal gearing: Everything must fit properly

Dimensional stability, excellent surface quality, and high profile and pitch quality must all be ensured in cycloidal gears, and the rollers must fit perfectly with the inner ring. New from Liebherr and specially developed for cycloid gearing: externally toothed cams can now also be produced using single or precisely paired double clamping by means of generating grinding. Thus, depending on the number of pieces required, not only is profile grinding available to users but also a further grinding method for the cam discs.

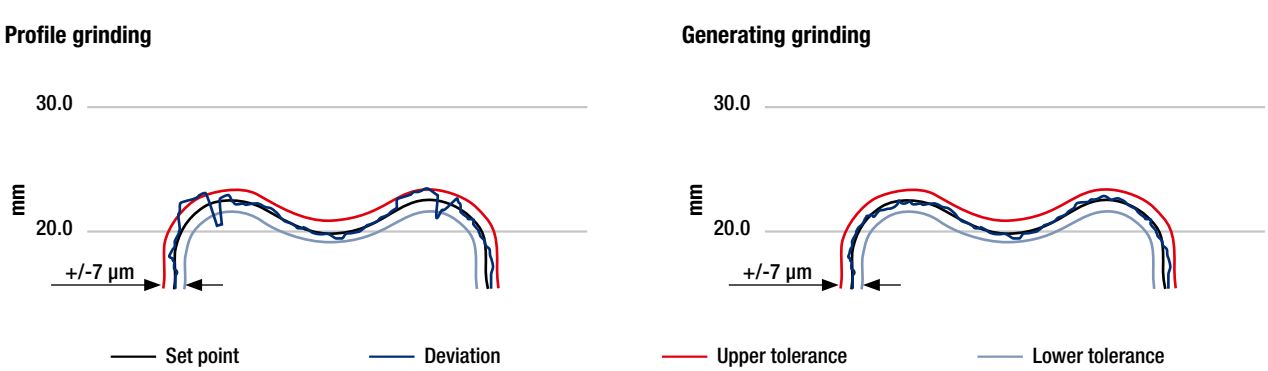
Generating grinding for cam discs

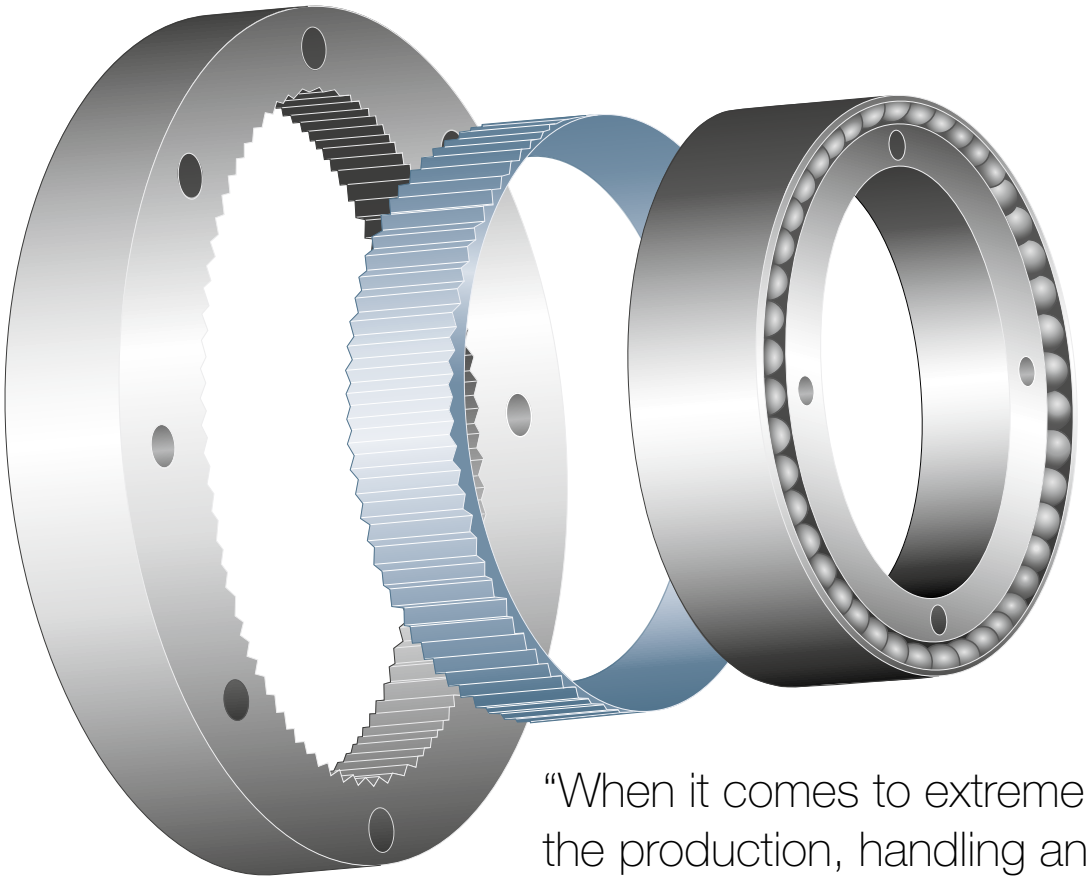
For this application, generating grinding offers a number of advantages over profile grinding such as higher pitch accuracy, improved dimensional stability and an even profile over the whole cam disc, thanks to the improved wear distribution of the grinding worm. “By avoiding the undesirable ‘steps’ in the profile, we have been able to improve the quality even more,” explains Dr. Andreas Mehr, who is responsible for gear grinding and gear shaping at Liebherr. Due to the faster grinding times, generating grinding is comparatively less expensive.

Profile-internal grinding with wear-resistant CBN wheels

For internal profile grinding of the roller seats on the inner ring, a grinding wheel had to be developed that is capable of grinding a full radius. Liebherr succeeded in doing this by producing its own CBN grinding wheels with electroplated bonds that are

Profile of the cam discs





Harmonic Drive® gearbox:
production of very small gears

"When it comes to extreme requirements in the production, handling and measurement of such small-module components, Liebherr is the perfect partner."

Dr. Oliver Winkel, Head of Technology Application

dressing-free and wear-resistant. This ensures maximum process stability and process quality. The user is also more flexible when changing from external to internal grinding on one machine: changeover is possible in less than 30 minutes.

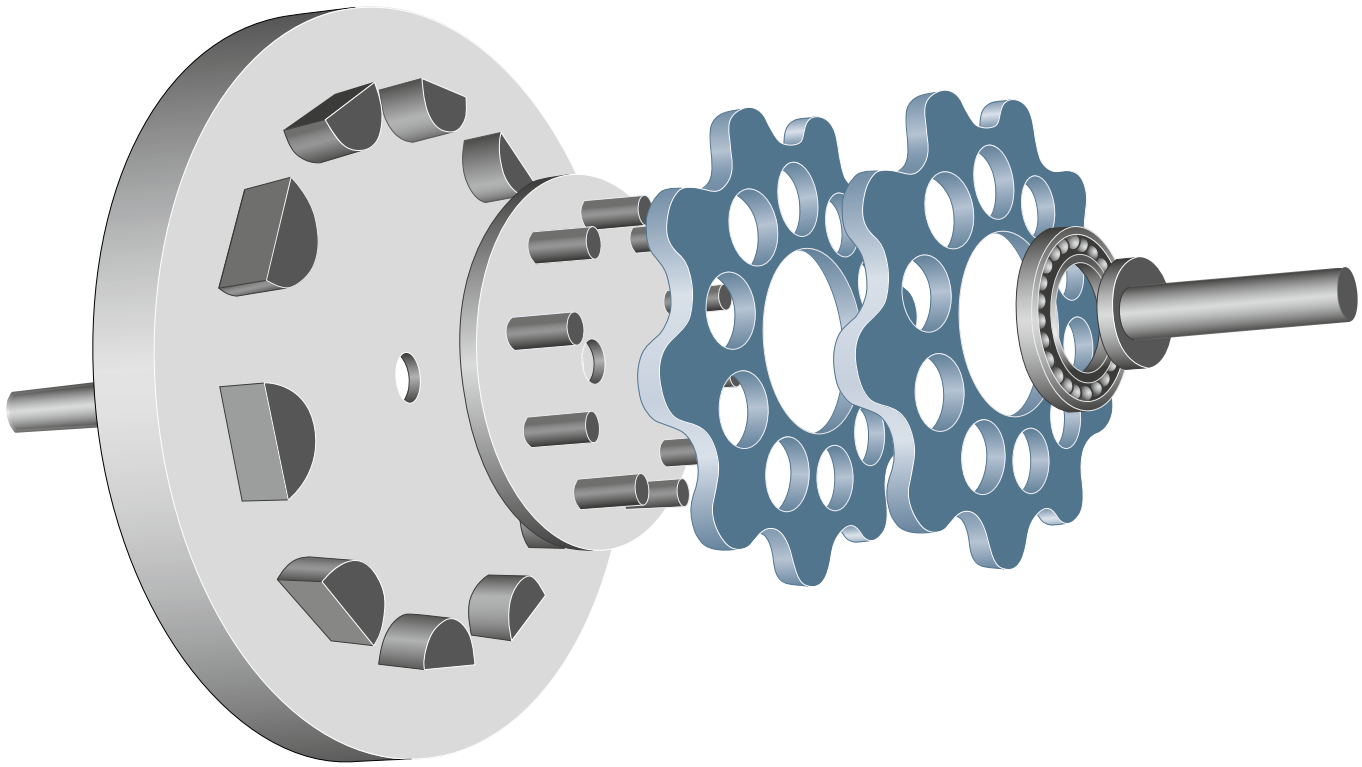
Internal profile grinding in full radius

Challenge Harmonic Drive®: smallest modules

The gear teeth of the Harmonic Drive® gearbox presented another manufacturing challenge. Here the load is distributed over a large number of tiny teeth, which, in extreme cases, are so tiny that they are barely visible to the naked eye. "When it comes to gear hobbing and gear shaping, we are sometimes at the limits of what is both technically feasible and still measurable," explains Dr. Oliver Winkel, Head of Technology Application at Liebherr. "But when it comes to extreme requirements in the production, handling and measurement of such small-module components, Liebherr is the perfect partner."

More than "just" machines: Liebherr provides solutions

Liebherr sees itself as a solution provider for the growing performance requirements resulting from the boom in automation, and is constantly working to expand its range of manufacturing processes. In the future, for example, the internal gear of the circular spline for Harmonic Drive® gearbox can also be produced by gear skiving, like on Liebherr's LK 180 – another option for greater flexibility and efficiency. This also applies to other special cases, for which there may not yet be a solution



Cycloidal gear: maximum precision with generating grinding of externally toothed cam discs

already on the market but which will be developed in cooperation with the customer.

Liebherr also sees itself as a competent partner when it comes to meeting the growing demand for components for robotic applications and increasing productivity. Dr. Oliver Winkel explains: “Whether setting up a new production from scratch, supplying machines, defining processes, training employees or providing service and support – we have the expertise to advise and accompany our customers throughout the entire process.”

Exactly paired cam discs

Dr. Andreas Mehr

Grinding and Shaping Technology
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Gear skiving with Liebherr: it's worth it

How to: Customized gear skiving

Gear skiving is over 100 years old and has recently been experiencing a renaissance as a flexible and economical alternative to other gear cutting methods. However, this complex process frequently presents great challenges to users. In addition to Skiving³, a "complete package" consisting of machine, tool and technology, Liebherr now also offers skiving tools for suppliers and contract gear manufacturers – and the appropriate consultation, if desired.

The almost forgotten method of gear skiving has again gained momentum through technological advancement. Modern, fast direct drives increase the cutting speed and therefore the productivity. Low-wear cutting materials and innovative coatings ensure a long tool life. Gear skiving is considerably faster than shaping and, in many cases, more economical than broaching. The combination of crossed-axis angle, cutting speed, feeding and other kinematic parameters make the method very flexible: particularly for internal gears in medium batch sizes and external gears with an interfering contour, gear skiving is an additional "ace up your sleeve" in the gear cutting range.

It's all about the process

So far, so good. Except that the highly complex process has to be mastered. The extreme dynamics and the complex axis arrangement demand a lot of the tool and make the method very challenging for users: "Gear skiving doesn't forgive any errors. Deviations in manufacturing tolerances often decide whether the machining will work or not. You have to know precisely which setting screws you have to turn," explains Dr. Oliver Winkel, Head of Technology Application. "We at Liebherr have taken the time and can justifiably claim that we understand the process." If the customer buys a machine or

Liebherr also offers skiving tools independently of the machines

"At a glance"

Better equipped for market requirements: Flexibility and economic efficiency thanks to gear skiving

Skiving³: complete package

Who: OEMs and Tier1

- Complete package: machine, tools and technology from Liebherr
- Process expertise
- Machines delivered ready-to-use
- Optional features and automation solutions

How to: Skiving tools for contract manufacturing

Who: Suppliers and contract gear manufacturers

- Tools for machines and machining centers from other manufacturers as well
- Process expertise
- Cylindrical and conical skiving tools in Liebherr quality
- If desired: consultation, support and service

"Gear skiving doesn't forgive any errors. Deviations in manufacturing tolerances often decide whether the machining will work or not. You have to know precisely which setting screws you have to turn."

Dr. Oliver Winkel, Head of Technology Application

tools from Liebherr, he is buying precisely this expertise and process reliability at the same time.

Economical in contract manufacturing as well

In times of fluctuating and generally decreasing batch sizes, gear skiving is also increasingly of interest to contract manufacturing – as a flexible and economical addition to the established gear cutting methods. However, many contract manufacturers shy away from investing in a new machine. An economical alternative is to use Liebherr tools on existing equipment. In Kempten, Liebherr uses an open concept and offers their own manufactured tools independently of the machines – with consultation on request.

Whether they are in the supplier industry or contract manufacturing, all customers ultimately want to be optimally equipped for future market requirements and to enjoy the benefits offered by gear skiving. With the tried and tested, comprehensive all-round package Skiving³ and the open tool concept, Liebherr is a suitable partner for both groups.

LHOpenConnect: Intelligent software for intelligent processes

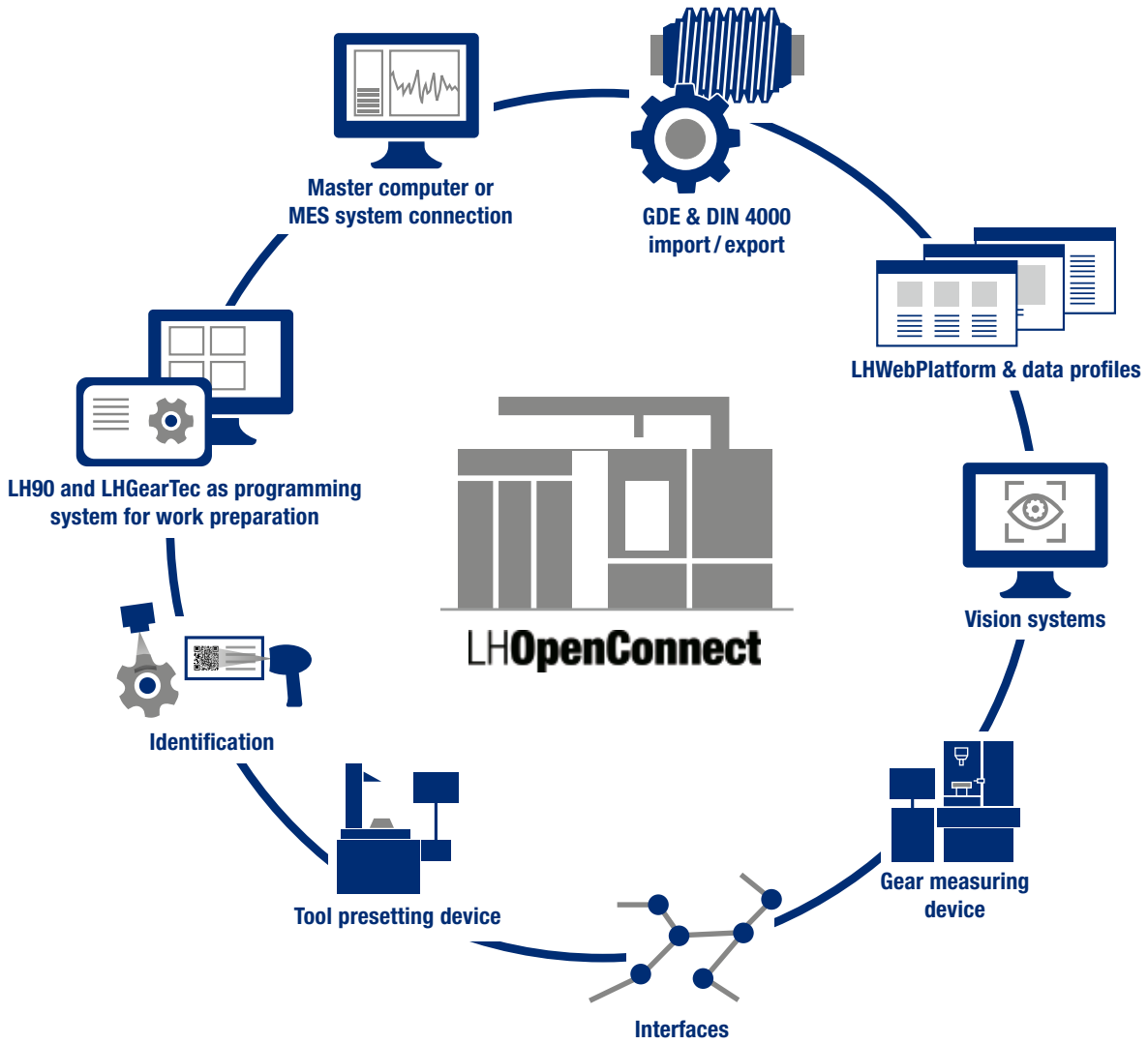
Liebherr connects

What does the name LHOpenConnect stand for? How can an open data structure help the user? Which software services does Liebherr-Verzahntechnik GmbH offer? Over the past few years, the company has gradually built up an application architecture that focuses not only on the machine, but on the entire process, which means it can support production in many different ways. Thanks to its modular structure, customers can select the tools which best complement their own specific production environment.

"LHOpenConnect is basically a complete bundle of application modules that users can put together individually," explains Florian Schuon, Head of Preliminary Development / Industry 4.0. Examples of these are the data profiles that Liebherr provides, which can be either standard or customer-specific. Using a selection of common interfaces such as OPC UA, MT Connect and umati, the gear cutting machines can be integrated into the customer's network, for example to exchange data with higher-level systems. "The LHWebPlatform tool is designed for visualizing the entire plant," says Florian Schuon, presenting a brand new application. "It allows the customer to see all the machine tools at a glance – regardless of the manufacturer."

Visualization of the data profile with LHSignalInfo

The signals from the machines are sent to LHWebPlatform via the corresponding data profiles and stored there. "LHSignalInfo can be used for visualization. This web application can graphically display all signals from the purchased data profile and also export them for further analysis." The data profiles are structured in three levels: Basic, Production, Process. In total, they include over 1,000 features that can be recorded and evaluated. Users can also create their own signals in the logic editor by logically linking the standard signals and saving them in an area reserved for the customer. The LHSignalInfo then displays these freely defined signals. "For example, customers can modify the behavior of the signal lights to their factory standard without interfering with the machine programming," says Florian Schuon. Along with the introduction of open data profiles, this is right in tune with today's requirements.



Keeping an eye on the workpiece
The software also offers a seamless workflow for the workpiece: the geometry and manufacturing data can be conveniently parameterized on the PC, which makes preparing the work much simpler. The prepared data can then be transferred to the control system via GDE interface using the import / export function. LHOpenConnect also has an answer to the "closed loop" question. If there is a gear inspection machine, it can exchange data directly with the gear cutting machine: The measurements thus directly influence the settings and improve the result. Different labels such as QR, RFID or data matrix codes are available for identifying workpieces.

“LHSignalInfo can be used for visualization. This web application can graphically display all signals from the purchased data profile and also export them for further analysis.”

Florian Schuon, Head of Preliminary Development / Industry 4.0

Three questions for Florian Schuon

What does LHOpenConnect aim for?
We don’t want to offer our customers a “closed” loop where they no longer have freedom – for example to transfer additional data. Instead, we want to offer our customers a comprehensive range of standard data profiles, interfaces and web applications, which can also be tailored and adapted to their individual requirements. Our goal is to make the machine as open and transparent as possible towards other production and inspection machines, control centers and data analysis systems.

So the offers go way beyond just gear cutting itself?
With LHOpenConnect, one of the many things we can do is to connect tool presetting devices directly to the gear cutting machine in order to exchange tool data in accordance with DIN 4000. Furthermore, we can connect to the measuring machine via GDE (GearDataExchange), and we can also connect work preparation programming stations to control panels, ERP systems and the machines using LHOpenConnect. Although our core area of expertise is still the gear cutting process, the applications of the LHWebPlatform and the connection options of the LHOpenConnect strategy open us up to higher-level systems and other machines on the shop floor. This means we can flexibly integrate our services and act as a system provider.

How important is LHOpenConnect for gear technology?
In addition to our core business of manufacturing gear cutting machines, LHOpenConnect enables us to establish another area of business by offering services. Nobody can integrate our machines into production processes as well as we can. Due to our own production we have also dealt extensively with machines and control systems from other manufacturers. On top of this comes our expertise in manufacturing automation cells and lines. We want to offer our customers this expertise in fully integrating manufacturing systems systematically and according to requirements – not only in the context of selling machines, but also as an additional range of services based on this.

Florian Schuon, Head of Preliminary Development / Industry 4.0

Liebherr stock tool catalog now online

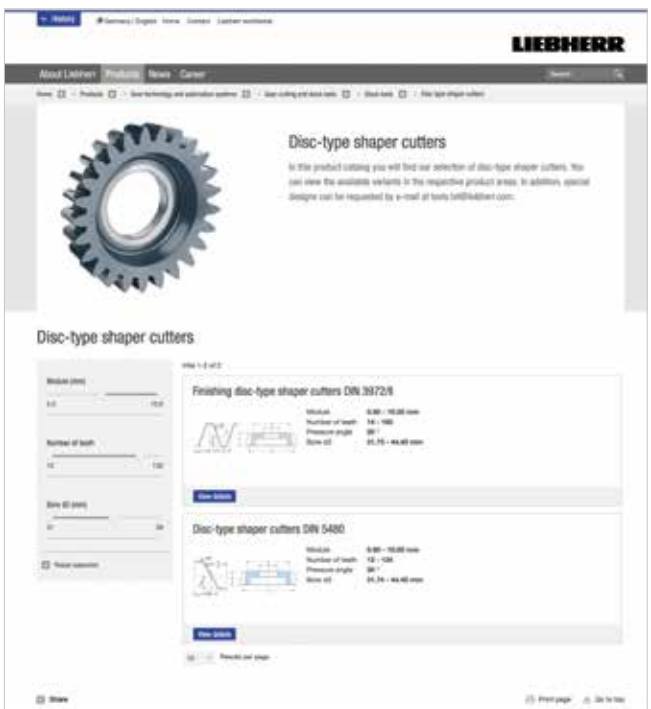
Find the right gear cutting tool with just a few clicks

If you need high-quality gear cutting tools at short notice, you can request them online from Liebherr. Many customers already use the practical and uncomplicated online catalog on the Liebherr-Verzahntechnik GmbH website. Haider Arroum, Team Leader for Tool Sales in Ettlingen, explains how it works.

How long has the catalog been online?
We put the catalog online in September 2019 in time for the EMO show in Hanover. It's currently available in six languages: German, English, French, Spanish, Portuguese and Russian.

What products can customers choose from?
We only offer our own gear cutting tools. These are shaper cutters made of ASP2052/S390 with a highly wear-resistant Alcrona Pro coating. They're available in the standard quality grade AA/A, DIN 1829. Other coatings are also available on request, of course.

How can customers make their selections and requests?
Customers can use filters in all tool categories for the technical features that they want, for example the module, number of teeth or bore diameter, and then choose from the products that are then displayed. Once they have made a selection, they enter the quantity they want and their contact details, send the request and receive an offer as a PDF the next day at the latest. After receipt of the order by e-mail, the stock tool is sent out on the same day along with the measurement report. Our delivery time is usually one day. If the product they want is not listed, customers can request a specially made product by e-mail. They also receive an offer for this the next business day at the latest.



The filter function makes it easier to select a suitable tool

What are the advantages of the online stock tool catalog?
We wanted to make it easier for customers to find the right product and make the process of requesting and ordering as straightforward and transparent as possible. Unlike in the printed catalog, the filter function allows customers to narrow down the technical features and only suggests suitable tools. They can then select the products from different categories, mark the appropriate items and add the quantities they want. This makes the online catalog a quick and easy way to find the right gear cutting tool.

Do you need a special design?
Send a request to our team: tools.lvt@liebherr.com

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Team Leader of Tool Sales Ettlingen

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New measuring technology at the Ettlingen site

Quality is measurable: every micron counts

Close to production, with high cleanliness and air conditioning standards: The two new measuring rooms of Liebherr-Verzahntechnik GmbH at the Ettlingen site are used for quality control during the production of Liebherr gear cutting tools and for contract manufacturing.

Measuring cabin with state-of-the-art equipment

In fact, they are not traditional measuring rooms, but two bright, modern measuring cabins, located within the production plant at the Ettlingen site. This is the new home of the latest measuring technology from Liebherr. Constant temperatures, air quality and optimal lighting conditions offer the perfect environment for the measuring instruments and for the four quality assurance staff to carry out their daily tasks. When manufacturing the gear cutting tools, they make sure that the highest standards (up to grade AAA) are also met. The same standard also applies to the various gears manufactured under contract on Liebherr gear cutting machines.

Production and measuring technology are closely meshed

"With the facilities in the new measuring rooms and various updates to our measuring equipment, we have raised quality control for our customers to a new level," says Uwe Leimenstoll, Team Leader for Quality Control at Liebherr. "You could say we get right down to the very last micron to extend our lead with our premium products."

This also applies when manufacturing the profile grinding discs, where the measuring system is connected to the production machine. The machines constantly exchange data, comparing the target parameters to the actual values. If the inspection machine detects a tolerance deviation, an automatic correction is immediately made on the production machine. The profile grinding disc is then completely machined with the corrected values.

The interface is also compatible with other measuring devices – a step towards an open connection with "LHOpenConnect" (see also page 28). The documentation of the measurement results is complete and transparent: the results for the functionally relevant dimensions are logged and the measurement and inspection records can be made available to the customer if required.

High standards in the equipment of the measuring rooms

- One measuring cabin for each application: gear cutting tools and contract manufacturing
- Size: 60 and 55 square meters
- Equipped with Liebherr WGT 400
- Four measurement technicians in two-shift operation
- Measurements are carried out according to VDI guidelines including VDI/VDE 2612 and 2613, Group 1
- Possible dimensions: tools from module 0.18 to module 16 and an outside diameter of four up to 300 millimeters
- Continuous optimization of the quality standard using the 5S method (sort, set in order, shine, standardize, sustain)

Expertise in every detail

Alongside automation, the expertise of Liebherr's measurement technicians and workers also plays a key role in the manufacturing of tools and gears. Because the geometries and dimensions of the parts from contract manufacturing vary widely and are sometimes very delicate, every detail is crucial: "We manufacture our tools according to the needs of our customers. This requires so much experience that it's not easy to automate certain processes," explains Uwe Leimenstoll. The new measuring rooms in Ettlingen are exactly the right environment for the interaction between production, measuring instruments and specialist personnel.

Interview: One year Liebherr measuring technology

System solutions from a single source – worldwide

A year ago, Wenzel GearTec GmbH, a successful manufacturer of gear inspection machines, was integrated into Liebherr-Verzahntechnik GmbH. How are the customers, technology and employees benefiting from this today? We spoke to Peter Biemer, Liebherr's divisional Head of Sales Gear Cutting Machines, and Heinrich Brüderle, Head of Measuring Technology, formerly of Wenzel GearTec GmbH.

Measuring technology has been part of the Liebherr portfolio for a year now. How would you assess the integration from today's perspective?
Peter Biemer: Liebherr has successfully expanded its portfolio as a full-service provider. Integrating measuring technology into the company was an important strategic step and the logical development of the partnership which has existed since 2015 with Wenzel GearTec GmbH. We can now offer coordinated system solutions for gear cutting and inspection machines from a single source.

Heinrich Brüderle: Our measuring instruments are known for their optimum accuracy when inspecting gears. The existing partnership with Liebherr made it clear to us that the integration was the right step in order to advance our technology together and continue to offer it to our customers at the highest level. The synergy effects can already be seen in the development of LHOpenConnect and other system solutions.

At EMO 2019, you presented a solution for transferring data between production machines and inspection machines. Your solution is called LHOpenConnect. How does it differ from the closed loop approach?
Peter Biemer: At EMO 2019, Liebherr presented the WGT 280 inspection machine, which has a manufacturer-neutral GDE interface for transferring data to the production machine. We have expanded this concept into a system which, unlike a "closed" loop, is based on open data structures and connectivity. The LHOpenConnect software enables the user to exchange data with other processing and inspection machines, control centers and data analysis systems, even more flexibly and across different processes (see also page 28).

Drawing a positive conclusion: Heinrich Brüderle (left) and Peter Biemer

So you've already achieved synergy effects on the technical side. What other advantages of integrating measuring technology do you see?
Heinrich Brüderle: Customers around the world benefit from our expanded product range, improved service network and greater international sales network. Because Liebherr has so many sites, we are never too far away from customers and can offer local service and support.

What has changed for the former employees of Wenzel GearTec?
Heinrich Brüderle: All 25 employees at the Karlsruhe and Shanghai sites were taken on. They appreciate the benefits of an international family business that is not only run for short-term profit. Our workforce sees the whole thing very positively. And that's also very important to us, because one of the most important factors in our success is the people who put in the work every day.

What do you think are the future challenges for Liebherr measuring technology?
Peter Biemer: The future trend will be towards automation and data exchange. Because Liebherr is working intensively on this and it's one of our core areas of expertise, I'm optimistic that we'll stay at the forefront in this area.

Heinrich Brüderle: We will be dealing with the area where automated, production-related and unmanned measuring systems interact with the expertise of the people who operate them. With Liebherr, we have the right technology partner to be able to offer our customers stability and certainty.

Heinrich Brüderle
Head of Measuring Technology

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Automation Systems

Solutions for the production of alternative drives

A flexible automation system for battery pack assembly

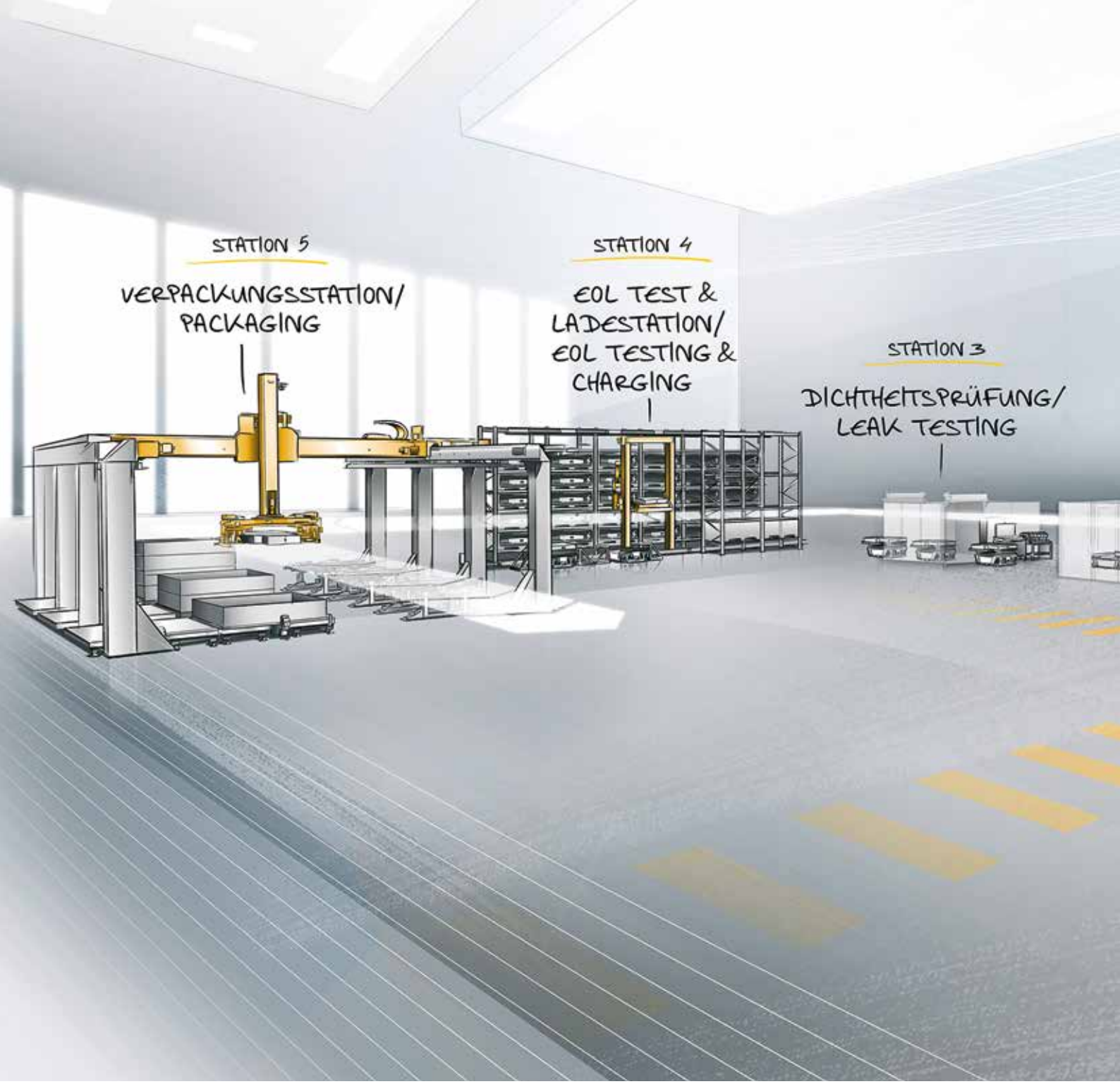
Liebherr is embracing technological change towards alternative drives and has developed a modular automation system solution for the assembly of battery packs for electric cars – from small batch manufacturing to fully automated mass production. Advantages: Liebherr automation is system-compatible and offers process reliability, fast cycle times and flexibility.

Alternative drives have been an important topic for some time at Liebherr. Many of the company's products, from concrete mixers to mobile cranes, already feature electric drives (see also page 38). In view of predicted future developments in the field of e-mobility, it was a logical step to take a closer look at Liebherr's automation systems portfolio with regard to the requirements associated with electrification in the automotive industry.

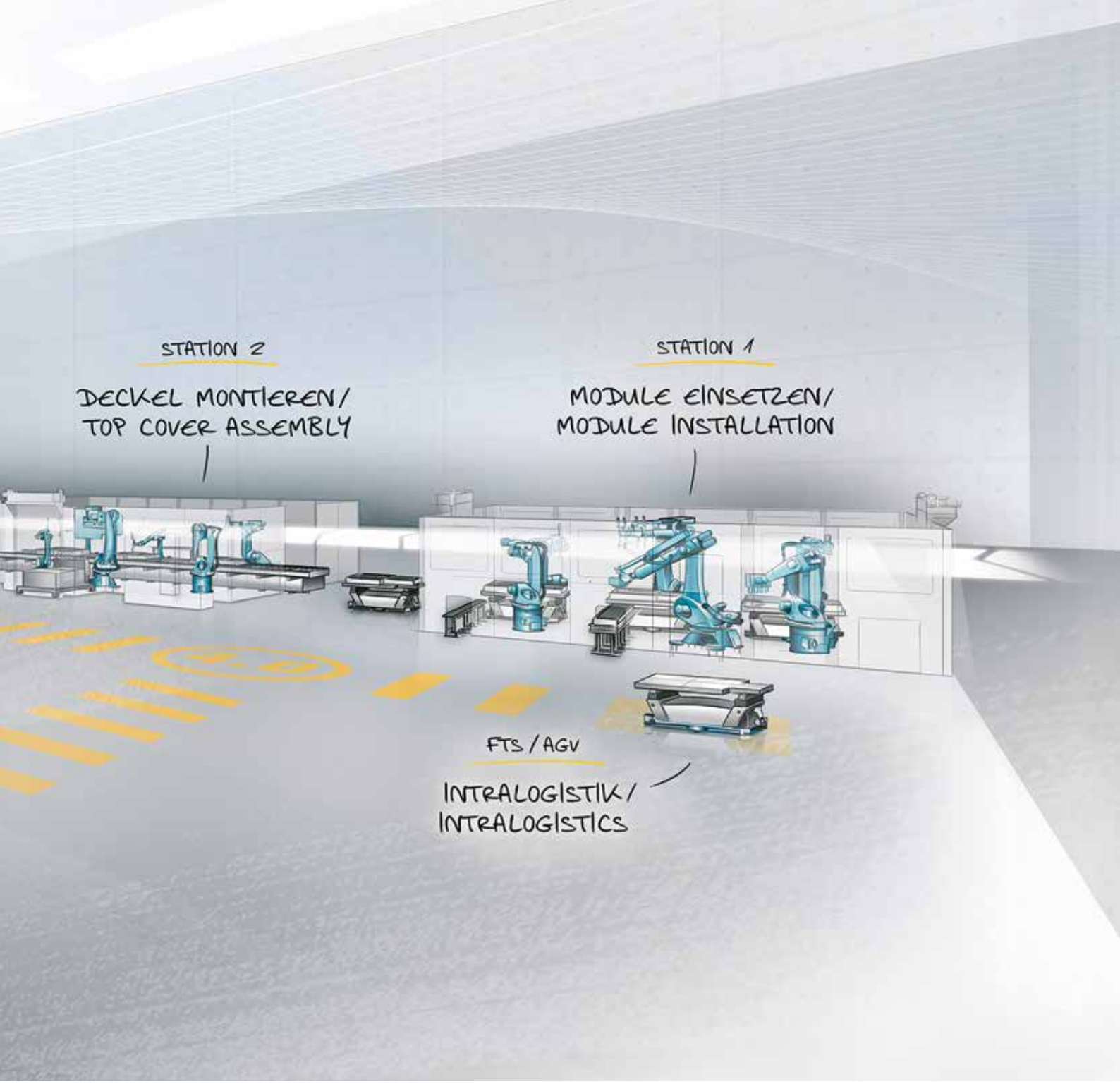
A development project with scientific support from KIT Campus Transfer GmbH, a spin-off of the Karlsruhe Institute of Technology (KIT), and PEM Motion GmbH, a spin-off of RWTH Aachen University, came to the conclusion that Liebherr is the perfect partner when it comes to the automated assembly of battery packs for vehicles with electric drives. Up to now, the majority of the production is done manually or is only semi-automated. However, increasing demand and the resulting orders can only be fulfilled with more extensive automation solutions. In terms of serial production of components for combustion engines, automated assembly has long been the core business of Liebherr automation systems.

Challenges in battery pack assembly

The conditions that prevail in the assembly of combustion engines cannot



be transferred one-to-one to the assembly of battery packs. One of the challenges in handling battery packs is the weight; a fully assembled pack weighs up to 800 kilograms in the automotive sector. Liebherr's handling systems are ideally suited to this weight class. Another challenge is the safety-relevant properties of battery parts. Strict customer requirements and safety regulations in system design are, however, already a matter of course for Liebherr. Thomas Mattern, Head of Development in Automation Systems, explains, "We can draw on existing experience, especially in production lines for the automotive industry. The big difference is that this is a workpiece that is subject to different assembly and technological processes. In addition, special requirements arise due to specific properties the workpiece should possess, such as the ability to contain hazardous substances, the degree of flammability and the electrical charge. But it is precisely such challenges that offer certain incentives for which we are well equipped." Here Liebherr excels with its system capability and expertise in process integration. Product-specific process stations such as metering units, screwing sta-



tions or leak testing, which are not part of Liebherr's core competences, are solved together with suitable partners and suppliers and integrated into the overall process.

Flexible solution with modular product kits: the Lego principle

Liebherr attaches great importance to modular design, scalability and networking of components. The user has an entire product kit at their disposal: handling systems specifically for heavy transport loads, linear gantries for fast cycle speeds, industrial robotics for complex tasks, storage solutions, intralogistics and the corresponding control systems. Thomas Mattern draws a vivid comparison: "It's like a Lego building set, the skill is in assembling the individual modules together. Our systems have universal interfaces like the nubs of Lego bricks. From this, we configure a completely individual system according to our customer's requirements". This unique capability of Liebherr automated systems allows for semi-automated systems for small quantities or fully automated lines for large serial production can be designed in a scalable way. Liebherr is an experienced partner when it comes to issues

such as interfaces, parallel processes, reproducibility, emergency strategies, and availability and tracking of parts. “For battery pack assembly, we can supply everything from a single source to individual process stations that can be combined to a complete turnkey system. Not many can do that,” says Jan Pollmann, Development Engineer for Automation Systems, summing up the scope of possibilities.

Such a flexible system ensures maximum automation density with minimum footprint. Space-saving linear gantries, which are suitable for easy handling of heavy weights, can be specifically combined with industrial robotics that take over more complex handling and process tasks. Further flexible solutions such as automated guided vehicles (AGV) can also be integrated. Thomas Mattern is optimistic about the future: “We have brought the ‘old’ and the ‘new’ world together and are well prepared for alternative drive systems.”

Highlights at a glance

- **Flexibility:** turnkey solutions from small batch manufacturing to mass production
- **Scalable product kits:** heavy-duty handling systems, linear gantries, industrial robotics, storage solutions, intralogistics, control system
- **System capability:** integration of product-specific processes
- **Process reliability:** fast cycle times, minimum footprint

E-mobility at Liebherr:

In order to be prepared for future developments, alternative drive systems are a major topic at the Liebherr Group, and are considered across all divisions. Liebherr is not only a supplier of production systems for e-mobility, but also a manufacturer of construction machinery and mining products with innovative drive concepts:

Concrete technology

- Concrete mixer ETM 905
- Stationary concrete electric pump 70E

Handling equipment

- Material handling machines LH 26 electric industry and LH 110 C gantry port

Mining

- Mining excavator R 9200E

Special underground engineering

- Heavy-duty drilling rig LB 16 unplugged (battery operated)

Mobile and crawler crane

- Mobile construction crane MK 88-4.1

Maritime cranes

- Liebherr portal crane LPS 420E

Discover more:
https://go.liebherr.com/G74771

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Optimal material flow and short distances for operators thanks to the parallel arrangement of the two independent systems for material and machine pallets. The system architecture is unique

Automated gearbox production with the PHS 1500 PRO pallet handling system

No more daily setup

How can we ensure maximum manufacturing productivity? What is the best automation system for our wide variety of parts? Which partner can reliably put our plans and requirements into practice? These are the kinds of questions that every manufacturing company aiming to increase its productivity has to ask. Kordel Antriebstechnik GmbH, based in the Westphalian town of Dülmen, found the right solution for its gearbox production with a pallet handling system from Liebherr.

Kordel's product range includes gearboxes for industrial trucks, agricultural machinery (headers in corn choppers and combine harvesters), and for construction machinery such as road cutters and pavers. Kordel is one of the few gearbox suppliers with sufficient vertical integration to cover every step from the blank to the finished gearbox part, including hardening and nitriding, all the way through to assembly. The company produces around 325,000 gearboxes every year.

The basic idea in this case was to replace the daily setup that was required on stand-alone machines with automated processes. Johannes Kordel, the General Manager responsible for technical management at Kordel, has been with the company for 35 years. Together with his team, he took a thorough look around the market before starting this major automation project. In order to successfully plan automation, it is important to know all the facts and weigh the requirements against each other.

Precisely defined requirements

Using the time "parallel to machining" has always been the key when it comes to optimum utilization of machine tools. If all the processes that are not directly part of the actual machining take place simultaneously elsewhere and all parts arrive at the next station at the right time, it means the machine is optimally utilized, and expensive downtimes are minimized. In addition to price and quality, timely delivery is the third key aspect that suppliers must guarantee in order to be competitive.

The plans to modernize production with automated systems in Dülmen and the second production site in Jawor, Poland,

Set-up drums close together allow quick action

began four years ago. For new machining centers for drilling and hobbing cast iron and aluminum gear components, an automated material supply system from the warehouse to the machine and back again was created. The two systems, each with two PHS 1500 PRO lines, were the biggest single order to date for Liebherr pallet handling systems.

The project planners first analyzed all the processes and then decided for each step whether it should be automated or carried out manually. “In some ways it’s different with us than at other companies, but at each point we chose the method that seems most suitable,” say Peter Hörsting and Dirk Strotmann, the experts in charge of programming, clamp construction and machining. While the main argument for automation in Dülmen was to minimize setup times, which used to take about a third of the machine time, at the Jawor location the decision was determined by the lack of qualified workers.

Two lines for a customized solution

Because Kordel produces around 25,000 different parts in-house, the material supply must be adapted to this huge variety. The processes are determined by the batch sizes of typically five to 30 parts per order. This makes the supply of materials a critical aspect; the shuttle that brings the blanks to the machine must not become a bottleneck. “The machining center is the most expensive component; it must always be running and must never have to wait for the connected systems,” says Johannes Kordel, summarizing the

Technical data PHS 1500 Pro

	Kordel Dülmen	Kordel Jawor
Maximum transport weight in kg	1,500	800
Maximum workpiece diameter in mm	1,200	900
Maximum workpiece height including pallet in mm	1,400	1,120
Lift module travel speed in m/s	3	3
Maximum travel speed of telescopic fork, loaded in m/s	0.6	0.6
Maximum travel speed of telescopic fork, unloaded in m/s	1.3	1.3
Number of machine pallets	74 of 630 x 630 mm	97 of 500 x 500 mm
Number of material pallets/lattice boxes	188	205

most important specification. It quickly became clear that, at the required cycle time, this could not be done with a single system. This was the determining factor for the system to consist of two lines: a material storage system and a production system, each with a storage and retrieval unit. The two systems continually communicate with each other via a shared control system. When the idea for the architecture with two lines was first conceived, it was calculated how many machines could be operated with this type of system. As a result, the pallet handling systems are now designed for up to six machines. There are currently five identical machining centers at both locations.

The lines are laid out in parallel to minimize the distance between the two sides. To maintain a high frequency and short cycle times, smooth processes at all the transfer points are required. On the material side, there are two loading and unloading stations for forklifts and eight for manual removal. When storage and retrieval unit 1 takes a finished housing from the machine to a setup station of the production system, storage and retrieval unit 2 removes a lattice box for finished parts and a lattice box with raw parts from the material storage system. All the required tools have to be stored and kept in stock as well. A small number of very specialized measuring devices are not provided at every processing station, but most of the workpieces will be processed at all the stations. In addition to the six setup stations on the machine side, which are arranged in pairs and operated by a total of three employees, there is a separate station for more complicated items, new clamping fixtures or problem cases so that the employees can continue working undisturbed at the double stations. The machine processes the job and returns the clamping fixture. Each component has its own lifting appliance, which must be provided at the right time. These accessories for specific workpieces are also essential for successful automation.

Removing the blank from the material storage system for clamping on the opposite setup station. The platform under the lattice box is lowered for removal

Filling the material side with new blanks

Not a 'run of the mill' solution

The system is unique because of the parallel lines of shelving in the material warehouse and the flexible manufacturing system with a shared master control system. In addition to this, Kordel requested that lowering platforms be installed on the removal side of the storage line. The normal height of the storage and retrieval machine is too high for manually removing the lattice boxes. In the high position, the box moves out of the device onto the platform, which then moves down so that the operator can easily remove the component and clamp it on the setup pallet in the processing line. These platforms were also supplied by Liebherr, but are not a standard part of the pallet handling system. Johannes Kordel judges: "We liked

the technical design of the mechanical parts as well as the tidy environment. The appearance meets our requirements and those of our customers, who regularly carry out audits at our site."

Cooperation

Alongside the technical expertise that Liebherr demonstrated with a gear cutting machine in Kordel's gearbox manufacturing facility, Liebherr's communication and flexibility were also deciding factors for the renewed cooperation on the automation project. "The first meeting with all the representatives took place within just 14 days. At that meeting, they were able to answer all our questions. This made us feel confident about the project from the beginning," says Johannes Kordel, recalling the start of planning. What he liked most of all was that Liebherr listened. "We formulated our ideas and a system was developed that is precisely tailored to our situation. That's not possible with companies who only let you order from their catalogs." Once the decision had been made in favor of the PHS 1500 PRO, all the details were discussed and individually resolved on a regular, often daily basis. The various adaptations and the two-line architecture, which was new to Liebherr too, made the project an exciting experience for both sides.

> "We formulated our ideas and a system was developed that is precisely tailored to our situation. That's not possible with companies who only let you order from their catalogs."
>
> Johannes Kordel, General Manager at Kordel Antriebstechnik GmbH

Liebherr's strength lies in its ability to flexibly implement individual customer requests. For example, Liebherr takes care of the connection to existing production systems and adapts the interfaces. At Kordel, all elements of the new production line communicate via the existing host computer supplied by the Berlin company PROCAM Steuerungstechnik.

Knut Jendrok, Liebherr's Head of Sales for Pallet Handling Systems says: "The specific issues that Kordel brought into the planning weren't at all obvious ones. It's extremely helpful when a customer formulates its requirements so precisely according to the circumstances. This helps us work well together and it becomes a productive cooperation."

KORDEL Antriebstechnik GmbH

Industries:	Gearbox manufacturing for industrial trucks, agricultural machinery, construction machinery
Company size:	950 employees
Founded:	1879 as a forging shop
Headquarters:	Dülmen, Germany
Locations:	Dülmen-Rödder, Dülmen-Dernekamp, Jawor (Poland)
Turnover:	Approx. 140 million euro / year
Website:	www.kordel.de

Modular pallet handling system: an addition to the PHS Allround family

PHS 800 Allround – the slim alternative

Liebherr presents the latest member in the PHS Allround family, the PHS 800 Allround. It has a narrower design than the PHS 1500 Allround, which makes it ideal for automated loading of smaller machine tools while retaining the basic principle of modular design and universal applicability and expandability.

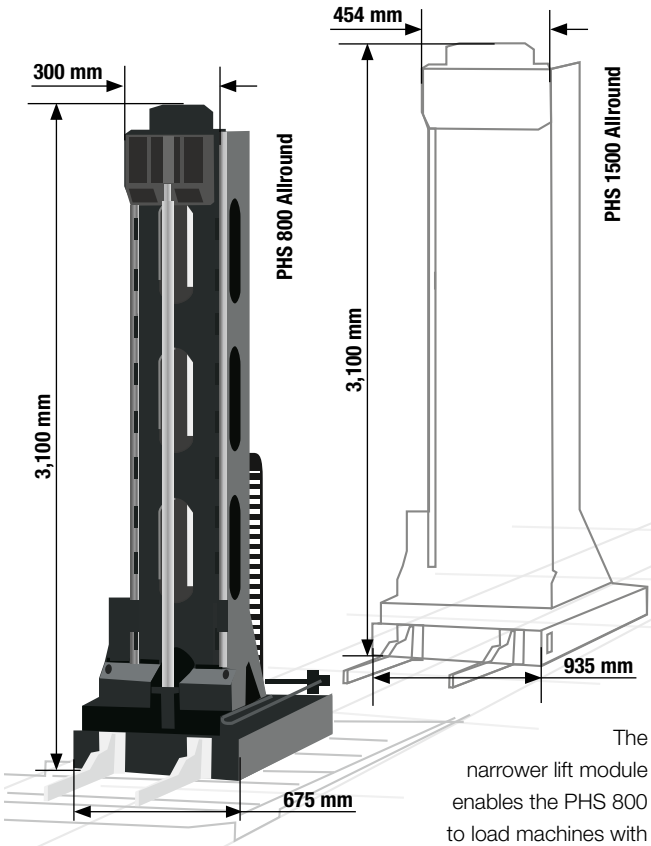
Flexible, modular and uniquely adaptable to the needs of automation customers, the PHS Allround pallet handling system has become Liebherr's best-selling automation system. Now, the family of Allround systems is being expanded: The PHS 800 Allround is narrower and lighter than its "big sister", the 1,500 kg version. It can handle transport loads of up to 800 kilograms and although it has the same height, it has a narrower lift module and a narrower telescopic fork for smaller pallets. This means that machines with a small machining chamber can now be loaded automatically.

Tried-and-tested components

The successful Allround system concept has been retained in this smaller version. The possibility of arranging machines, additional devices and shelves at the front ensures high flexibility in the system design. The unique design principle with a detachable front access allows individual machines to be disconnected from the system, while the remaining machines continue to produce without restriction in automatic mode. Two control variants for the master computer (Soflex and Procam) can be exclusively configured to the requirements at hand. Many components of the PHS 1500 Allround are also installed in the smaller version: proven high-quality components such as the floor track, sprocket, mount, C-axis and rotary axis have been retained.

Effective automation from batch size 1

The expanded PHS Allround system not only offers intelligent parts handling, but also maximum flexibility with regard to batch sizes; automation can be effective and economical even from batch size 1. For complex workpieces with high component variance, the PHS system acts as a workpiece storage unit and performs organizational tasks. This means that spindle running times can be increased to more than 90 percent and expensive setup times can be significantly reduced, freeing up operators for value-adding tasks.



The narrower lift module enables the PHS 800 to load machines with small work areas

Technical Data

	PHS 800 Allround	PHS 1500 Allround
Payload incl. pallet single loader (double loader) in kg	800 (2 x 600)	1,500 (2 x 1,200)
Collision circle diameter in mm	Ø 600 / 900	Ø 900 / 1,400

Highlights at a glance

- Modular system
- Flexible layout
- Front access
- Optional: double loader
- User-friendly control system
- **NEW:** narrow lift module with narrow telescopic fork (for PHS 800)

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Tried-and-tested Bin Picking with Liebherr software LHRobotics.Vision

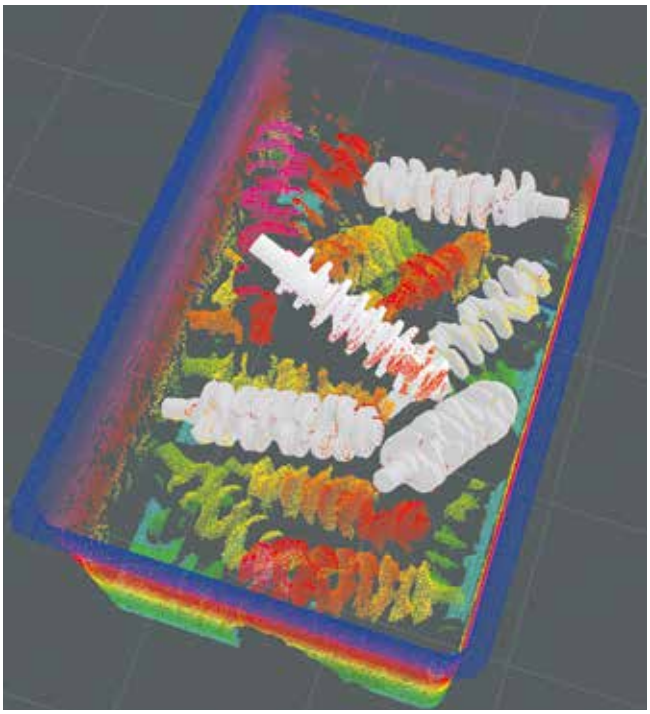
From the software package to the turnkey robot cell

Until now, Liebherr has provided Bin Picking solutions with software supplied by a partner. Now the company offers its exclusive software package with new features that can also be integrated into systems from other manufacturers. Liebherr's combined expertise in software development and industrial application also makes LHRobotics an interesting product for integrators.

With Bin Picking, a robot must use a vision system to recognize objects, remove them without collision, place them in the correct orientation and transfer them to a machine. The software for this, the "brain" of the robot so to speak, was developed by Liebherr together with a leading research institute, but initially used exclusively on its own systems. In 2019, the decision was made in Kempten to market the software and to distribute it exclusively. Liebherr strengthened its technological competence with additional technologists and software specialists for vision systems and Bin Picking.

New: simulation tool to optimize the gripper concept

The package consists of a camera, software and documentation. What is new is the optional simulation tool developed by Liebherr. With a virtual camera and a virtual point cloud, it simulates whether the gripper concept will work and enables the user to modify the gripper geometry and optimize processes in order to achieve better emptying of the bins. This feature closes a gap in the offline programming of the robot, because the entire process, including Bin Picking, can now be mapped virtually.



The software recognizes the arrangement of parts in the scan

Integration in systems from other manufacturers possible

What is also new is that the LHRobotics software can be integrated in systems from other manufacturers. This makes it particu-

Operator-friendly user interface

larly interesting for system integrators. They now have available a fully developed product and can also draw on Liebherr's system expertise. "We don't just have the software – we bring our entire system expertise and industrial experience to the table. That's pretty unique," says Thomas Mattern, Head of Automation System Development. Many users trust Liebherr's know-how when deciding on a Bin Picking system. "For many smaller plant manufacturers, Bin Picking is initially a very complex application. If they know that Liebherr is behind them, they're more willing to tackle the topic," continues Thomas Mattern.

Ready for future requirements

Bin Picking is not just limited to heavy machined components whose ergonomics make it necessary to use robots. The trend in Bin Picking is towards increasingly complex parts, such as chassis and body components, which have to be detected, evaluated and transported using sensor systems. There are also interesting applications for the technology in overall vehicle assembly. With its wide range of products – from software to robot cells to turnkey systems – Liebherr can always respond individually to the needs of its customers. "We'll also be dealing with topics such as artificial intelligence (AI) and deep learning in the future, but together with our technologists and software specialists, we're ready for anything," predicts Thomas Mattern.

Finalist in the ERF TechTransfer Award 2020

The software development project reached the finals of the European Robotics Forum (ERF) 2020 in Malaga, where outstanding innovations in robotics and automation resulting from cooperation between industry and research are selected.

Jürgen Groß
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Test hall: Bin Picking robot cells

New test hall with customer area in Kempten

Liebherr Tech-Center: Experience new developments in automation systems

Liebherr opened a new test hall for automation systems in Kempten. Prototype solutions are tested and the systems are "put to the test" here. This new facility allows the customers to experience the tests "live" and gives them the opportunity to conduct virtual tests themselves.

A few minutes by car from the main plant in Kempten is the new test hall for automation systems by Liebherr-Verzahntechnik GmbH: the "Liebherr Tech-Center". Originally rented as a testing ground for projects, Liebherr also quickly recognized the added value of the area as a place to interact with customers and decided to move the test systems entirely into the Tech-Center.

Diverse testing possibilities in the test hall

Over an area of approximately 700 square meters, customers now receive an insight into the world of high-quality automation systems by Liebherr. Systems are tested and demonstrated to current and potential customers. Whether tests on prototypes or new products, feasibility analyses or simulations: "The testing possibilities in our new Tech-Center are diverse. In addition to our pallet handling system, we have also set up two test cells for Bin Picking. We are also testing a flexible manufacturing cell with an automated guided vehicle and our LP 100 linear robot," says Thomas Mattern, Head of Automation Systems Development, explaining the layout of the test hall.

Two test technicians are permanently on site to commission the test systems, carry out prototype or customer tests and document the results. Other employees such as assembly workers, installers, software developers and computer scientists are deployed as required. Before the system receives sales approval, relevant components and drives are tested here for wear under real conditions, and tests are conducted under maximum load and with a maximum stroke.

Focus on optimized Bin Picking

Bin Picking is also continuously refined here. Gripper and load tests for the removal, placement, and fine-positioning of geometrically complex parts are refined to optimize workflows. "This automation solution enhances process reliability and increases productivity. With the two Bin Picking test cells, our Tech-Center is another factor in a modern manufacturing site," continues Thomas Mattern.

Tests on the automation of systems for the e-mobility market are being planned.

Customer area as a place of innovation

A particular highlight of the test department is the customer area. Slightly raised and with a view of the hall, customers can follow the tests "live" in a pleasant atmosphere. At a Bin Picking workstation, they can experience the Bin Picking system and process as a 3D visualization or even simulate it themselves. The top floor has an office and meeting area which offers space for undisturbed project meetings and technological discussion, while being close to the systems at the same time. "We are talking about a win-win situation for both parties: our customers and Liebherr. While we can effectively carry out tests and test series with new products in terms of development, our customers receive professional support. We are convinced that we have created a place of innovation in the Tech-Center," concludes Thomas Mattern.

Customer area: Overview of components and systems

Opening of the Tech-Center in February 2020 (from left to right): Michael Messer, Managing Director Production, Wilfried Fischer, Production Manager Assembly Automation Systems, Thomas Mattern, Head of Automation Systems Development, Dr. Christian Lang, Managing Director Sales / Marketing; Dr. Hans Gronbach, Managing Director Construction / Development

In Focus

2020 marks 50 years for Liebherr in the United States

United by success

Liebherr in the United States is proud to celebrate five decades in North America and establish itself as a leading manufacturer. Liebherr has built its U.S. business on a foundation of trust, innovation and engagement with customers. Five decades later, Liebherr's growth, diversity and stability are evidence of how the company is united by success with customers as they work on the challenges of tomorrow and focus on the future together.

"United by Success" is not just the 50th anniversary tagline, but rather the way Liebherr goes about business with its customers. The company and its customers are one through each other's successes and stronger together. In the U.S., Liebherr offers a vast range of solutions: this includes Gear Technology and Automation Systems, Aerospace and Transportation Systems, Domestic Appliances, Components, Concrete Technology, Earthmoving Equipment, Tower Cranes, Mobile Cranes, Mining and Maritime Cranes.

With the company's vision for continued growth and commitment to the U.S., Liebherr is excited to celebrate its anniversary with some big initiatives throughout the year: Completing the expansion of its Newport News campus in spring 2020, introducing new technologies and equipment and having a major presence with customers during industry trade shows.

Trusted family-business
The direction the pioneer Hans Liebherr once started the business with is still inherent throughout the organization. This includes company values, innovation and craftsmanship, and at the very heart of it: putting customers and employees at the center.

The inauguration for innovation started when Liebherr introduced the world's first mobile tower crane, followed by Europe's first hydraulic excavator. This coupled with several other innovations along the way created the path for the Liebherr Group to be the global leader it is now. Liebherr constantly improves upon its high-quality products and makes significant investments to ensure it continues on the leading edge of technological progress.

Spanning more than 140 companies across all continents, the Group's independent corporate structure puts the company in a position to react flexibly to competition and transform ideas rapidly into impactful and lasting results.

The center of it all: customers
Liebherr is driven by a passion to deliver solutions to solve customers' challenges. Rather than being content with short-lived success, the company aims for a long-term relationship. Alongside the customer's journey for anything needed from customization to assistance, their range of products and services feature advanced engineering, leading technology and a wide variety. With all of its solutions, Liebherr always focuses on customer satisfaction.

This long-standing relationship is paying off for generations in the United States: Liebherr began to gain the trust of its customers and business partners in the early 1970s and has accompanied them over the years. Meanwhile, the commitment spans generations as Liebherr grows with the demands of its customers.

Today, tomorrow and years from now Liebherr in the United States will continue to devote its efforts to creating the best quality and best performing machines and services.

The company continues to be driven by ingenuity and craftsmanship, consistently coming up with innovative solutions for customers all over the world.

Liebherr Gear Technology and Automation Systems in the USA

Since the year 1952, Liebherr has been producing gear machines. Production began in Kirchdorf and then transferred to the present-day Kempten factory in the year 1969. The division's story in the USA began in Ann Arbor, Michigan, in 1974. Since then Liebherr Gear Technology, Inc. has been responsible for the sales and service of these machines for the North American market. In 1986 Liebherr Gear Technology moved to the current location based in Saline, Michigan. Over the years, after starting with gear hobbing machines, Liebherr expanded the technology offerings to include gear shaping (1979), gear grinding (1989), gear chamfering (2005), and recently gear skiving (2017). Today, Liebherr gear machines are used to produce a wide variety of gear systems. From small gears which would fit in your hand like in automotive planetary transmissions and aerospace flap-actuators, to up to 50-foot diameter gears used in mining applications like rope-shovels, or slewing bearings for wind-power applications.

In the Liebherr factory in Saline, Michigan, gear cutting machines and turnkey automation systems are manufactured for customers in the USA, Canada and Mexico

Furthermore, Liebherr Automation Systems, Co. also produces automation systems for Liebherr's own gear machines and for other types of machining centers, which are offered to the North American market from the same Saline office. The first automation projects in the US were installed in the late 1980s and were turnkey systems combining the gear machines and factory automation for the automotive and truck markets. Liebherr's gantries, robotic systems and palletizing equipment can be found in many industries across the US today.

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1. First annual dealer meeting in Newport News, 1973, 2. Liebherr USA opened its gates in the 1970s, 3. Liebherr takes off on the US market, with construction machines and more, 4. Liebherr expands its product portfolio in the USA to include concrete technology, 5. The early days of Liebherr mining excavators in the USA, 6. Liebherr starts manufacturing mining trucks in 1999. At 600 tonnes, the T284 is currently the heaviest product in the product group, 7. The Newport News Campus in 1972.

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Liebherr Industrial Services present customer solutions

Preemptive rather than reactive: the right service package for every case

When founding the Industrial Services for Gear Technology and Automation Systems department in 2018, Liebherr already began rolling out the topic of services again from a user perspective. By now, customers can choose the service that fits their individual requirements from a total of five different service packages.

Maximilian Hofmann is Liebherr's Global Industrial Services Manager. His mission is to ensure the seamless operation of machines and plants at the customer's premises. In order to optimize their availability and productivity, his department offers the appropriate service – right from the start. "We offer our customers preemptive measures and individual consultation. This helps them to use our machines optimally and to avoid downtimes. This ultimately saves costs and ensures competitiveness," says Maximilian Hofmann, explaining the concept.

The department sees itself as a universal interface between customer requirements and what Liebherr can offer. Each user has his own maintenance strategies for his equipment and machines, which result in different requirements for manufacturer support. Liebherr's service packages are tailored precisely to this.

Service over the entire life cycle

Whether a replacement of wear parts is planned or fast and uncomplicated help for an acute malfunction is needed, whether the time or cost factor is most important – Liebherr gives its customers specific support with individual service offers over the entire life cycle of a machine or plant. In addition, training offered on the topics of operation, maintenance and planning increases the user's competence in specific ways.

The offer comprises five service packages which Liebherr has tailored to its customers' requirements (also see the adjacent graphic). The focus is on productivity and user satisfaction at all times and in all places, says Maximilian Hofmann: "Our customers receive all these services worldwide, through the same system and in the same quality".

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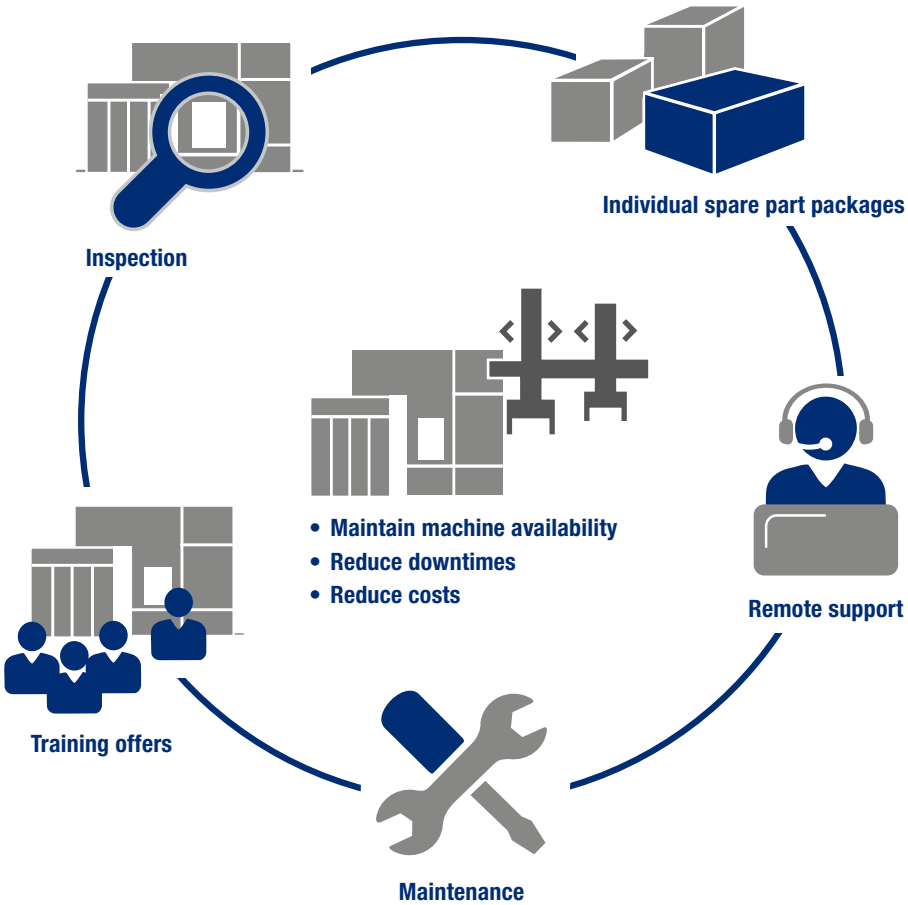


Inspection*
Preventive analysis of the machine condition
- Analysis log with recommendations for action based on field experience
- Implementation based on the customer's individual maintenance strategy

Training offers
Effective technical training for operators, maintenance personnel and planners
- Attachment of workpieces, processing start and error detection
- Electronics / mechanics, part exchange, test reports
- Application expertise

Individual spare part packages
The right spare parts for every situation, on site
- "Start-up" for a smooth production start
- "Emergency" to maintain machine productivity

Remote support*
Fast and uncomplicated assistance by remote access in case of malfunctions
- Function tests and troubleshooting
- Removal of software problems by remote maintenance
- Liebherr experts provide support for mechanical challenges

Maintenance*
Safeguarding machine availability
- Analysis log with recommendations for action based on field experience
- Replacement of standard wear parts
- Professional testing of individual machine parts

***individually or as part of the contract**

Portrait: Interview with service engineer Karl-Heinz Klöble

“There’s always something to do”

Karl-Heinz Klöble is responsible for putting large gear cutting machines into service in China. We spoke to him about his experiences there and what fascinates and motivates him in his unusual job – and why he’s too busy to retire yet.

Mr. Klöble, you’re responsible for the smooth installation and commissioning of machines for customers in China. How did you get this job?
I’ve been with Liebherr for 42 years and, as a trained industrial mechanic, I was responsible for the assembly of gear cutting machines at the Kempten plant. From 2007 there was a boom in demand for gear cutting machines for large workpieces. Because I had previously overseen individual commissioning projects in Korea, I already had some initial experience with the Asian market. My boss then came and asked if I would look after the on-site assembly of these machines in China.

How does the assembly take place on site and what is important?
The machine is shipped in individual parts and then assembled, set up, measured and commissioned on site. Good coordination is very important here and that’s what I’m responsible for. No day is like any other: there are always challenges and you often have to make quick decisions. Sometimes a special tool is missing, or there’s a delay in delivering materials. And then you have to improvise.

Happy to be of service: Karl-Heinz Klöble

No small thing: The gear hobbing machine LC 6000

Tell us…
For example, there was once a supply shortage of Powerline chips for controlling a machine. In the end we got other chips delivered, but nobody really knew how to install them. Because of the time difference, we had to make a lot of night-time phone calls. But we managed it and got the machine up and running a few weeks later. Another time, there was no equipment for mixing the liquid concrete for the machine bed mounting fixtures. So we built a tub and an agitator out of an old oil drum and some reinforcing steel.

How do you deal with challenges like that?
It takes a lot to unsettle me. But you do need plenty of patience because there are all kinds of unexpected situations and

challenges. Every assembly project is different. I'm always there at critical points during the installation. The customers know that, and for me it's just part of the job. At these moments, I'm by the customer's side, representing Liebherr.

What do you like about your work?
The processes are never the same and you're always faced with new challenges. I'm my own boss on site and can make my own decisions. I get to see the world. And my colleagues in Xuzhou, where I've been for combined three years now, have become something like my "Chinese family". We also socialize and go out for a meal together every week. I've even been invited to family celebrations.

Nothing escapes his scrutiny

Finishing touches during commissioning

Who's going to take up the baton when you stop?
As long as I'm still there, I'll be teaching my colleagues: I always take a mechanic and an electrician with me. Third-year apprentices can also come along. For example, in 2019 I took two apprentices to Chengdu to repair a large machine table weighing 33 tons. That took some good old-fashioned workmanship. I can only recommend field service, particularly to our younger colleagues.

When you look back – what do you associate with Liebherr as an enterprise?
I enjoy my job. I feel appreciated and my colleagues are very nice. I've been there a long time and have never had a bad experience, not even in economically difficult times. I really like working for Liebherr and feel connected to the companies.

You're not far away from your well-earned retirement. What are your plans?
I want to travel around China with my wife and visit my colleagues in Xuzhou with her. My big dream is to go to Norway in our camper van. And there are plenty of jobs to do at home and in the garden. As you can see I won't be bored. There's always something to do (smiles).

Liebherr Summer Program 2019

Kempten trainees run a programming course for US pupils

In August 2019, trainees Fabian Altenried and Julia Fetzer participated in the Liebherr Summer Program at Liebherr Gear Technology Inc./Liebherr Automation Systems Co. (LGT/LAU) in Saline, near Detroit. There, they ran the PLC programming course for pupils of the robotics course from the local high school, which was offered for the first time, and got to know the work routine at the Liebherr site. Fabian reports on his experience here:

We were very warmly welcomed by our American colleagues, led by Lisa Bozzi, the event manager at Liebherr. Gaining our first impressions of the Saline site, we started our programming course with the eight participants from Saline High School. Their task was to write a PLC program with the aid of TIA software. This program was then transmitted to the PLC control system in order to control the loading portal. To do this, we had to instruct the pupils in the construction and operating principle of the loading portal and of the TIA training unit. The participants were particularly motivated by the practical relevance of working on the loading portal – a system which is also a central component of our training in Kempten. We were surprised at how ambitious the individual teams were in solving the tasks; they didn't become discouraged if everything did not go right straight away. They were all the more motivated when things finally did work. However, we benefited just as much from passing on the specialist context of automation technology to the pupils in English.

The trainee as a teacher: Fabian Altenried

Exciting tasks and good supervision

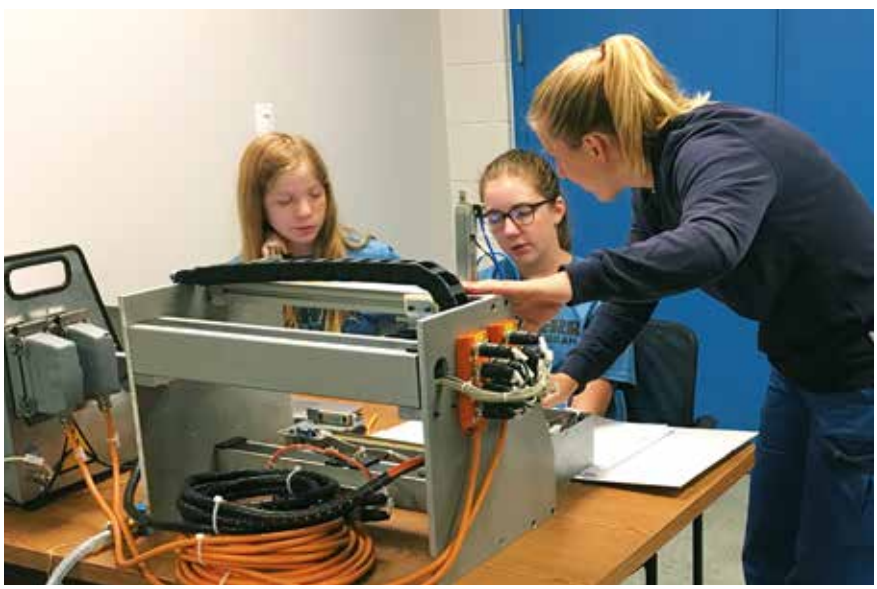
In addition, we were able to accompany various real projects in the LGT/LAU and give our colleagues positive support – for example, in the conditioning and commissioning of two gear hobbing machines which were overhauled as part of the REMAN program, including switching to new control software. Our cooperation with Liebherr Aerospace Inc. in Saline was equally interesting. Here, we helped with the conditioning of cooling units for charging stations for electric cars.

There was a lot to discover during our free time. Various leisure activities such as bowling, barbecues, trips in amphibious vehicles and military vehicles and, of course, sightseeing were on the agenda. A highlight was a visit to the soccer test match between FC Barcelona and SSC Naples in the Michigan stadium, the largest football stadium in the USA. We were also particularly impressed by the "Sleeping Bear Dunes," giant sand dunes at Lake Michigan, and the view from the 103rd floor of the Willis Tower, the highest building in Chicago. Our final weekend took us on a spectacular trip to the Niagara Falls in Toronto, Canada, which we explored on foot and with a harbor tour.

We did it! The proud graduates of the programming course

“Every trainee should take up this opportunity”

In summary, I can say that our foreign deployment in the USA was a complete success for me and my colleague Julia. As well as the many interesting impressions, it was an exciting experience to give the pupils at Saline High School a small insight into the world of automation technology. Our thanks go to Liebherr for the great organization of this extraordinary internship. I hope that Liebherr continues the Summer Program in subsequent years, because it provides enrichment in many ways for both sides. I can only recommend that trainees in subsequent years take up this unique opportunity.



Practical approach: Julia Fetzer provides assistance

Author:

Fabian Altenried, trainee at Liebherr-Verzahntechnik GmbH

Around the world with Liebherr

Insights into the highlights of the group

Aerospace

Boeing Dreamliner takes off with Liebherr on board

In the future, every Boeing 787 Dreamliner will fly with a remote electronic unit from Liebherr. This enables sensor data to be evaluated and systems to be controlled locally. The remote electronic unit is used on board the Dreamliner to control the steering angle of the nose wheel.

Components

9.5-meter steel rings

A new production plant for large roller bearings has started up at Liebherr-Components Biberach GmbH. The new machine can produce roller bearings of up to 9.5 meters in diameter, setting a Liebherr record. The first roller bearings to be produced – weighing 34 tons and 7.8 meters in diameter – will be used in the installation of offshore wind turbines.

Mobile cranes

Half a century of mobile cranes from Ehingen

In 2019 Liebherr-Werk Ehingen GmbH celebrated its 50th anniversary. Opened on February 22, 1969, the plant has become a success story of German engineering. Today Liebherr is the world market leader in mobile cranes. Around half the all-terrain mobile cranes used around the world come from Ehingen. 3,600 employees produce more than 1,800 mobile and crawler cranes there every year.

Concrete technology

Concrete for the Brenner base tunnel

Two Liebherr Betomix 3.0 mixing plants are producing concrete for one of Austria's and the European Union's most important infrastructure projects: the Brenner base tunnel. The two plants have a combined output of around 240 cubic meters of fresh concrete per hour. The purpose of this major project is to build a new rail connection between Austria and Italy. At 64 kilometers, it will be the longest underground stretch of railway in the world.

Mining

R 9800 mining excavator immortalized in LEGO

The LEGO® Technic™ Liebherr R 9800 mining excavator is now on sale for enthusiasts around the world. The model of the Liebherr heavyweight has 4,108 parts, seven motors and many of the technical capabilities of its big Liebherr brother. With its smart device connection, the excavator is the first programmable LEGO model that can be controlled using a smartphone app.

Domestic appliances

Liebherr domestic appliances opens new customer center

The new customer center for Liebherr domestic appliances in Ochsenhausen sets new standards in architecture. In the building, whose glass facades are decorated with refrigerawtors, visitors can get to know the latest range of refrigerators and freezers up close in a public showroom. In addition to the showroom, the five-story building also has office space, conference rooms, training rooms and event rooms with a total area of over 3,500 square meters.

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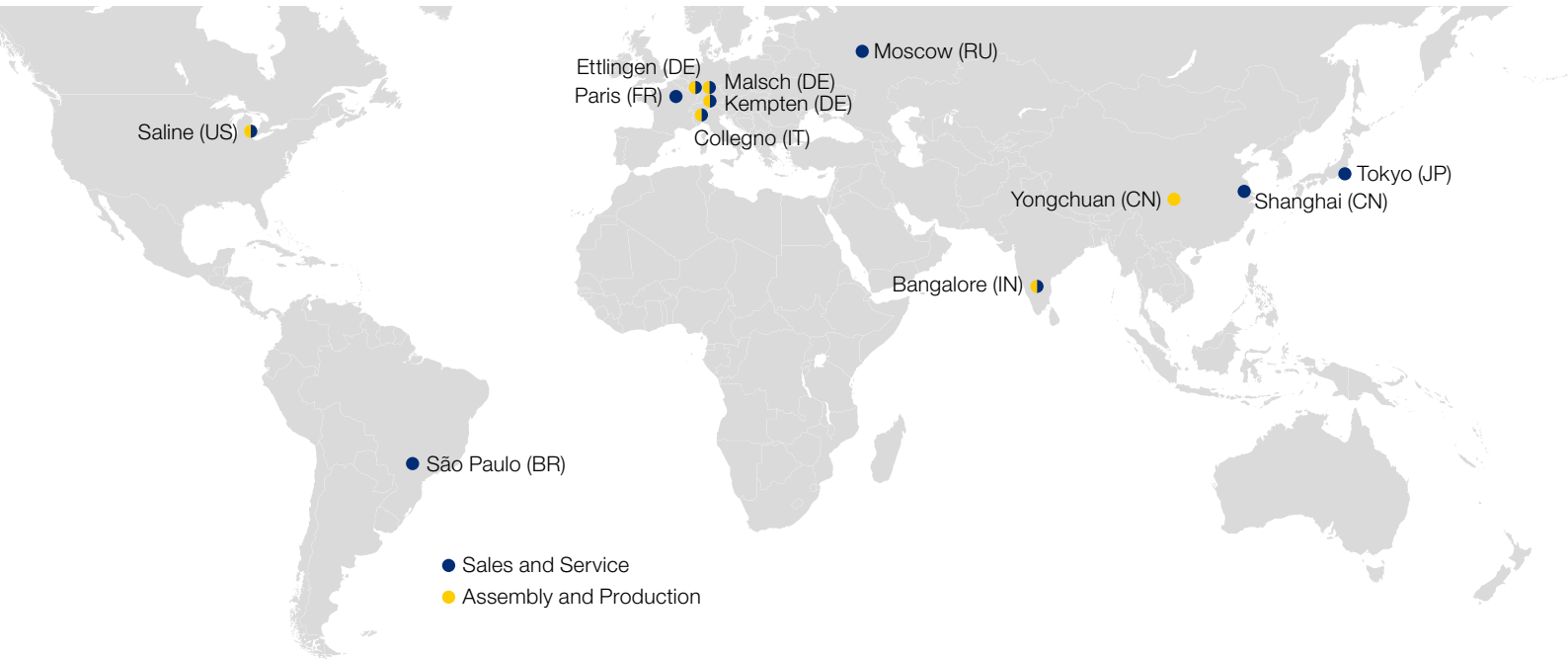

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