
An eye for detail

Robot systems

Bin picking or depalletizing tasks, machine loading or parts stores: our flexible cells and robot vision applications keep track of complex processes.

LIEBHERR

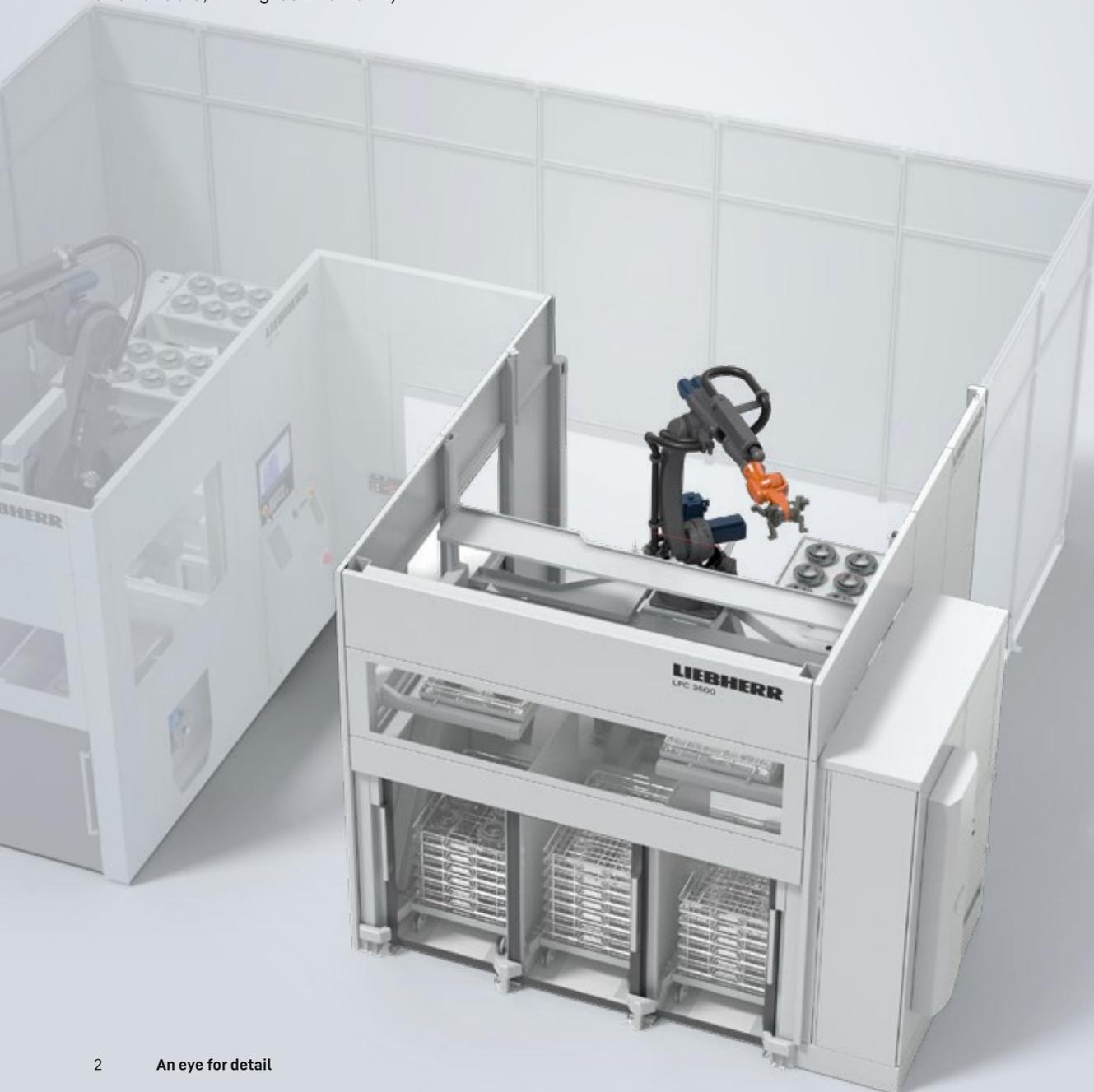
Automation systems

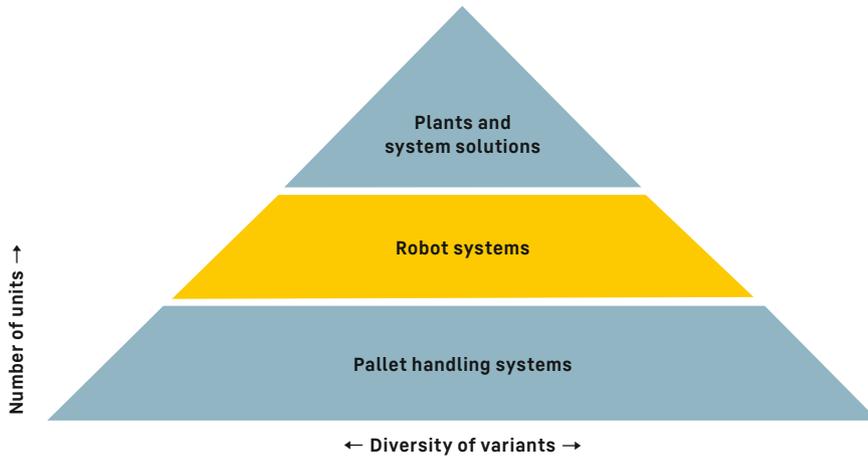


Liebherr robot systems

Liebherr offers a wide range of automation systems for modern, high-efficiency manufacturing. These solutions help to reduce production costs and enable a flexible response to changes in the market: systems can be expanded retrospectively, helping to maximize production capacity or add additional functions. Our focus is on ensuring that our products are economical, user friendly, high quality and reliable, with great flexibility.

As system provider, we make use of our broad product portfolio, consisting of gantry robots, pallet handling and conveyor systems, robot cells, and technological solutions. We combine these products intelligently to form flexible manufacturing cells, systems or lines for small and large projects, from one unit through to mass production.





Our product areas for diverse requirements

Flexible solutions are needed to ensure that all process steps, from the blank through to the finished part, can be provided from a single source. Robot systems are unmatched in terms of their versatility, enabling Liebherr to perform parts handling, palletizing, depalletizing and bin picking tasks.

Economy

Robot systems make your manufacturing process more efficient and relieve operators of monotonous tasks, such as loading heavy workpieces into a manufacturing system. This guarantees a high degree of process reliability and quality.

Automated handling increases productivity: parts, even misaligned parts, are fed in continuously and precisely. Our bin picking technology eliminates the need to carry out pre-production positioning processes. Robots can also load machines automatically, significantly increasing machine utilization.

Flexibility

Liebherr robot cells are designed in close collaboration with our customers in order to meet their requirements.

In contrast to rigid automation concepts, such as those found in manufacturing lines, a robot cell can be used for a much greater number of variants. Retooling is quick and automated, allowing you to respond to demand flexibly.

User-friendliness

All software products for robot systems are designed to be user friendly. LHRobotics. Vision guides you quickly and simply through the setup of 3D vision applications. All processes in the cells are clearly displayed. When it comes to the system's user interfaces, we give due consideration to ergonomics and safety, as well as ease of access for performing maintenance.

Parts are fed into the line via robot cells. Rather than parts having to be manually loaded onto belts, they can be loaded onto pallets or into wire baskets or pallet cages in the feed module. The finished parts are provided in the desired form at the line output, minimizing the need for manual intervention.

Quality and reliability

Quality is the ultimate priority at Liebherr. Every production stage is consistently monitored in order to achieve optimum results at all times and to ensure reliability and long product life.

Liebherr-Verzahntechnik GmbH's quality management system is certified in accordance with ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018, as well as VDA 6.4. Moreover, many years of experience and state-of-the-art technology flow into product development.

This high standard means that our automation systems guarantee high availability and part quality for the end customer.

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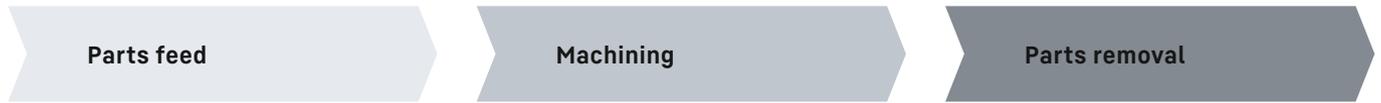
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Liebherr provides automation systems for automated feeding of blanks and removal of finished parts in production facilities, with a focus on the powertrain and bodywork sector. Liebherr also has extensive expertise in the field of systems and software for object detection independent of the vision system. Liebherr robot systems perform parts handling, palletizing/depalletizing and bin picking tasks in the process from the blank to the finished part.

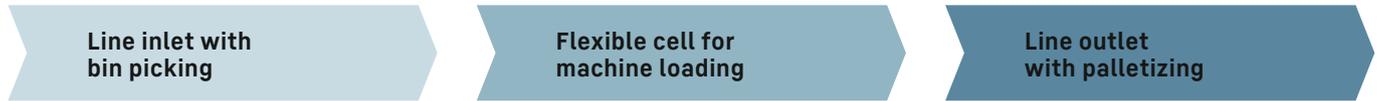
Applications for flexible cells



Your tasks



Our solutions (examples)



Machining processes are highly customized, meaning that flexible products are needed. Our robot systems are unmatched in terms of versatility and provide economic solutions from “line in” to “line out”.

Parts feed – Liebherr moves all parts into place

Automation is needed even at the very beginning of the process, different devices are required depending on how parts are supplied:

- Fully positioned parts can be fed in using pre-programmed movement sequences.
- Partially positioned parts can be detected using a low-cost vision system for depalletizing, for example workpieces at predefined heights with slight deviations in the horizontal plane.
- Randomly positioned parts are the pinnacle, requiring the notorious “bin picking” function. A 3D vision system enables bin picking of randomly arranged parts.
- 3D robot vision applications can be supported by our LHRobotics.Vision technology package. This software calculates the robot’s path for collision-free removal and transport to the deposit position.

Machining – flexible cells for flexible applications

Liebherr robot cells can be used to automate individual process steps in manufacturing lines or systems. They have many different possible uses:

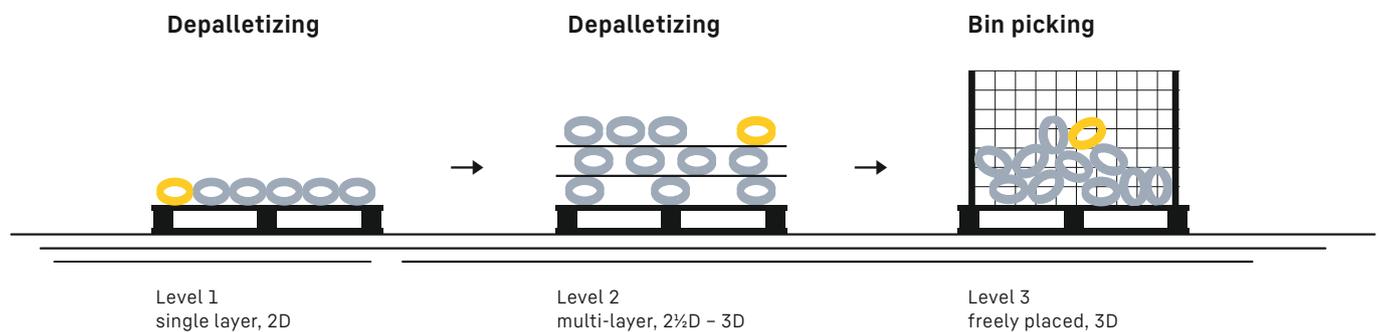
- Automated setup of devices or machines
- Loading workpieces into machines
- Palletizing cells for storing parts between machining steps
- Sorting and stacking tasks
- Picking tasks
- Additional tasks, such as cleaning, marking, deburring

Parts removal – ready your parts for the next step

Parts removal is the counterpart to the line inlet. Depending on the requirements of the subsequent process (or loading), a robot at the line-out provides the parts as desired.

Solutions for line inlet and outlet

The automation at the beginning and end of a line depends on how the workpieces are fed and stored. In Liebherr systems, parts are fed using standardized feed modules. This allows workpieces to be fed in in various different ways, regardless of whether they are contained in wire baskets, pallet cages, plastic containers or on pallets and whether this is manual or automated, using belt automation or AGV systems.



If the workpieces have different orientations and positions in the horizontal plane or are randomly placed, the robot will require a vision system for object location recognition. If the condition upon delivery is single-layer, simple 2D contour or feature recognition is generally sufficient. If the workpieces are in several layers, such as stacked blister packs or tablet packages, the robot requires a 2.5D or 3D vision system. In the former case, the third dimension is calculated using a laser distance sensor. For a real 3D process, the vision system measures using points in space.

The same is true of positioning, the more accurately the workpiece has to be placed, the more demanding the requirements. Placement on a conveyor belt is simple, positioning within a machine tool is challenging. The more flexibility required for loading and unloading a workpiece (into and out of the machine), the more complex the system. There are also application-specific strategies, such as position recognition and collision issues. As an expert partner, we give due consideration to all of these requirements and provide a functional all-in-one solution.



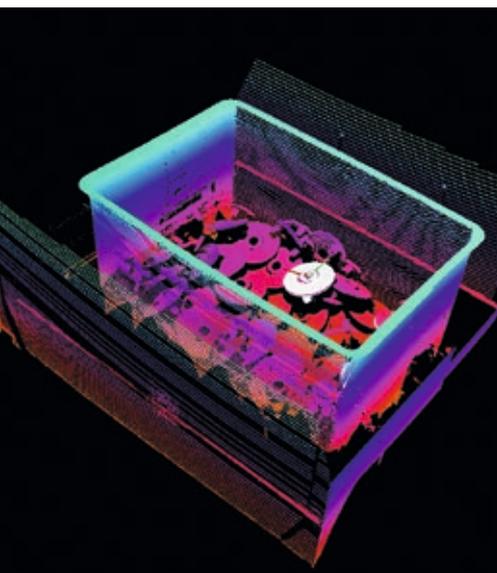
Palletizing and depalletizing

In this simplified task, the camera can be attached directly to the robot arm. A permanent camera system is not required. This saves space and costs.

Example: A robot palletizes refrigerator shelves



Automated line inlet and outlet in an engine block production line



Bin picking

Automatic unloading of randomly arranged parts from transport containers, otherwise known as bin picking, is one of the most challenging industry automation applications. To date, only a few robot designs have met the demands for sturdiness and cycle times. The bin picking routine can be automated cost effectively with the flexible robot systems from Liebherr. This raises capacities

and lowers unit costs. Many tasks can be performed using tried and tested workpiece handling components from Liebherr's array of automation systems.

Liebherr has drawn on its many years of experience with automation systems across a variety of industries in the development of this technology. Our bin picking systems are equipped with a robust and reliable 3D object detection system and the high-performance LHRobotics.Vision software for object identification and selection, collision-free withdrawal of parts, and robot path planning to the stacking point. Specially developed grippers with additional axes enable collision-free access and removal of all parts from the transport containers

Process description

Removing randomly arranged workpieces from a transport container requires complex interaction between the image recognition system, software, gripping technology and robot.

To take account of the range of parts, all of the necessary steps have to be adapted to each other in such a way that optimum removal and positioning is achieved.

01 Visual data acquisition and evaluation

Reliable 3D object detection systems optically capture and evaluate data.

02 Object identification and selection

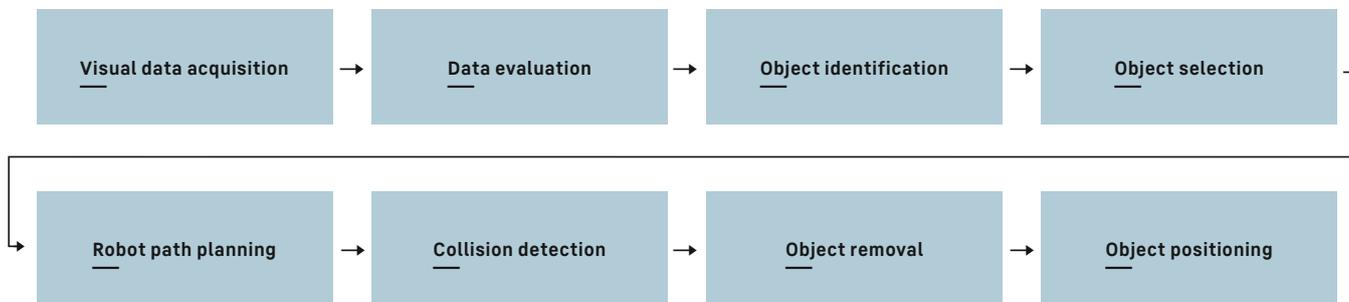
Liebherr's LHRobotics.Vision software identifies and selects the workpieces in the bin using the object data generated by the vision system.

03 Collision-free withdrawal of parts

Calculating the robot path for collision-free removal of parts from the bin.

04 Object positioning

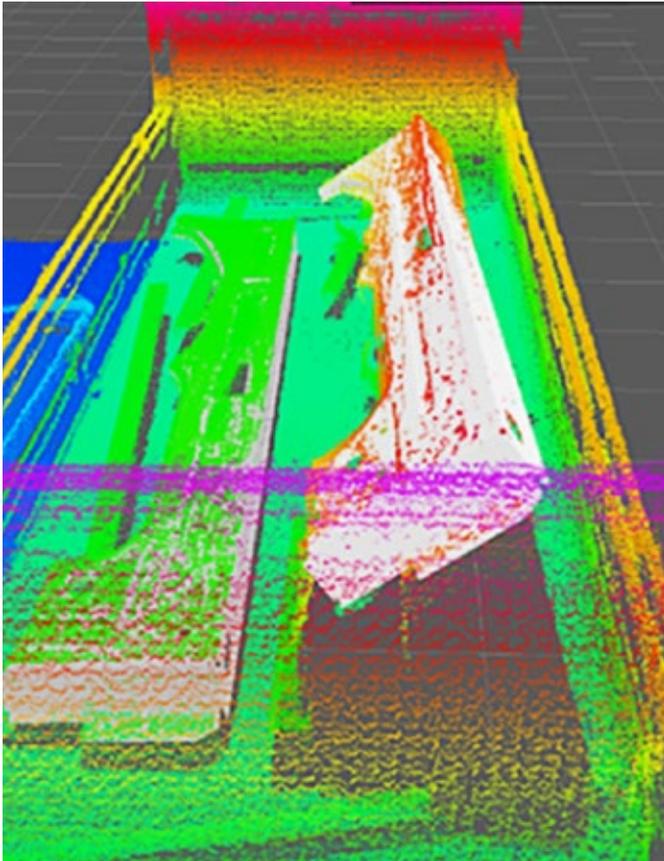
Finally, the workpieces are precisely positioned at the predefined stacking location or directly in the machine.



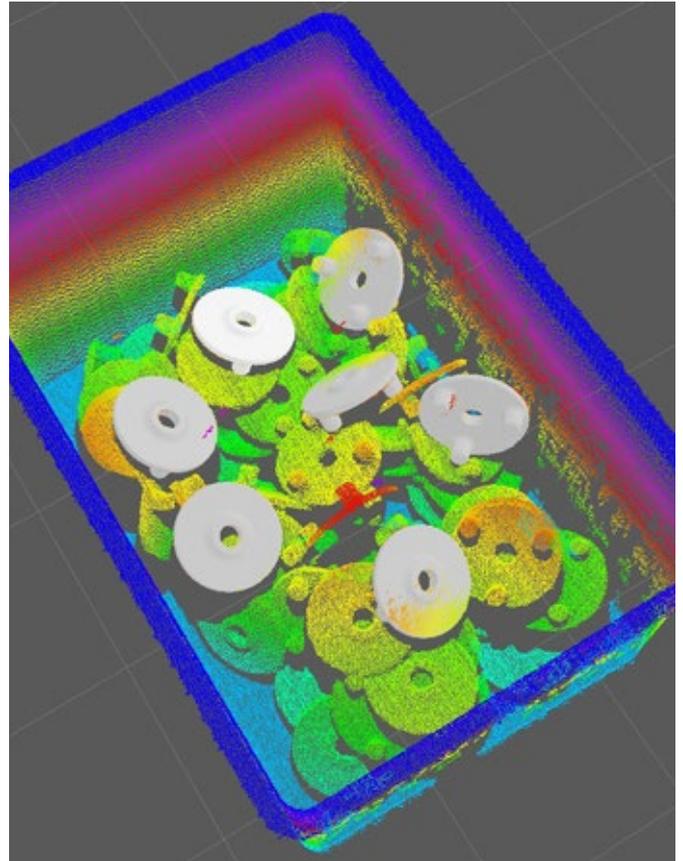
Planning security

At the Kempten factory, Liebherr offers the possibility to verify the feasibility and cycle time in advance on test cells using different robots and vision systems depending on customer requirements.

3D vision systems



Bodywork panels



Planetary carriers

Liebherr uses highly flexible 3D stereo vision systems for point cloud generation. Complete and homogeneous depth maps of the scene can be generated using special projector technology. These systems deliver high-resolution image quality with very quick scan times. The LHRobotics. Vision bin picking software can be operated via a standardized interface using camera systems from various

manufacturers. Camera systems from the following manufacturers have already been implemented:

- Ensenso
- Keyence
- Photoneo
- Wenglor
- other manufacturers on request

Positioning devices/gripping systems

Positioning device

To optimize the removal process from the transport container, the workpieces are gripped at different points. These picking positions are not always suitable for final positioning of the workpieces. If necessary, Liebherr can offer suitable options such as intermediate stacking, repicking stations, positioning devices or detection stations.

Transfer/stacking position

The workpieces removed from the transport containers can be transferred to a wide range of different customer-specific systems. Examples of this are direct loading of a machine tool, transfer to a conveyor system or organized storage in transport containers for further transport.



Intermediate stacking



Repicking station

Gripper systems

Depending on the task, a flexible gripper kit is available for payloads ranging up to 5 kg, up to 20 kg or up to 40 kg. In combination with suitable compensation elements, a high flexibility of the system is guaranteed. If required, the gripper units can be supplemented with a 7th and 8th axis.

This increases flexibility during gripping of the workpieces within the transport container. The degree to which the transport container is emptied is optimized.



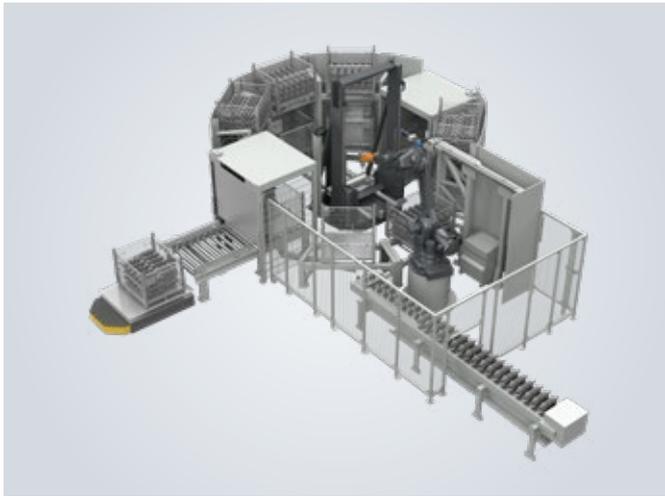
Gripper with compensation element



Gripper with 7th and 8th axis

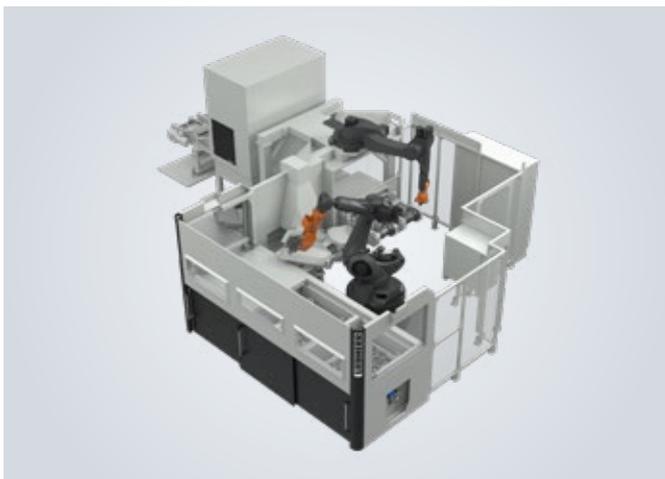


Implemented solutions



Highly flexible intralogistics concept for the automated loading of a passenger vehicle crank shaft line

The combination of Liebherr's rotary loading system (RLS) and bin picking application resulted in a highly flexible line inlet. The crank shaft blanks are randomly arranged in pallet cages and are delivered to the line inlet by means of an automated guided vehicle (AGV) system. The customer's host computer can control the quantity specifications for different part types and load parts into the line to order.



Line inlet for a truck engine connecting rod production line

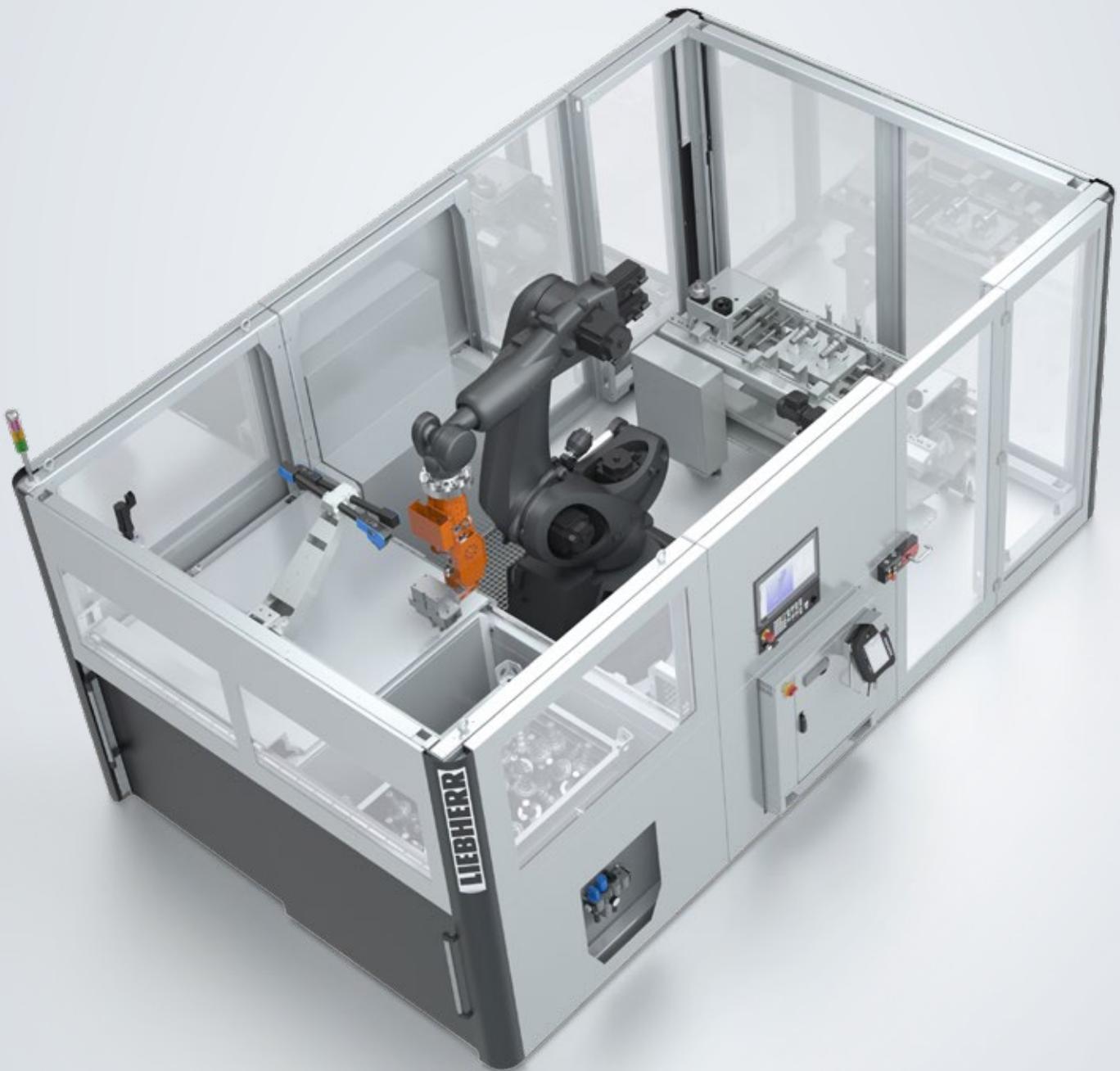
Pressed and forged parts are typical uses for bin picking applications. Two robots are used in this bin picking cell for connecting rods: the first robot removes the randomly arranged connecting rod blanks from metal boxes and places them onto an orientation station. The second robot grips the pre-positioned workpiece and places this on an infeed conveyor.

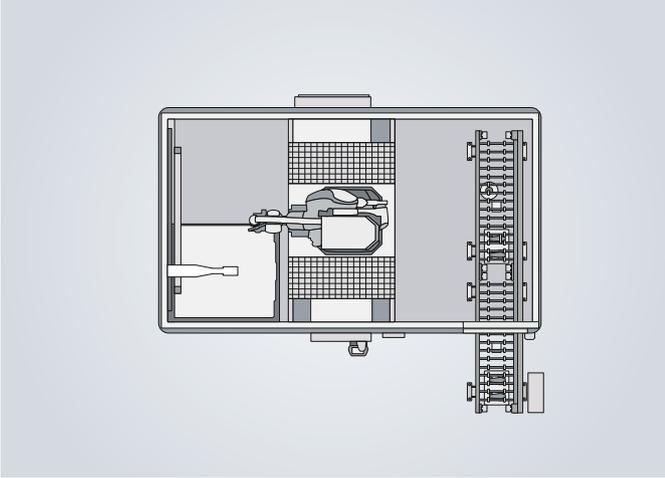


Bin picking cell for gear manufacturing

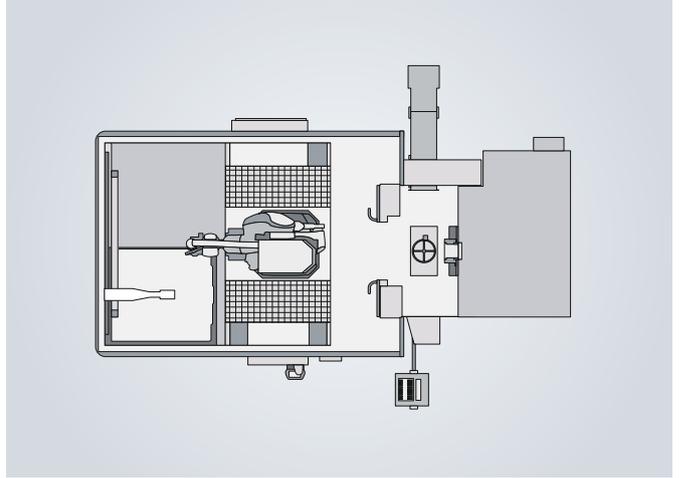
Due to its small footprint, this compact bin picking cell is particularly suitable for halls with limited space. Two permanently installed vision systems enable the workpieces to be scanned simultaneously with the operating cycle, making it possible to achieve very fast cycle times.

Examples and types of layout

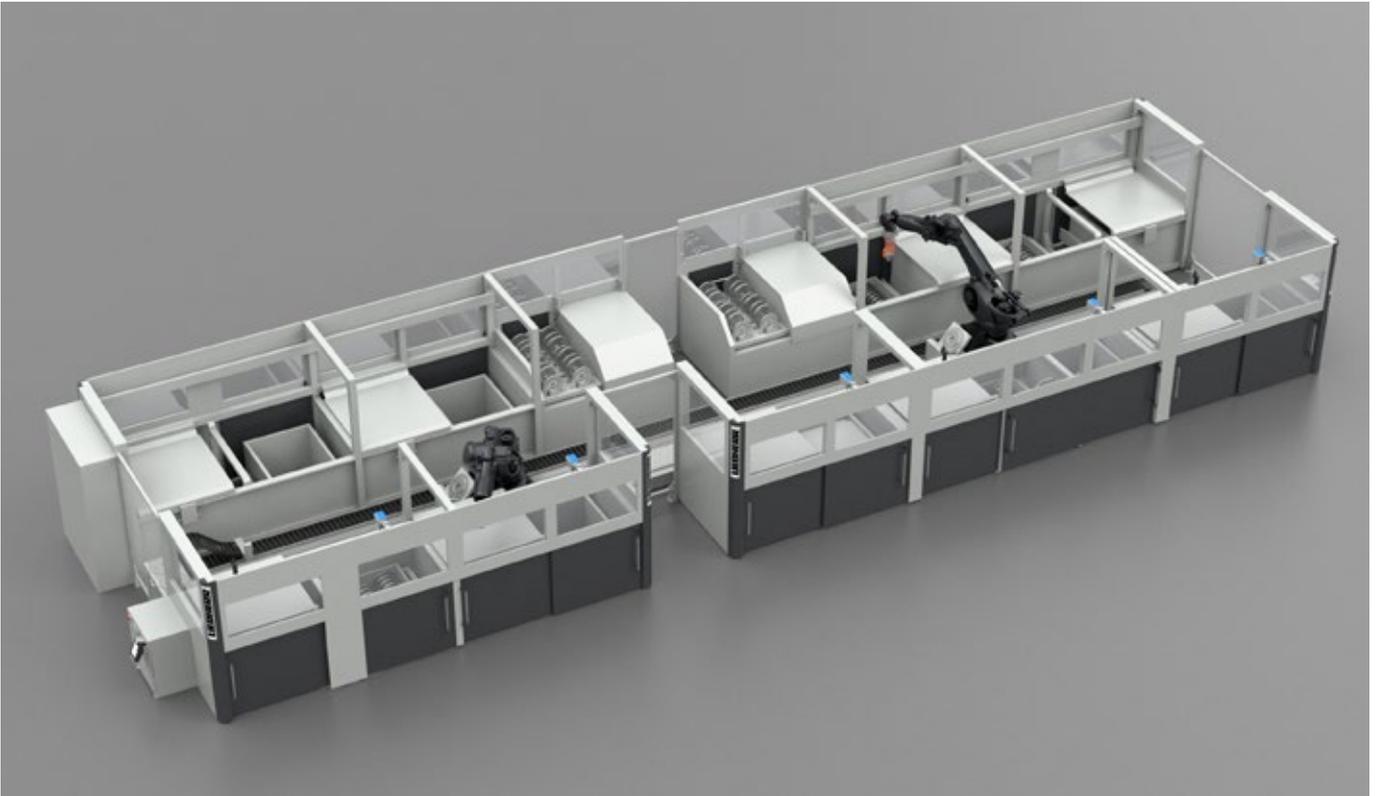




Conveyor belt or wire mesh bin loading



Machine loading



Picking system

Robot vision technology packages



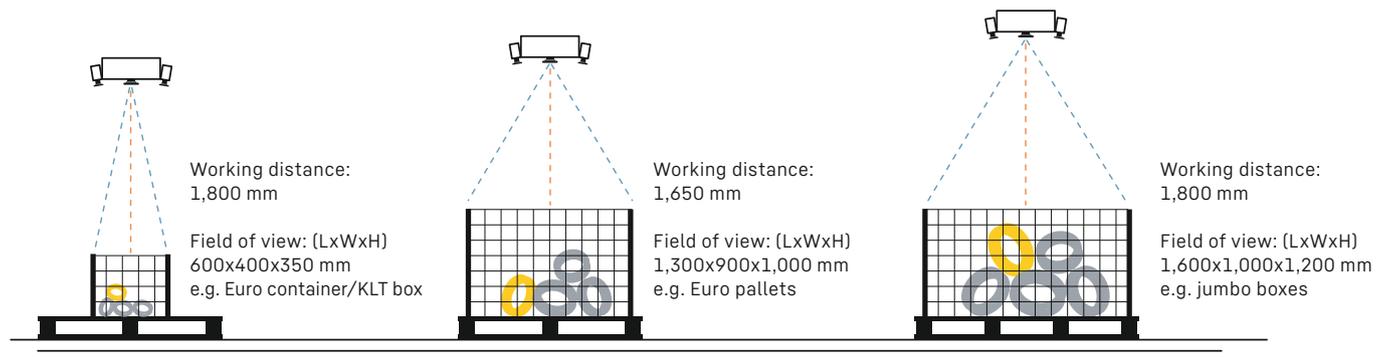
LHRobotics.Vision

Liebherr is making its expertise in the field of industrial robot vision applications available to a wide user group with the LHRobotics.Vision technology packages.

The technology packages consist of a projector-based stereo vision camera system for optical data collection and software for object identification and selection, collision-free withdrawal of parts, and robot path planning to the stacking point.

1. Standardized vision system

Ensenso X36 with different frame variants for each application



2. Software

Basic license

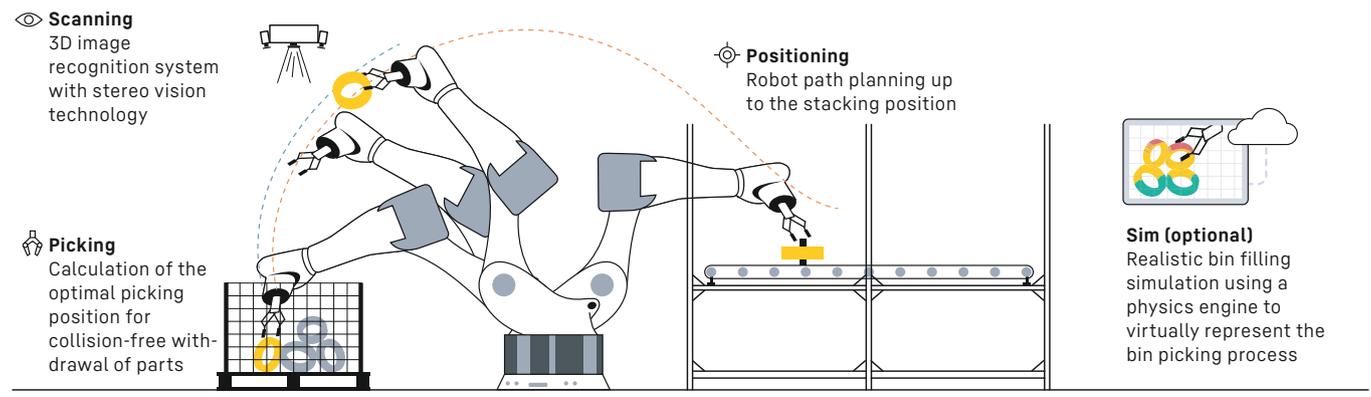
The more cost-effective basic license is suitable for customers who only need to roughly set the gripped workpiece down. A stacking plan is not necessarily required for this. Due to the lack of robot model and obstacles, it is also suitable for customers who place less value on collision checking outside the bin, for example in cases where the gripper is never able to fully enter the bin.

Professional license

The professional license offers unrestricted use of the LHRobotics.Vision software. This license is particularly suitable for customers who place value on full collision checking of the path from removal to possible stacking.

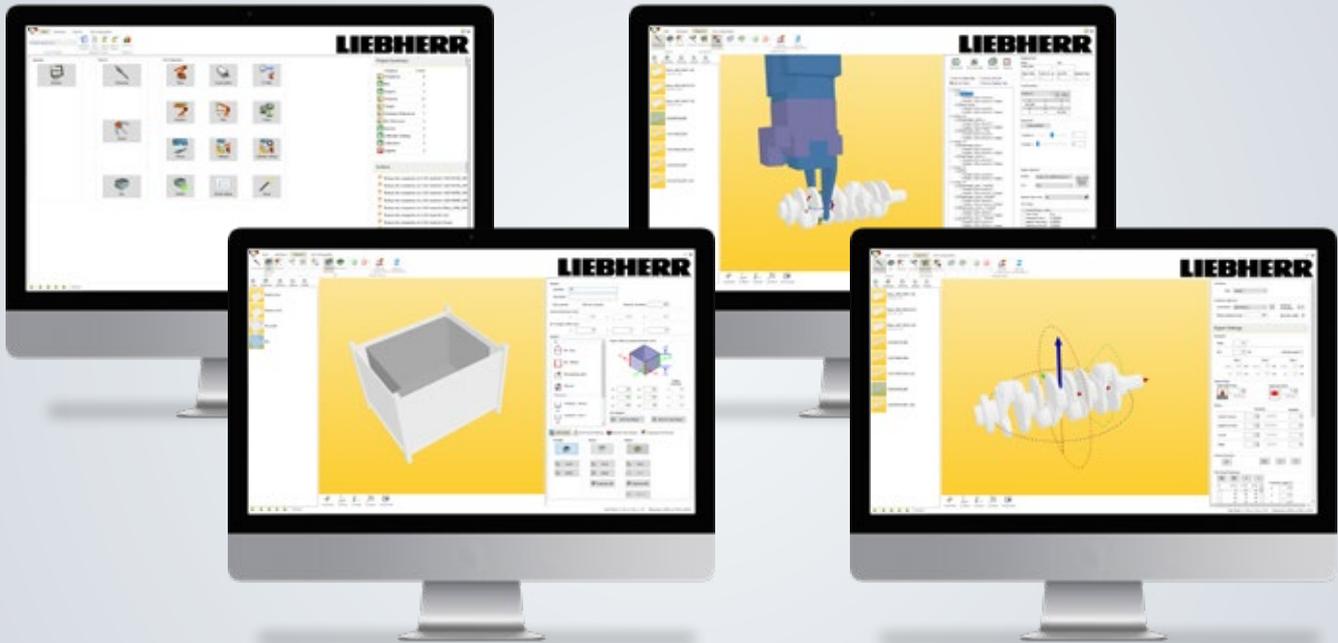
The basic license allows a restricted version of LHRobotics.Vision to be run. The following functions are not included in the basic license:

- Creation of stacking points and thus path planning for stacking purposes
- Addition of obstacles
- Addition of a robot model



- **Basic** collision-free withdrawal of randomly arranged parts
- **Professional** collision-free removal of parts with path planning to the stacking position

User-friendliness



The user interface makes it possible for all of the necessary information to be quickly entered in easy steps:

- Teach-in of workpieces and definition of potential picking positions
- Configuration of transport containers (by entering dimensions or integrating existing data)
- Configuration or adaptation of grippers
- Selection of robot used to check work area
- Input of obstacles present in the robot's work area
- Calibration of the system
- Definition of framework conditions for collision-free withdrawal of parts
- Path planning

The processing steps are entered in a user-friendly manner via a menu-based user interface. Special programming knowledge is not required. Depending on what data are available from the customer, configuration of the work steps is carried out by means of:

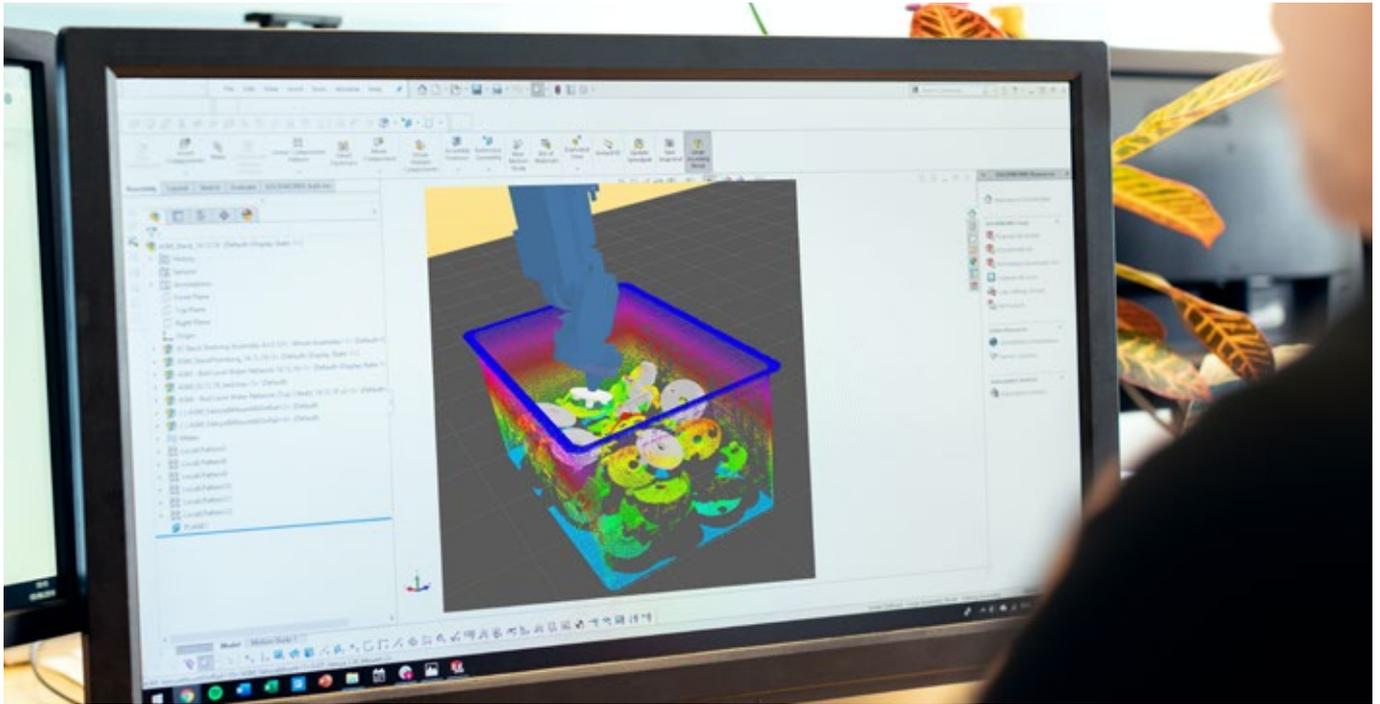
- Graphically controlled programming screens
- Pre-existing data sources (e.g. CAD data)

Potential picking positions are thus simulated and consideration given to collisions.

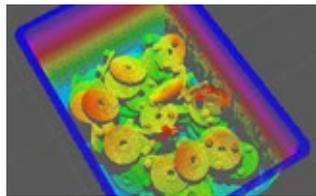
Automatic setup of new parts using AI

LHRobotics.Vision uses artificial intelligence to automate system setup – a quantum leap that saves time and costs.

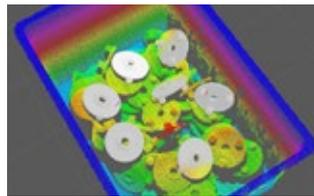
LHRobotics.Vision Sim



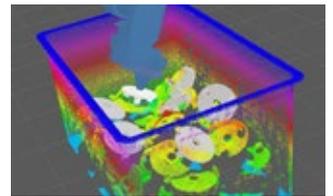
Virtual bin filling



Virtual point cloud



Matching CAD model



Gripping simulation

Using the optional simulation tool LHRobotics.Vision Sim, the user can test and optimize processes completely virtually:

- No hardware investment is required to test different gripper designs and verify their performance
- Testing and analysis of problems in order to optimize the degree to which the container is emptied
- No production downtime needed to set up new parts or test new gripper designs

LHRobotics.Vision Depalletize

For complex depalletizing tasks where the orientation of the workpieces may vary due to tilting, for example, 2D and 2.5D vision systems are at their technical limits. Liebherr offers a low-cost 3D robot vision solution for this

purpose. Optical data is collected via an Ensenso N35 camera, which is mounted directly on the joint of the robot arm. A restricted version of Liebherr's LHRobotics.Vision bin picking software is used to evaluate 3D images.

Solutions for parts handling

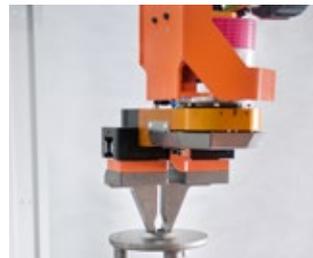
In the area of parts handling, Liebherr performs loading tasks for a wide range of machine tools. Over the past few years, solutions for the automation of machining centers, turning machines, gear grinding machines, rotary transfer machines and gear grinding machines have been implemented in this area.

The structure of Liebherr's robot cells is based on a modular system. This allows quick and easy configuration and almost unlimited possibilities. The basic structure is made up of the following components, which are selected, designed and incorporated into the overall system by Liebherr. We provide a variety of services in this area.



Robots

- Kuka, Fanuc or ABB
- Design
- Commissioning
- Programming



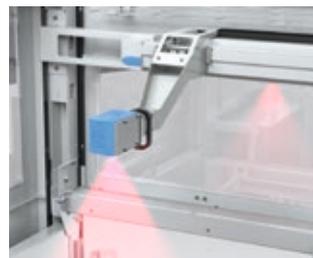
Gripper

- Selection
- Design



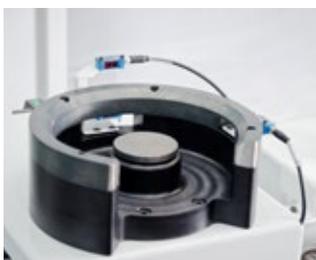
Software

- Cell control
- Implemented with our own software or with partners
- LHRobotics.Vision



Vision system

- Selection of a 2D, 2½D or 3D system for object detection or quality inspection
- Validation, testing
- Commissioning



Other functions

Integration of other functions, for example:

- Measuring
- Labeling
- Washing
- Reorientation
- ...

Example systems are shown on the following pages to provide an insight into the different configuration options and areas of application.

Automated setup

Workpieces can be loaded directly into machines or clamped on pallets beforehand and delivered to a parts store. If parts are to be clamped onto clamping fixtures, robots can be used for automated setup.

The setup procedures occur in parallel to machining operations, thus increasing machine runtime and productivity. For complex tasks, there is also the option of reverting to camera-guided robotics.

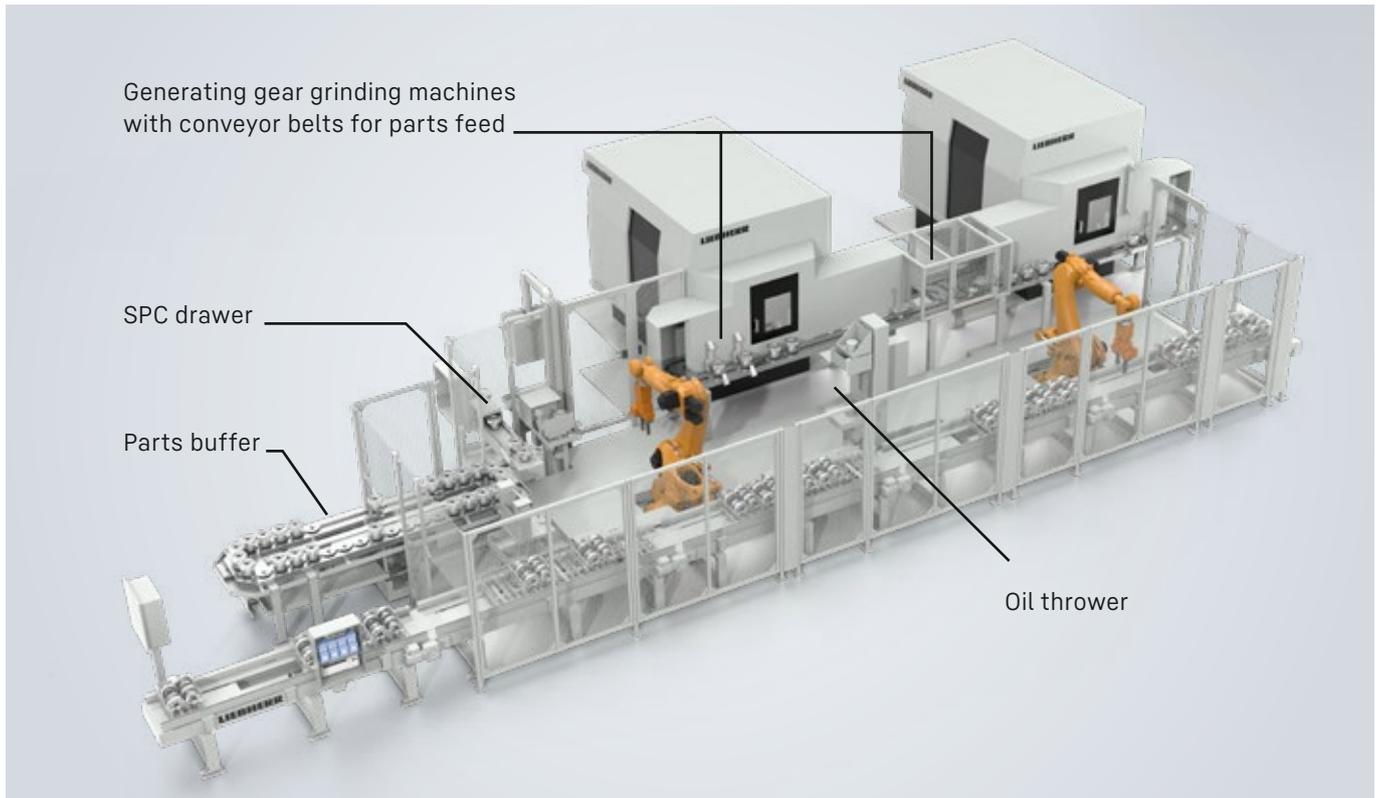


Example application: automated setup

Workpieces are provided by a feed module, captured by a vision system according to need and correctly oriented by the robot and placed on the clamping fixture. Automatic

clamping is mechanical through the use of an automatic screwing unit above the clamping towers. Alternatively, clamping can be hydraulic.

Machine loading



Example application: robot cells for loading two machines

Workpieces are supplied in wire baskets via hinged chain conveyors. Two robots separate the parts and distribute them to Liebherr's gear grinding machines. After machining, the parts are cleaned in an oil thrower before being placed back onto the conveyor belt and fed to the next process step.

SPC random samples are placed into an SPC drawer, from which they can be manually removed. Instead of manual removal, an AGV interface can also be installed for the samples.

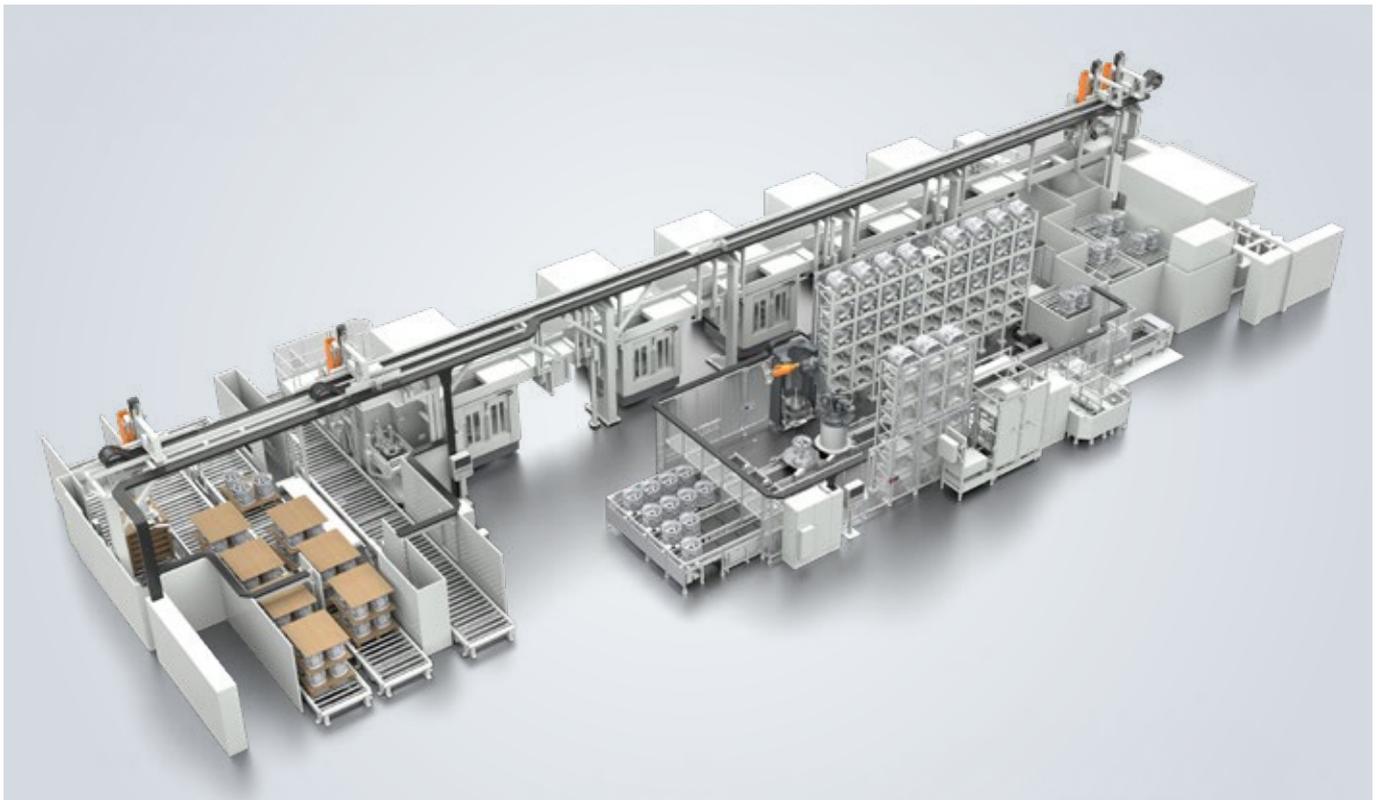


Oil thrower



Parts in wire baskets

Buffer store with linear axis robots



Example application: gearbox housing line – fully automated by Liebherr

Liebherr supplied the entire automation technology for this production system for the mechanical machining of truck gearbox housings. Parts are fed using a robot vision

depalletizing system to the automated line inlet. The parts are then distributed to gear cutting machining centers via a gantry loader and, at the end of the machine column, loaded into a cleaning system.

The cleaned workpieces are transferred to a buffer store. A linear axis robot receives the housing and places it onto an assembly station for installation of an RFID chip to ensure traceability. The robot then stores the housing on a storage shelf.

This provides extra options for downtimes, for example due to maintenance, and allows a customized JIS strategy to be implemented: housings are output “just in sequence” in defined batches.



Buffer store as palletizing cell

Liebherr's palletizing cell (LPC) acts as parts storage and loading device for individual machines, but can also be used as a decoupling module. Due to its storage function, a palletizing module blocks the process sequence, creating buffer times and reducing the strain on the employee.

Stacking in wire baskets allows numerous workpieces to be kept in stock. All that the operator needs to do is remove empty basket stacks and supply blanks. Multiple machines can thus be operated with minimum effort.



Flying robot



Flying robot with carriage on gantry

Teaching the robot to fly lends itself to various applications:

- if the aim is to save on floor space
- if loading needs to be performed from above with complex movements
- if the aim is to transport parts without floor automation

A robot is equipped with an additional axis by mounting it on a gantry. Such a flying robot then has degrees of freedom in every spatial direction and a view over everything. Above the machine column, it supplies machines, guarantees the flow of parts, transfers parts to individual cells or performs loading tasks itself.

The robot's range of motion is thus heavily influenced by the robot itself and how it is mounted. Lateral mounting ensures a large range of motion, including directly underneath the robot. Vertical mounting allows gripping in a 360° radius around the robot.

Liebherr uses robot arms from Kuka, Fanuc and ABB, which are integrated in the Liebherr automation system. A gantry modular system allows many different combinations to be realized. The control system's design is also flexible. It can be designed as a higher-level master cell control system or integrated as a slave in a complete system.

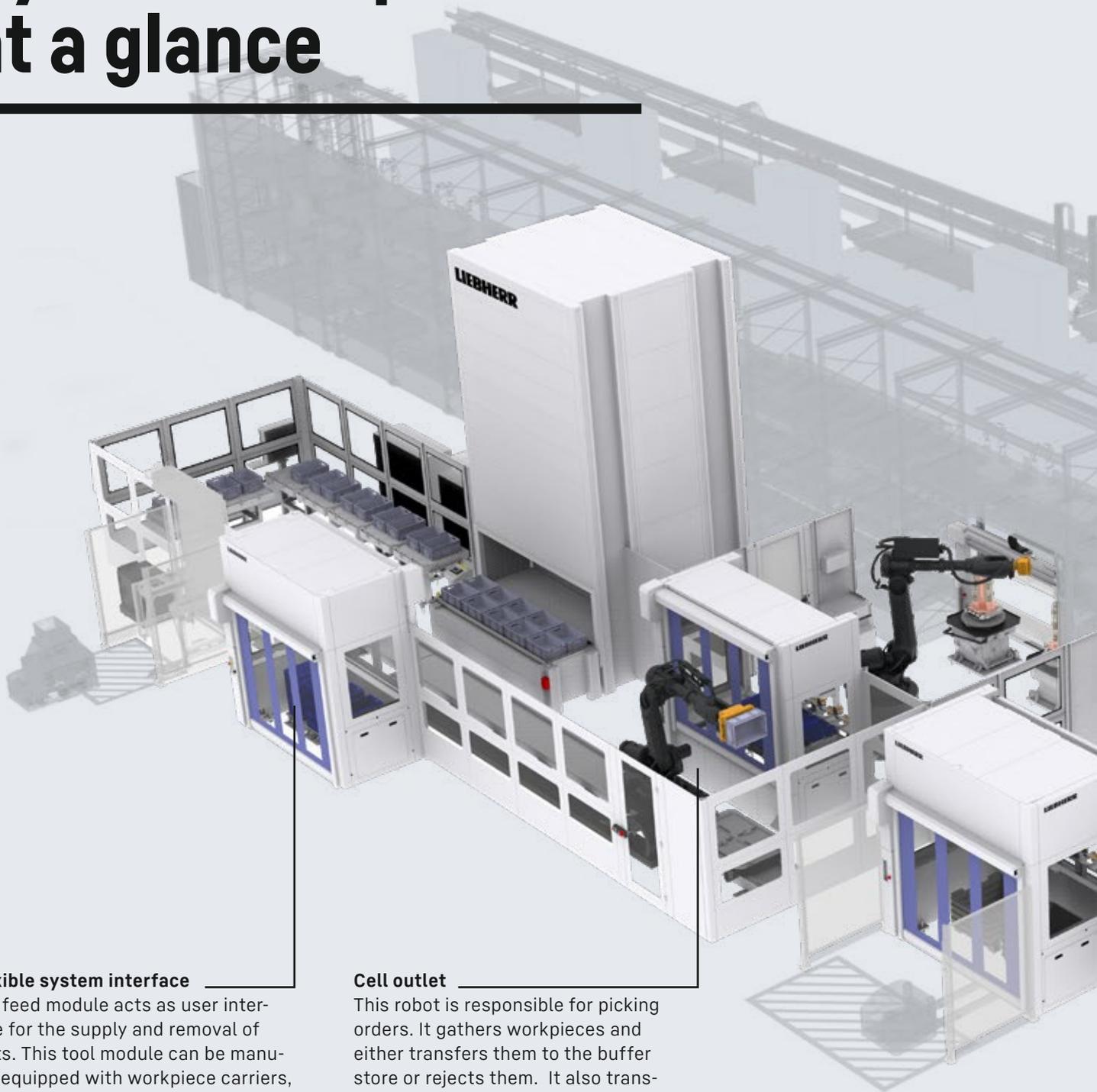


Lateral mounting



Vertical mounting

System competence at a glance

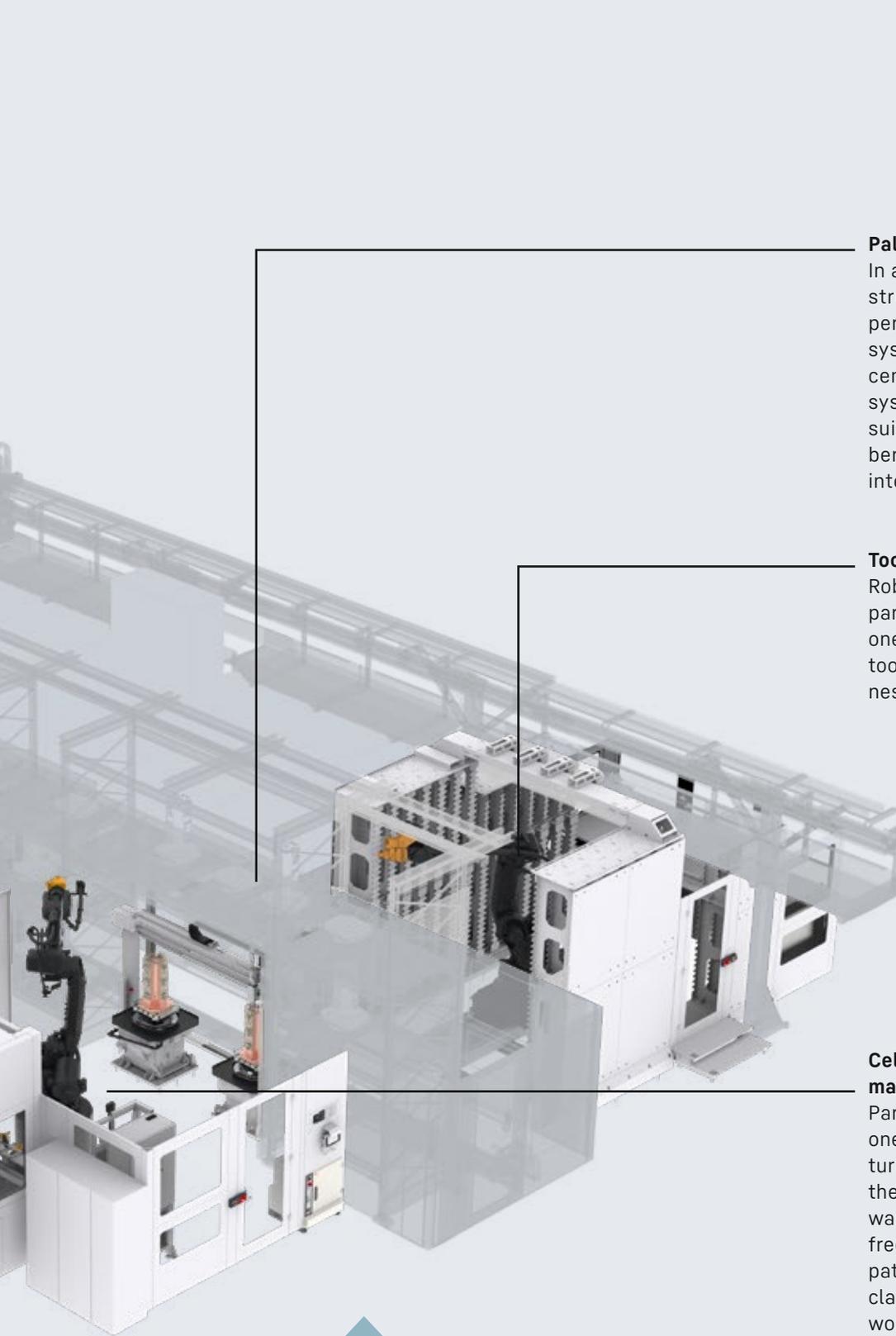


Flexible system interface

The feed module acts as user interface for the supply and removal of parts. This tool module can be manually equipped with workpiece carriers, but can also be designed as an AGV tool module or a palletizing cell.

Cell outlet

This robot is responsible for picking orders. It gathers workpieces and either transfers them to the buffer store or rejects them. It also transfers parts to an automated guided vehicle (AGV) system at predefined intervals, which then transports these samples to a measuring room.



Pallet handling systems

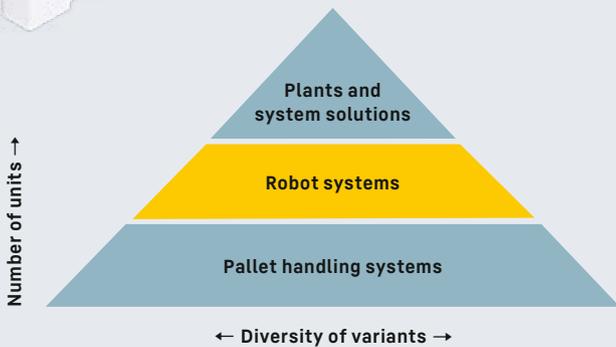
In addition to the manufacturing cell structure, production can also be performed in flexible manufacturing systems with interlinked machining centers. Liebherr's pallet handling system (PHS), which is primarily suitable for small to medium numbers of units, offers a possibility for interlinking.

Tool storage system

Robots can be used to handle not just parts, but also tools. In this system, one robot manages several thousand tools, which are distributed to machines using a PHS.

Cell inlet: bin picking cell with automated setup

Parts that have not been pre-positioned are fed to the flexible manufacturing system. A vision system scans the parts, the LHRobotics.Vision software product calculates a collision-free withdrawal of parts and the robot path up to the depositing point in the clamping fixture. The robot takes the workpieces and sets them on pallets which are fed into the PHS. Machines could also be directly loaded in the same way.



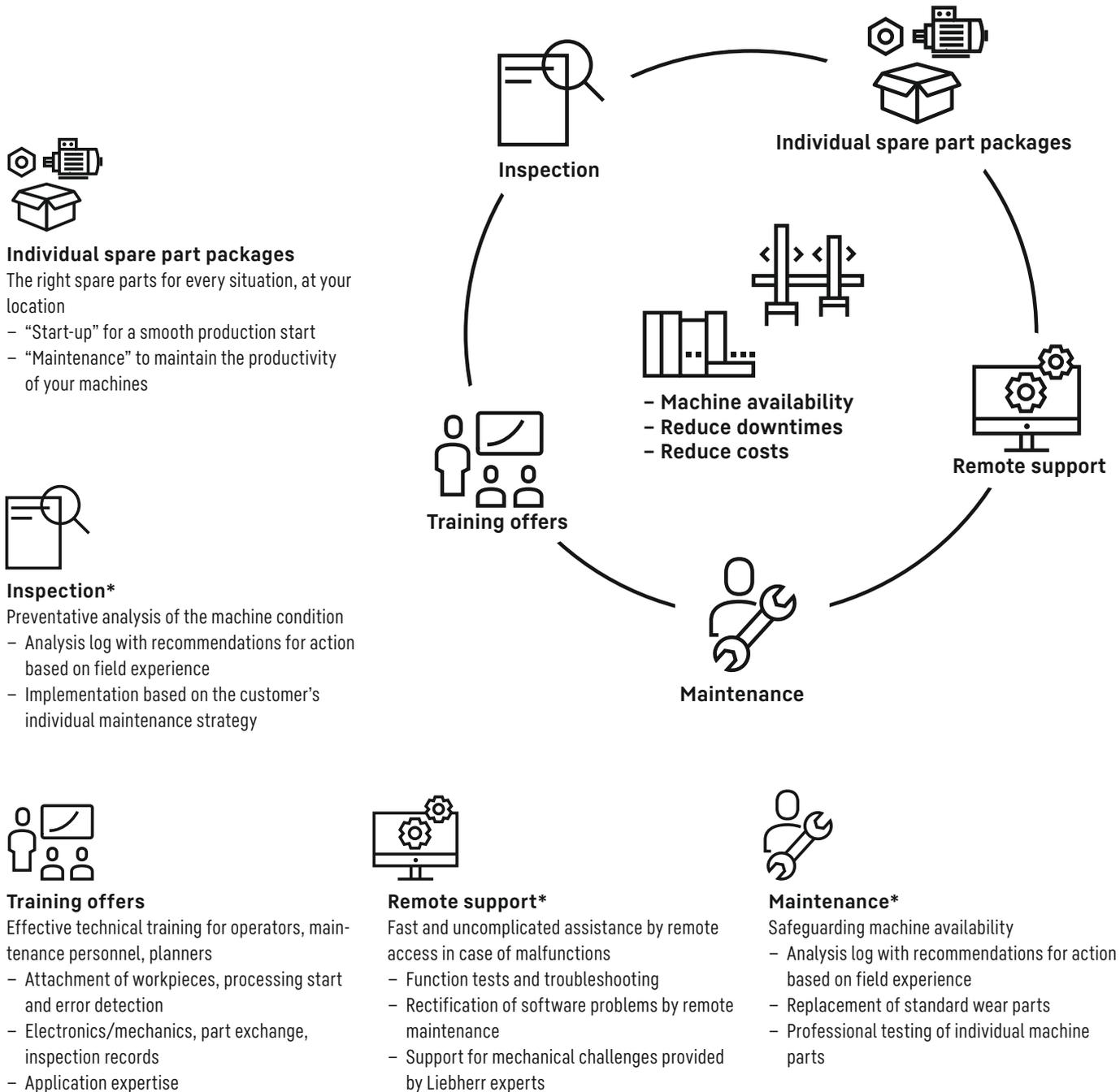
Discover all our product areas:
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Service over the entire life cycle

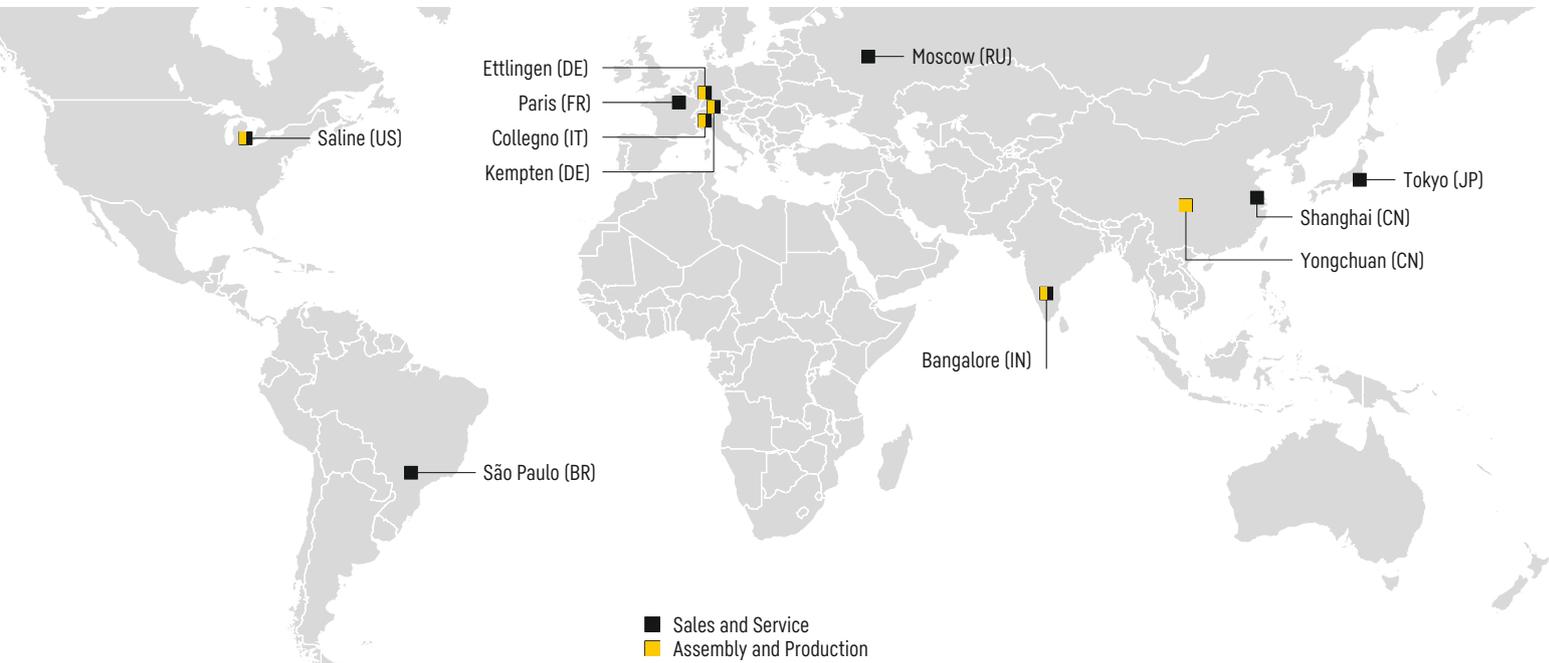


Worldwide presence and spare parts availability

With our main location in Kempten, Germany and global offices and service support points, we guarantee very fast response times which enable us to dispatch a service engineer to the customer location immediately if necessary. Our range of services includes inspection, training, individual spare part packages, remote support and maintenance or conversion of systems.



Your solution provider



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