Machine vision

Let there be light

Orange Box From your brownfield to the cloud

Digital twins A revolution in time to market

OPC UA over TSN The dawn of a new standard

PERFECTION IN AUTOMATION
A MEMBER OF THE ABB GROUP

editorial

Dear Reader,

Six years ago, an assignment from B&R management set me off to find out what product or solution we could offer that would make our customers' lives easier. Along the way, I met with manufacturing OEMs all over the world.

In our many discussions, there was one topic that resonated particularly loudly: While many control systems already offer motion control, safety and many other functions as fully integrated elements, machine vision has so far been neglected when it comes to synchronization with the rest of the machine. They were tired of spending so much on implementation and getting so little precision in return. What they really wanted was a machine vision solution fully integrated in the automation system.

An analysis of the market showed that there were neither cameras nor lights suitable for interface-free integration into an automation system. So we developed our own from the ground up. Doing so enabled us to integrate unique functions and achieve a level of integration that was previously unthinkable in the world of machine vision.

Over the past twelve months, numerous pilot customers have evaluated our system – and the feedback has been enthusiastic. What they're able to accomplish goes far beyond anything they imagined.

Keep reading to find out more about how a completely integrated machine vision system will improve the development of tomorrow's most innovative, high performing machines.

Happy reading!

Andreas Waldl
Product Manager - Integrated Machine Vision

contents

10

14

04

Let there be light

Machine vision cameras can be found in an increasing number of manufacturing systems – controlling processes, sorting products or performing quality inspection. Easily overlooked, however, is the important role played by lighting in helping these cameras achieve precise, repeatable results.
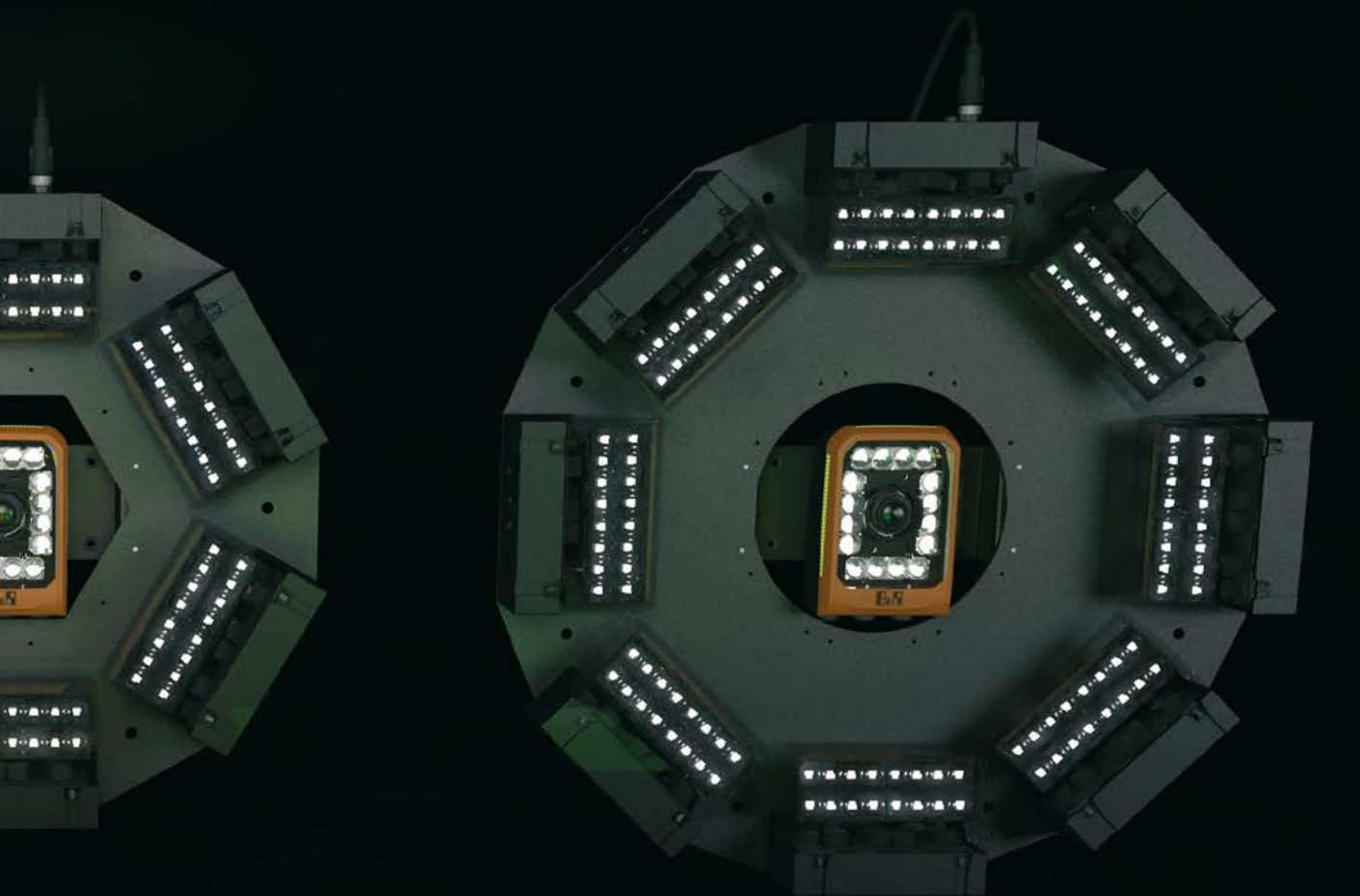
"No machine vision solution is complete without lighting," clarifies B&R's machine vision expert, Andreas Waldl. It's the lighting that determines if and how the camera sees the targeted object. In addition to the intensity, angle and wavelength of the beam, two factors that make all the difference are precise timing and intelligent control. In the real world, however, the potential for synchronization is severely limited. "The vision sensors, lighting, strobe controller and machine controller each come from a different supplier," explains Waldl. Without a common communication protocol, all the data exchanged between these devices has to pass through digital inputs and outputs.

Tight synchronization

This introduces a variety of delays and sources of imprecision. Timing the strobe to fire at the exact microsecond the camera opens its aperture, for instance, is simply impossible. "As an engineer, all you can do is extend the duration of the strobe pulse to ensure that it's on while the camera is exposing," says Waldl. Doing so shortens the lifespan of the LEDs dramatically, however. The engineer could compensate by reducing the intensity of the light, but that would in turn require a longer exposure. In high-speed applications, a longer exposure can easily result in blurry images. The other option would be to amplify the sensor signal.

"Doing that adds noise and lowers the quality of the captured image," Waldl points out. "It's really a catch-22." In B&R's machine vision solution, the camera, strobe controller and lights are all part of the same system. This has some decisive advantages. Since the lighting control and automation system are synchronized with sub-microsecond precision, the light pulses can be extremely short. This extends the life of the LEDs while still ensuring razor sharp images of even the fastest moving objects. The illumination coverage is also extremely uniform and highly reproducible. Quality is increased across the board.

High intensity

"The extremely short strobe pulse allows us to operate the LEDs at up to 300% of their rated current," notes Waldl. B&R is able to achieve a level of intensity that would be impossible with conventional continuous lighting. The enables very short exposure times and reduces noise while at the same time making the solution virtually immune to the effects of extraneous light.

"Machines stand in production halls, where the lighting conditions are difficult and change over the course of the day," says Waldl, "so extraneous light is a notorious source of problems." Eliminating that factor can substantially improve the quality of measurement and inspection results. The machine builder can achieve that either by encasing the machine in a bulky, costly housing – or by using high-intensity strobe lighting.
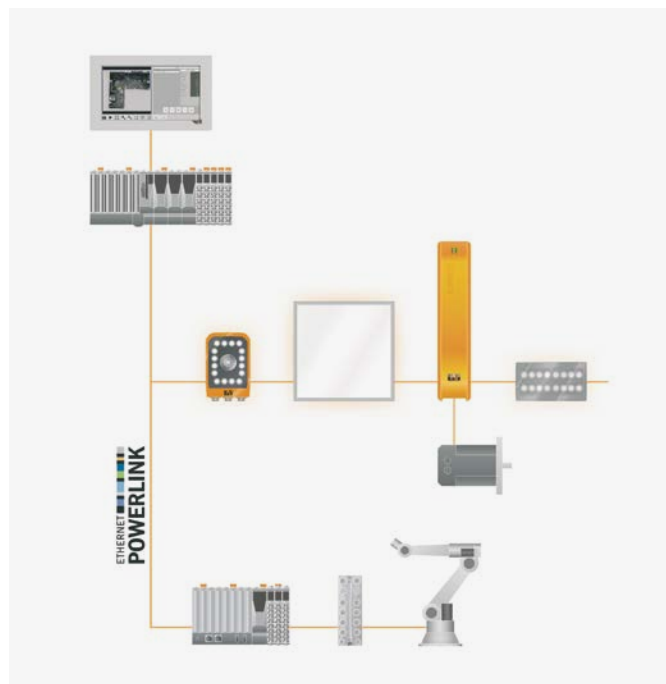
The camera and lighting elements are seamlessly integrated in the machine network.
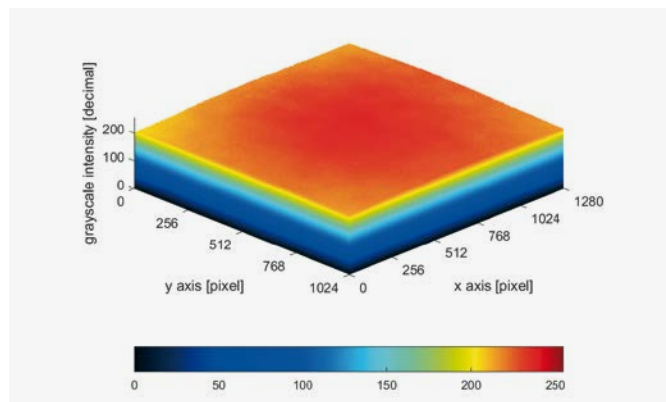
The LEDs built into B&R's machine vision cameras provide extremely uniform illumination. This enables vision applications to achieve consistent results.

Andreas Waldl
Product Manager –
Integrated Machine Vision, B&R

"No machine vision solution is complete without lighting."

Photos: B&R

Uniform illumination

For a machine vision application to produce consistent results, objects must be illuminated as uniformly as possible. This can be achieved through intelligently designed lights. Each LED in the B&R solution has a special lens to ensure that the light is radiated evenly. The lights are factory calibrated by B&R, so there's no need to perform manual calibration in the field or during series production. Temperature fluctuations and the passage of time affect the intensity of light generated by an LED – but B&R's intelligent lights compensate for these effects automatically.

Flexible application

"A machine vision solution that can do one specific thing really well is simply not enough," emphasizes Waldl. In the age of Industry 4.0 and the Industrial IoT, on-the-fly product changeovers are becoming an everyday occurrence – and a vision solution must be able to accommodate that. B&R's fully integrated solution adapts with ease: all the parameters can be stored in recipes and recalled as needed.

At any time, the user can adjust the color of the lights, the duration or focal length of the strobe pulses, the exposure time of the camera or the angle of the light bars – simply by changing a few software settings. With the same lighting components, they can implement both bright-field and dark-field illumination simply by using different parameters.

The significance of color

"Many machine builders underestimate the potential of using different flash colors," notes Waldl. The choice of color can either highlight or hide specific product features or registration marks, for example. That's why B&R offers each of its lighting products – even the camera-integrated LEDs – with up to four different colors, including infrared and ultraviolet. With different LED colors, it's possible to take multiple photos of a product under different lighting conditions to capture a variety of features. And they can be taken in such rapid sequence that only a single camera is needed.

Configuring instead of programming

"By the way," adds Waldl, "setting up a machine vision system no longer requires any real programming in the traditional sense." B&R has developed ready-made software components that enable users to set up their application via drag and drop. The machine vision software components can simply be linked to other components that implement things like motion control, user management, recipe management and alarm systems. Since they are an integral part of the machine network, comprehensive diagnostics are available in real time. B&R has drastically reduced the development overhead involved in creating a machine vision application. ←
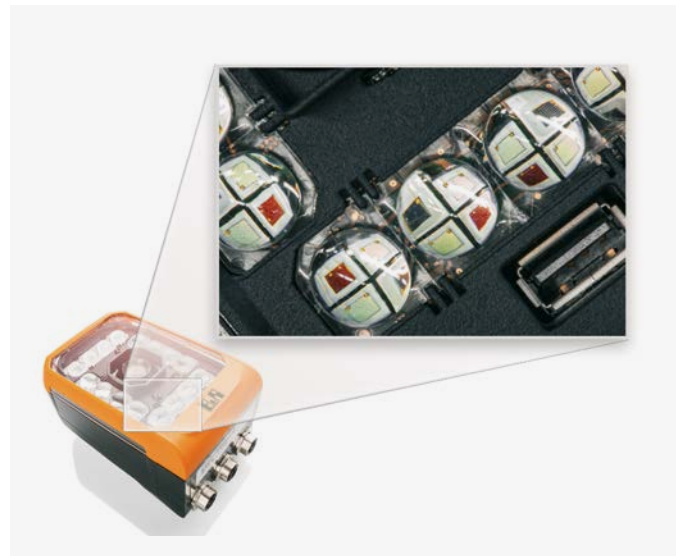
Each light in B&R's portfolio supports up to four different colors. Specially developed lenses ensure uniform illumination.

The B&R lighting portfolio

B&R's lighting portfolio includes flexible light bars, light rings and backlights. Cameras are available with up to 64 integrated LEDs. Each light has an integrated strobe controller and can feature up to four different LED colors at a time. The selection ranges from white and various visible colors to infrared and ultraviolet. This makes it possible to achieve just the right contrast, color, illumination and intensity for any application.

B&R's flexible light bars feature electronic angle adjustment from -40° to 90°. The light bars are also available as pre-assembled ring lights in groups of four, six or eight. Integrated into the machine network via an M12 hybrid connector, which also supplies the necessary 24 VDC power, B&R lighting systems each need only a single cable. A second hybrid connection enables daisy-chain cabling with additional lights or cameras.

"Previously unimaginable"

B&R is the first automation provider to fully integrate machine vision into its automation system. Product manager Andreas Waldl explains why so many machine builders are speechless the first time they learn what is possible with the new solution.

↓

Mr. Waldl, how do your customers react when you show them B&R's machine vision system?

Andreas Waldl: I would describe the first re-action as reserved curiosity. What they can see immediately is the opportunity to re-duce the variety of different systems in their application. Having a single source not only for controls, motion and safety – but now machine vision as well – saves them con-siderable work and valuable resources.

Those sound like serious benefits, why the reservations?

Waldl: Because they tend to be stuck in a rut with the way they think about their pro-jects. Many times, they want to jump right into talking about specific components and technical specifications – that's when I ask them to take a step back and begin by de-scribing a typical application. Then, I'm able to explain what would be possible with our

vision solution – at which point I often find them blinking in disbelief.

Why's that?

Waldl: What we're doing is completely new in the field of machine vision. At first, it can be hard to imagine what it means in practi-cal terms to have machine vision fully inte-grated in the automation system. Over the course of the conversation, it begins to dawn on them just what a significant leap forward this really is.

What are the advantages of B&R's vision solution?

Waldl: The complete integration gives us an unprecedented level of synchronization. We're able to time the lighting and image cap-ture with sub-microsecond precision. Light-ing, camera, drives, controller – everything's talking on the same network and running from the same application. That means you're able

synchronize control loops and view comprehensive diagnostics in real time. In fact, the integration makes us so fast that we can accomplish things with our standard hardware what would otherwise require highly specialized high-speed cameras.

So you could say that B&R offers high-speed cameras?
Waldl: We don't have a high-speed camera – and in fact it's only the rarest of cases where our customers actually need something that specialized. The secret is all in the integration. With our exceptional synchronization and high-intensity LEDs, we're able to freeze a razor sharp image of an extremely fast-moving object at a very precise moment with a short pulse of light – and then immediately process it with sophisticated algorithms. And it doesn't matter if you're using the LEDs integrated in the camera or an external lighting component.

Could you give us an example of a case where a B&R camera is used in a high-speed application?
Waldl: A certain B&R customer from the food and beverage industry was so impressed by the performance that they have begun phasing out their obscenely expensive high-speed cameras in favor of our machine vision solution – at a fraction of the cost. This was a perfect example of the type of conversation I described earlier. The customer started out a little skeptical. But then, they began to realize that they could ignore all their preconceived notions about what machine vision can and can't do, and simply focus on developing an optimal machine process.

That's what happens when you integrate machine vision into the automation system: instead of being a design constraint, it becomes a powerful tool that opens up previously unimaginable possibilities in machine development. ←

Andreas Waldl, Product Manager - Integrated Machine Vision, B&R

Digital twins

A revolution in time to market

All across the world's markets and industries, products are moving from conceptual design to market release in a shorter and shorter amount of time. How long it takes to develop a machine's hardware and program its software can be a decisive factor in its success or failure against the competition. So, naturally – the faster, the better. Digital twins can play an important role in rapid development and testing of a machine's hardware and software.

Using a digital twin, the physical behavior of the intelligent ACOPOStrak transport system can be simulated in real time before any part of the real system has been constructed. Not only does this simplify and accelerate hardware and software development, it also makes it possible to perform virtual commissioning of the track.

Photo: B&R
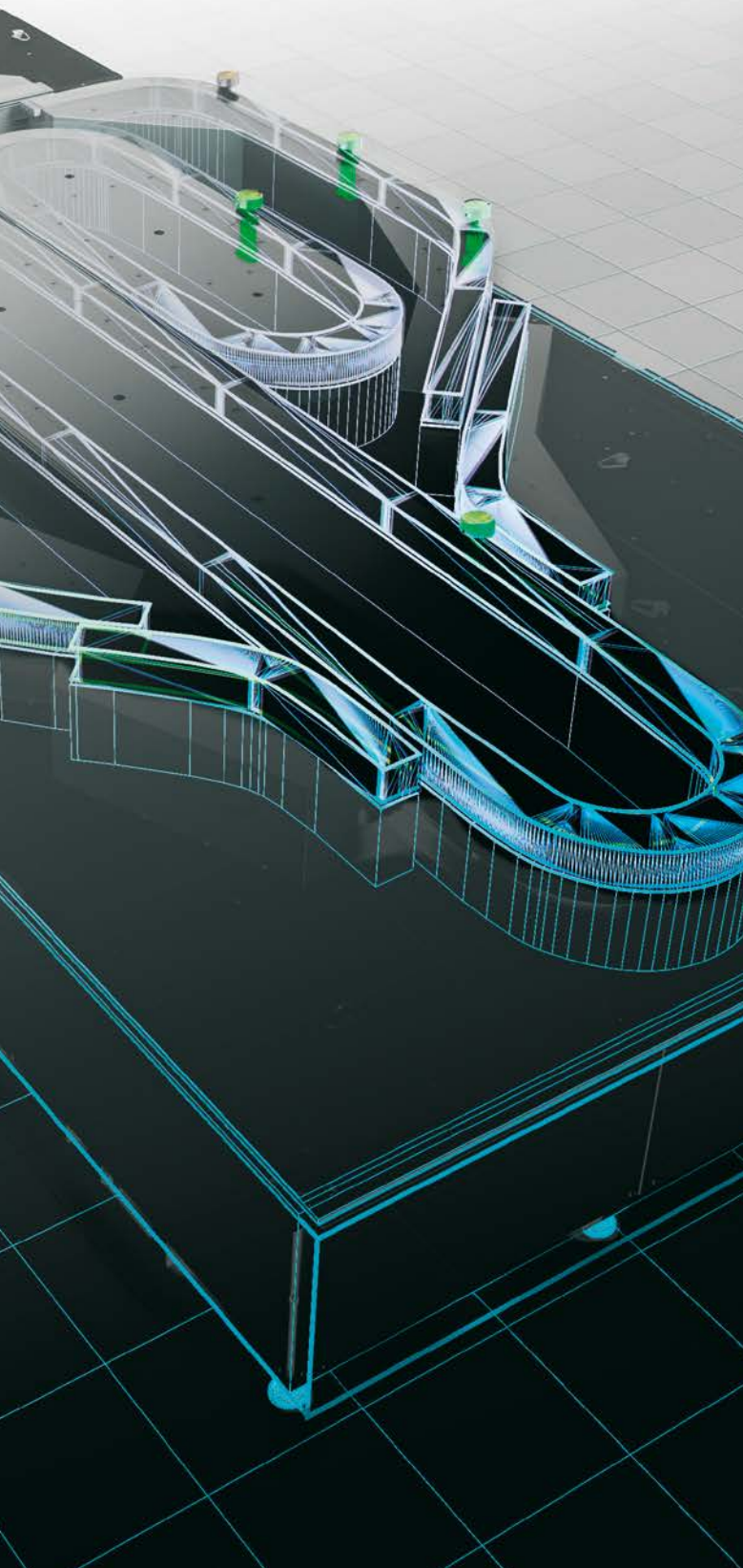
The only way for machines to achieve their ever tighter development schedules is with highly efficient processes. Errors must be ruled out from the start rather than corrected after the fact. Even the prototype of a new machine has to be just right the first time. "To meet these lofty targets, simulation is an approach that has proven itself in many different disciplines," says Kurt Zehetleitner, responsible for simulation and model-based development at B&R. A digital twin makes it possible to evaluate the characteristics of a product before any part of it actually exists.

This approach is already common practice for developing the mechatronic systems used in the automotive and aviation industries. Mechanical systems are modeled on the computer and tested in a simulation environment. This development strategy is still gaining a foothold in other areas of manufacturing. This can be largely attributed to the widespread misconception that developing simulation models is a time-consuming task that can only be performed by developers with a strong understanding of advanced mathematics, and that models themselves are prone to errors. "That may have been the case early on," says Zehetleitner, "but today, creating simulation models is considerably easier and faster."

Digital twins accelerate commissioning
Today's simulation tools make it very easy to generate digital twins. Not only does this simplify and accelerate hardware and software development, it also makes it possible to perform virtual commissioning. Simulating the physical behavior of a machine in real time makes it possible to identify bottlenecks and potential for optimization very early in development. "With seamless interaction between development tools, simulation facilitates a high degree of flexibility and efficient resource management," says Zehetleitner. "This contributes to optimal utilization of development resources and helps reduce commissioning times by up to 80%."

In the B&R Automation Studio engineering environment, a digital twin gives application developers a decisive advantage – they can start up the virtual model directly on the PC and connect to the machine controller in a software- or hardware-in-the-loop configuration. The application software can be developed, verified and tested in advance, and performance requirements can be tested on the controller.

In Automation Studio, a digital twin gives developers a decisive advantage – they can start up the virtual model directly on the PC and connect to the controller in a software- or hardware-in-the-loop configuration.

To create a digital twin, the developer imports the CAD data for the machine into a modeling tool, such as MapleSim. They can easily use important characteristics from the CAD design, like mass and density values, and can also provide individual mechanical components with additional properties, like degrees of freedom and an interface to the controller.

Modeling without equations

With tools like MapleSim and industrialPhysics, even complex models are easy to implement. MapleSim offers a library of modeling elements like masses, joints, springs and dampers that make the process of expanding and fine-tuning a model intuitive and easy. The system generates the equations for the model in the background. A B&R app in MapleSim allows the model to be automatically exported to Automation Studio, along with the CAD data. There, users can test the machine software with regard to motor load and controller tuning. B&R's Scene Viewer tool uses the provided CAD data to visualize movements in 3D. "This makes testing and troubleshooting very easy for the software developer," says Zehetleitner.

The approach is similar with the industrialPhysics simulation tool. The tool has an integrated physics engine that provides an approximate simulation of physical systems with an emphasis on real-time performance. "It's this type of system that now makes it possible to simulate entire machines and plants," says Zehetleitner. "You can even verify the real-time behavior and the system load on the target hardware in a hardware-in-the-loop environment."

Automatic code generation

Once the digital twin has been created, automatic code generation plays an important role in the development and implementation of machine functions on the target system. Among the many benefits, it substantially reduces the amount of programming required. The MATLAB/Simulink tool is particularly well suited for automatic code generation. B&R has developed a bidirectional interface between MATLAB/Simulink and Automation Studio. With Automation Studio Target for Simulink, the developer's work is reduced to only a few mouse clicks. "They can get very quickly from creating a model in Simulink to running high-quality program code on the B&R controller," says Zehetleitner. "Including some very sophisticated diagnostic options." Automation Studio Target for Simulink helps achieve high product quality while at the same time significantly accelerating the development of machine software.

Open interfaces

When working with simulation tools, open standards and interfaces are essential to allowing the different systems involved to communicate freely and seamlessly. The ability to use existing software also saves valuable time. B&R offers openness on all levels and in all products. With the independent industrial standard

Kurt Zehetleitner
Head of Development – Simulation & Digital Twin, B&R

"With seamless interaction between development tools, simulation facilitates a high degree of flexibility and efficient resource management."
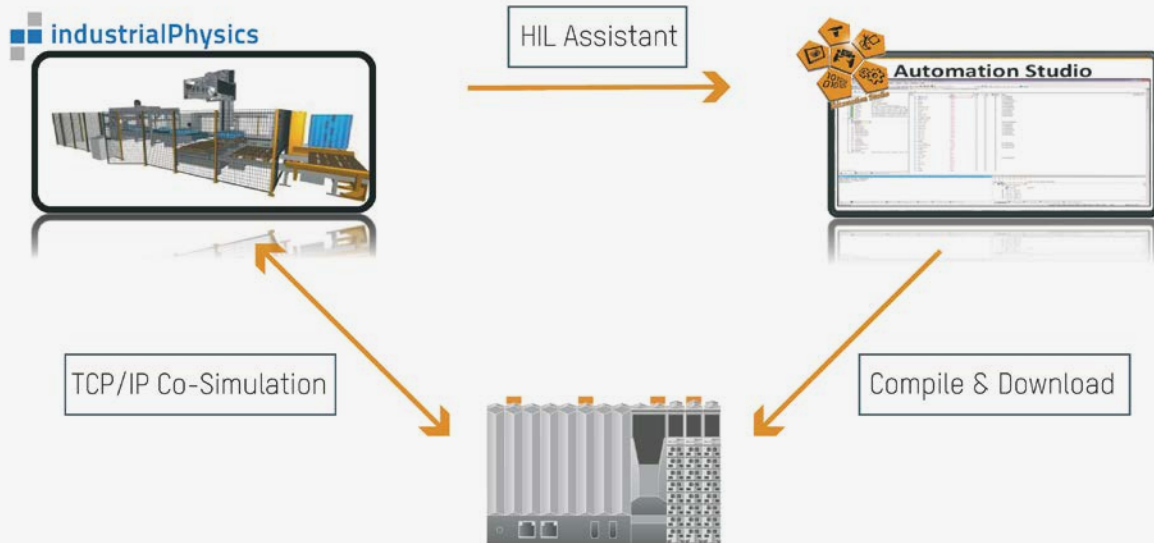
The industrialPhysics tool has an integrated physics engine that provides an approximate simulation of physical systems with an emphasis on real-time performance.

B&R's Scene Viewer tool uses CAD data to visualize movements in 3D.

Functional Mock-up Interface (FMI), models can be exchanged and co-simulated using a variety of development tools. B&R offers a mechanism for importing Functional Mock-up Units (FMUs) in accordance with the FMI 2.0 standard. "FMUs are seamlessly integrated into Automation Studio as function blocks," explains Zehetleitner.

Simulation tools can be used to test models in all defined scenarios and perform comprehensive virtual commissioning. Testing performed during virtual commissioning can range from simple logical sequences to complex, critical scenarios to ensure the overall efficiency and quality of the machine's hardware and software. Using a digital twin drastically reduces the amount of time needed to commission the actual machine and minimizes the risk of errors. ←

Digital twins

A digital twin is a detailed, dynamic representation of a real machine. Three-dimensional CAD data is used to create a digital model, which can be assigned all the characteristics and functions of the machine being developed – including the materials and sensors used as well as the movements and dynamic properties of the actual machine. This allows the behavior of the machine to be simulated in real time to identify potential errors or areas for improvement without the time, risk and expense of creating a physical prototype.

When yielding is a sign of strength

Martin Fritz, managing director of 4activeSystems, still remembers the first project well: "The first system we ever developed was for car manufacturer Audi. Our goal was to design and build a complex testing facility made of fiber-reinforced composite." In this project, a crash-test dummy was sent across the road and pulled upwards using bungee ropes at a very high speed only 50 milliseconds before it would have been hit by the vehicle. "B&R had the only drive and control system on the market that was up to the task," says Fritz. "It was during this project that B&R won us over. We knew that they deliver performance that can be relied on."

Perfect simulation right from the start
The project presented many challenges. Not only did the dummy need to be as human-like as possible, it was also necessary to ensure the technical equipment involved would not activate any

of the cars' sensor systems. The advantage was obvious: If neither the car nor the dummy were damaged during testing, they could keep being reused – a factor that should not be underestimated, considering that a dummy can cost up to €15,000. "We needed a solution that would be invisible to radar systems, infrared and heat scans," says Fritz. "This system was originally intended to be a prototype used for one or two years. Eleven years later, however, it is still being used at Audi."

In addition to dummies that look like pedestrians, 4activeSystems also manufactures and tests two-wheeled and four-wheeled dummies in the form of bicycles, motorcycles and cars. This company is the world's only certified dummy manufacturer. In the field of self-propelled platforms, the relatively small number of competitors can be found in the USA, UK and Austria.

In collisions involving motor vehicles, it is usually pedestrians and cyclists who pay the highest price. More than 90% of traffic accidents are caused by human error, and the consequences are often fatal. 4activeSystems was formed in 2014 by the 4a technology group, with a focus on active automotive safety. At their facilities in Traboch, Austria, they have since been developing and manufacturing both mobile and stationary AEB (Autonomous Emergency Braking) testing devices for outdoor use, as well as crash-test dummies for testing predictive collision avoidance systems. B&R was selected right from the start as their preferred supplier for automation components.

Photo: 4activeSystems

3D car dummies for the active protection of motorists, cyclists and pedestrians

The safety regulations for automotive manufacturers are extremely strict. In the event of an accident, it is not enough to only protect the passengers inside the vehicle. In the event of a collision, a vehicle must also protect cyclists and pedestrians as much as possible. Doing so requires autonomous braking systems able to automatically detect people in order to prevent collisions from occurring in the first place.

These systems are tested in specific scenarios, which are determined based on accident statistics. These scenarios include, for example, children and adults emerging onto the street from behind a parked vehicle. The car's autonomous emergency braking system must be able to immediately detect and correctly assess

the situation with the help of cameras. In order to test this, 4activeSystems developed its 3D car dummy, 4activeC2. This realistic 3D model of a car can accelerate up to 85 km/h and withstand impacts of up to 65 km/h without being damaged. Important criteria in the design of the 3D car dummies were user friendliness and quick reassembly following each test collision. The 4activeC2 retains its form as it travels on the moving platform. In the event of an collision, the 3D dummy car loses its form, but can be reassembled in just two minutes by two people using zippers.

GNSS-controlled, self-propelled platform, 4activeFB

The dummy object (3D car dummy or cyclist) should react realistically, but the equipment that moves it must be invisible to all sensors. To make this happen, 4activeSystems developed self-propelled platforms that move the dummies, which it calls Freeboards. With vehicles passing over the autonomous platforms at speeds of up to 100 kilometers per hour, one of the greatest challenges is ensuring that the platforms don't inadvertently become ramps. To avoid this scenario, 4activeSystems defined a maximum height of five centimeters for the Freeboards. This also means, however, that any components used – including drive technology, control technology and battery technology – must not only fit in the tight 30–40 millimeters of installation space, but offer excellent thermal contraction as well. During testing, large amounts of heat are generated in the drives and motors, so 4activeSystems goes to great lengths to ensure this heat is dissipated order to ensure that its autonomous platforms are absolutely safe to operate.

The latest highlight at 4activeSystems is their platform "4activeFB", an extremely flat Freeboard controlled by GNSS/INS (global navigation satellite system) and propelled by three powerful 3x14 kW drive units. When it comes to the instrumentation of the Freeboards, GNSS is not comparable to the conventional GPS used in smartphones and navigation devices. While GPS systems are accurate to between one and eight meters, GNSS is accurate down to one or two centimeters. It offers a very high clock rate and is combined with an acceleration system. Two GPS antennas are used to measure the angles of the platform and to calculate its

"In physics we trust" – the slogan speaks for itself at Styrian vehicle safety system manufacturer 4activeSystems. (left to right: Mario Bungic, B&R and Martin Fritz, 4activeSystems).

position. This information is essential for the control system. During testing, the vehicle must adhere to the defined collision points with a tolerance of ±5 centimeters and react very quickly with control adjustments, so high-speed communication between vehicle and control station is essential.

The 4activeFB platform uses a Power Panel C70, an X20 controller with I/O and safety solutions from automation specialist B&R. Safe I/O modules from B&R's X20 series offer a wide spectrum of fail-safe digital and analog inputs. A perfect example is the robust temperature input module for thermocouples, which makes the safety products particularly suitable for the extremely hot conditions in 4activeSystems applications. "We left the development of the safety functions up to B&R for this project," says Fritz. "We defined the safety requirements, and then B&R handled develop-
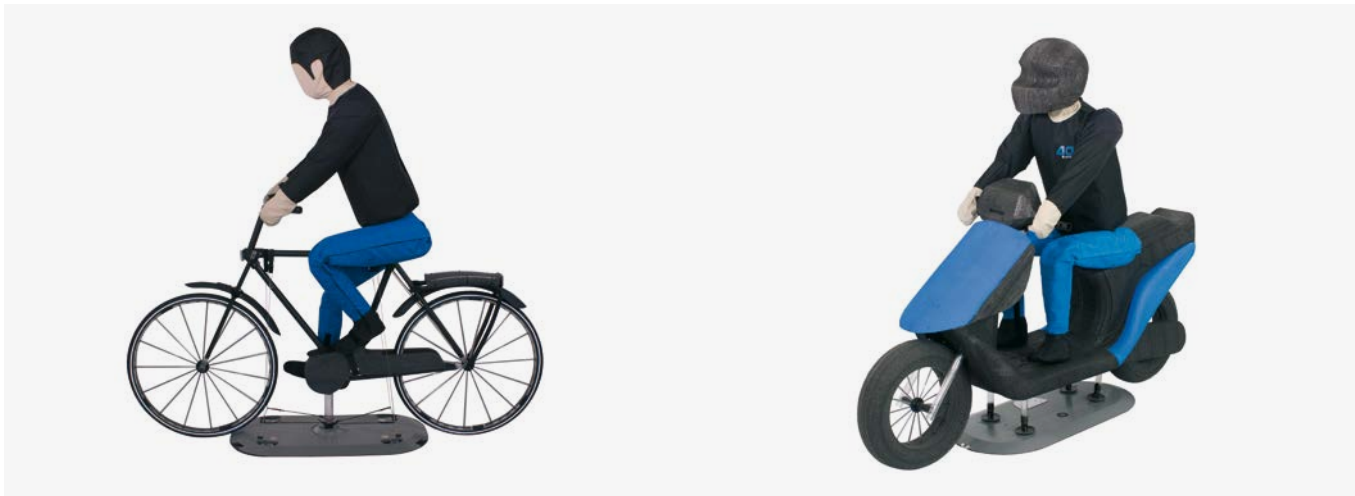
The existing passive measures are enhanced by active pedestrian protection. At 4activeSystems, realistic dummy vehicles are used to test collision avoidance systems.

ment and implementation. The process went smoothly, and the B&R components proved to be extremely reliable – our specifications were always met to our satisfaction," says Fritz.

The future of autonomous driving

In the near future, Level 4 and Level 5 autonomous vehicles will be participating in everyday traffic. The industry has defined five different levels of autonomous vehicles. Level 4 applies to the kind of fully automated car that will be around by the year 2022. These cars will be self-driving most of the time. They will park themselves and drive autonomously along country roads or in the city. This will free drivers to concentrate on other things, without having to keep an eye on traffic the entire time. These cars will also communicate with their environment. Traffic lights, for example, will signal before turning red or green, and other vehicles will signal when changing lanes. For this all to be possible, cars must be able to communicate and warn each other. Vehicles must also interact with their surrounding environment. Traffic lights must communicate phase-changes, gates at railroad crossings must signal before closing – and last but not least, public transportation systems must also be fully integrated. The vehicles must also know when to yield to police and emergency vehicles. Essentially, the entire traffic environment must therefore be digitized. High-resolution maps will be necessary, because the cars need to know their location at all times. This all sounds quite complex, and indeed it is. It means that every street in the world must be measured right down to the last centimeter. At Level 5, cars will be so autonomous that they will no longer even be equipped with a steering wheel. It will take some time before cars like this appear on the roads, however – realistic estimates predict sometime around 2025.

Autonomous driving will be accompanied by major changes in our transportation infrastructure. In order to reach these levels of autonomous driving, a countless array of traffic scenarios must first be tested. "Many of our customers are involved in the research and development of autonomous driving, including automobile manufacturers, suppliers and well-known service providers," says Fritz.

The longer-range outlook

B&R is involved in every project at 4activeSystems, whether as a partner in a shared project or as a component supplier. "B&R is well valued at our company – we see them as a true partner. We are more than satisfied with the overall service, from the products and delivery to the support that we receive. We highly value the »Made in Austria« quality and try to draw as many components as possible from partners in Austria," says Fritz. ←

Martin Fritz
Managing Director, 4activeSystems GmbH

"B&R is well valued at our company – we see them as a true partner. We are more than satisfied with the overall service, from the products and delivery to the support that we receive. We highly value the Made in Austria quality."

The 4activeFB platform is controlled via navigation system and used to test AEB VRU scenarios. The platform has an exceptionally low profile, is very robust and can be driven on by passenger and commercial vehicles.

Fast and precise motion control

B&R's ACOPOSmulti multi-axis servo drive now enables even shorter cycle times down to 50 µs.

B&R servo drive controls highly dynamic processes with greater precision

↓

With the latest upgrade to its ACOPOSmulti multi-axis servo drive, B&R now enables even shorter cycle times down to 50 µs. Highly dynamic processes can bow be controlled more precisely than ever. For demanding motion control applications, such as those found in the printing and packaging industries, movements must be controlled very quickly and precisely. The ACOPOSmulti's short cycle time of 50 µs for current, speed and position control opens up new possibilities for virtual sensor technology.

Lag error compensation

Using a virtual motor position encoder eliminates the need for an encoder, encoder cable and evaluation unit in the servo drive and at the same time increases availability. Other special functions for more precise control and faster reactions can be implemented using virtual sensor technology. These include model-based control with autotuning and a repetitive control function for predictive lag error compensation. ←

Photo: B&R

B&R safety module saves space in the control cabinet

The new X20SO6530 digital output module provides six safety relays on a unit with a width of only 25 mm.

New B&R module provides six safety relays on a unit with a width of only 25 mm

The new X20SO6530 digital output module provides six safety relays on a unit with the X20's standard 25 mm width, allowing B&R to offer a cost-effective and space-saving solution for applications where numerous floating signals are needed. To meet safety requirements, positively driven feedback contacts must be evaluated in a manner that is appropriate for safety technology. This new X20 module evaluates this data internally, making it just as easy to use the six safe relay outputs as it is to use semiconductor-based outputs. The digital output module has single-channel isolated outputs with a maximum switching capacity of 230 VAC / 6 A or 24 VDC / 6 A. ←

Simulation & digital twin technology

"Develop with confidence, commission with ease, perform with excellence"

Kurt Zehetleitner, B&R's head of development for simulation and digital twin technology (left) and Chad Schmitke, senior director of product development at Maplesoft (middle) discuss how their companies' partnership will help shape the future of machine development.

MapleSim is an advanced modeling tool from Maplesoft that computes the physical forces experienced by complex mechanical systems. Partnership with B&R now makes it easier than ever to incorporate these models in B&R's Automation Studio engineering platform and on the machine itself as a digital twin. Chad Schmitke from Maplesoft and Kurt Zehetleitner from B&R explain the immediate payoff for machine builders as well as the long-term implications of this exciting technology.

↓

We're hearing a lot about simulation and digital twins these days. What's behind all the hype?

Chad Schmitke: The excitement is understandable. These technologies address some of the biggest challenges machine builders are facing, and they will bring lasting changes to how machines are engineered. With an increasing share of intelligence in what used to be primarily mechanical systems, control software is becoming more critical to machine performance. And as machines grow more complex and adaptive, you need more sophisticated methods of testing and evaluation.

And that's where simulation comes into play?

Schmitke: Exactly. You don't want to go through all the expense of creating a physical prototype and then just hope for the best. If you can base your hardware sizing and software testing on a realistic simulation, and even perform virtual commissioning on a digital twin, you can have confidence from an early stage that your machine is going to do what you've designed it to do.

So, the main impact will be on design and development?

Schmitke: Well, it will certainly start there – but beyond that we can see the next phase starting already. People will use the models they have created to put value-added features into the product. They'll discover new ways to use real-time data from the machine for things like diagnostics, predictive maintenance and advanced control.

Do these topics come up a lot in your conversations with customers?

Schmitke: There are a lot of big ideas being tossed around about where the technology is going. But what I've heard from customers – especially the SMEs – is that they aren't quite sure where to start at a practical level. What they want to know is how to get started

on that journey – what are the first steps that will let them start seeing returns right away.

And how do B&R and Maplesoft address those concerns?

Kurt Zehetleitner: When it comes time to create the software for their machines, many of our customers – again, particularly the SMEs – are used to jumping right into the programming. The preliminary step of modeling the system is something new, and MapleSim is a really approachable way to get started with that. Through our partnership, we've created a package, B&R MapleSim Connector, that streamlines the workflow between the tools and helps our customers navigate this new territory in a way that brings real results very quickly.

Schmitke: Maplesoft's heritage is in engineering computation – simplifying symbolics and building tight sets of equations. So we're able to generate extremely compact code, and our cooperation with B&R means that can now be applied in the engineering system for hardware-in-the-loop and software-in-the-loop simulation. So it's a really good match in terms of B&R's knowledge of the hardware and what their customers are doing and our expertise in how to model those systems.

Can you tell us a bit more about the B&R MapleSim Connector?

Zehetleitner: The MapleSim Connector package contains MapleSim, as well as a B&R app for MapleSim for automated export of the model and CAD data to Automation Studio. There is also an export function for our SERVOsoft sizing tool. So it's a bundle that makes the workflow between all of these tools as streamlined and helpful for our customers as possible. The basic idea is that the model data is automatically reused for different purposes throughout the development process. This ensures, for example, that the most up-to-date CAD data is used for both hardware sizing and software development. MapleSim Connector is currently available upon request,

and in the future will be available for download from the B&R website. Customers who are struggling with software development will see that with MapleSim and Automation Studio, they have a really approachable solution with a straightforward workflow that enables the different engineering disciplines to work together seamlessly.

So, it's a good way for machine builders to get started with digital twin technology?

Schmitke: That's right. Bringing a model of your system into a powerful engineering tool like Automation Studio opens up some very exciting possibilities. You can test your controller in real time with no risk, and then put it right onto the machine. That's the piece of the process that's going to disrupt and transform the traditional approaches to machine software. In the past, you put in the effort to create a model and you could maybe size a motor with it, but that's where it ended. But now there's this gateway to so many other possibilities. You can develop with confidence because you can see with your own eyes that it's going to work. You can commission with ease, because you've already gone through it virtually. And you can perform with excellence, because you've had room to play around in the conceptual phase, and you have new ways to utilize feedback from the machine.

Could you describe the streamlined workflow between MapleSim and Automation Studio?

Zehetleitner: The developer starts by importing their existing CAD data into MapleSim to create a model without having to deal with any kinematic equations. From there it's just a few clicks to create the C code and import it into Automation Studio where it can run in a simulation environment or on the actual PLC hardware, almost like any other function block. Since the CAD data is also imported, the developer can view a 3D representation in B&R's Scene Viewer. This digital twin shows them at a glance whether everything is performing correctly. And, as the mechanical design inevitably

changes over the course of the project, they can keep this model up to date to avoid any unpleasant surprises when they go to run the software on the actual machine.

How will machine builders take advantage of all these new possibilities?

Zehetleitner: As machines get more dynamic and adaptive, the increasing complexity and variability make it difficult for engineers to rely on their gut instinct to tell them which components are going to perform. So sizing and virtual commissioning will be very important applications. With our ACOPOStrak transport system, for instance, having a digital twin makes it easy to figure out the exact number of shuttles that will maximize productivity.

Schmitke: It will start there and then move on to things like predictive maintenance, advanced control and tuning. When the torques you're drawing don't match what your model predicts, you know something might be going wrong with a given mechanism, for example. Also, you can explore what-if scenarios. You can look at given set of parameters and ask: "What's the fastest cycle I can achieve on this motion profile and still be within the torque limits of my motors?" From there it's up to the imagination: How does it fit into the sales process, perhaps? The future is wide open.

Speaking of the future, what else can we expect to come out of this partnership?

Schmitke: What we hope to see is that customers are encouraged to get started with this exciting topic. With easy access to a tool that they know will work, and where they can rely on expert support from both Maplesoft and B&R. From there, it will be a matter of listening to the feedback and prioritizing what features to pursue first. Overall, the driving question will remain: "How can we make it easier for our customers to use the information from their model to enhance their controls and overall system with added value?" ←

Industrial IoT

From your brownfield to the cloud

ISO on TCP

EtherNet/IP

PC UA

INA

ETHERNET **POWERLINK**

Orange Box

SiteManager
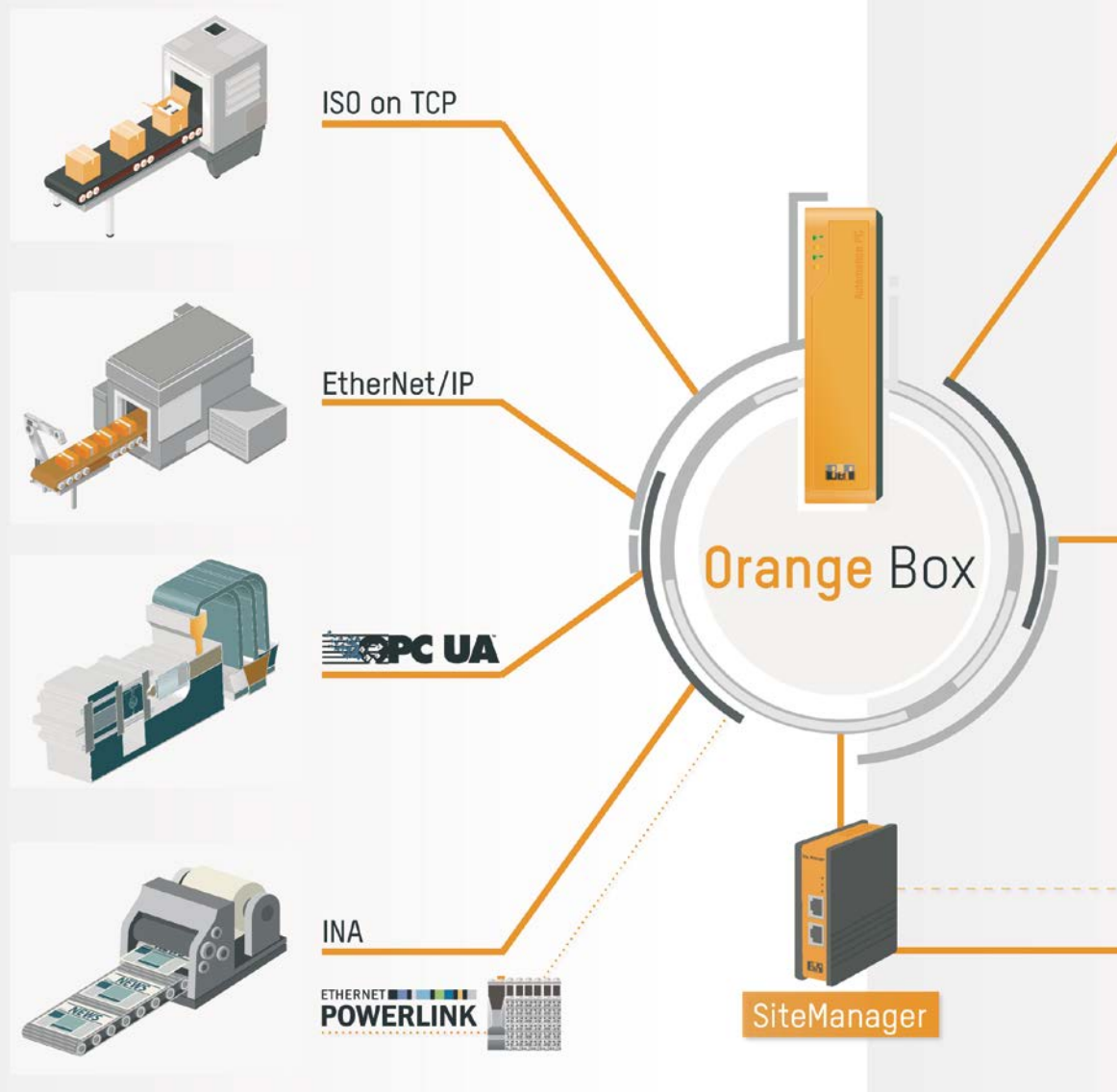
Orange Box, the data acquisition and analysis tool from B&R, will now be able to transfer data from existing machines to the cloud.

Existing plants rarely offer a way to collect machine data automatically. That's why B&R developed the Orange Box. To allow users to compare the collected data across multiple lines, locations and continents, B&R has now equipped the Orange Box with a cloud interface.

Photo: B&R
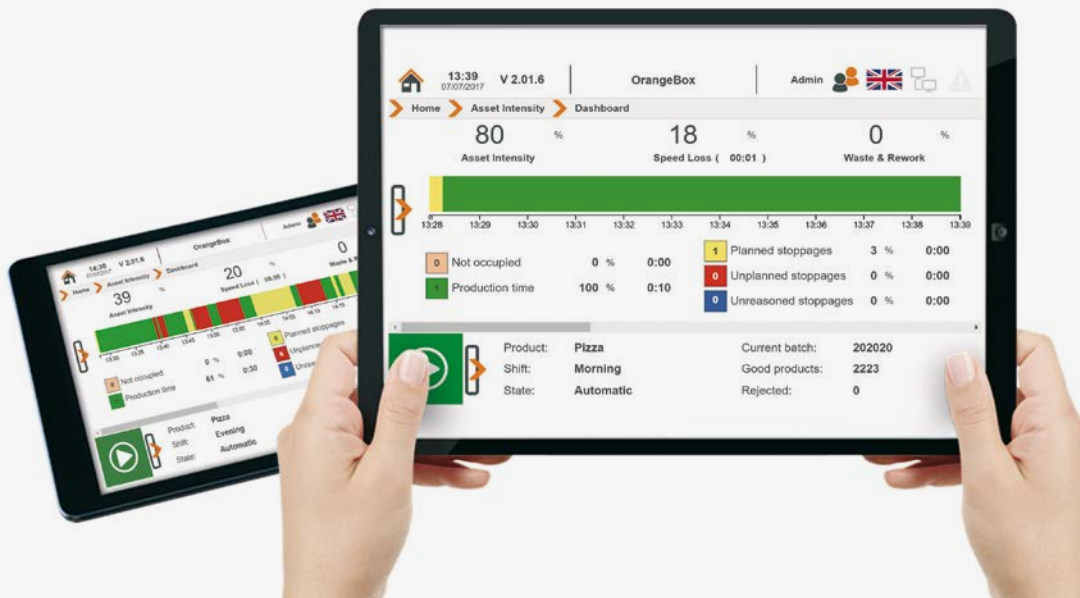
The Orange Box has an easy-to-use, state-of-the-art dashboard created with B&R's HTML5-based HMI solution, mapp View.

Machines can have a service life of 20 to 30 years or more. Over time, they are typically adapted and upgraded to keep pace with the state of the art. When it comes to identifying problems before they occur or determining measures to boost productivity and availability, however, many brownfield operators still reach first for pen and paper.

"Until now it hasn't been possible to automate the collection of operating data digitally isolated machines," says René Blaschke, B&R's product manager for Industrial IoT. Those who wish to evaluate data from multi-vendor lines. "The trick in this case is finding a common denominator for the quite imaginative naming conventions of the various automation manufacturers," says Blaschke, explaining explains the challenge he and his team set themselves.

Into the cloud
The solution B&R developed is called Orange Box. It allows operators to read, systematize and analyze data from all types of ma-

chine controllers. "We launched the Orange Box two years ago, and the feedback from the market has been excellent," Blaschke is pleased to report. The information they have gathered has helped many operators of existing plants significantly increase the productivity of their machines and thus their profits.

"So far, this has only been possible for individual machines or lines," says Blaschke, adding: "But now we have gone a step further." In the future, the data acquisition and analysis tool will be able to transfer data from existing brownfield machines to the cloud. This will allow operators to monitor, compare and optimize their machines and plants across lines multiple, locations and even continents.

Secure connection to the cloud
"When you're sending data to a cloud provider over the Internet, the issues of data protection and cybersecurity become very important," Blaschke emphasizes. It is therefore advisable to use a cloud service that has been specially optimized for the requirements of the industry, such as ABB Ability. As the operator of this cloud platform, ABB uses state-of-the-art security standards and transmission protocols to ensure the security and integrity of the stored data. Through the use of the standard MQTT protocol, the Orange Box can also transfer data to any other cloud platform.

Deploying the Orange Box is very simple: "Unpack, connect the industrial PC with the software to the machine controller and IT network via network cable and the Orange Box is up and running," says Blaschke. Production does not have to be interrupted during installation, and there are no changes to be made in the system software. If it is not possible to connect via a fieldbus interface, data can alternatively be aggregated via existing I/O interfaces or through parallel wiring and additional sensors.

René Blaschke
Product Manager - Industrial IoT, B&R

"With the ability to send the data it collects to the cloud, Orange Box can help reduce downtime, extend service life and boost output."

A SiteManager enables the Orange Box to communicate externally, for example with cloud platforms or email and SMS servers.

Orange Box allows operators to read, systematize and analyze data from all types of machine controllers.

Ease of handling

The user simply links the desired data points in a visual editor and can then calculate the overall equipment effectiveness and other key figures. The Orange Box can send the results to the cloud or forward them via OPC UA to an output device with a browser. Its OPC UA server allows any manufacturing execution system (MES) or enterprise resource planning (ERP) system to access the data.

Integrated in the Orange Box is an easy-to-use, state-of-the-art dashboard created with B&R's HTML5-based HMI solution, mapp View. This allows results to be displayed on any web-enabled device – from machine controllers and office PCs to smartphones and virtual cloud applications. This gives plant managers a quick overview of their plant's most important efficiency metrics so that they can react quickly to any changes, such as a drop in equipment availability.

Automatic notifications

B&R offers a wide variety of software components for adding additional functions, such as sending automated email or text message notifications for certain alarms or automatic logging of data in an SQL database. The software components are fully networked and exchange data automatically. All the user needs to do is enable the desired functions.

The Orange Box is based on a small industrial PC with pre-installed software. An operator panel and/or SiteManager unit can be added if needed. A SiteManager enables the Orange Box to communicate externally, for example with cloud platforms or email and SMS servers.

"SiteManager plays a decisive role in allowing the Orange Box to provide secure connections to cloud platforms," says Blaschke. The small device allows important functions such as automatic certificate handling and security updates. "This also ensures that the security guidelines of the cloud providers are always adhered to.

Eliminating inefficiencies

By connecting the Orange Box to cloud platforms, B&R has significantly expanded data acquisition tool's range of applications. Cloud-based analytics allow users to easily identify and resolve problems and inefficiencies in their existing machines and lines in the field – resulting in less downtime, longer service life and higher output. "They can do all these things thanks to the data Orange Box is able to collect from machines that were previously not connected to any network," says Blaschke.

Clear display of online parameters
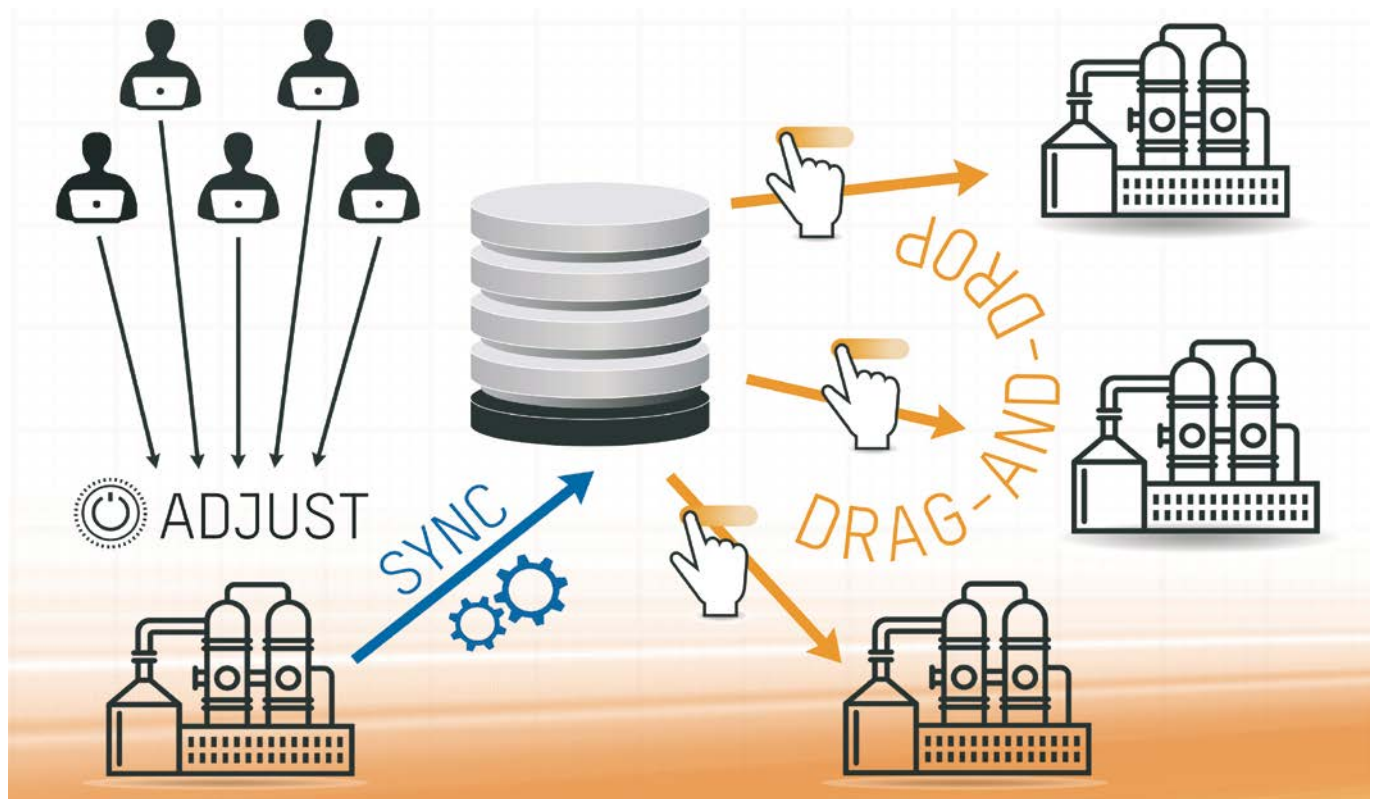
Get a clear overview of online parameters and apply them to other systems via drag-and-drop.

Convenient online parameter management for process control technology

↓

The new version R4.2 of the APROL automation platform provides a powerful and convenient system for managing online parameters. APROL DisplayCenter displays a clear overview of online parameters and facilitates the commissioning of measurement and control loops. Online parameters can be dragged and dropped to other systems. Different views allow a clear display and uncomplicated modification of the online parameters. The faceplate view offers a well-structured user interface. The system logic is displayed in the control module view. Parameters can be entered and controlled modules can be enabled in the list view. Depending on the requirements, the appropriate view can be selected or you can switch between the views.

Transfer parameters

The new operating dialog boxes not only provide a better overview of the parameters, but also allow existing online parameters to be transferred to other measuring points. To ensure seamless traceability, when online parameters are fed back into the APROL project engineering tool CaeManager, a new version is created automatically with a corresponding comment. ←

Photo: B&R

Better bandwidth utilization

The new POWERLINK bus controller from B&R enables better bandwidth utilization with a star topology CAN network.

B&R bus controller overcomes CAN topology restrictions

↓

The new POWERLINK bus controller X67BC8780.L12 from B&R has an integrated hub for eight CAN connections. The star topology of the CAN network allows a higher maximum total cable length and better utilization of the bandwidth. It also greatly simplifies cabling.

External CAN devices can be connected to each of the eight separate CAN lines with a standard CAN bus topology. Each line can extend out to the maximum length determined by the baud rate. All eight CAN bus controller connections are terminated using integrated terminating resistors. Full FPGA implementation allows the hub to achieve minimal throughput times. The device offers IP67 protection and is suitable for installation outside the control cabinet.

Hub optimizes CAN network

According to its specifications, a CAN network can only be built as a line structure with very limited branch lines. The new X67 hub groups various CAN segments into a collision domain. It functions similarly to an active star coupler in a fiber optic network. With the active coupling, the individual segments are no longer subject to the restrictions of branch lines, which greatly simplifies cabling.

Integrated sensor power supply

At each CAN connection, 200 mA are available for the sensor power supply. The connections are short-circuit proof. The bus controller has a wide voltage range of 9 to 32 VDC. All sensors used in the industrial and automotive sectors can be connected directly using a single cable. An additional connector allows the I/0 power supply to be daisy-chained to additional modules. The M12 connection technology and use of prefabricated standard cables, commissioning teams can immediately begin setting up the machine without having to first tediously check cables. ←

Photo: B&R

Safety logic that boosts productivity

The market for electric motors is booming, and the ongoing e-mobility trend is not the only reason – demand in industrial applications is also growing steadily. When developing a semi-automated production line for electric motors, risomat found that the complexity of its safety logic was hampering productivity. The solution: visualizing system states using the software modeling language UML (Unified Modeling Language).

The new production line for motor stators has manual workstations located in areas that are also traversed by a gantry crane – making the safety logic particularly complex.

Photo: risomat
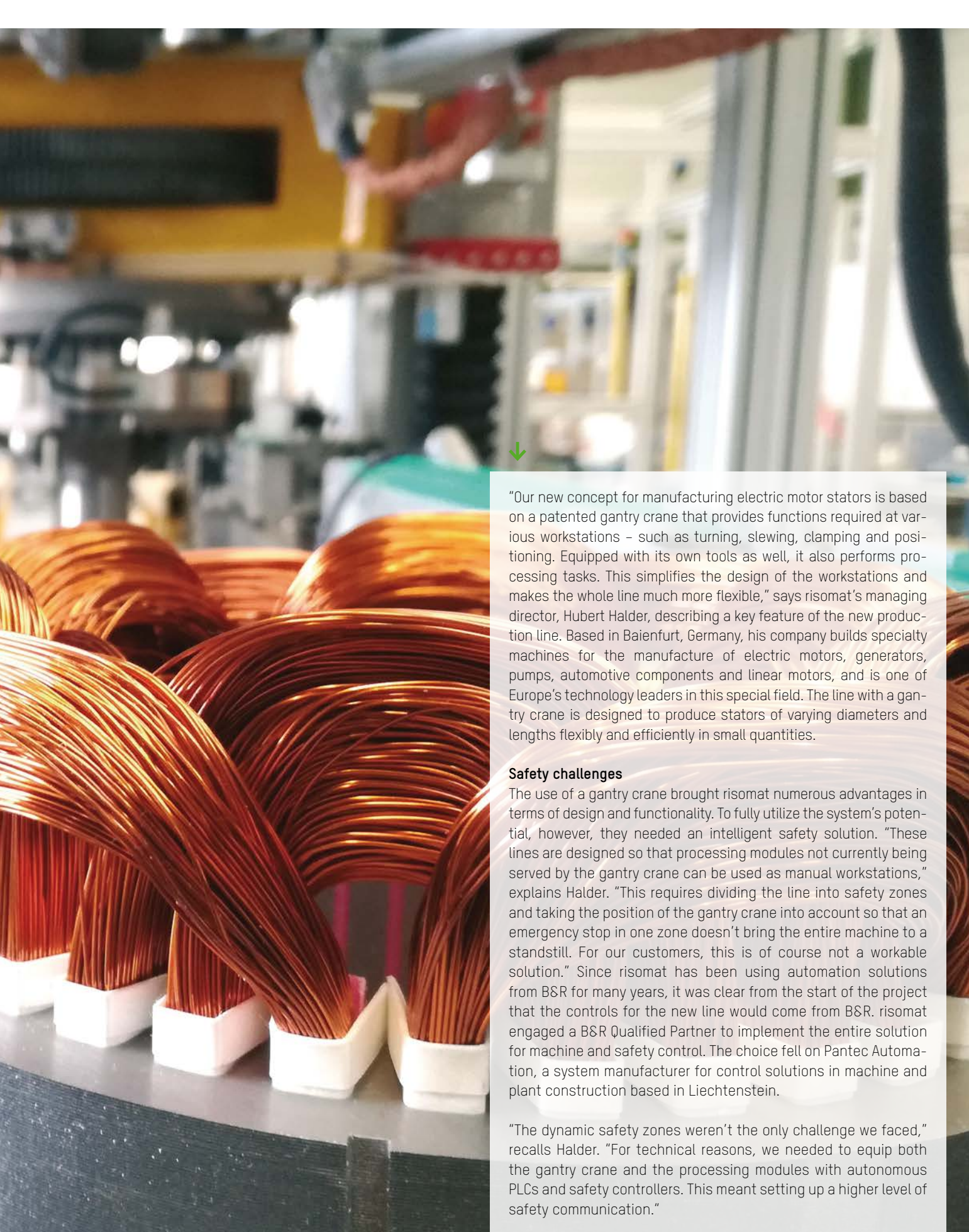
"Our new concept for manufacturing electric motor stators is based on a patented gantry crane that provides functions required at various workstations – such as turning, slewing, clamping and positioning. Equipped with its own tools as well, it also performs processing tasks. This simplifies the design of the workstations and makes the whole line much more flexible," says risomat's managing director, Hubert Halder, describing a key feature of the new production line. Based in Baienfurt, Germany, his company builds specialty machines for the manufacture of electric motors, generators, pumps, automotive components and linear motors, and is one of Europe's technology leaders in this special field. The line with a gantry crane is designed to produce stators of varying diameters and lengths flexibly and efficiently in small quantities.

Safety challenges

The use of a gantry crane brought risomat numerous advantages in terms of design and functionality. To fully utilize the system's potential, however, they needed an intelligent safety solution. "These lines are designed so that processing modules not currently being served by the gantry crane can be used as manual workstations," explains Halder. "This requires dividing the line into safety zones and taking the position of the gantry crane into account so that an emergency stop in one zone doesn't bring the entire machine to a standstill. For our customers, this is of course not a workable solution." Since risomat has been using automation solutions from B&R for many years, it was clear from the start of the project that the controls for the new line would come from B&R. risomat engaged a B&R Qualified Partner to implement the entire solution for machine and safety control. The choice fell on Pantec Automation, a system manufacturer for control solutions in machine and plant construction based in Liechtenstein.

"The dynamic safety zones weren't the only challenge we faced," recalls Halder. "For technical reasons, we needed to equip both the gantry crane and the processing modules with autonomous PLCs and safety controllers. This meant setting up a higher level of safety communication."

Integrated safety technology from B&R

For Pantec project manager Florian Hartmann, however, the question of safety communication had a pragmatic answer. "B&R offers a complete range of control and safety technology that is perfectly suited to creating modular systems," says Hartmann. "Even with a hierarchical structure, there are never any conflicts between systems, and all the components can be programmed with B&R's Automation Studio software." The safety controller is comprised of an X20SL8100 SafeLOGIC together with IP20 and IP67 safety modules.

The solution satisfies PL e or SIL 3. Two safe axes are also used in the gantry crane, because the vertical and horizontal position of the crane has safety implications for processing at the individual stations. Other safety equipment includes light curtains, 2D laser scanners and pressure-sensitive safety mats.

The challenge of dynamic safety zones

Hartmann and his team soon realized that a classic text-based description of the safety logic was not sufficient to describe the system states completely and transparently. The path to a solution was paved by the idea to derive and describe the safety states using UML, which Pantec's software developers regularly use for things like dynamic state descriptions. Based on the UML approach, a three-stage safety process was developed that describes the path from the approved safety concept to the tested safety controller. This process makes it possible to develop and document a safety application in a transparent way. As a result, the functionality of the safety controller can be tested and documented seamlessly during the acceptance process.

The three-stage UML safety process in detail

In the first stage of the process, the safety components incorporated in the electrical plan are represented in UML as use cases. Then the safety logic is developed. In doing so, the developers define which use case leads to which safety status. This step requires close cooperation between software developers, safety officers and designers. One priority here is to define the safety status in such a way that local emergency stop functions don't affect overall machine operation any more than necessary.

In the second stage of the UML safety process, the modeled safety application is coded and the acceptance test is derived directly from the use cases. In addition to the logic, acceptance testing also covers all the safety hardware and its wiring. In the third stage, acceptance testing is carried out and the safety system is then approved by the safety officer.

In risomat's stator production line, the workpiece and workpiece carrier are transported between processing stations by a gantry crane.

The emergency stop button is linked to the safety controller via an emergency stop console. All the safety components from the electrical plan are implemented in UML.

Florian Hartmann
**Project Manager,
Pantec Engineering AG**

"The perfectly orchestrated B&R
portfolio lets you weave modular
safety technology seamlessly into
the control system."

Halder finds the model impressive from several perspectives: "On
the one hand, the UML safety process allows me to offer my cus-
tomers higher machine availability."

New B&R innovations for risomat
In addition to safety controller modeling with UML, Pantec Automa-
tion took further innovative steps for risomat during the develop-
ment of the stator production line. One significant step was the
development of a completely modular software framework. The
ability to automatically generate B&R control code significantly
reduced the time and effort required to develop the software for
the machine. This was also their first project using B&R's mapp
components.

Overall system performance was increased by switching to a B&R
Automation PC 2100 controller.

The HMI got an upgrade as well, now using a 15.4" panel with B&R's
SDL3 connection technology. In addition, the existing operating
concept was subjected to usability analysis and optimized. The
results were incorporated into a style guide for future risomat op-
erator panels. ←

**Advantages of UML (Unified Modeling Language)
at a glance:**

Highlights

→ Conceptual design phase: The UML model greatly
simplifies communication between software engineers
and mechanical engineers. It provides a clear overview
and facilitates additions and changes.

→ Acceptance phase: The UML visualization makes it easy
to plan comprehensive test cases. Acceptance testing
is documented seamlessly and transparently. The well
structured process shortens the time required for testing.

→ Operational phase: The simple visualization in UML
provides both operator and service technician a quick
overview of how the programmable logic controller works
and what functions are available.
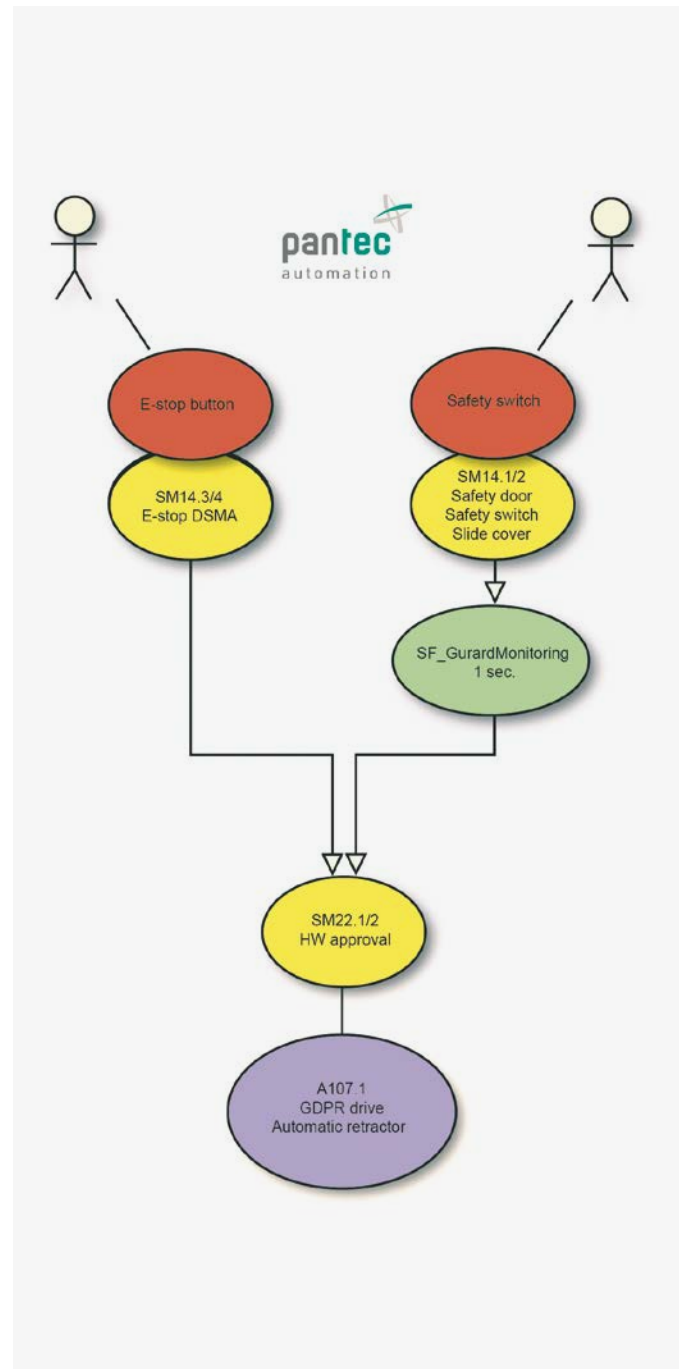
Representing the safety logic in UML: Safety components are represented as
use cases and then connected by logical operators.

In-sync with robots

mapp Motion makes it easy to synchronize the movements of robots with gantry systems or tool tables with no additional programming.

B&R software better utilizes the potential of robots

↓

B&R has added new functions to its mapp Motion software package. It is now possible to represent the actual structure of a complex machine intuitively in the configuration. The various subsystems of a machine can simply be linked together. The movements of robots can be easily synchronized with gantry systems or tool tables with no additional programming.

The "Frame hierarchy" function can be used to represent the actual structure of a machine. Coordinate systems can be positioned at key points, such as the tool mounting flange. Each coordinate system can be assigned a name that identifies it within the application. This ensures clearly organized, easily readable code – even in complex applications.

Optimized robot movements

The "Programmed moving frame" function couples a coordinate system to an axis and defines an additional degree of freedom. This allows optimized movements and better utilization of robot dynamics. The func-tion incorporates the movement of the gantry system into the path calculations of the robot. The programmer doesn't need to coordinate the movements of the gantry system and robot manually. The same applies in cases where robots or CNC machines are combined with moving workpiece tables.

General path planning

Only one controller is necessary for the machine, robot and other moving components. The robot and additional components act as one unit. Coordinated path planning allows optimal utilization of the dynamic limits of the individual components. It also guarantees that all specified process parameters are adhered to, such as the relative speed between tool and workpiece. ←

Photo: B&R

B&R brings safety to mobile equipment

Intelligent safety functions and extremely short response times are the key to a whole new realm of possibilities for the safe operation of outdoor equipment and mobile machinery.

New safety controller offers intelligent safety functions for outdoor applications

The X90 control and I/O system for mobile equipment is now available with integrated safety technology. Intelligent safety functions and extremely short response times are the key to a whole new realm of possibilities for the safe operation of outdoor plants and mobile machinery. The control system meets the ISO 13849 mobile machinery requirements up to PL d as well as the ISO 25119 requirements up to AgPL d.

All 48 of the I/O channels on the X90 controller can be used where appropriate for safe or non-safe functions or combinations of the two. The housing on the controller is extremely robust and features IP69K protection.

Safe communication

With the bus-independent openSAFETY protocol, the safe X90 system offers the option of connecting decentralized safe I/Os or sensors. For this, B&R highly recommends using POWERLINK – the real-time capable industrial Ethernet. The communication corresponds to SIL 3 and is also secured via non-safe modems wirelessly.

Central safety software

B&R provides pre-certified software components for a variety of TÜV safety functions. The task of safety programming itself is thus reduced to simple configuration and linking of the safe software blocks via ladder diagram. The machine manufacturer only has to prove to TÜV that this work has been carried out in accordance with the guidelines for safe development. This reduces the complexity, workload and time required for certification. ←

Photo: B&R

Flexible condition monitoring made easy

Eliminate the need for rigid service intervals without risking production downtime – that is the goal of condition monitoring systems. Together with automation specialist B&R, Wittmann Battenfeld developed such a system for its injection molding machines. Their motivation for doing so is clear: purchasing decisions are no longer based on a machine's price tag alone, but on the total costs over its entire lifecycle.

Each year, Wittmann Battenfeld produces around 1,000 injection molding machines, 95 percent of which are exported all around the world.

Photo: Wittmann Battenfeld

Together, the two companies Wittmann and Wittmann Battenfeld form the Wittmann Group – one of the world's leading manufacturers of injection molding machines, robots and peripheral equipment for the plastics processing industry. They operate a total of eight production plants in five countries and are represented at an additional 34 locations in all major plastics markets worldwide. In the Lower Austrian town of Kottingbrunn, Wittmann Battenfeld builds injection molding machines with clamping forces ranging from 5 to 2,000 tons. Each year around 1,000 injection molding machines are produced there, 95 percent of which are exported to customers all around the world, primarily in the EU. The lion's share comes from the automotive industry (50 percent), medical production (15 percent) and the toy industry.

Automation specialist B&R is one of Wittmann Battenfeld's primary suppliers. The manufacturer has installed B&R machine controls in every injection molding machine built in the last 15 years. B&R's APROL software has been used for condition monitoring for almost three years now.

Intelligent condition monitoring for injection molders

Before switching to APROL solutions, Wittmann Battenfeld would check key sensors at scheduled intervals. Beyond continuing to use more and more sensors, what they also wanted was the ability to perform maintenance predictively. The goal was to use vibration sensing to identify potential machine and plant failures as early as possible – ideally before they even occur. Doing so would

substantially reduce maintenance costs and increase availability. The right solution was found at B&R. Not only do the I/O modules reliably detect potential maintenance issues, they are also easy to configure and compatible with any controller topology. Condition monitoring is based on vibration analysis performed locally on the modules. The results provide detailed insight into the system mechanics and allow efficiently targeted optimization of existing processes. The injection molding machine manufacturer relies on this feature to detect contamination, such as when water gets into the oil. Although invisible to the naked eye, this kind of contamination can result in a defective pump within weeks. With an oil sensor system evaluated via APROL, this is now a thing of the past.

New opportunities with B&R's condition monitoring system

"What has long been common practice for wind turbines and refineries was an absolute novelty for injection molding machines, and we were the first to present condition monitoring at the 2016 K trade fair," says Dietmar Schabauer, head of technical customer service at Wittmann Battenfeld. "The greatest advantages will certainly go to customers with larger machines," says Schabauer. "In their case, the cost of a CMS system is more easily outweighed by what is saved in prevented downtime."
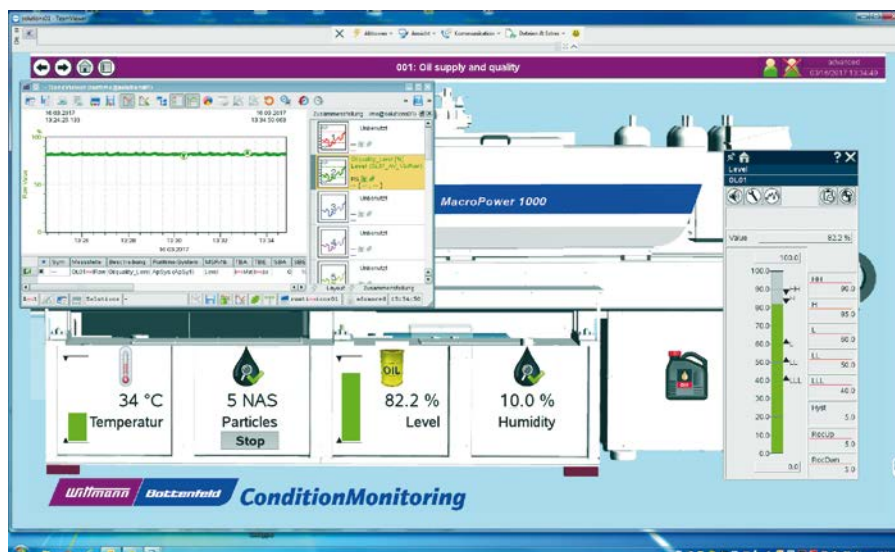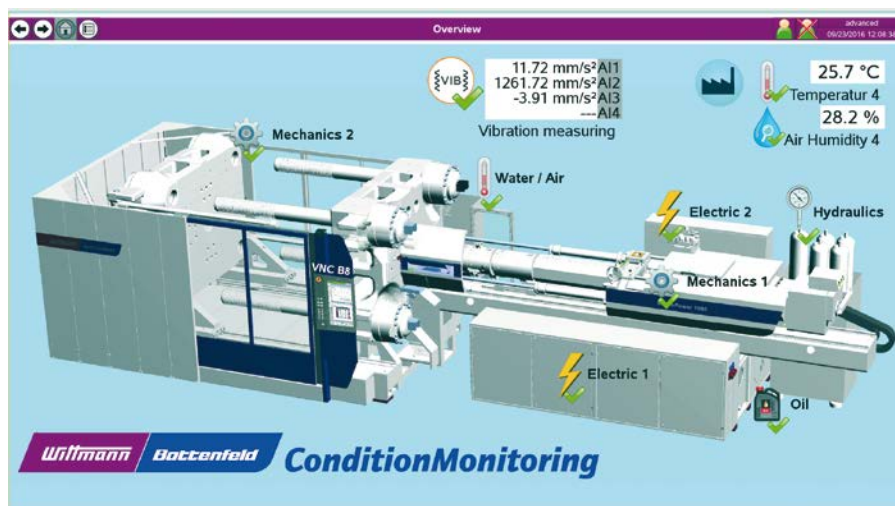
Project completion within a few months

Together with B&R, Wittmann Battenfeld was able to present a completed condition monitoring project within six months of the first meeting. "We had dedicated contacts at B&R and got active support throughout the entire project, including training. Since we were breaking new ground with this project, we were especially pleased that the cooperation with B&R worked so well," says Schabauer.

The rapid completion was made possible in part by the involvement of Wittmann Battenfeld's internal software development department. It was there that initial specifications were defined, such as which parameters were to be monitored, measured and evaluated. Developed in this way, the system is now continually updated and expanded to address new and changing customer requirements. "We wanted to monitor the oil and temperatures in the gearbox, for example, and to make some changes to the HMI. We wanted to view the sensor data for two machines side-by-side for direct comparison," says Schabauer. "At the same time, we made sure to stick to uniform standards to keep our long-term development costs sustainable."

APROL for targeted analysis of measurements

Condition monitoring takes place in a three-level process. The first level is the collection of measurement data. Depending on the type of data, appropriate sensors are installed at specific measuring points to transmit the actual values to the analysis systems. It is possible to evaluate vibration, torque, temperature, humidity, oil quality, flow rate or screw functionality, as well as all the data from the control cabinet. At the

B&R's condition monitoring solution reads and evaluates values such as vibration, torque, temperature, humidity, oil quality, flow rate and screw functionality, as well as all the data from the control cabinet.

second level, the collected data is analyzed and prepared. The heart of the CMS system is the evaluation unit, comprised of a CPU and a measuring module, which converts the measurements into analysis variables. The third level is where data evaluation and condition analysis are carried out.

It is currently possible to monitor and store around 80 different condition parameters for the machine. These values are stored on APROL servers for up to one year and can be retrieved and compared retrospectively – which is particularly helpful for service analytics. Until now, this system has been used by customers themselves as a stand-alone solution to monitor measured values on site. Wittmann Battenfeld's long-term goal, however, is to connect its machines to the Internet and send the recorded data to the customer via the cloud. This enables them to receive notification about various machine states, such as when oil needs to be changed or service is required.

CMS systems have become an integral part of the value chain

Condition monitoring has become an integral part of the value chain. Only systems that are able to transmit and analyze detailed data on wear and tear are able to forecast the remaining service life of plants, machinery and components.

"I worked as a service technician for ten years myself," recalls Schabauer. "In the past, you had to rely on your own senses and personal experience. Now every process is monitored digitally, and with much greater precision." Customers now also have the advantage that the machine's condition is monitored and evaluated automatically. If there are any changes in the measurements, they can be informed via email or text message. That way, they can carry out targeted maintenance without interrupting ongoing production.

Left to right: Robin Sasshofer (Technical Service Software IoT, Wittmann Battenfeld), Lucas Conditt (B&R) and Dietmar Schabauer (Head of Technical Service, Wittmann Battenfeld) in front of the MacroPower 1100, a compact, energy-saving machine from Wittmann Battenfeld's high-performance PowerSerie lineup.

It's all about lifecycle costs

"The prototype was extremely well received by the visitors at the 2016 K trade fair," Schabauer is pleased to report. "We were able to sell systems right from the start – before we had even defined a sales price."

This can clearly be attributed to a shift in focus among plant operators, who are thinking more than ever in terms of lifecycle costs. What matters is no longer just the purchase price of a machine, but all the costs that accumulate over its entire lifecycle. As a result, there is much more emphasis on keeping machines running consistently and efficiently. If the customer can be informed that maintenance will be needed in a few days, for example, they are able to incorporate that work into an already scheduled production changeover. ←

The dawn of a new standard

It was an unusual sight: At the 2018 SPS IPC Drives, representatives of all the major automation companies crowded the stage in the event center of the Nuremberg trade fair. Together, they made an announcement that will have a major impact on machine builders and operators: OPC UA over TSN will be the new, uniform standard for real-time Industrial IoT communication.

Photo: B&R

↓

The commitment to a common standard heralds a new era. An era in which machine builders and operators are no longer forced to struggle with a hodge-podge of communication protocols. Gone are the days when OEMs had to offer an array of machine variants to satisfy varying requirements for the control and bus systems.

A standard for the IoT

"A few years ago, it was becoming apparent that the Industrial Ethernet protocols were reaching their limits," explains Stefan Schönegger, vice president of strategy and innovations at B&R. In addition to bandwidth and cycle times, the requirements of the Industrial IoT have been the main driver of demand for a new technology. "We began thinking about what the next step in the evolution of industrial communication might look like," says Schönegger. "We spoke with our customers about their requirements, and it quickly became clear that, aside from the technical issues, there was also another major pain point: the heterogeneity of the protocols and the lack of a globally accepted standard."

JA

goes real time

At the 2018 SPS IPC Drives, representatives of all the major automation companies announced that they would be using OPC UA over TSN as the uniform standard for communication in the Industrial IoT.

"So, in September of 2016, B&R and network specialist TTTech invited interested automation and IT companies to talk about the establishment of such a standard based on OPC UA and the Ethernet extension TSN," recalls Schönegger. It was at this meeting that the OPC UA TSN initiative was founded. Its members would later become known as the "Shapers".

Seamless connectivity

The group's vision was to achieve open, interface-free communication from the sensor to the cloud – including the real-time capabilities needed for highly synchronized motion control. The goal was to offer increase performance by a factor of 18 compared to existing technologies.

From that point on, the Shapers grew steadily in number as they hashed out the technical details. "By 2018, many of the biggest names in automation technology had joined our initiative," reports Schönegger. "The industry has faith in OPC UA over TSN as a common standard and wants to actively shape the technology."

The role of the OPC Foundation

"As a group, the Shapers were just a loose coalition," notes Schönegger. "To set things up for the future, we wanted a more permanent home for OPC UA over TSN, and we finally found it in the OPC Foundation" To this end, a dedicated steering committee consisting of 22 industry heavyweights was set up within the organization for the new technology. In addition, three global players in automation were added to the board of the OPC Foundation: Schneider Electric, Rockwell and B&R's parent company ABB.

The first products

The fundamental specifications for OPC UA's publish-subscribe mechanism and the essential sub-standards for TSN have since been completed. These include IEEE802.1AS for time synchronization and IEEE802.1qbv for the guaranteed transmission times for data on the network. "Our efforts are now already focused on equipping our entire portfolio for OPC UA over TSN," explains Schönegger. A B&R bus controller with OPC UA over TSN is set to go into production, and controllers and drives will follow.

"In a few years' time, you won't find a new machine without OPC UA over TSN," Schönegger is confident. As the barriers of the hetero-

Stefan Schönegger
Product Strategy & Innovation, B&R

"The industry has faith in OPC UA over TSN as a common standard and wants to actively shape the technology."

The Shapers first unveiled their plans for a unified communication standard based on OPC UA and TSN at he 2016 SPS IPC Drives exhibition.

B&R presented the first bus controller with OPC UA over TSN at the 2018 SPS IPC Drives exhibition.

geneous protocol landscape fall, machine builders and operators will have a much easier time implementing connected manufacturing systems and Industrial IoT solutions. Schönegger expects the transition phase to go smoothly. "Companion specifications such as those between POWERLINK and OPC UA," he notes, "make it easy to integrate existing machines and systems into new networks." ←

OPC UA over TSN – How it all began

September 2016: Foundation of the OPC UA TSN initiative at the invitation of network specialist TTTech and automation specialist B&R. The companies involved would later became known as the "Shapers".

April 2017: Belden/Hirschmann and Phoenix Contact join the Shapers.

November 2017: Pilz, Hilscher and Wago join the Shapers.

April 2018: Rockwell Automation announces it has joined the Shapers.

November 2018: The OPC Foundation announces its expansion into field-level communication with OPC UA over TSN.

November 2018: ABB, Schneider and Rockwell join the board of the OPC Foundation.

November 2018: Presentation of the steering committee for OPC UA over TSN at the field level: ABB, Beckhoff, Bosch-Rexroth, B&R, Cisco, Hilscher, Hirschmann, Huawei, Intel, Kalycito, KUKA, Mitsubishi Electric, Molex, Omron, Phoenix Contact, Pilz, Rockwell Automation, Schneider Electric, Siemens, TTTech, Wago and Yokogawa.

November 2018: The first functional devices with OPC UA TSN are presented at the SPS IPC Drives exhibition.

Flexible picking systems for e-commerce

Vertical storage lifts from Weland Solutions help producers manage more stock in less space with greater speed, precision, safety and reliability. As Weland customers adapt to the e-commerce boom, they need picking systems with increased flexibility and scalability. To meet these needs, Weland equipped its new generation of vertical storage lifts with a full control solution from B&R – including a completely revamped HMI solution based on B&R mapp View, with web-based operation and an intuitive, smartphone-like interface.

Photo: Weland
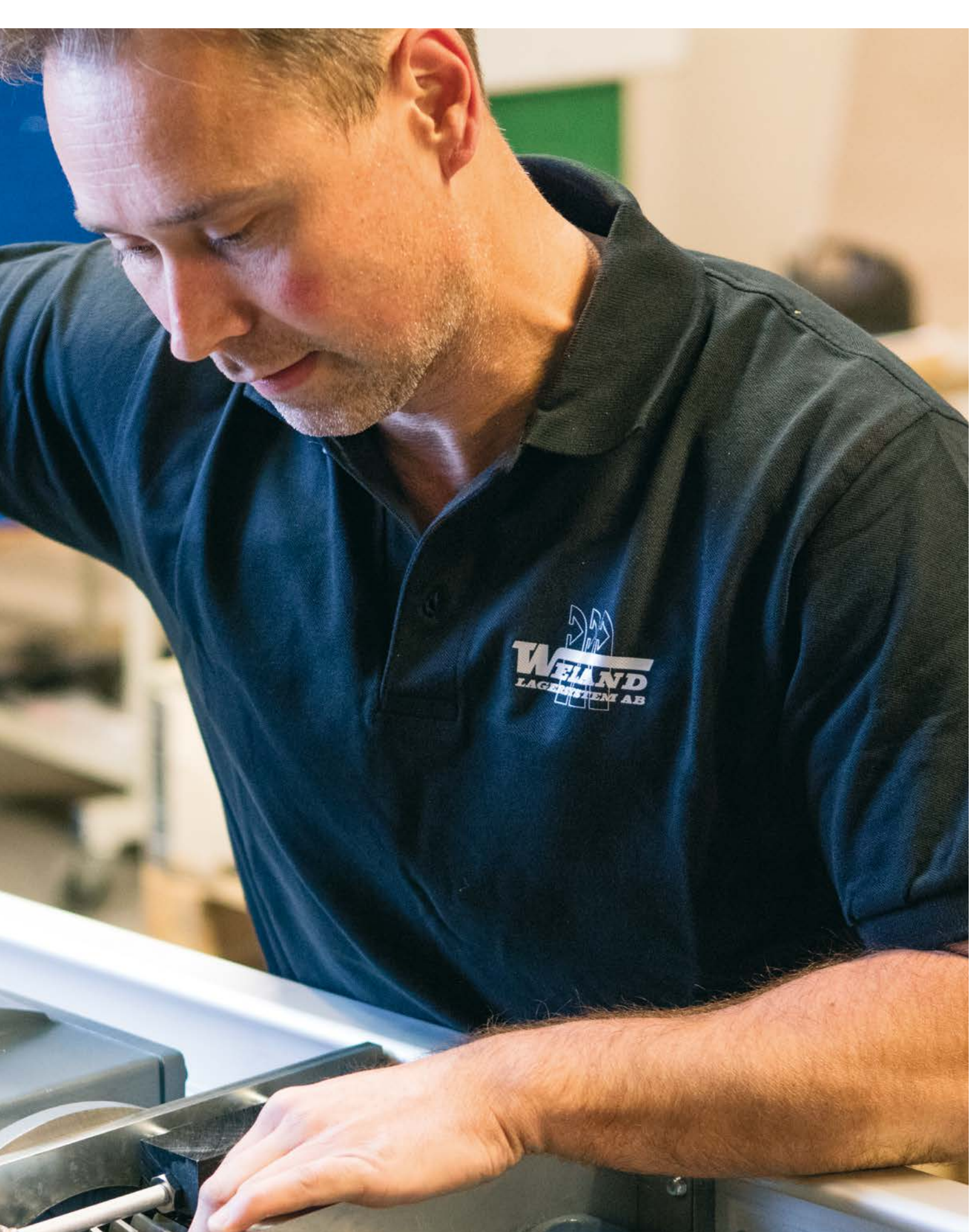
The new generation of vertical picking systems has a complete B&R control system, including a web-based HMI solution based on mapp View.

↓

In the southern Swedish town of Gislaved, Weland Solutions builds and customizes vertical storage lifts that help customers from Singapore to Brazil manage their warehouses more efficiently. Conducting a tour through his production hall, product manager Per Larsson stops to point out the Compact Twin model, whose dual trays can more than double the picking rate - to a capacity of 1200 order lines per hour.

E-commerce demands flexibility

Larsson explains how Weland adapts each lift to the customer's needs, including the size of the premises and ceiling height as well as the number, size and weight of goods to be stored. Vertical storage lifts save a considerable amount of floor space while providing faster, more precise order picking. Thus began a generational shift in the company's portfolio – aimed at increasing performance, flexibility and scalability. With an entire solution designed to be modular from the ground up, it would be essential that the solution allow hardware to be chosen, connected and swapped out freely. Over a decade of partnership with B&R has helped Weland maintain its pace of 15% annual growth and an impressive ability to customize, produce and deliver a custom lift in only four weeks. Little surprise, then, that the company turned to B&R for a complete package of control hardware for its new design, including PLC, I/O and motion control technology. System communication is handled via POWERLINK.

Generational shift

E-commerce requires producers to take a much more consumer-oriented approach to stock handling. Weland saw that serving these customers would require lift systems to be more modular and flexible than ever, with control hardware able to scale along with the rest of the system. Thus began a generational shift in the company's portfolio – aimed at increasing performance, flexibility and scalability. With an entire solution designed to be modular from the ground up, it would be essential that the solution allow hardware to be chosen, connected and swapped out freely. Over a decade of partnership with B&R has helped Weland maintain its pace of 15% annual growth and an impressive ability to customize, produce and deliver a custom lift in only four weeks. Little surprise, then, that the company turned to B&R for a complete package of control hardware for its new design, including PLC, I/O and motion control technology. System communication is handled via POWERLINK.

Scalable web-based HMI

To accompany its new generation of vertical storage lifts, Weland also planned to completely revamp its HMI solution. Requirements for this part of the project were an open architecture and web-

Photos: Weland

Per Larsson
Product manager, Weland AB

"The straightforward, swift channels into the B&R support organization have been particularly valuable. That a big company like B&R can act with true local presence in Sweden bodes well for a long future together."
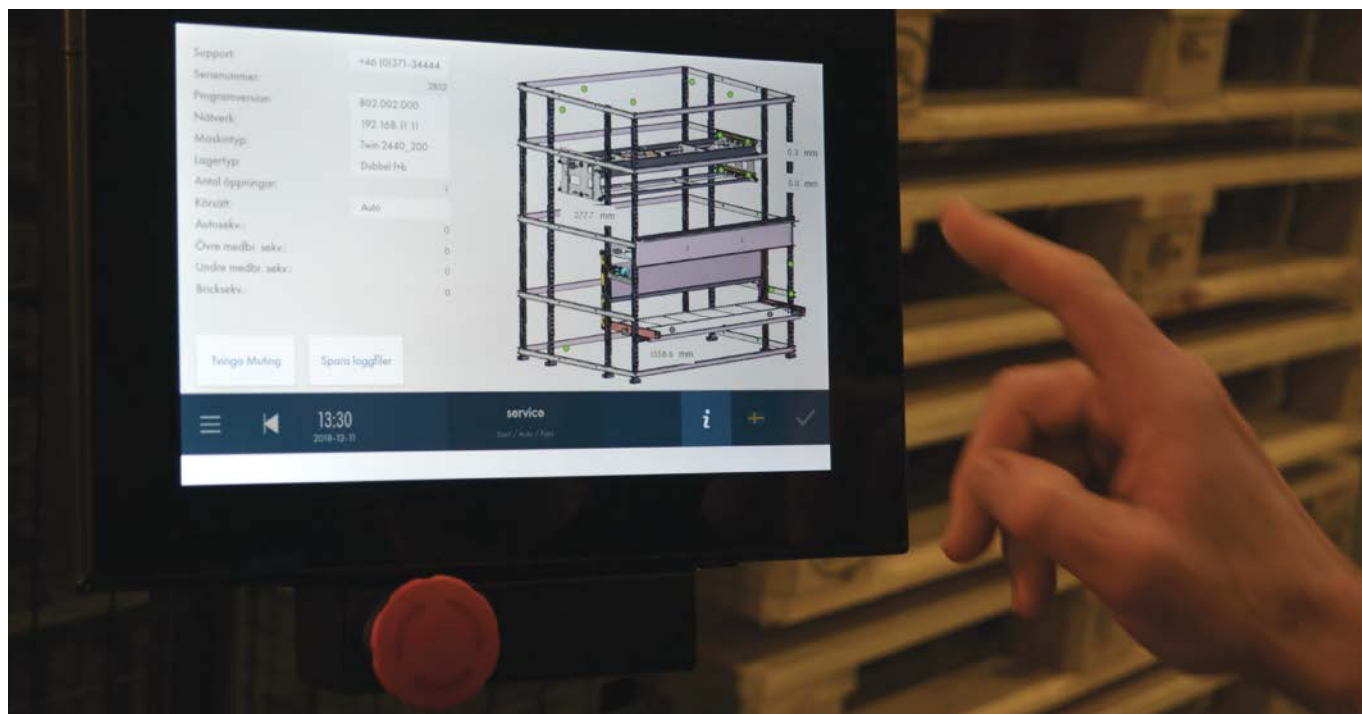
The new generation of storage lifts offers a completely revamped HMI experience.

based operation, including the ability to view the HMI application on a variety of devices. The user interface would need a clean, modern design to make operation intuitive and enjoyable. These requirements lined up nicely with B&R's web-based HMI solution, mapp View. By encapsulating powerful web standards like HTML5, CSS3 and JavaScript into convenient drag-and-drop widgets, mapp View made it easy for Weland to create a modern, web-enabled HMI application. With the intuitive user guidance of a smartphone, the HMI application can be viewed on displays of any size. It is possible to connect multiple clients and shift workload between them. Operators enjoy helpful features such as ready access to PDF documentation and instruction videos. "We now have a control panel that feels like a modern website or smartphone app. The new widgets allow for smoother control and the HMI has a uniform graphic design featuring our corporate identity," says Larsson.

The partnership goes on

The result of this development project is a new generation of storage lifts with increased functionality. According to Larsson, the ma-

jor advantage lies in added flexibility, with B&R's approach making it simple to swap out anything from a motor to a display. Weland particularly values B&R's ability to back up innovative technology with accessible technical support. "The straightforward, swift channels into the B&R support organization have been particularly valuable," says Larsson. "That a big company like B&R can act with true local presence in Sweden bodes well for a long future together."

An off-the-shelf future

Larsson anticipates a future where industrial machinery relies more on standard off-the-shelf hardware and software. "The world of industrial manufacturing needs to catch up with the agility and ease of the smartphone world," he says. "Stable operation is crucial, but standard technology could be more integrated in industrial applications, and B&R is doing a great job leading the way in this direction." He also looks forward to exciting new possibilities. "I imagine a future where I can check the production status on my smartphone when I arrive at work in the morning, or where operators are automatically logged in when in the vicinity of the lift." ←

Smart pharma

The digital transformation is impacting every industry, and pharmaceuticals are no exception. With some of the most stringent quality regulations to follow, the pharmaceutical industry faces unique challenges for which smart manufacturing offers promising solutions. When the starting point is a brownfield site with aging infrastructure and digitally isolated legacy systems, implementing the necessary connectivity can be a major hurdle. With its Orange Box solution, B&R offers an easily manageable way to get brownfield sites connected and ready for the digital future.

B&R's Orange Box enables machine operators to collect and analyze data from previously isolated machines and lines and get them fit for the smart factory.

Photo: B&R
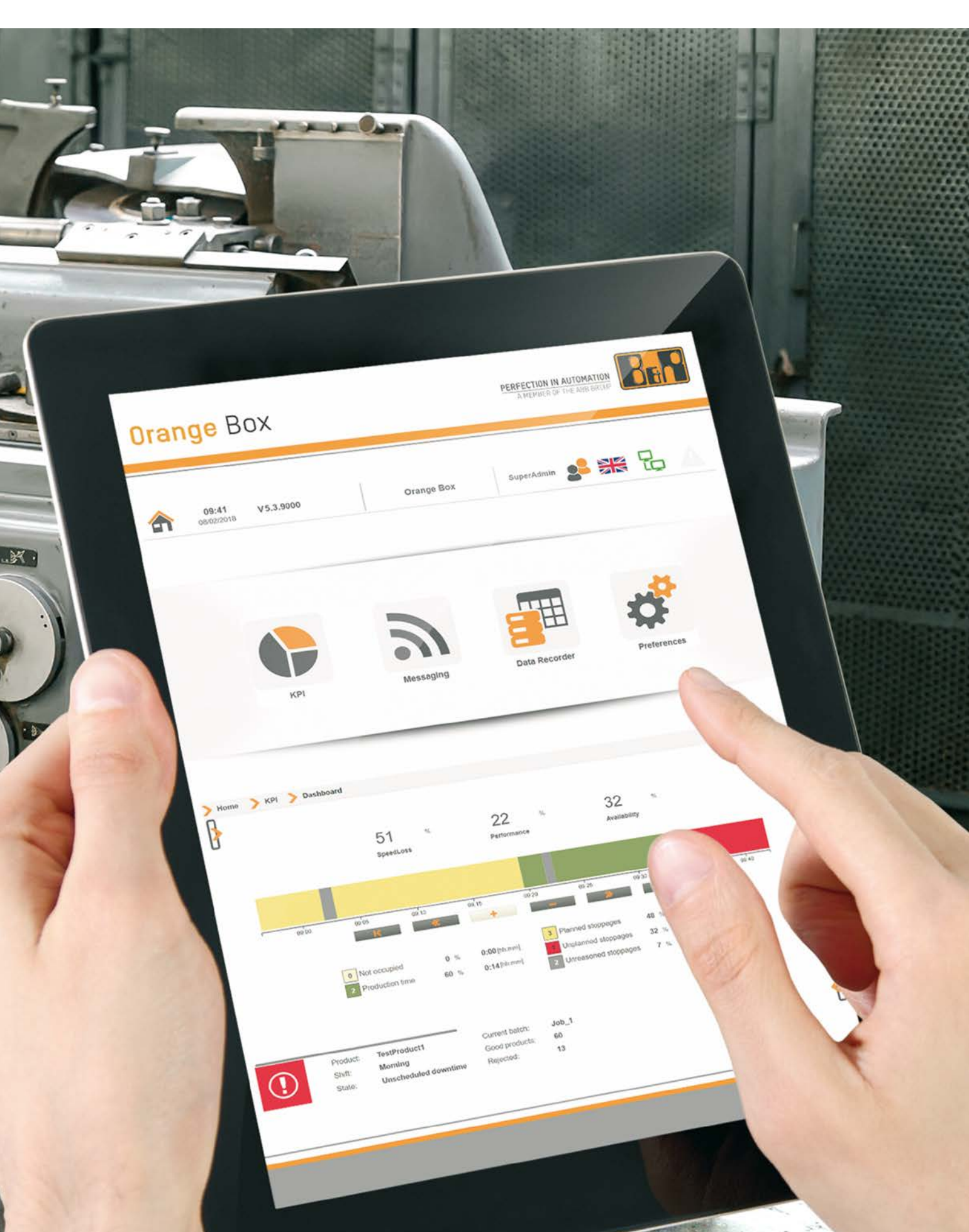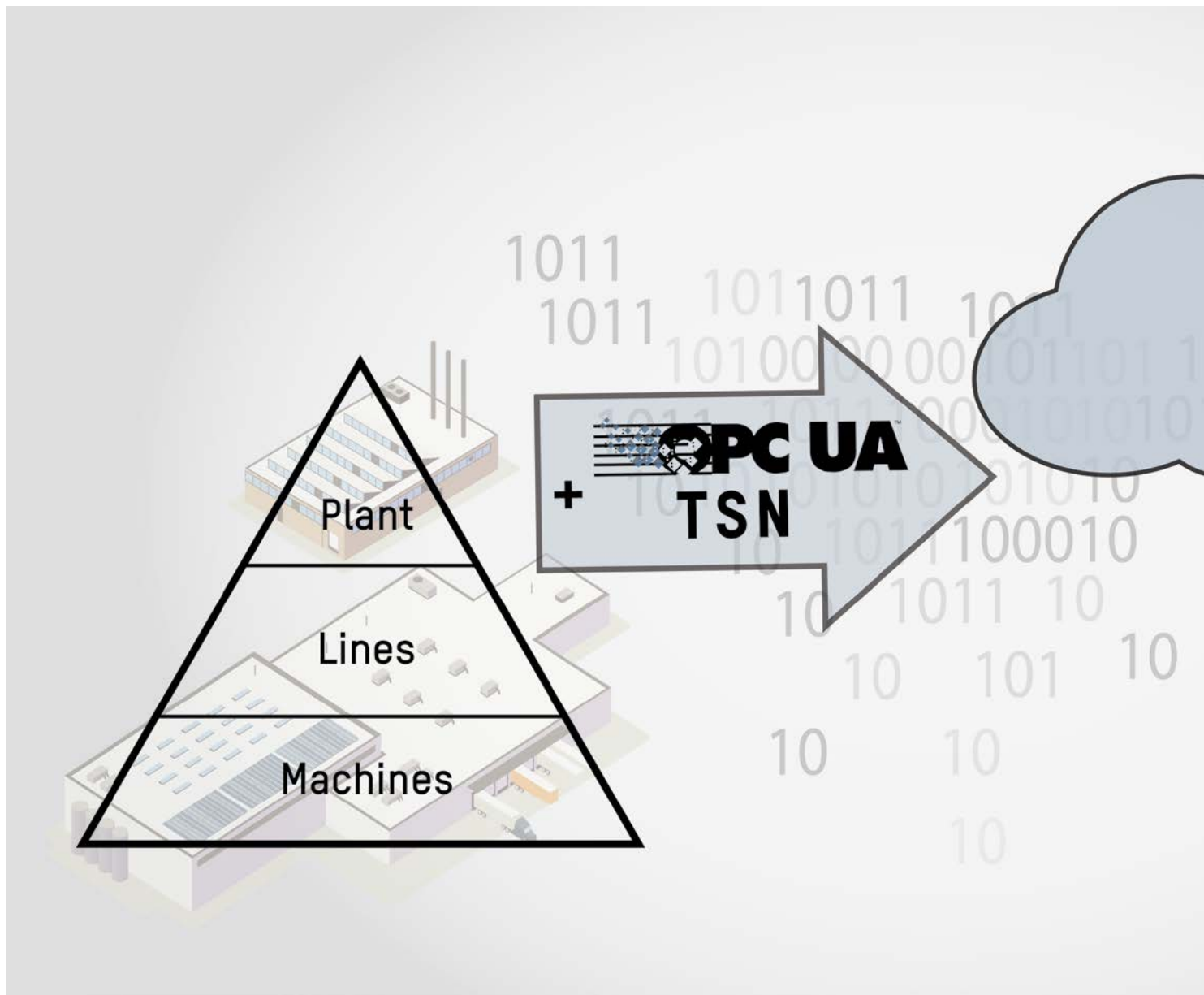
OPC UA over TSN enables seamless communication from individual sensors and actuators up to ERP/MES systems or the cloud.

↓

With the arrival of Industry 4.0 in the pharmaceutical industry, traditionally human-driven processes are becoming increasingly digitized and automated. The data that is generated allows for faster and better-informed decisions. It allows problems to be predicted and corrected before they result in costly downtime or faulty products that could damage the manufacturer's reputation. Digitalized, fully integrated operations are more adaptive and responsive. They allow better utilization of raw materials, and increase both productivity and quality. Yet even with the many benefits these advancements offer pharmaceutical manufacturers, they also come with their share of new challenges. Among the most common concerns is the unknown cost of upgrading legacy equipment. For many factories with isolated islands of automation, a further challenge is how to achieve seamless communication both

machine-to-machine and machine-to-cloud. And even with a shop floor that is connected both horizontally and vertically, the next challenge is how to process and secure the flood of new data that is generated. Pharmaceutical companies need innovative ways to mitigate these risks as they take steps to leverage the benefits of the latest technology trends.

Retrofitting brownfield plants
Implementing smart manufacturing practices can seem an insurmountable challenge for brownfield plants with decades-old infrastructure. The time and cost involved in upgrading legacy systems, machines, devices and sensors acts as a major barrier to adoption of new technology. One specific challenge is how to collect plant-floor data and share it with higher-level control and IT

Photo: B&R

Industrial IoT

MQTT communication. As simple and intuitive to use as a smartphone, the Orange Box can be installed without any changes to existing hardware or software. Equipment owners can achieve a substantial boost in productivity with a remarkably small investment in time and cost. The advanced energy management function allows energy consumption to be measured directly on the machine and observed intuitively on the HMI screen. At a glance, operators can see the energy consumption of individual devices or machines, or get an overview of the entire factory.

Secure data connectivity with OPC UA

As their shop floors become increasingly connected, organizations face a whole new set of security challenges. Pharmaceutical companies have highly sensitive intellectual property in the form of drug formulations and processing know-how that could be extremely damaging if compromised. The OPC UA protocol offers platform and vendor-independent communication with built-in security mechanisms that make it the ideal solution to the cybersecurity challenge. With the recent addition of Time-Sensitive Networking (TSN), it now offers secure, seamless, standardized communication all the way from individual sensors and real-time control systems up to ERP systems and the cloud.

A smart future

Despite its natural aversion to risk, the pharmaceuticals industry has slowly but steadily embraced its digital transformation. With the Orange Box and OPC US over TSN, B&R is helping to remove the remaining hurdles and give brownfield plants the connectivity and data analytics they need to benefit from the unprecedented productivity and profitability of smart manufacturing.

Operational excellence with collaborative robots

On the production floor, robots help eliminate human error, increase accuracy and reproducibility, and remove the potential for human contamination. In the laboratories used to develop and test new drugs, they are perfect for performing repetitive, unskilled tasks such as blending, stirring and titration, allowing scientists to make better use of their education and know-how. B&R's openROBOTICS seamlessly integrates robots into the machine control system. New software features make it easier than ever for machine builders to synchronize robots with track-based transport systems and other dynamic machine components. Completely uniform programming for every component in the line has benefits from development and operation to diagnostics and maintenance. Together with B&R's SafeROBOTICS software package, human operators can work safely shoulder-to-shoulder with robots without the restrictions of safety cages. ←

systems. As a way to allow brownfield plants to start enjoying the benefits of smart manufacturing with minimal capital investment and little modification, B&R developed the Orange Box. With it, users can easily access energy consumption and operating data from previously isolated machines and lines, making them Industrial IoT ready with minimal effort. An Orange Box can substantially reduce downtime and boost the availability of existing machines and lines, making operations more productive and profitable. Each Orange Box consists of a controller and preconfigured software components. The controller is able to collect operating data from any machine via its I/O channels or a fieldbus connection. With this data, the software modules generate and display overall equipment effectiveness (OEE) and other KPIs, and can share this information with higher-level systems using open source OPC UA or

Controller and multi-touch HMI in one device

To allow optimal use of this performance, the Power Panel C50 has a wide range of integrated interfaces, including POWERLINK, Ethernet and USB.

B&R's new Power Panel offers a dedicated processor for HMI

The Power Panel C50 provides the combined advantages of a powerful controller and a modern projected capacitive touch screen in a single HMI device. The Power Panel is equipped with a dedicated processor for the HMI application, and is therefore an optimal solution for mapp View HMI applications. It can be used at temperatures ranging from -20°C to +60°C and does not require a fan.

The modern multi-touch HMI is available with clear or anti-reflective glass, and is ideally suited for premium machine designs. The touch screen reacts precisely and reliably even when operated with thick leather gloves. Gestures such as zoom or swipe provide an intuitive user experience. The Power Panel C50 is available in widescreen format in four different sizes from 7.0" to 15.6".

Compact and maintenance-free

This Power Panel has an extremely compact design, minimal installation depth and an intelligent cable outlet arrangement, making it an easy-to-mount space saver. With no hard disks, fans or batteries, it is also maintenance free. The front of the panel provides IP65 protection, making it extremely well-suited for harsh industrial environments.

Numerous interfaces

To allow optimal use of this performance, the Power Panel C50 has a wide range of integrated interfaces, including POWERLINK, Ethernet and USB. I/O modules, axes and safety components can also be connected directly to the panel. There's no need for additional controllers.

Using the advantages of mapp View

The high-performance Power Panel C50 is ideal for running mapp View HMI applications. With the mapp View software package, B&R offers direct access to the wide world of web technology right from the engineering environment. Automation engineers have all the tools they need to create powerful and intuitive HMI solutions. There is no need to deal directly with HTML5, CSS and JavaScript technology. mapp View is based entirely on web standards, ensuring optimal viewing on any device. Content of multiple screens can be customized for specific users or user groups. ←

Photo: B&R

Integrated automation
Global presence
Solid partnership

ETHERNET **POWERLINK**

open **SAFETY**