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A KUKA customer journey into the world of Industrie 4.0

Augsburg/Hannover, April 2016 - Surprising, fascinating, forward-looking: At Hannover Messe 2016 KUKA is showcasing the possibilities of digitization in production. Visitors can delve into the world of Industrie 4.0 at three stations: Smart Factory, Digital Insights and Advanced Robotics.

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Smart Factory – KUKA demonstrates Industry 4.0

In its “Smart Factory” application at Hannover Messe, KUKA is demonstrating the networking of production components in versatile and modern concepts. Here, KUKA interconnects its own products designed for Industry 4.0 to create a perfect example of a modern production concept.

Trade fair visitors can have an individual protective cover made for their smartphone in the Smart Factory. Once they have used the tablet to send their order to Swisslog’s Warehouse Manager WM 6 software, production of their smartphone cover begins directly at the trade fair booth. The entire production process is controlled via WM 6.

If the protective cover is not already available in the production stock, the order placed using the tablet is converted by the system controller



into a start signal for the KMR iiwa – a KUKA lightweight robot LBR iiwa in kinematic combination with an omnidirectional mobile platform that navigates autonomously. The mobile robot system moves autonomously as it navigates within the production environment, first of all from the start position to the warehouse area. This is where the Swisslog CycloneCarrier is located.

The warehouse shuttle system, an innovative and high-performance product for case and carton storage, forms one rack level of a warehouse and delivers cases according to the online orders received from the WM 6 system. For this purpose, the CycloneCarrier moves to the correct rack position and accepts the ordered case. This is then brought directly to the transfer point, which is located in a mobile rack. The mobile rack is autonomously presented and collected using KUKA's omnidirectional mobile platform KMP 400.

The KMR iiwa removes the smartphone cover to be processed from the rack that has been delivered, finding the correct position in the rack every time thanks to a navigation software and relative positioning. If multiple orders are pending, several covers can be produced in one cycle. To increase the throughput, these covers are temporarily stored on the KMR iiwa. The sensitive KMR iiwa then autonomously navigates to a laser engraving printer and hands over the cover to this printer. Following the printing operation, the lightweight robot removes the smartphone cover and transfers it to the pickup station. As soon as the cover arrives at the station, a notification of completion is sent directly to the trade fair visitors via WM 6.

Visitors can then collect their personalized trade fair gift. By scanning a QR code sent to the cell phone when the order is placed, visitors can see where their personalized cover is at any time. Once the personalized cover has been completed, visitors can use the same QR code to request the LBR iiwa to hand it over to them. From time to time, a KUKA small robot of the KR AGILUS type additionally



carries out a quality inspection of the covers via a vision system. Using a smartphone, the operator can, at any time, observe this small robot via asset management in the KUKA Cloud, retrieve general information, obtain a diagnosis of problems or contact KUKA Service directly. Through Warehouse Manager WM 6, all Smart Factory components are capable of communicating with one another and sharing the respective order status.

Digital Insights

The entire KUKA world on a single screen – and interactive down to the smallest robot screw. That is the ‘Digital Insights’ attraction at the KUKA booth at Hannover Messe. Here, visitors and customers can experience real example scenarios, such as how Cloud computing and networking simplify asset management in a modern factory and thus help minimize downtimes and service costs.

The global KUKA network is displayed on a LED wall, and there is also a digital replication of the Smart Factory at the KUKA booth with all networked devices. The entire modern infrastructure can be viewed on the monitor, and a few clicks pull information on to the screen about every individual component. What is showcased here using the example of the KUKA Smart Factory can become an everyday reality in the factory of the future:

All assets on the KUKA booth are connected to the Cloud via the Nebbiolo box. This is how KUKA is showing how simple it is to network robots and machines, and to connect them to the Cloud. The Nebbiolo box thus forms the basis for collecting and processing large volumes of data in the context of Big Data. Digital Insights visualizes asset management; visitors can also experience live demonstrations on this topic in the field of quality control.

Thanks to networking, customers can centrally monitor all of their devices. They immediately see which systems are where and which tasks specific robots are



currently carrying out. It is also possible to receive a complete overview – from operating times to scheduled maintenance – with just a few clicks. In this way, companies can easily check if, for example, the software of all robots is at the same level or if a robot can be reused at another plant.

In the event of a malfunction in the production process, the error message is immediately sent to the Cloud with all of the details and a repair order is automatically sent to the service technicians responsible. Thanks to the comprehensive data, the technicians immediately receive a precise description of the error. All malfunctions and downtimes are stored in a knowledge database in the Cloud. This enables technicians to react immediately without time-consuming searches and queries, to quickly locate the cause of the error and to start the necessary intervention.

If a spare part should be needed, it can be ordered with a single click. The serial number of every component is visible and provided with a direct link to the relevant online shop. That minimizes downtimes and service times, therefore saving costs. An example scenario of this ‘condition monitoring’ is being demonstrated at Hannover Messe on the basis of the Smart Factory. Software updates too can be performed quickly and easily. The update status of every robot and every system component is shown in the Smart Factory. If updates are necessary, a click is sufficient to bring the robot up to date. The software is immediately available for download and installation.

All data are saved in the Cloud rather than on a server. This saves daily overhead costs and IT resources while also enabling access from anywhere in the world whenever information is needed. Implementation of this application is not limited to new products and solutions. It is also possible for robots, cells and systems that are already in operation to be networked. This is how the factory of the future is already becoming a reality today.



Body shop 4.0: flexible, versatile and networked

Visitors to the KUKA booth at Hannover Messe will also have a look at the future through a virtual reality headset: with the virtual tour through the matrix body shop, the Augsburg-based company is showcasing how Industry 4.0 can be implemented in the automotive industry.

The concept for the matrix body shop is characterized by configurable basic cells, the transfer of parts using Automated Guided Vehicles (AGVs) and the separation of logistics from production. The advantages: production is flexible, versatile and networked. This allows for shorter product cycles and a differentiated product portfolio as well as for keeping pace with the changing manufacturing processes in industry.

The underlying idea of the concept is founded on standardized basic cells equipped with universal equipment as well as universal basic functions and arranged in a matrix structure. Inside the cells, there are either turntables for the setdown of parts, or tools and robots which perform the relevant process. These basic cells can then be expanded with dedicated equipment to suit customer needs. Welding, gluing, punching, brazing and clinching: any process can be integrated into the system. Workpieces and tools are transported by AGVs, which navigate to the individual cells using a navigation algorithm. The workpieces are stored in the warehouse. The dedicated tools, on the other hand, are located in the tool store. The autonomously navigating AGVs can transport the workpieces using individually configurable load handling attachments.

New processes can be easily integrated with the aid of the retoolable basic cells. Quantities are scalable. Standardized test cells shorten commissioning time, and interface standards make maintenance easier. Beyond this, our integrated digital value creation chain enables new products to be introduced into the manufactur-



ing cells without disrupting production. Through the matrix concept and the consistent use of digital planning and design methods, KUKA Systems is demonstrating that the Augsburg-based company is ready for Industry 4.0. At the trade fair, visitors can put on a virtual reality headset to view a 3D simulation of the system.

KR 3 AGILUS

With the KR 3 AGILUS, KUKA is providing a preview of the newest member of the small robot family. This robot also boasts extremely high speed and precision, but it is even more compact and thus an ideal solution for small cell concepts such as those required in the 3C market (computers, communications and consumer electronics). In compact cells measuring just 600 x 600 mm, the KR 3 AGILUS is able to carry out a wide variety of tasks – from soldering to assembly, handling and inspection and on to packaging or palletizing. With a payload capacity of 3 kg and a reach of 540 mm, it is ideally suited for meeting the needs of diverse sectors, particularly one of the largest and fastest-growing markets for automation: the electronics industry.

Safe human-robot collaboration with KR AGILUS Cobotics Concept

Following the LBR iiwa, KUKA is now showcasing HRC implementation on the basis of its industrial robot portfolio at Hannover Messe 2016, taking the KR AGILUS Cobotics Concept (CC) as an example. For this, KUKA has equipped the KR AGILUS series with a force/torque sensor in the robot base as part of a concept study. This enables the KR AGILUS CC to detect collisions with humans and perform sensitive tasks. For the purpose of collision detection, the sensor continuously measures the acting forces and torques. In the event of a collision, the difference between the setpoint and actual values is detected and the robot immediately stops the action.

But that is not all: thanks to its unrestricted manual guidance capability, the KR AGILUS CC can be optimally used for teach processes. This is made possible by



the position and load-specific calculation of the motor currents, which keep the robot balanced in space. If a new force acts on the robot in its state of equilibrium – for example, through manual guidance – the KR AGILUS CC supports this as a motion. The small robot on display will allow trade fair visitors to get an insight into the technology as well as to experience at first hand the advantages of combining the extreme speed and precision of an industrial robot with the HRC functionality. The trade fair application allows the visitor to carry out a teach process by manually guiding the KR AGILUS CC in HRC mode. The robot then executes the application at production velocity in automatic mode within the enclosed area.

Process-oriented, consistent, simple – KUKA Graphics-based programming

Humans and robots working hand in hand: with the KUKA LBR iiwa, a “robotic colleague” that can be deployed universally is already a reality. At Hannover Messe 2016, any trade fair visitor will now easily be able to graphically program the LBR iiwa – even without programming skills. The users decide which program they would like to execute with the lightweight robot. They do this by selecting pre-programmed blocks from the application toolboxes in the KUKA Sunrise.Workbench engineering suite. In this manner, users can quickly create their individual robot application in just a few steps. The robot program is then transferred to the controller. Users subsequently have the opportunity, as usual, to intuitively teach the target points by simple demonstration and to optimize the parameters of the blocks.

Immediately afterwards, the LBR iiwa executes the application as desired by the users. The application toolboxes, consisting of pre-programmed blocks and smart object templates, are suitable for implementing the simplest of handling applications as well as complex assembly tasks in HRC mode. There are no limits on the types of robot applications that can be implemented. Graphics-based programming from KUKA will be available in conjunction with the KUKA Sunrise.OS robot operating system. As an example, the use of graphics-based programming will

also be demonstrated on the KR AGILUS CC. The visitor can follow the structured program sequence of the application on the display.

Coffee 4.0: KR AGILUS as a barista

No matter whether with milk and sugar or unsweetened and strong – coffee at KUKA is ordered via the Cloud and served by robot.

The Internet of Things is fast approaching, and with the coffee application, KUKA is showing visitors at Hannover Messe what this might look like, illustrated by the simple example of coffee production. In a real production environment, this could involve any imaginable manufacturing process. Instead of grinding and brewing, technologies such as welding, adhesive bonding, casting or laser cutting would be employed.

When initially placing the order, each customer receives a cup with a QR code which is thus linked to its virtual twin in the Cloud. If customers scan this code, they can enter their milk and sugar preferences on their smartphone. It is also possible for them to enter their e-mail address in order to receive status updates concerning their cup – just like monitoring the processes in their industrial production systems. The system itself consists of two KR AGILUS robots with a KRC ROBOTstar controller, each of which operates one coffee machine.

The robots also help each other, passing on cups to avoid bottlenecks. And this is how it works: the robots first scan the QR code on the cup. Thanks to the link to the cup's virtual twin in the Cloud, the robot now knows the cup's status and can, depending on the coffee that has been ordered and the system status, fill the cup or pass it on. For this, the robot communicates with the intelligent coffee machine.

The cup status is updated in the Cloud and enhanced with additional information concerning the status of the coffee machine and the process parameters for



preparation, such as the order data, coffee and milk temperature, fill level of the system, consumption data, etc. These data can then be retrieved at any time by scanning the cup's unique QR code with the mobile end device. In the same manner, this would be possible for any component in an industrial production environment – safety-relevant components in the automotive industry, for example, can be fully traced via their serial number, barcode or similar. Once the hot beverage is ready for collection, customers are informed via a monitor. At the same time, they receive a notification directly on their smartphone.

A tracking function enables customers to keep an eye on their order throughout the entire process, at the end of which a real image of the coffee cup is displayed on the screen with the key production data. Operators in an industrial application can similarly monitor the component. For example, they could observe the effect of changes in production settings, enabling them to intervene at an early stage if necessary.

All the data required for this are stored in the Cloud. The benefits are obvious: system data can be called up from anywhere on a mobile device and material flows can be optimized and forecast. Maintenance requirements can be predicted and the service team can be sent an e-mail reminder of any maintenance due.

The Paulii Brothers – Two LBR iiwa robots jointly perfect the art of pouring a wheat beer

Two robots as bartenders: the Paulii Brothers support service personnel at Hannover Messe and perfect the art of pouring a wheat beer with an ideal head. Last year, an LBR iiwa, dubbed “Beer Paulii”, began pouring wheat beer for trade fair visitors and achieved international renown.

As a duo, the pair of sensitive robots are not only faster, but also stronger. They take the full beverage crate from service personnel without any difficulty and lift



it into the refrigerator. This frees their human colleagues from physically strenuous tasks. Despite their power, the lightweight robots can work safely with humans since they are equipped with intelligent safety technologies. They can grip a glass without breaking it, detect whether it is full or empty, and open bottles by applying just the right amount of force.

With the Paulii Brothers, KUKA is providing an example of what the direct collaboration of humans and intelligent robots looks like in the factory of the future.



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KUKA Aktiengesellschaft

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