ProduktionNRW
Cluster Maschinenbau/Produktionstechnik

Innovations Made in NRW
Opportunities of Digitalisation

VDMA

Content

A Vision for North Rhine-Westphalia

Prof Dr Andreas Pinkwart
Minister of Economic Affairs,
Innovation, Digitalisation
and Energy of
North Rhine-Westphalia

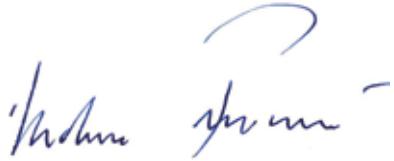
Dear readers,

The state of North Rhine-Westphalia (NRW) is one of Europe's leading industrial regions. Industrial productivity and innovation is the foundation for our prosperity, and enables us to tackle the economic, environmental and social challenges that we face. The mechanical engineering sector of the NRW economy is a strong motor of the industrial landscape. A total of approximately 200,000 people are employed in around 1,600 businesses, generating a combined turnover of more than 42 billion euro. The mechanical engineering sector in NRW is a by-word for innovative technologies, reliability and efficiency.

For the mechanical engineering sector, digitalisation is a key to remaining competitive into the future. And by incorporating digital solutions in its products and processes, and through the solutions it develops, the sector also drives digitalisation in the operations of its customers. Mechanical engineering businesses are pioneers in digitalisation in the fields of many industries and aspects of life.

For us as state government, digitalisation is right at the top of our agenda: North Rhine-Westphalia intends to be a leading supplier and a lead market for future-capable and reliable Industrie 4.0 solutions, and for business models for the digital economy. We aim to use the digital transition to maintain the advantages of North Rhine-Westphalia as an industrial location, and indeed further enhance them. This is the reason for initiatives such as our "empowerment offensive", to create a framework structure that individual businesses can slot into with initiatives on the ground. With our competence centers and hubs, we also provide a wealth of contact points for SMEs for specific advice and information on digitalisation, networking and connectivity.

The publication series of "Innovations Made in NRW" issued by the ProduktionNRW state cluster is designed to highlight specific innovations and success stories, to show businesses some of the options available for advancing digitalisation across a wide range of economic sectors.



Yours,
Prof Dr Andreas Pinkwart

Leveraging the Potential for Networking

Wolf D. Meier-Scheuven
Cluster Spokesman
ProduktionNRW

Dear readers,

North Rhine-Westphalia's mechanical engineering sector is the biggest industrial employer in our land, and it occupies a key position. It not only is a user of modern technologies, but acts as an enabler for the whole economy. Its purpose is to find solutions for the problems of our times – issues such as urbanisation, mobility, climate protection and food. Innovations in mechanical and plant engineering ensure greater productivity and prosperity world-wide. The success of mechanical engineering in North Rhine-Westphalia is based on its strength in networking with suppliers, producers and customers at the right junctures, and making sensible use of shared resources and synergies.

To support small and medium-sized businesses in mechanical and plant engineering on their journey into the future, the Cluster ProduktionNRW is bringing out the forthcoming information series 'Innovations made in NRW'. The information series, tackling issues that affect our industry, will be published quarterly in German and English.

You hold in your hands the first issue, which focuses on digitalisation. Using selected best practice examples from throughout North Rhine-Westphalia, the magazine shows how innovations can succeed in Industrie 4.0. The practical examples show not only how it's done, but that it can be done! Following a phase of getting our bearings, we're now starting the phase of identifying innovative potentials and implementing them in business.

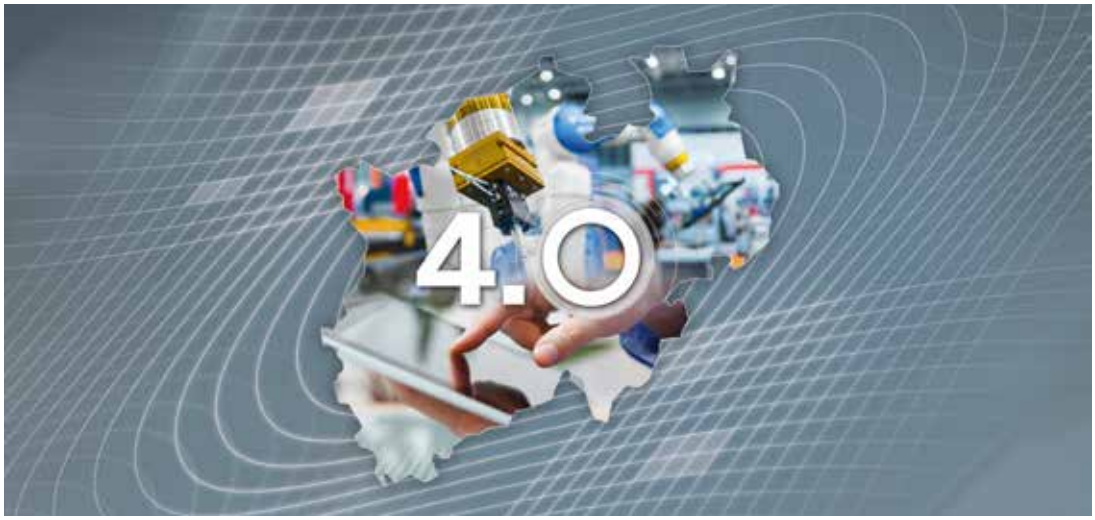
But it is also becoming very clear that there's no single approach. In fact, the strategies for implementation are as many and varied as the companies in the sector. However, the examples have one thing in common: they demonstrate the productive capacity of the industry, and its desire to continuously reinvent itself.

I hope you will find it interesting reading!

Yours,
Wolf D. Meier-Scheuven

ProduktionNRW

Innovation is the lifeblood of the mechanical engineering sector, and crucial for the leading position held by our capital goods industry. ProduktionNRW, as the cluster of mechanical engineering and production technology in North Rhine-Westphalia, has been working for many years on providing assistance to local businesses, with their limited resources, to help them compete successfully with suppliers to global markets.



Graphic: VDMA

Technological progress is the secret for future-proofing North Rhine-Westphalia businesses in an increasingly tough competitive environment. The mechanical engineering industry makes use of the resultant opportunities in order to retain the leading position currently held by local businesses, the challenges this brings need to be addressed jointly. ProduktionNRW provides support for the local economy on its path towards to the factory of the future, the “smart factory”, and in the quest for new business models building on the digital transition.

Networks are the most efficient structure for generating innovation and inventions. ProduktionNRW provides a platform for promoting networking, and offers support with meeting the challenges resulting from increasing networking and connectivity between the human operator, the machine and the workpiece. Information material put out by ProduktionNRW and numerous cluster events support businesses and offer valuable guidance for their future strategy. Workshops and experience exchanges brings all relevant players together and enables knowledge transfer and mutual learning. So it is that mechanical engineering and production technology as a lead market is becoming a driver of digitalisation in NRW. At the same time, the success of the mechanical engineering sector is radiating out to other industries, and helping this state in its efforts to become a pioneer of future-capable, reliable solutions in the Industrie 4.0 environment.

www.produktion.nrw.de

KNOW-HOW

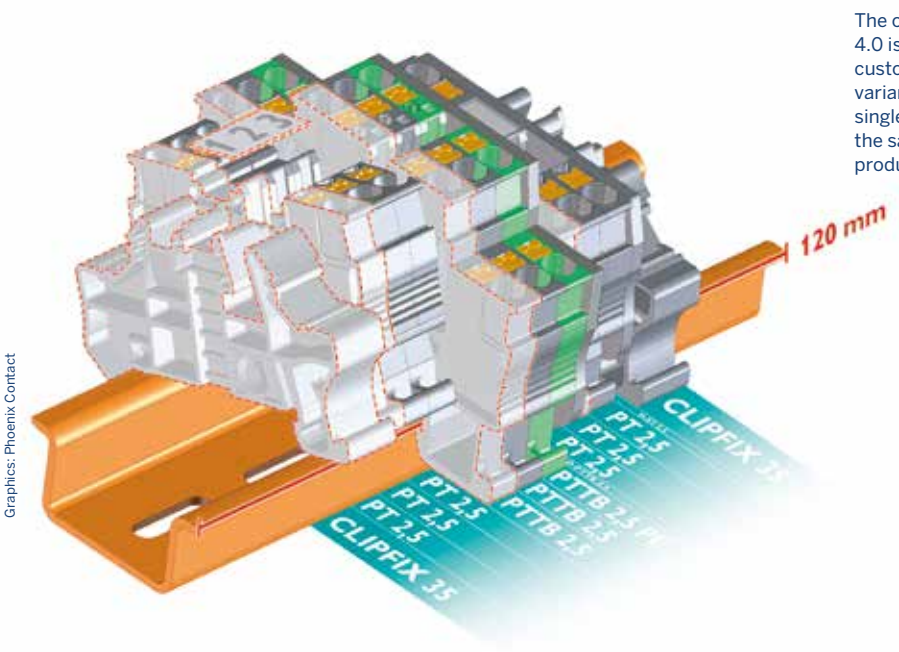
ProduktionNRW

The cluster policy and targeted innovation strategy of the German state of North Rhine-Westphalia are mechanisms for supporting industries of the future. ProduktionNRW, as the cluster of mechanical engineering and production technology in NRW, operates under the leadership of the state Mechanical Engineering Industry Association (VDMA NRW). The joint project between the German Mechanical Engineering Industry Association and the state of North Rhine-Westphalia has been working on strengthening mechanical engineering and production technology as cornerstones of the NRW economy. The platform offers businesses and institutions the opportunity to form networks and enhance value added chains. A significant proportion of the services provided by ProduktionNRW are funded by the European Regional Development Fund (ERDF).

Digital Transformation Urgently Needed

FRANK KNAFLA

Much is being said in the manufacturing industries about the subjects of Industrie 4.0 and digitalisation. It is easy to confuse goal with purpose, but the one thing that is clear is that digitalisation is an essential precondition for the implementation of concepts that are part of Industrie 4.0.



Graphics: Phoenix Contact

The objective of Industrie 4.0 is to manufacture customer-specific variants and products in single-unit batches for the same cost as series production.

We first need to define what we mean by Industrie 4.0. We readily refer in this regard to the fourth Industrial Revolution. The term “mass customisation” is a suitable definition that considers the actual application. This refers to the ability to manufacture a product tailored to the customer’s needs down to a batch consisting of a single unit, but for the same cost as a mass-produced item.

It is already possible to manufacture individual products that are painted in a special colour, for example, or come with special printing. But the processing and production costs in such cases rise disproportionately. And at the same time, the manufacturer will not always be able to demand the price from customers that a commercially feasible solution would require.

In many cases, it is simply not possible to meet customer requirements without a costly special development process.

The future-oriented Industrie 4.0 project therefore aims to make this kind of mass production possible in Europe, from a technical and commercial viewpoint. This involves combining machines and people in the Internet of Things, horizontally and vertically, to form value-added networks. The individual protagonists must be networked to be able to share information.

Digital description

What form does the manufacturing process for a customised product take? First of all, customers configure the product to suit their specific needs using a web application. A software application then uses the digital data provided to calculate the requirements this imposes on the production processes. In detail, for example, this may mean calculating the sequence of the processing stages required for manufacture. The necessary processes must also be identified and the requirements compared against the digital description of the production systems that are needed to manufacture the product.

A digital parts list and a digital work plan must then be created. This can be done only if the processes and the machines are also described digitally, along with their properties and abilities. The digital description of the article therefore directs the manufacturing sequence.

Reduce operating costs

The future-oriented Industrie 4.0 project aims to increase efficiency and curb costs in the horizontal value chain. To this end, all processes and means of production must be digitalised, from development through to product delivery. This means using Virtual Reality

with 3D models in the development and design phase, to test the suitability of the design at an early stage.

3D designs are not a new invention. But the rigorous application of standardised data models throughout the value chain in future will make it possible to use data to manufacture prototypes and develop manufacturing systems. When this scenario is put into practice, mechanical engineers and plant manufacturers can start developing the production systems and operating consumables in parallel with the design phase. It will be possible in an ideal situation to make use of existing machines, because the designer will have details of their properties and what they can do.

The digital information on design can be used to parameterise and configure the processes for tool manufacture. In combination with the systematic approach of continuous flow manufacturing ("one piece flow"), machine tool setup times can be substantially reduced, which will increase the amount of productive time. Fully automated, unmanned overnight and weekend operation is also conceivable. Digital information is used to control parameterisation of the manufacturing systems, the same as with configured articles.

Data is constantly updated

Article and variant-specific operating instructions and parameters are saved in a database in the plant's distributed control system, for example. The tool tray, tool and component tray all have an RFID tag, which wirelessly collects the production information from the digital article at the start of the manufacturing process. The component is then directed to the manufacturing system on the component tray.

The individual production stations read the specific operating instructions from the RFID tag and start processing them. Once this stage is complete, the information about the working stages that have been completed is stored on the RFID label, along with additional data such as measurement results, as needed. At the integrated manual work stations, workers are guided by wizard functions on industrial PCs. The display selection is a part of the digital article and is controlled using the tag.

The solution lies in the fact that the necessary manufacturing information is available digitally throughout the manufacturing process for the product or variant. The data is stored in the PLM (Product Lifecycle Management) system, either by serial or batch number. Users can use the serial number to access the documentation about the parameters used, and measured at any time.

Basis for new business models

The basis for the success of the future-oriented Industrie 4.0 project is the availability at all times of all information, continuously updated and in digital form, on the product and its manufacturing processes throughout the entire lifecycle. This is known as a 'digital twin'. The networking of products and production systems in the Internet of Things makes it possible to access and exchange information to build up a flexible manufacturing system. Data from products and production systems, in combination with commercial data from the business processes, forms the basis for data-centred business models.

Examples are preventive maintenance, as a means of avoiding foreseeable outages, and updates to software functions, which are familiar from the world of smartphones. New forms of inter-company collaboration are also becoming evident. In the Internet of Processes, manufacturing systems and products are networked in such a way that parameterisation and production sequences can be flexibly determined, based on the information communicated, using self-optimising algorithms.

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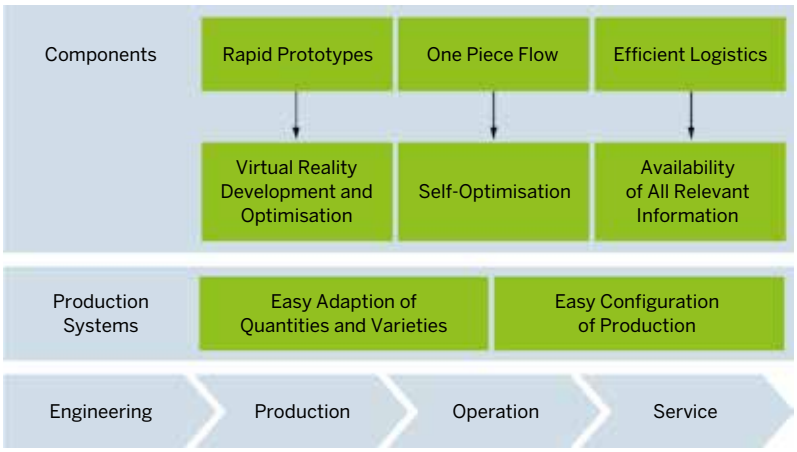

Digital article description: the digital twin contains all information on production, the properties of the product, and its possible application.

Even Steel is Going Digital

MAXIMILIAN WAGNER

In continuous casting, forging, strip finishing, or in the recently opened Learning Factory at Big River Steel – digital technologies are being used everywhere to improve processes and make new and profitable production strategies possible thanks to their intelligence and their overarching system of networking.

Photos: SMS digital

The intelligent alarm enables users to recognise relevant alerts more quickly.

From customer interviews, Düsseldorf-based SMS digital GmbH has learned that insufficient attention is often paid to alarm signals, or they are ignored altogether. Many users are also quite simply overwhelmed by the flood of unfiltered alarms. The main reasons lie in the way existing automation systems are operated, which is inconvenient and not particularly intuitive. Alarm signals are often simply clicked off, with no check to determine the cause or rectify the fault. The result is unscheduled machine outages and increased repair costs.

This is precisely why SMS digital has developed “Smart Alarm”. This application is an intelligent alarm management system that prioritises and groups alarms from a plant, and presents them in a way that is easy to follow and so enables the cause to be swiftly identified and the problem put right. The web application also thinks as it progresses, and can recognise cor-

Visualisation: the cause of the alarm is displayed in the event of a fault in the plant. Unfiled errors can be quickly added.

relations between errors. That means that typical consequential faults can be identified at an early stage and prevented. Additional functions are the ability to provide notification by e-mail or text message in the event of critical alarms, and to document solutions as a means of safeguarding valuable know-how and making it available to other employees.

Smart Alarm helps users to concentrate on relevant alarms and respond correctly to them. To reduce the time needed to trace and resolve problems in the plant, the system offers intelligent visualisation of alarms using a tree structure. Solutions for alarms can be documented directly in the system, to share knowledge among users and maintenance staff. It can be connected to existing automation systems, with no need to purchase additional sensors or hardware.

SMS digital is the centre of competence for digitalisation and Industrie 4.0 within the SMS Group. It draws on state-of-the-art methods of innovation, expertise with metallurgical processes and professional technical knowledge to create new digital products. It is the one-stop contact and ensures that existing plants can also be made ready for the age of digitalisation. The experts highlight potential solutions to make profitable and sustained use of existing technology. Machine learning and artificial intelligence are used to leverage as yet unused potential from customer data and make new business models possible on that basis.

Using agile methods

The digital products are developed using methods such as Design Thinking. Right at the development stage, they provide perceptible added value for customers. This is because a Minimum Viable Product can very quickly let the customer see the initial results. This is not a finished product, but contains only the basic functions that are being tested.

Further functions are added in short development cycles. The customer follows the development process step by step, and is able to influence the creation process. Even in the early development stage, the solutions stand out on account of their high quality, intuitive operation and possibilities for far-reaching integration, which means they are suitable for industrial use right from the outset.

State-of-the-art technologies and software architectures serve as a basis to create scalable applications that fit seamlessly into the customer's existing environment. The focus is on web applications that offer a high level of flexibility for industry-wide use and are immediately ready for use on the plug-and-play principle.

Maximilian Wagner
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KNOW-HOW

SMS digital

The "SMS digital" centre of competence is a start-up within the SMS Group that is designed to serve as an instigator. An agile, dynamic team of experienced developers, UI/UX designers and product managers works together within the company. The latest working methods, like Scrum, Lean Startup and Design Thinking are characteristic of the rapid and results-oriented way the team operates.

With support from SMS, the parent company, and in close coordination with the various divisions, SMS digital makes expertise and a professional network available to its customers. Many new applications have already been developed through the fruitful collaboration between the various divisions. Smart Alarm is just one example of these digital products.

NRW Economy and Employment 4.0 Platform

SILKE STAHL-ROLF

The Economy and Employment 4.0 professional network brings together players and projects associated with the topic of digitalisation in NRW. It is designed to help SMEs and their employees to find their way through the digital transformation.

Photo: Eric Lichtenscheidt

The Economy and Employment 4.0 professional network serves as a platform for communication and collaboration. It brings the players in the digital transformation in NRW together.

Starting point: digitalisation meets the worlds of the economy and employment

Digitalisation is much more than just the introduction of digital technologies, in the area of production, for example, in networking company processes, or in the way we work with suppliers and customers. Ultimately it will change the ways in which companies do business and people work. If implemented in a way that will encourage participation, digitalisation offers major opportunities for developing new products and business models and opening up new markets, and will mean an improvement in efficiency within the company and opportunities for employment in equal measure. Employment 4.0 is associated with many opportunities in this regard – from more individual responsibility in hierarchies that are growing flatter to an increasing number of crossovers between work and private life – but is also perceived as a challenge. Key concepts here are greater flexibility for performance in terms of space and time, new ways in which humans and machines can work together, and an increase in solo/self-employment.

Strong requirement for consulting among companies and employees

Companies sometimes find it difficult to define the benefits that digitalisation offers them, to find a suitable means of entry into the world of the digital economy and employment, and to put it into practice as part of their business. Employees often have unanswered questions about the impact that digitalisation will have on them and their area of activity, and seek information about how to prepare for changes. In this connection, qualification, participation, co-determination and IT security are topics that affect companies and their employees alike. Many companies therefore delay their own process of digitalisation, leaving potentials unused. According to a current study by Germany's Ministry of Economic Affairs and Energy, 29 percent of companies in Germany do not consider digitalisation relevant for them, and a further 27 percent describe themselves as "only slightly digitalised".

Highly differentiated support landscape

Not least because of the substantial need for information and support on the part of local companies and their employees, North Rhine-Westphalia has developed a broadly based range of networks and initiatives that cover the various needs of the digital transformation with a regional and a topic-

based focus. New technologies are trialled, new business models are developed, and new forms of digitally assisted work are tested for their practical suitability as part of transfer projects, in living labs and in experiment rooms.

Central communications node for digitalisation

The goal of the NRW platform Economy and Employment 4.0 is to make all the various activities and players transparent and more accessible for use by companies and employees. The platform thus perceives itself as a central communications point and node for the digital transformation, and provides information about topics, challenges and opportunities offered by the digitalisation of the economy and employment, as well as the many activities being performed in NRW. It makes a contribution toward networking projects and players, and makes practical examples visible. All in all, the platform sees itself as a pilot in the broad-ranging information and support landscape. To this end, it is engaged in constant dialogue with players from businesses, science, centres of competence, Chambers of Trades and Industry, Digital Hubs, Digital Networks, clusters, trade and professional associations and unions in NRW. It brings together players to engage in systematic discussion, identify synergy potentials and common projects, and thus expand their visibility and effectiveness, in addition to their transfer activities within the target group of small and medium-sized enterprises (SMEs) and their employees.

Networking – digital and analogue

The work of the platform combines web-assisted activities with personal contacts and accompanying research and analysis. At www.digitales.nrw, it offers a network and knowledge management portal for SMEs and their employees that covers a broad range of subjects. The range of information is developed in line with the various topics and challenges that arise from the perspectives of the companies and employment. The companies and employees are guided toward the right transfer, grant and support services and contacts at a State, national and EU level. Guidance regarding the many events at a State level to assist with the digital transformation is also provided. A special service is offered by the portal with the "digitales.nrw display window", a State map in which examples of good practice, players and contacts for digitalisation can be searched by location or post code.

In the area of "analogue networking", workshops on the challenges and fields of action for digitalisation are the focus of work by the platform, in addition to many bilateral discussions. Topics range from questions of qualification and a new culture of learning in businesses to the development of specific projects to pool the wide range of products and services in North Rhine-Westphalia to make them easier for the target groups to access. The nationwide Industrie 4.0 platform is also involved in these workshops, to ensure synergies with activities being performed at a Federal level.

Photo: Eric Lichtenscheidt

Insight into laboratories: As a leading location for digitalisation, NRW supports transfers from science to practice.

The NRW platform Economy and Employment 4.0 observes trends and developments in the area of digitalisation that are important for companies and their employees in NRW. In addition to desk research, it also draws on details and information from events and engages in discussions with players in NRW.

Dr Silke Stahl-Rolf
Head
NRW Economy
and Employment 4.0 platform
www.digitales.nrw

Photos: Julius Gnoth

Research projects and activities on digitalisation in NRW are the focus for the professional network.

All Aboard the Steam Train for Industrie 4.0

KATRIN BECKER

Raspi, Emma and Sicony – they're not pets, but names that designate elements of Industrie 4.0. Modern technology helps with cylinder manufacture. Processes are leaner, more effective and more profitable. What's behind the names Raspi, Emma and Sicony?

Photos: IMI Precision Engineering

Tugger train Emma transports goods between the logistics centre and production.

When you step onto the factory floor at IMI Precision Engineering Norgren GmbH, it wouldn't occur to you that the site in Alpen is one of the company's oldest. Industrie 4.0 is becoming an essential part of the company's work. Monitors in the production halls marked the start of this innovation. Controlled by Raspberry (Raspi) compact mini-computers, the monitors visualise information – from general order data to live production data from an ERP system – directly to the assembly cells.

"The first idea was to keep our staff informed about the status of current orders", says plant manager Torsten Norff, "and it went on from there. We now even use the visualisations to adjust the capacity utilisation of assembly cells during a shift. The results were measurable after a short time; within just a few months, we've reduced our delivery times by more than 30 per cent."

The success resulting from the visualisation of order data and processes motivated the team to introduce even more Industrie 4.0 innovations into the factory's work. "For me as plant manager, it's absolutely crucial to be up with the play at all times. Times have changed – in this day and age, you need to respond quickly to changes. Process and IT technology helps us enormously in that regard", says Norff.

Simplified processes

In 2015, 'Emma' arrived at the Alpen factory. As in other companies, at that time production staff were still transporting materials from A to B. To simplify the process, the site brought in a tugger train called Emma. She's named for the steam train from the children's book 'Jim Button and Luke the Engine Driver'. The train passes through the factory and production halls, stopping at various stations along the way.

In addition to the route, which is displayed in the driver's cab, the driver receives information about which materials are to be loaded and unloaded at each station. The materials are scanned and managed directly in the warehouse management system. Staff in the assembly cells are able to give 100 per cent of their attention to the orders, while Emma gets on with delivering the materials required for each order. The finished products are then transported directly to storage or to the European logistics centre, which is also based in Alpen, for dispatch.

The route and information on transporting the material is provided to the driver in real time.

The latest project is called Sicony. This start-up company, created by the Fraunhofer Institute IGCV, develops digital machine operator guidance systems. As one of Sicony's first customers, the Alpen site has contributed many ideas and suggestions in the development of the software. The aim is simple. Sicony provides digital assistance for production staff. For instance, work procedures are created digitally via a tablet, edited and made available to all relevant individuals. The great advantage here lies in the swarm intelligence.

"In addition to standard products, we also have numerous custom-made products in small quantities. It was important to us that the experience gained during production and assembly of these custom products be recorded and saved. We can then make use of that information with the next order, thus working more quickly and efficiently", says Lean Manager Eva Niemann, highlighting the software characteristics.

Industrie 4.0 supports lean

Lean management has played an important role in the IMI group for a number of years now. In the beginning, there were fears that Lean and Industrie 4.0 could end up competing against one another. But it quickly became clear that the two systems not only work well together, but actually belong together. "Through the process knowledge and process optimisation, Lean provides the foundation for implementing Industrie 4.0. On the other side of the coin, digitalisation can simplify lean management processes", explains Niemann.

The move to digital production is far from over. In the next step, Sicony is to be expanded to include the company's standard products. Each product will receive an individual RFID label. At each workstation, the employee can scan and read this RFID tag, and via the software he will receive information on the required components, work steps, work instructions and other data. Coupled with the ERP system, for instance, the relevant pick-by-light system of that operator position is activated, showing the employee the components and number of pieces for the work step. At the end of assembly, the RFID tag is removed from the finished product, and the tag then goes through the assembly process again attached to a new component.

IMI Precision Engineering has relied on Industrie 4.0 for a number of years. The company will continue to work on introducing new systems in the future. In addition to the implementation itself, it's important to convince employees of the benefits of the technology. "There are many challenges when it comes to adapting and improving processes", says Norff, "but that has just become part of the business landscape. We involve our employees in our projects from the very start, and it's worked well for us."

Katrin Becker
Trade Press Officer
IMI Precision Engineering
Norgren GmbH
www.imi-precision.com

State-of-the-art assembly according to the one-piece flow system is used in manufacturing cylinders.

For logistics, the picks per hour are visualised directly at the picking place.

Assembly operators can generate digital work instructions directly on the tablet.

Successfully Digitalising SMEs

WOLFGANG MARQUARDT

How can small and medium-sized enterprises in the manufacturing sector exploit the potential of digitalisation to increase their competitiveness? In Ostwestfalen-Lippe, the top cluster 'it's OWL' offers effective support.

Photo: it's OWL Clustermanagement

In transfer projects, companies tackle concrete challenges in the context of Industrie 4.0 with the support of research institutions.

In the 'it's OWL' (Intelligente Technische Systeme OstWestfalenLippe) technology network, 200 companies, research institutions and organisations are working together, with the support of the state of North Rhine-Westphalia, to develop technologies for smart products and production methods. Small and medium-sized enterprises (SMEs) can take part in transfer projects where they're able to use new technologies from the top cluster, teaming up with a research institution to tackle specific challenges within their company.

This includes, for instance, the intuitive operation of machines, intelligent networking of systems, efficient energy management or strategies for interdisciplinary product development. 170 transfer projects have been implemented over the past three years. The companies gain access to proven technologies that they are able to make use of quickly and easily. The transfer projects offer a useful entry point to the topic of Industrie 4.0.

The 'thinking' painting system

In one transfer project, painting systems manufacturer Venjakob Maschinenbau GmbH & Co. KG from Rheda-Wiedenbrück collaborated with the Heinz–Nixdorf Institute of Paderborn University to investigate the possibilities for self-optimisation of painting systems. In the project, new functions were developed with which the system independently recognises changes in individual process parameters, and 'counteracts' or adapts downstream processes accordingly.

During cleaning, for instance, an ionising bar neutralises electrically charged dust particles on the workpiece, facilitating their elimination. The dust particles are then removed with compressed air. If the performance of the ionising bar deteriorates – due to soiling or impurities, for instance – and maintenance is not carried out promptly, this impacts on the entire painting process: dust particles remain on the workpiece and are then sealed in the paint coat. As a result, the workpiece is unusable.

To avoid problems like this, machine learning is used for predictive maintenance scheduling. The painting system indicates to the operator via a display that the system element needs maintenance. In addition, a computerised sys-

tem model has been developed which identifies potential areas for further improvements to the systems and processes.

Mechatronic modular system

In a transfer project in collaboration with the Fraunhofer Institute for Mechatronic Systems Design IEM, Wächter Packautomatik GmbH & Co. KG from Bad Wünnenberg has created a mechatronic modular system which simplifies the design and production of customised tray- and wrap-around packers. These are systems that set up, fill and seal boxes and trays (secondary packaging) for foods and consumer goods.

A product configurator was developed by virtually disassembling the machines. In concrete terms, the possible and practicable functions of a system were first organised hierarchically, taking into account the relevant design data of all subsections involved. These functions – numbering more than 50 – can be combined to form system elements. The configurator is so intelligent that it can fall back on available solutions and blank out incompatible ones.

In the configurator, the designer selects (based on the requirements) functional modules and system elements which are linked into complete customised machines and systems. Each module consists of design data from a variety of disciplines. This requires a departure from the traditional methodology of designing one discipline after another and, as it were, 'handing on' the design data from the mechanics to the electrical engineering right up to the PLC programming, and processing it at each stage. As a result, the product development process has been significantly accelerated.

Shaping the work environment

With increasing digitalisation, the social aspects of work organisation are moving into the spotlight. How will jobs change? How should employees be qualified? For this purpose, it's OWL has developed recommended actions for companies, based on practical experience. Model projects have been implemented in which top management, production management, HR department, employees, works council and trade unions work together. The keys to success are a positive basic attitude to the topic of digitalisation, intensive communication within the company, and employee involvement.

Other offers of support for SMEs are training courses that provide employees with knowledge about new technologies and their areas of application. Demonstration centres such as the OWL Smart Factory in Lemgo offer the opportunity to try out new technologies and to discuss the enterprise's own applications with researchers.

Dialogue among companies is enabled by open information exchange groups and learning networks, where experts from companies and businesses can share their views on challenges, experiences and solutions in various fields of technology such as human-machine interaction, Big Data in production and IT security. In 'Quick Checks', experts from the research institutions will examine your company's production processes and identify specific possibilities for optimisation. This allows SMEs to create their own Industrie 4.0 roadmap.

Wolfgang Marquardt
Press Officer
it's OWL Clustermanagement GmbH
Paderborn
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Photo: Wächter Packautomatik

With the aid of systems engineering, product development is optimised.

Machine learning reduces faults in painting systems. The painting system alerts the operator that the ionising bar needs to be serviced.

Photo: Venjakob Maschinenbau

Implementing the Digital Transformation with Smart Connections

IN CONVERSATION WITH MICHAEL MATTHESIUS

Michael Matthesius, Head of the Automation Products and Solutions Division at Weidmüller.

Networked, intelligent and transparent: expectations of the Smart Factory of the future are high. Automation and digitalisation will grow ever closer together in the process. In this interview, Michael Matthesius, Head of the Automation Products and Solutions Division at Weidmüller GmbH & Co. KG, describes the resulting benefits for businesses.

What are the challenges of digitalisation for the mechanical engineering and plant construction industry?

Matthesius: There are currently many demands on the factory of the future. It must be based on genuine machine-to-machine communication, and must include a flexible production system that will make it possible to manufacture a range of different products quickly. Many of these developments are currently subsumed under the expressions “Industrie 4.0” and “Smart Factory”: these relate to the interlinking and networking of machines and plant, a much greater dominance of software, greater penetration of automation solutions, and also collecting and analysing data material for preventive maintenance.

We need to be able to manage the striking growth in interdisciplinary questions. In this connection, it is important to look at the optimisation of production in a different light, and develop novel business models and services. A machine is no longer delivered as a finished unit, but will adapt flexibly to future demands. This can take the form of software updates, modular expansions, revised networking arrangements or redesigns. Mechanical engineers will also have to pay greater attention to their customers and their business models. In addition to approaches such as remote maintenance, new consulting and other services will also be developed. Innovations must be put into practice swiftly and skilfully.

Which special solutions can overcome these problems?

Matthesius: Communications-capable components provide the foundation for the intelligent, security-focused networking in production that we refer to as “Industrie 4.0”. These create the preconditions for rapid provision and processing of process data, since they make it possible to exchange data profitably between machines and IT systems. The key products for these applications are an open and individually scalable automation toolbox, or solutions to put in place Predictive Quality or Predictive Maintenance. In this context, the vendor-neutral, open and future-proof communications standard OPC UA has an important part to play as the backbone for machine-to-machine communication.

Looking at Industrial analysis, what is the situation with data analysis, one of the trending Industrie 4.0 topics?

Matthesius: Industrial Analytics solutions and Cloud service can draw added value from machine and production data. They enable you to be platform-independent and align yourself with specific customer requirements. For data acquisition in the field, you need experience from traditional business, so you can integrate data analyses in a context of specific applications, and derive conclusions from them that will provide added value. In practice, that means that self-learning machines can recognise and avoid potential process errors, and thus signifi-

Photo: Weidmüller

Demands on the Factory of the Future are high. Networking of machines and plant, dominance of software, and advances by automation solutions will all become necessary.

cantly reduce unplanned downtimes, which increases machine productivity overall as a consequence.

What is the best approach to follow when developing solutions of this nature?

Matthesius: While traditional PLC programming has remained highly stable in the past 25 years, IT technologies have progressed rapidly in that time. This can be used to advantage in monitoring and assisting companies in the development of automation systems.

Do experiences gained with our own production systems also play a part here?

Matthesius: A very big one, in fact. We are often the users of our own products – in other words, we also use the solutions in our own production systems. With the Industrial Analytics solution, for example. In Detmold, we started by optimising consumption of electricity and compressed air, and collected a lot of data for the purpose. And for Condition Monitoring, we then had to deal with the concepts of Predictive Maintenance and Preventive Maintenance for the first time. Since this trial in our own facility, we have been constantly expanding our own knowledge.

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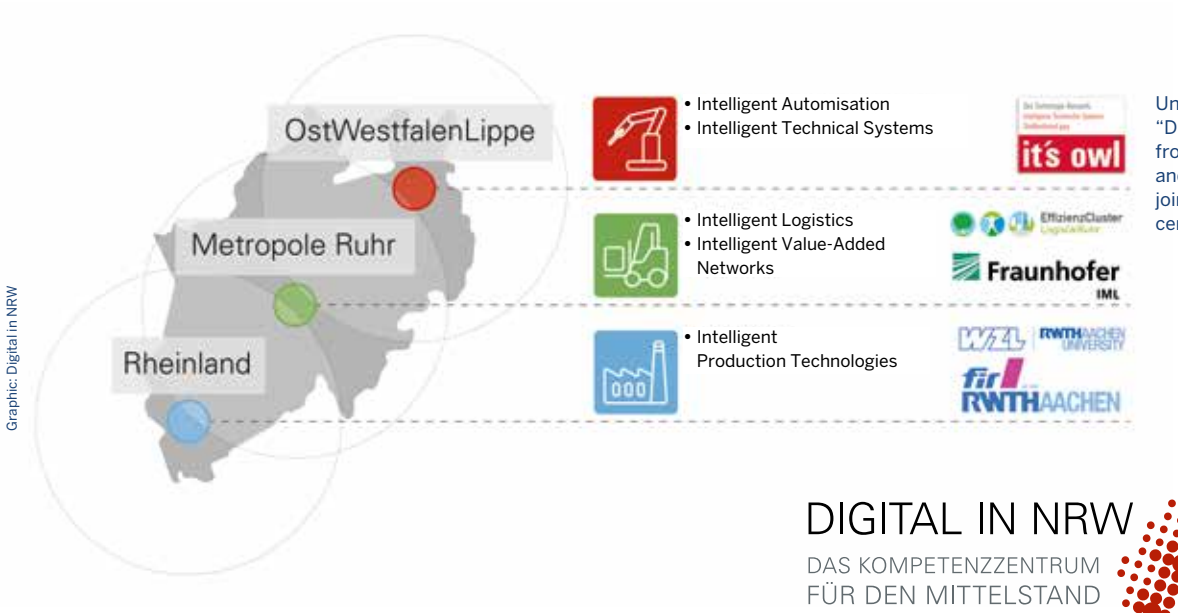
Graphic: Weidmüller/yoh4nn, iStock

The Smart Factory is making headway at all levels.

Get SMEs Started on the Path to Industrie 4.0

The SME 4.0 centres of competence in Dortmund and Siegen are helping SMEs in North Rhine-Westphalia to gear up their digital skills and future-proof their business. NRW aims to be a leading supplier for Industrie 4.0 applications for the industry of the future.



Graphic: Digital in NRW

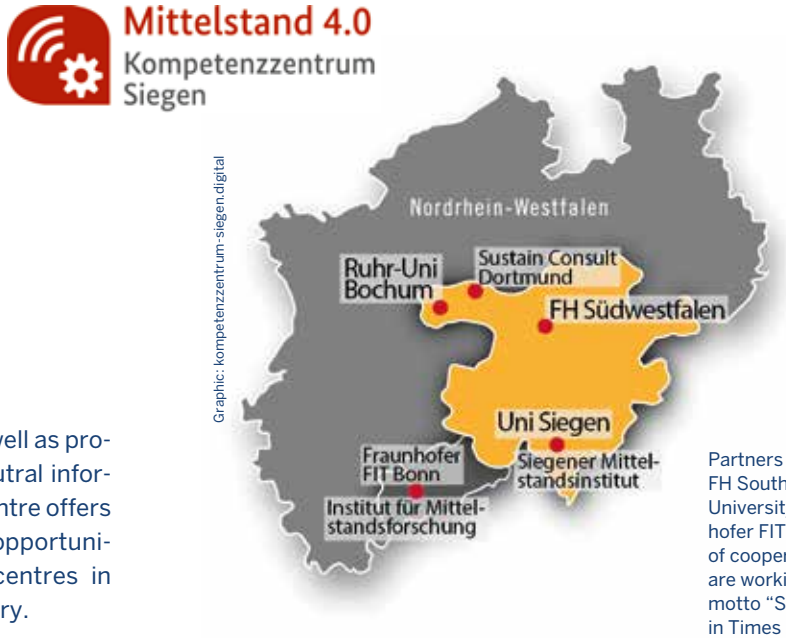
Under the headline "Digital in NRW", partners from OWL, Ruhrgebiet and Rhineland are working jointly in the competence center Dortmund.

In the world of Industrie 4.0, machines, service providers, products and consumers communicate digitally with each other across every stage of the value-added process. But the implementation of digitalisation concepts in the industrial landscape involves some major challenges for SMEs in particular. To provide some practical assistance in this area, the German Federal Ministry for the Economy has created the "SME 4.0 – Digital Production and Work Processes" initiative. The initiative is tasked with supporting SMEs and skilled trades businesses with digitalisation, connectivity and the implementation of Industrie 4.0 applications, via SME centres of competence set up throughout Germany. The funding network comprises thematic centres for overarching topics such as cloud computing, communication, wholesale and retail, and processes, and two of these are located in NRW.

Digital in NRW

"North Rhine-Westphalia aims to be a leading supplier and lead market for future-capable and secure Industrie 4.0 solutions and innovative business models for the digital economy", says State Minister for Economic Affairs and Digitalisation Prof. Dr Andreas Pinkwart. The state of NRW is focused on particular on seizing the economic opportunities opened up by digitalisation, he says. "The primary objective is to make major industrial businesses and SMEs more aware of the opportunities opened up by the digital transition", he says. Under the motto "Digital in NRW", the SME 4.0 centre of competence in Dortmund addresses the themes of digitalisation and connectivity.

"SMEs can work with our experts on the digitalisation of their products, production operations and all their value-added processes", says Maria Beck, Business Manager of the centre in Dortmund. The main focus is on SMEs in the mechanical engineering sector, production technology, and businesses in the mobility, logistics and information economy sectors. "We help businesses to enter at all levels of



Graphic: kompetenzzentrum-siegen.digital

Partners of Siegen University, FH South Westphalia, Ruhr University Bochum, Fraunhofer FIT as well as a series of cooperational partners are working jointly under the motto "Skilled Employment in Times of Digital Change".

Industrie 4.0", she says. As well as providing practical, supplier-neutral information free of charge, the centre offers professional development opportunities and access to demo centres in research facilities and industry.

Strong network of experts

The Dortmund SME 4.0 centre of competence is based on a strong network: "We bring together the knowledge and experience of technology experts from three major industry and research hubs in NRW, and provide regional contacts", says Maria Beck. In Rhineland, the Machine Tool Laboratory WZL and Research Institute for Rationalisation FIR of RWTH Aachen University are working on intelligent production technology. In the metropolitan Ruhr region, the Fraunhofer Institute for Material Flows and Logistics IML and EffizienzCluster Management GmbH are the specialists in intelligent logistics and value added networks. And in the OstWestfalenLippe (OWL) region, universities of applied sciences and research institutes in the "it's OWL" cluster of excellence offer support with intelligent automation and intelligent products and production systems.

Employment in the digital transition

The initiative has a further support base in NRW, with the SME 4.0 centre of competence in Siegen, devoted to the human factor as a key element in the new equation. Under the overarching concept of "skilled work in the digital transition", this SME is working on addressing the sociotechnical challenges of digitalisation.

"Employees have been, and will remain, at the centre of attention in the digitalisation process. Human work skills and the expertise of employees are crucial considerations, and must therefore be brought into the spotlight", says Dr Thomas Ludwig, Business Manager of the Siegen centre of competence. SMEs are supported through demonstrations of assist systems and the implementation of employee-centred digitalisation projects with specific solution ideas on technologies and concepts. The focus is on solutions for the mechanical engineering, automotive component supply and building automation sectors, as key industries in the South Westphalia region.

The Siegen SME 4.0 centre of competence has three demonstration and learning factories and two thematic laboratories for application-based familiarisation training for SMEs on the implementation of the digital technologies. The training can also be provided on site if desired. A wide range of training courses and seminars are offered to explore new approaches to employee innovation, in the area of usability and user experience, blended learning and Change 4.0. The range of services and activities is rounded off by networking meetings and discussion events in the form of focus groups. The lead partner in the Siegen SME 4.0 centre of competence is the Institute for Business Computing, under the direction of Prof Dr Volker Wulf, at the University of Siegen. Other partners are the South Westphalia University of Applied Sciences, Ruhr University Bochum and the Fraunhofer Institute for Applied Information Technology (FIT).

HSME 4.0
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SME 4.0

Closing a Digital Gap

DIGITAL IN NRW
DAS KOMPETENZZENTRUM FÜR DEN MITTELSTAND

The fourth industrial revolution is bringing ever greater changes in the mechanical engineering sector. But to seize the resulting opportunities, businesses must be prepared to explore some innovative approaches. Himpe AG is gearing up for the future by digitalising its order processing operation.

Industrie 4.0 offers the vision of an intelligent factory, with products controlling the process that produces them. This transformation opens up new opportunities for SMEs in the mechanical engineering industry to fulfil customer orders more efficiently in terms of time and costs. But this depends on the digital connection of plant, machinery and products across all the business's departments, and along the entire value-added chain. So in order to remain competitive, businesses need to move quickly to address the structural changes resulting from the digital transformation. The best way to do this is sometimes to focus initially on one particular part of the process. The process measurement technology company Himpe AG, for example, is working with the "Digital in NRW" initiative to close a digital gap in its order processing operation.

Opportunities analysis in the digitalisation process

The Kamen-based company was suffering from a lack of end-to-end system support in order processing. Production scheduling and control were carried out centrally as manual processes. In addition, there was insufficient transparency in production progress status reporting, deadlines, bottlenecks and work in progress. This "digital gap" was identified in an opportunities assessment carried out by the "Digital in NRW" centre of competence.

"We already realised that the lack of end-to-end capability in order processing was a problem for our production operation. But 'Digital in NRW' helped us to identify the specific area where digitalisation would have the greatest impact. So now we are working with the experts in a transfer project", says Commercial Director Manon Himpe.

Transfer project for an assist system

The solution is now rapidly taking shape. Since September 2017, Himpe has been working with experts from the Fraunhofer Institute for Material Flows and Logistics IML to develop an assist system for decentralised and autonomous production control at workstation level, on tablets, for example.

The assist system captures the material and production data for the order in real time, and simplifies and supports internal communications, particularly between production and sales, resulting in greater transparency. At the same time, it also generates proposals for the sequencing of orders so as to optimise capacity utilisation and prevent bottlenecks. In addition, employees have a comprehensive overview of the status of the order, and, thanks to the transfer project, are able to manage subcontracting inputs as required, with prioritisation according to urgency. "The assist system is essentially a digital replication of the actual situation", explains Dr Matthias Parlings, project leader at "Digital in NRW". "We have developed similar systems in previous transfer projects, and are now building on that experience".

Once the implementation of the digital assistant is fully completed, the next step will be a four- to six-week pilot phase, for the staff at Himpe to put the new technology through its paces in the real-life production environment. As from May 2018, manual production scheduling at Himpe should be a thing of the past.

Photo: Fraunhofer IML

Assistence system to control decentralised and independently.

SME 4.0

Connected Machine Hammer Peening

DIGITAL IN NRW
DAS KOMPETENZZENTRUM FÜR DEN MITTELSTAND

Trial and error is a time-honoured method of arriving at a solution, but is also a very expensive and inefficient one. The advantages of a rather different approach have been demonstrated by the Lippetal-based accurapuls GmbH firm, which has been working with the WZL machine tool laboratory of RWTH Aachen University to develop an innovative measurement chain for wireless data transfer, thereby optimising the machine hammer peening process.

There is nothing new about the basic principle of hammer peening – scythe blades, for example, have been worked with hammers from time immemorial. As well as sharpening the blade, the process also hardens the material, without any chemical processes or high-temperature treatment. The same principle is still applied today in the manufacture and treatment of metal components such as turbine blades, ship's propellors and and deep drawing dies.

Relying on experience

One of the companies using peening techniques in Germany is accurapuls GmbH in Lippetal. It has developed an electromechanical peening system for the plastic deformation of tool surfaces. The hammer plunger works and smoothes out roughness peaks in the border zone with impact frequencies of up to 500 Hertz. This boosts hardness levels and strengthens the border zone, which also increases wear resistance. "But naturally, this process has to be adapted according to the specific component and the required material properties", says general manager Christian Löcker. "So up until now, our employees have had to rely to some extent on their experience". While some of the parameters could be set, it was never possible to get information on the force with which the plunger was impacting on the workpiece. "It simply has not been possible to have a precise analysis of the process in real time", he says.

Sensors in the hammer head

So in the "Connected machine hammer peening" transfer project within the "Digital in NRW" initiative, in 2017 the company's experts joined forces with the machine tool laboratory of RWTH Aachen University to address this problem. "The idea was to integrate a suitable form of measurement technology in the hammer head", Löcker says, and to develop an analysis process based on real time signal recording capability and wireless transfer of the data to a cloud-based platform. The partners worked together to define the requirements for the sensor technology and select suitable force and distance sensors, and considered the optimum configuration for placement of the sensors in the hammer head and plunger. The result was a modified peening system with integrated sensors to capture the required information online and transfer the data by wireless technology to a platform for analysis.

Precise real-time measurement

accurapuls has not been the only beneficiary of the new knowledge generated from the project. "Right from the outset, we designed the project with a view to retrofitting the new sensor technology in existing systems", says Robby Mannens from the WZL machine tool laboratory at RWTH Aachen University. "The data captured in this way also allows the precise simulation of the peening process. This enables us to investigate even parameters that are difficult or impossible to measure. With this kind of simulation, we can make predictions about the behaviour of the material in the material border zone, for example." And as Löcker says: "This becomes particularly important when switching to the use of new materials. Where previously we often had to fall back on difficult and costly 'trial and error' methods in such situations, we are now able to work with precise predictions. This brings huge benefits for an SME like accurapuls, and also takes us a significant step further along the path towards digital production. As well as providing valuable new knowledge, the real-time analysis of production data also promises to result in significant efficiency gains."

Foto: DFA Demonstrationsfabrik Aachen

Together with research partners – as shown here in the demonstration unit in Aachen – SMEs can take initial steps in digitalisation.

SME 4.0

New Paths in Switching Cabinet Construction

Photos: Michael Adamski

Heinz-Dieter Finke and Uwe Friedrichs (both directors at Westermann, from left), seen here with employee Kai Watts, have spent the past year working with research facilities on digitalisation strategies for their company. They are shown here presenting the results with Robert Joppen from Fraunhofer IEM.

End-to-end data flow and tablets for employees – the switchgear manufacturer Westermann is working with partners to create a reference process for the digitalisation of SMEs in the mechanical engineering sector.

Smart devices such as tablets and smartphones have revolutionised our use of information and communications, and are now an integral part of our daily lives. As part of the ongoing digitalisation process, information and communication technology is also making increasing inroads into industry, on the basis of the outstanding opportunities it opens up for the optimisation of workflows and processes. The Minden-based firm Schaltanlagenbau H. Westermann GmbH has recognised these opportunities, and its "Digitalisation in switching cabinet construction" project charts new paths towards Industrie 4.0.

The switching cabinet is at the heart of any production system, as the element ensuring the correct distribution of electrical energy and data, and the safe and secure handling of these resources. It contains kilometres of wires and cables and innumerable integrated sockets, all essential for smooth communications between the various electrical devices. For the employees in a switchgear production operation, this represents a huge logistical challenge, particularly because switching cabinets are generally built in a production run of one.

At Westermann, the assembly of such a switching cabinet had traditionally been a manual process, with constant reference to a set of hard-copy assembly instructions. "Unfortunately, leafing through these mountains of paper in search of the required information has just been part of the job. Things get really complicated when an employee has to work from handwritten notes made by a colleague", says Kai Watts, who has been working at Westermann for ten years.

Assembly instructions on tablets

The company has therefore made the decision to take some first vital steps towards digitalisation. Westermann is being supported in this undertaking by the "Digital in NRW" initiative, with research partners from the region: the Fraunhofer Institute for Mechatronics Design Technology IEM, the University of Bielefeld and the Software Innovation Campus of the University of Paderborn. Between them, the project partners have developed design concepts for an end-to-end flow of data from

DIGITAL IN NRW
DAS KOMPETENZZENTRUM FÜR DEN MITTELSTAND

Employee Kai Watts and CEO Heinz-Dieter Finke testing the use of tablets in fabrication processes at Westermann. The task is made significantly easier by a digital twin and intuitive fabrication instructions.

Digital twins of switching cabinets will now simplify the construction and assembly processes involved in building them.

design through to fabrication, which will now be implemented, step-by-step.

"In this project, we have been able to lay some valuable foundations for a structured approach to digitalisation. We have charted our current processes, and formulated how those processes are going to change in the context of digitalisation. And we have looked at what IT systems and data we are going to need as the basis underpinning the digitalisation process", says Uwe Friedrichs, the company's Commercial Director.

Crucial knowledge for individual assembly processes, such as construction data or step-by-step assembly instructions, will now be stored electronically, and will be readily available to all employees at their work locations through the use of tablets. As well as ensuring more efficient work processes, in future this could even allow the digital tracking of orders or the direct identification of missing materials, which could then be ordered with a single click of the mouse.

Cooperation partners from the region

The project is assisted by a support group comprising representatives of Eplan, Phoenix Contact, Rittal, Wago and Weidmüller, all businesses based in the region. They provide the specialist expertise on switching technology components, software and processes. As Heinz-Dieter Finke, Technical Director at Westermann explains: "With our support group of key partners in the area of automation and Industrie 4.0, we are able to map the entire value-added chain. This partnership enables us to take a holistic approach to 'Digitalisation in switching cabinet construction' from an industry perspective. We are especially looking forward to later being able to transfer the project results as a reference model to other projects, and acting as a forerunner for similar companies."

SME 4.0

From Research to Production

Mittelstand 4.0 Kompetenzzentrum Siegen

The SME 4.0 centre of competence at Siegen, under the leadership of the Institute for Business Computing at the University of Siegen, is helping the Haiger-based robot and welding technology manufacturer Carl Cloos Schweißtechnik GmbH with the development of data-based services for industry customers – with very positive results.

Over the last few months, a team from the Institute for Business Computing and New Media at the University of Siegen, led by Prof Dr Volker Wulf, has been working on design concepts for the visualisation of machine data. Their research is located right at the interface between production technology machines and information processing.

"Industry keeps on ramping up its requirements for machine data capture. To enable their customers to determine and display the data needed for quality control, production component capture or malfunctions, manufacturers of plant and machinery now need to offer machine data with added value", says Dr Martin Stein, from the Institute. In his role as deputy manager of the SME 4.0 centre of competence in Siegen, he helps SMEs to meet the challenges of digitalisation.

Focus on the human element

The Siegen centre of competence is specifically focused on the human-machine interaction. "Our visualisation concepts are designed for the needs of the human operator. In practice, this means enabling each employee to formulate the data required for his or her task on an individual dashboard," he says.

Stein illustrates the concept with the following scenario: "In a given fabrication plant, individual employees will be interested in very different sets of data. The machine operator only wants to see the information on the machine

Photos: Cloos

Concatenated robot line to weld drive axle bridges for utility vehicles at Voestalpine.

Robot plant to weld steel components for hall production.

Compact robot cell to weld soft face hammers.

he or she is using. But the foreperson will be interested in data from the complete production line, while the plant manager needs the information required to boost the efficiency of the plant."

Successful knowledge transfer

Cloos produces fabrication solutions based on welding and robot technology for industry clients across a range of sectors, including construction machines, rail vehicles, energy, automotive and agriculture. The firm has decided that along with fully automated production lines, it will now offer its customers additional data-based services. This involves the capture, processing and forwarding of relevant plant and machinery data with integrated gateways.

"We are developing gateway applications for production, quality, maintenance and communication functions, as the best way of meeting the increasingly complex requirements of our industry clients", says Cloos IT and Organisation Director Ralf Pfeifer. Accordingly, in February he and several members of his team attended an information presentation at the SME 4.0 Centre of Competence in Siegen. "We were specifically interested in exploring the opportunities for a collaboration with the centre", Pfeifer says. The centre of competence quickly identified some relevant market solutions, and presented a number of proposed R&D approaches.

"Our discussions with the researchers centred on the question of what an open, scalable gateway infrastructure might look like", Pfeifer says. The people at Siegen came up with some great ideas, and provided valuable support on the system architecture. "Drawing on our experience on past projects across a range of sectors, we were able to offer Cloos some assistance. But then the team at Cloos went on to develop their solution for the capture and visualisation of the required data all on their own", says Stein. "Without the ideas input from the centre, we would never have been able to develop a pilot solution so quickly", Ralf Pfeifer points out – in just two months from the initial contact to a mature product. Both parties now agree in describing this process as "a copybook example of successful knowledge transfer from research to the real production environment".

The Data Path from Sensor to Cloud

JÖRG LANTZSCH

For most approaches to Industrie 4.0, continuous data communication from the field level to higher-order systems is an absolute prerequisite. To support users in meeting this challenge, new solutions that are specifically dedicated to managing sensor data gathered in the field on their journey to the cloud are being developed.

Photos: ifm electronic

The user has his key data in view at all times. The software allows configuration according to the user's own needs.

IO-Link can be a standard for the successful implementation of Industrie 4.0 concepts. "The data volume must be sorted at the source", says Peter Wienzek, Manager Business Development Systems at ifm electronic GmbH, summing up one of the key requirements. As a modern alternative to analogue interfaces, the IO-Link standard has the potential in this regard to replace conventional measured value transmission.

Because of the digital transmission principle, corrupted or incorrect values due to interference on the line are virtually eliminated. Another advantage of IO-Link transmission is the possibility of transmitting additional information, such as the status of the sensor, at the same time. Even when configuring sensors, IO-Link offers advantages: for instance, the parameterisation can be transmitted directly from an IO master, so there's no need for complex adjustment to the sensor. Consequently, many new products have an IO-Link interface as standard.

As the sensory organs of the machine or system, sensors must do more than just record measured values and emit signals. They must also seamlessly communicate those values and signals, as straightforwardly as possible, from the sensor level via the control and command level up to the enterprise level. This is the only way many of the benefits of Industrie 4.0 can be implemented in the first place.

With IO-Link connection of the sensors, the user has an easy way to use data from the field for higher-level systems. Usually, however, a programmable logic controller (PLC) processes the data from the attached sensors, while there is no provision for routing to the command level. If you wanted to implement any such routing, the PLC program would need to be modified.

Second communication channel

To avoid this effort, data can be passed on to higher-level systems from sensors that have an IO-Link interface. However, this requires a tool that can handle different data sources and work with all common protocols. This could be, for instance, a software gateway that affords bidirectional communication between different interfaces. This enables communication between commercial systems on the one hand, and data from devices from the field, control and command levels on the other.

"A lot of sensor information that's required for predictive maintenance or measuring energy consumption is not necessary for the control tasks in the machine, and is therefore not available in the PLC", says Wienzek. "For this reason, a second communication channel is provided which bypasses the control level." The data can go to the PLC using one communication channel, and directly to the enterprise management level via the other.

Monitor machinery and equipment

A visualisation system can help users easily monitor the condition of machines and equipment. The visualisation can be adjusted according to the user's wishes. The tool enables many applications where sensor data are important.

A typical example is condition-based machine maintenance. Sensors detect vibrations which indicate a bearing inside the machine is becoming badly worn. Based on the sensor data, replacement of the bearing can be scheduled in good time. Machine stoppages due to abrupt bearing failure, and unnecessary maintenance operations, are both avoided.

Another example is the monitoring of compressed air systems. Many machines already feature sensors that measure compressed air consumption to ensure they run smoothly. The data from these sensors can be used to detect and correct air leakage. This only works if the sensor data are available to a higher-level system, which is possible with the second communication channel.

Because benefits such as increased availability, global access to data or reduced hardware costs are clearly evident, cloud solutions are gaining ground in many industrial sectors, including mechanical engineering. With appropriate solutions, remote services and new business models can be put in place without the need to implement costly software.

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IO-Link products provide an easy way to use sensor data in higher-level systems.

Productive Connections and High Expectations

GUDRUN MATTIG

Kampf has developed an integrative platform for mapping the value-creation chain in cutting and winding technology. Machines and processes are networked via 'the@vanced' to increase the efficiency of the entire production process.

Photos: Kampf

the@vanced informs its users about the state of the running machines so that actions could be taken immediately.

Higher machine speeds coupled with increased run lengths, and thus more demanding processes, are presenting challenges to mechanical engineers in the cutting and winding industry. At the same time, batch sizes for customised products are decreasing. With smaller batch sizes, improving machine performance won't open up any potential for greater efficiency. So the company Kampf Schneid- und Wickeltechnik GmbH & Co. KG from Wiehl is taking a different direction with its future-oriented project 'Converting 4.0', to support the company's transition to a digitised business. How do you implement real-world solutions?

For Kampf, the answer is: "Operate in a networked and open manner", as Dr Donatus Weber, Head of Innovation and Industrie 4.0, puts it; "above all, don't hesitate – just get started." He considers it particularly important that the issues of digitalisation and networking be addressed at a very early stage. Digitalisation will secure a company's future viability, because the requirements of customers in the cutting and winding industry are becoming increasingly specific.

Exchanging views with customers and specialists in the industry on the complex topic of Industrie 4.0 is the basis for creating networked solutions. This exchange has produced the 'Converting 4.0' network, which has developed into a strong alliance of mechanical engineers, OEMs, software providers and specialist institutes.

At Kampf, the Converting 4.0 project kicked off with the establishment of interdisciplinary teams and setting up the new Industrie 4.0 department, with the aim of uniting the world of IT with that of mechanical engineering. The specialists quickly realised that the connectivity of machines and components has to come before future-oriented industries and their people are linked in.

As part of the newly created network, 'the@vanced' was developed. This integrative platform provides the partner network with a basis for mapping the entire value-creation chain. Users are able to collect data – including from upstream and downstream components – and evaluate these data in real time. The data can be evaluated holis-

Digitalisation secures future sustainability.

tically and displayed together with the process data and information from the machines anywhere and at any time, allowing operators to initiate optimisation measures.

These networked production data identify potentials to optimise overall production, and thus respond more flexibly to customer requirements. The user receives a real-time overview of all relevant production parameters. He can monitor how the track position changes across the roll and assess the winding product. Information about defects, position and time is stored, and other information such as temperature and humidity may potentially be added. He can take appropriate actions and directly verify their outcomes; this results in a much more efficient and faster production process, while simultaneously enhancing the products.

In addition, the intuitive platform offers tools such as machine manuals, spare parts catalogues, help videos and predictive maintenance support, as well as the option of remote maintenance. The networking of machines and systems creates a digital CV – providing complete documentation of the finished product's manufacture. The operator and the user receive full transparency about the product. "The platform allows us to enter the smart production environment of the future", says Weber.

Supported open systems

Now, Kampf believes, the priority is to get other people interested, in order to jointly press ahead with the ideas thrown up by Industrie 4.0. For this reason, Kampf is involved as a founder member of the 'Mindsphere World', a user organisation which aims to expand the ecosystem around the open IoT platform Mindsphere world-wide. Together with 18 partner companies, Siemens AG founded this global user organisation for the cloud-based, open IoT operating system.

The association aims to support individual members in developing and optimising IoT solutions and opening up new markets in the digital economy. This includes suggestions on requirements for the IoT operating system and recommendations for creating uniform rules for data utilisation.

Gudrun Mattig
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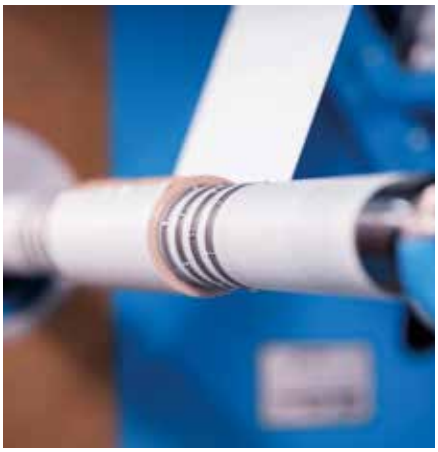

The platform developed by Kampf opens up new potential to act in a networked and open manner.

Smart Production of Customised Turbo Technology

ALJOSCHA SCHLOSSER

The ‘smart factory’ is a fully networked, intelligent factory. Human, machine and component communicate with each other to turn out products using very special technology.

Photos: Boge

Engine assembly with digital assistance system: the coding allows direct projection of the work instructions and assembly information.

Smart production for smart products: Boge Kompressoren Otto Boge GmbH & Co. KG has developed a highly efficient compression principle for a high-speed turbo compressor. To manufacture the technology cost-effectively and in high quality, a new production model is needed. The compressed air manufacturer has therefore built a fully networked, intelligent factory in Bielefeld: the ‘smart factory’, where human, machine and component communicate with one another. A digitised assistance system supports assembly operators in the ergonomic implementation of complex production steps, and adjusts for each individual component. The result: maximum process reliability, and production in zero-defect quality – whether series production, or custom manufacture in a batch size of 1.

The concept of the smart factory

As a result, the system delivers 100 percent oil-free compressed air. Previously, the turbo-compressor was produced under factory conditions. In the smart factory at the company headquarters in Bielefeld, the compressor is manufactured in a consistent, reproducible quality. Over 2,000 square metres, the ‘smart factory’ combines modern manufacturing technologies with the expertise of the company’s employees.

Digitalisation, manual work and automation are combined based on the model of the OWL Smart Factory, an initiative of the Fraunhofer-Gesellschaft and the Hochschule Ostwestfalen-Lippe in Lemgo, where Industrie 4.0 technologies are scientifically researched and tested. The facility allows for the setting-up of plant components and machinery, to enable thorough testing in pilot operation. Suitable prototypes and procedures have been further developed for the company’s own operations.

Assistance systems help

In the Boge smart factory, assistance systems support employees in manufacturing engines and frequency converters, coating of components and the assembly of complete compressor modules. The systems allow for rapid familiarisation, and guide employees through the individual assembly stages. Supplied and manufactured components are clearly coded. When the employee scans a component, he immediately receives further instructions and assembly information.

All process flows are continuously documented and the parameters transmitted to the ERP system. Each operator's position adjusts automatically to the assembly requirements of the individual components – without elaborate modifications or programming. The operator's positions are equipped with a modular assembly kit. Pick-to-light, for example, gives the assembly operator precise information to enable him to extract the required elements. So-called e-balancers provide mechanical support for employees when transporting heavy components. This allows large loads to be moved easily and precisely to the millimetre.

The smart factory enables ergonomic working and the straightforward performance of complex work steps. Individual labelling of separate components ensures full traceability of relevant production parameters, and thus absolute transparency of the production stages.

Smart tools

In the smart factory, torque wrenches with WLAN access are used. These assembly tools are linked to the ERP system and therefore know, specifically for each product, what torque is required; they then adjust the torque independently. The current status of the production and assembly lines is displayed on a board for all employees to see. The system offers maximum transparency and creates the conditions for paperless production and logistics.

The smart factory has been in operation since September 2017.

"Our smart manufacturing has met all expectations: we produce in zero-defect quality from a quantity of 1", says Thorsten Meier, Managing Director at Boge. The smart factory is evolving constantly. Boge plans to expand the manufacturing principle in the future, and transfer it to other model ranges. In the next stage of expansion, mobile production information systems displayed on tablets and driverless transport systems are planned.

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A digital assistance system provides support with the unit assembly, simplifying complex work processes.

Assembly line for frequency converters.

Digital Solutions for Future Processes in Manmade Fibre Production

ANDRÉ WISSENBERG

Global competition in the manmade fibre industry and changing expectations among end consumers for more individualised fashion are creating challenges for yarn manufacturers. Production must be considered carefully from all angles if it is to be flexible and efficient.

Photos: Oerlikon Manmade Fibers

A digitalised production system improves efficiency and quality. This contributes substantially to ensuring competitive production, even for small, flexible batch runs.

Special manufacturing requirements, such as spun-dyed products or special yarn cross-sections, must be made flexibly, quickly and efficiently in small batches, without impacting on the manufacture of standard products. The risk of waste, quality problems or over/underproduction can be ruled out by planning the switchover between products as perfectly as possible.

A workflow management system makes it possible to keep an eye on all aspects of production in a manmade fibre plant, from polycondensation to the spinning mill, texturing and the downstream further processing stages. In this way, process sequences can be optimised, production planned in the best way possible, and product quality improved. This concept thus supports the constantly increasing need for more flexible production processes. The Plant Operation Center (POC) workflow system used by Oerlikon's Manmade Fibers segment is structured on a modular basis. With more than 30 modules in the areas of quality assurance, maintenance and production planning, and formula management, for example, the management system is perfectly tailored to suit customer needs.

The key element is to ensure traceability of all process data in real time. This makes it possible to respond directly to deviations in machine efficiency or product quality. Not only is data from the in-house laboratory incorporated directly into the sequence, but also data from further processing stages such as texturing, once the appropriate connections are in place. Likewise, the Center can also monitor ancillary plant such as air-conditioning, the compressed air supply and the entire polycondensation plant. Workflow management offers the following:

- Transparency throughout the production process and across many plants around the world;
- Reliable real-time data analysis;
- Rapid identification of error sources;
- Support for short decision-making channels and rapid implementation of process changes;
- Ideal capacity utilisation of personnel and reduced downtimes;
- Avoidance of incorrect process settings.

Modules in detail

The modular structure lets yarn manufacturers coordinate their workflow management to suit exact requirements. As an overall concept, the POC takes over a large part of the duties of the Manufacturing Execution System

(MES), including the connection to higher-level ERP systems and it interfaces with automation systems like reel handling and warehousing at the spinning mill. The concept includes control over automation systems in the spinning process. Each individual module offers specific potential for saving production costs.

Production planning: Optimum preparation of production orders is followed by incorporation into production process scheduling. This helps to ensure transparent production, and avoids production overruns or shortfalls, even for small volumes.

Formula management: Machine settings optimised for the product in question are saved in the formula management system and transmitted to the production plant without error when it is time to switch to a new product. This ensures product quality, even with frequent product switches.

Quality assurance: Incorporation of data measured in the laboratory ensures a high level of product quality is maintained. In addition to hundred-percent traceability for every individual product unit (reel) throughout the entire manufacturing process, a "cyber physical system" also enables rapid identification and response to any potential quality deviations.

Efficiency monitoring: The statistics module continuously monitors the efficiency of production of individual products or entire machines and plants. Breakdowns in the production process, which may lead to reduced yields or higher levels of waste, are identified at an early stage and quickly rectified.

Alarms and maintenance planning: A system of alarm management and maintenance planning coordinated with the production process enables the system to help customers to minimise downtimes and unplanned interruptions, and thus also production waste. The work of personnel and capacity utilisation can be optimised at the same time. Breakdowns in the plant are displayed transparently via monitors or on mobile devices to enable them to be quickly rectified, and any necessary maintenance can be scheduled as part of the production process as the personnel with the necessary skills become available. There is also support for shift planning in line with actual personnel requirements.

Performance monitoring: For real-time monitoring of production facility efficiency, data can be displayed in the customer network or on mobile devices broken down by Key Performance Indicators. This means that management can check plant efficiency at any time, even when away from the plant. If unplanned machine downtimes should arise or if process problems should occur, service experts can contact the plant directly using the Remote Support function and provide the plant operator with assistance at short notice.

Upgrade to existing plants

A workflow management system is the system of choice for process monitoring, not only for new plants. Existing manmade fibre plants can usually be incorporated without difficulty. This means that an improvement in quality and efficiency is assured even for older plants.

Digitalisation does not end at the production plant itself. A platform also offers assistance with maintenance, spare parts supply and customer support. Oerlikon Manmade Fibers provides a view of what the future will offer with further Industrie 4.0 solutions, drawing on augmented reality solutions, support from the Microsoft HoloLens in the field of predictive maintenance, and online process and maintenance support.

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Unscheduled machine downtimes can lead to problems. Experts can provide assistance using the Remote Support function that gives them a direct view inside the plant.

Imprint

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Publisher
VDMA Verlag GmbH
Lyoner Straße 18
60528 Frankfurt

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Layout and Design
VDMA Verlag GmbH

Production
designtes, Frankfurt

Front Page
Photo Zapp2Photo/iStock

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ProduktionNRW is the mechanical engineering and production technology cluster in North Rhine-Westphalia managed by VDMA NRW. It is conceived as a platform to enable companies, institutes and networks to link up, both among themselves and along the value chain, and to provide an opportunity for information and marketing. Substantial parts of the services performed by ProduktionNRW are sponsored by the European Fonds for Regional Development (EFRE).

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