2015

industrie 4.0 magazin

Magazine for integrated production processes

The Importance of IT Systems for Future Production Processes

IT drives Production

PSI

HANNOVER MESSE TRADE FAIR: Hub of Innovation for Industrie 4.0

Dr. Jochen Köckler, Board Member of Deutsche Messe AG

There are good reasons why politicians, academics and the business community have decided to use the HANNOVER MESSE trade fair to launch and promote the future-oriented project Industry 4.0. There is no other event where the cumulative innovative capacity of German industry is so comprehensively represented. The focus is on what can feasibly be achieved and what future visions will actually look like in practice. Industry 4.0 entails the completion of the digital factory. When integrated digital value creation processes and actual production merge together, intelligent networked products can be created which will be successful in the Internet of Things. As a leading international exhibition for integrated processes and IT solutions, the Digital Factory has become a melting pot for these developments. All the strands of IT that are required for the comprehensive digitalization of industry will be represented – most crucially, PLM, ERP, MES and CAx systems.

Industry 4.0 is all about networking. The integration and interlinking of value creation processes and the supporting IT infrastructure, networking of manufacturers and suppliers and, ultimately, the networking of industry and the market in the Internet of Things. All parties will be represented at the HANNOVER MESSE – manufacturers of machines and systems, components and drives, equipment and IT. They are beginning to see themselves as the nucleus of a network that is aiming to play a leading role in the fourth industrial revolution.

This means that the exhibition in Hanover is more than just a trade fair – it is the place where the pioneers of the industry get together. Integrated Industry – Join the Network!

Editorial

Dear readers,

The term #IndustryFourZero is everywhere at the moment – a German concept with the potential to establish „Made in Germany“ as a global benchmark. Even the German Chancellor has recognized this and is calling for more collaboration among Germany‘s key industrial sectors and the country‘s IT industry, which she believes has slept through the emergence of the Internet.

If we are struggling to achieve success with end users and consumers, the „Industrial Internet“ should be made for us. In the future, German industrial suppliers will be able to deliver their solutions complete with the required software systems and web infrastructures, making them independent of large collectors of data. Therefore the outlook is very promising.

However, so far, there are few signs of German talents being pooled. Wherever you look, there‘s a dispute over responsibilities, despite the fact that digitalization is meant to foster social togetherness. The established industries in Germany and throughout Europe are under immense pressure. The larger the company, the greater the fear of being replaced by new business models.

In other countries, people are referring to this as „German Angst“, even though we‘re doing better than ever and, economically, we are not dominated by a small number of huge corporations but instead benefit from a wide range of flexible, pragmatic and innovative smaller companies.

Germany is a high-wage country that is not blessed with a wealth of raw materials, but we still manage to produce things profitably. Individual companies are copied, but replicating a network of suppliers who operate in partnership, conduct joint research and maintain shared business relationships is much harder.

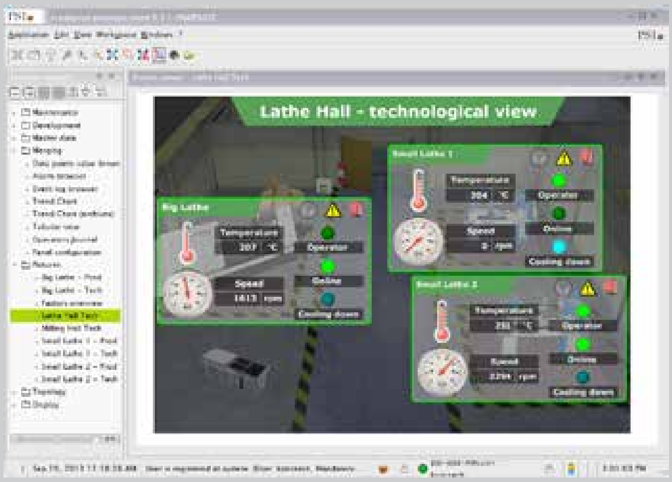
This magazine reports on solutions, initiatives and research projects that all believe in the vision of the fourth industrial revolution without going crazy over it and that are taking pragmatic steps towards making it a reality.

We hope you enjoy reading it.

Peter Dibbern
Head of Business Development
PSIPENTA Software Systems GmbH

Page 08 | **How Operational Data Can Be Used to Generate Added Value Information for Production**

Page 26 | **Visualization Solutions that Allow an Expanded View of Production Processes**



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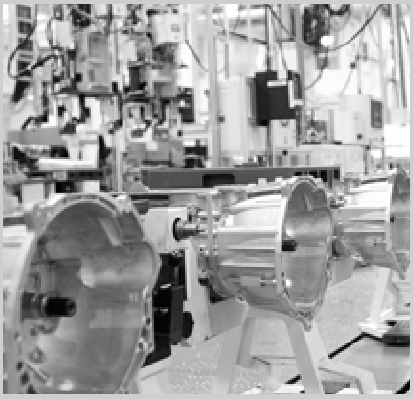



GEMÜ

PSI Solutions Support Structural Change toward Industry 4.0

The revolutionary concept of self-organized, flexible production will conquer the world in no time. PSI began preparing its products for the requirements of Industry 4.0 at an early stage.

➲ Karsten Pierschke
Head of Investor Relations and Communication
PSI AG

As one of the most experienced software companies in Germany, PSI has many years of expertise and products that cover the entire production and logistics process, as well as all planning levels. This enables us to provide effective support in the gradual implementation of the fourth industrial revolution.

In close collaboration with leading partners from the fields of science, research and industry, we are involved in implementing the Industry 4.0 vision in production and logistics in a range of research projects. The results are tested practically in pilot projects and are incorporated into the ongoing development of our software products, making them available to all PSI customers.

From Research to Practice

One of these research projects is the WInD project, completed in the summer of 2013. The overriding objective was to devise an adaptable production system. The results obtained were used to develop production of the StreetScooter electric car.

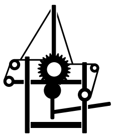
The StreetScooter – Affordable Electromobility thanks to Innovative Production Concepts

In a short period of time, the StreetScooter research alliance has created a totally new class of vehicle. The innovative structure and development concept enabled the first series production model of the electric car to be developed in around half the time and at a tenth of the cost. The integration of all software components enabled the first integrated visualization of all processes, from ordering to design changes, purchasing processes, production planning and control through to the workshop level. In this project, PSI provided the software basis for order management, production planning and control, and concepts for optimizing the supply of power to the manufacturing processes. Newly developed methods and standards are used, which have been devised in various research projects on issues relating to the fourth industrial revolution.

Short Development Times for Individual Developments

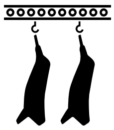
Within a year, the first series production model of a customer-specific version based on the StreetScooter prototype

The Changing Face of Industry



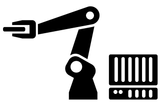
1.0

1784 | Mechanical loom
Introduction of mechanical production systems using water and steam power



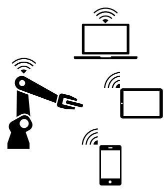
2.0

1870 | Production line
Mass production based on division of labor using electrical power in slaughterhouses in Cincinnati



3.0

1969 | Programmable logic controller
Beginning of the use of electronics and IT for further automation of production



4.0

In Germany, the „Industry 4.0" program is seeing Internet business paradigms being applied to the production of goods. By 2025, this fourth industrial revolution will break up, recombine or even totally replace many of the accomplishments of the past. Mobile Internet technologies will be used to create self-organizing, highly flexible production. Production lines will be replaced by manufacturing cells.

was developed and tested for use as a delivery vehicle for mail deliveries. Once the custom-designed electric van obtained its operating license at the beginning of 2014, 50 vehicles proceeded to endurance testing under everyday conditions in the area around Bonn, Germany.

Modular Principle

The development of the vehicle structure was consistently based on a modular principle. This modular structure ensures that the StreetScooter can be repeatedly upgraded and reconfigured for different applications. Unlike in conventional automotive manufacturing, this enables low volumes to be produced at competitive prices, thanks to innovative Industry 4.0 concepts and flexible IT support.

Smart Production is the Future

The combination of customer proximity, ground-breaking research projects and important industry standards as part of our group platform is a key element of our product strategy. It ensures that our solutions take into account current and future trends and actively support the structural change as we move toward Industry 4.0. i4.0

More information about the StreetScooter project and the real-time production system can be found at: www.youtube.com/user/PSIPENTATV

Data and Software as a Critical Competitive Factor

Increasing the productivity of value creation systems is at the heart of every industrial revolution. While all previous industrial revolutions – mechanization, mass production based on the division of labor, and the automation of production – focused on productivity increases in the production system itself, the fourth industrial revolution is pursuing the objective of bringing about an integrative increase in productivity in both management and production systems, and thus optimizing the indirect value creation costs, which have remained relatively constant in past decades.

➲ Prof. Dr.-Ing. Volker Stich
FIR Chief Executive
FIR e. V. at RWTH Aachen University

Dr.-Ing. Niklas Hering
Head of Production Management Division
FIR e. V. at RWTH Aachen University

As part of its overall high-tech strategy, the German federal government has initiated the future-oriented project Industry 4.0 to address the efforts described to bring about the fourth industrial revolution. Within the Industry 4.0 project, a wide variety of research projects, technological developments, studies and implementation projects relating to the future of production and logistics are currently in progress. At the heart of all these activities are what are known as cyber-physical systems, which link the virtual data world to physical objects and use mutual networking to enable them to exchange information with one another as a basis for decentralized decision-making.

The Focus of All Industry 4.0 Activities Must Be Commercial Benefit

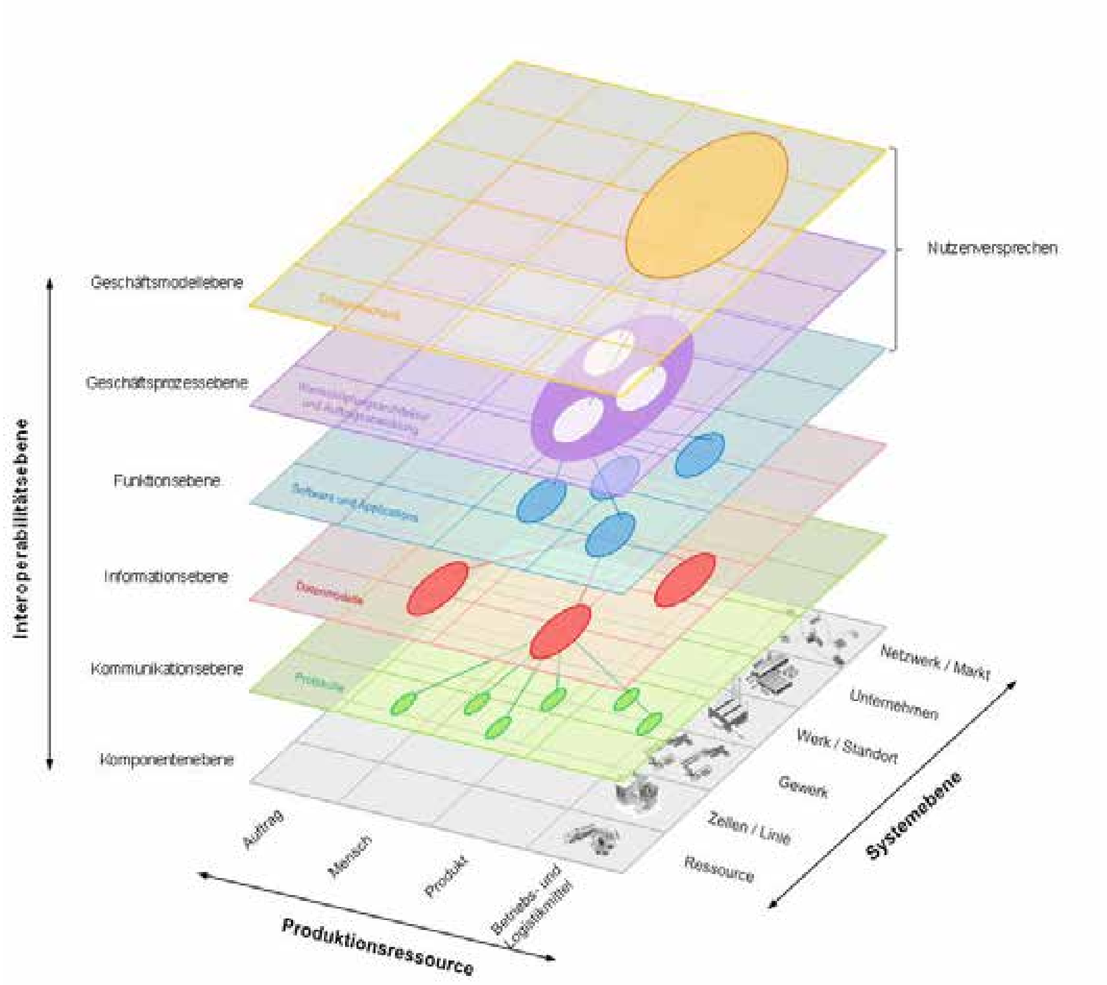
A key characteristic of all Industry 4.0 efforts is their benefit-centered approach, i.e. all applications relating to Industry 4.0 must focus on and address the economic benefit to the user, for example using ROI calculations. This is a clear criterion that differentiates Industry 4.0 from the Industrial Internet movement in the USA, where technology as an end in itself often plays a predominant role (technology push). Thus, new technologies and their potential uses are the focus, and the quantified potential benefits, for example based on business cases, are frequently ignored.

As an initial conclusion, it is apparent that the future-oriented project Industry 4.0 is based on the realization that the aim of a significant increase in productivity can only be achieved by adopting an integrated perspective of the organization and its management. Enhancements of existing basic technologies can only deliver their full potential benefit in the organization if the organizational structures and processes (order processing, production planning and control, direct value creation processes) are synchronized, the supporting IT systems are integrated as effectively as possible and the most productive degree of autonomy for the decision-making systems has been identified.

Data and Its Intelligent Use Will Be a Critical Competitive Factor in the Future

As the productivity perspective is extended in the context of Industry 4.0, information technology takes on huge significance. Highly automated production plans and efficient shop floor organization are no longer seen as the sole success factors in increasing productivity. Instead, it is the operational data and its intelligent use that will make the crucial difference in the future performance and cost dimensions of manufacturing companies. The focus is primarily on those information technologies that allow generation, processing, analysis and exchange of operational data, and thus create a basis for digitalized and highly networked production systems. In addition to AutoID technologies, these are predominantly operational application systems.

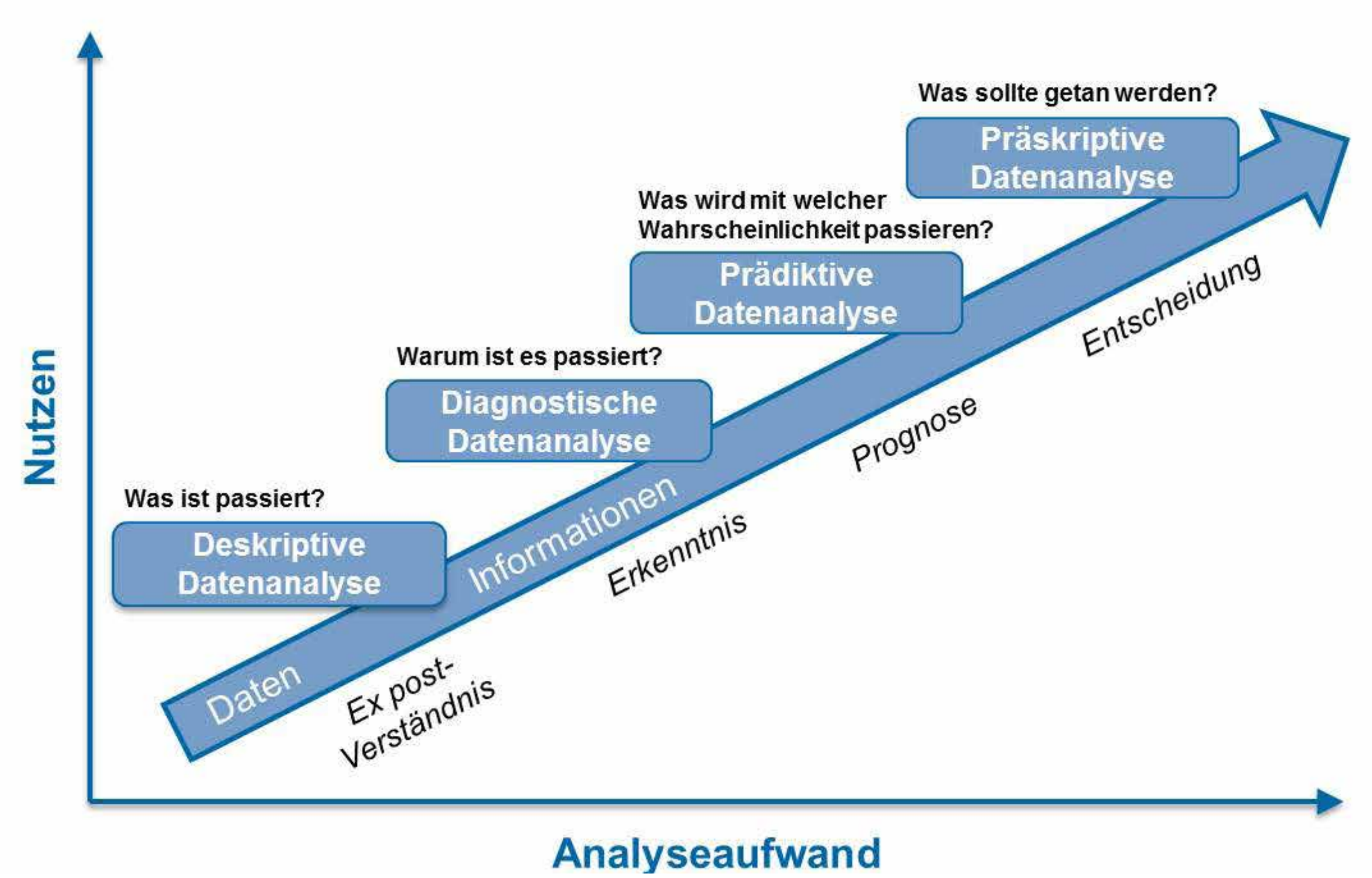
The concept of integrating intra and intercompany data and information flows is particularly and clearly illustrated by the different interoperability levels in operational value creation. Companies primarily realize the potential benefits that result from the data and the associated digitalization at functional, business process and business model level.



The different interoperability levels in operational value creation highlight the importance of an internal and intercompany integration concept.

Operational data alone has no benefit. It first has to be qualified by intelligent transformation to produce added value information, which delivers conclusions and findings that promote better decision-making and provides optimum support for operational routines using self-learning systems. As a consequence, the operational data and its analysis and evaluation enables almost complete transparency all the way along the process chain (information relating to order progress, material availabilities, etc.), significantly increases planning accuracy in production planning and control (production forecasting), and improves the quality of business decisions using simulation-based support systems.

Data analysis methods and models transferred to an application context from production and logistics are used to develop and implement decision support systems. The method is based on a four-stage concept in which the various IT systems take on different roles.



The four-stage concept assigns the various IT systems different roles and supports decision making.

Four-Stage Concept

Descriptive Data Analysis
The starting point for the first stage of the method – known as descriptive data analysis – is structured and unstructured data, which is generated in different operational processes and is enhanced and contextualized to provide meaningful information. As part of this analysis, methods from descriptive statistics are used to carry out data aggregation and evaluation, with the aim of drawing conclusions about past events and answering the question „What has happened?".

Diagnostic Data Analysis
At the next stage, known as diagnostic data analysis, the data records are examined for correlations and relationships using data exploration, enabling any cause-and-effect relationships to be identified. The diagnostic analysis answers the question „Why did it happen?".

Predictive Data Analysis
The third stage, known as predictive data analysis, involves the use of statistical models and methods to forecast future events and thus to answer the question „What will happen and how likely is it?".

Prescriptive Data Analysis
The final stage is known as prescriptive data analysis. Here, optimization algorithms and simulation methods are used to generate possible recommendations for action and answers the question „What should be done?".

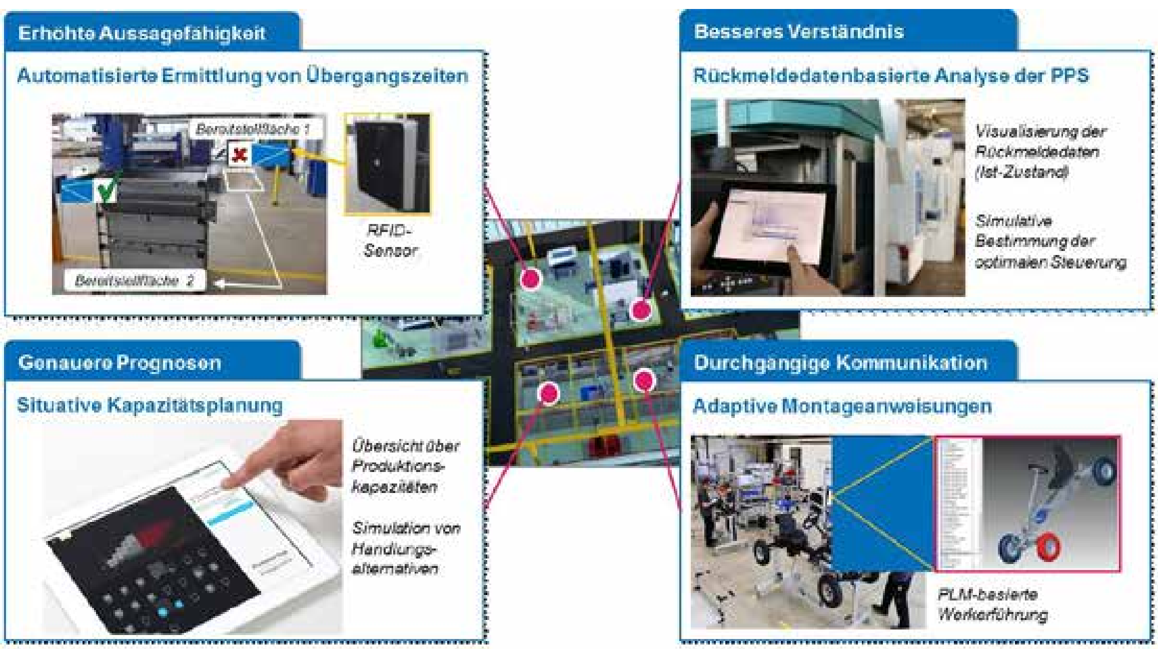
A key prerequisite for the data analysis and an important area of activity in terms of digitalization efforts is data management. It is essential on the one hand to guarantee that master and movement data is of very high quality and, on the other hand, to establish non-redundant data storage in line with the „single source of truth" principle. To ensure that data is used efficiently, it is also necessary for operational applications to be integrated as fully as possible at all planning levels using standardized interfaces and for smooth and fast data exchange to be possible, all against the backdrop of an exponential increase in the amount of high-resolution data theoretically available.

The Aachen perspective of collaborative productivity emphasizes the productivity increases resulting from networking and the integration of decentralized intelligence.

A new research environment in Aachen that is unique in Europe is responding to the latest developments and establishing itself as one of the central hubs of the future-oriented project Industry 4.0. FIR – part of the Logistics cluster at the RWTH Aachen University campus – and its industrial partners have set themselves the target of researching practical issues and applications relating to Industry 4.0 based on comprehensive and interdisciplinary value creation expertise. They are aiming to develop new processes, systems, prototypes and products that will play a significant role in shaping tomorrow's production and help to secure the future international competitiveness of the manufacturing industry in Germany.
The research and development is conducted in a unique infrastructure made up of three innovation laboratories and an associated real factory (Aachen demonstration factory), which acts as a reference factory for testing, validating and quantifying the benefits of new solutions in the context of Industry 4.0. Within this research infrastructure, FIR and collaboration partner PSI are investigating the future of production from an integrated perspective, and supporting companies of all sizes in equipping themselves for the fourth industrial revolution.

PSIPENTA Is the Ideal Partner for Developing a New Generation of ERP Systems in the Industry 4.0 Age

Against the backdrop of the increased analysis required in the context of Industry 4.0, PSI, as an innovative software provider, is the ideal partner for developing intelligent solutions for planning and controlling future production and logistics processes. PSI software systems are characterized by their ability to plan, control and optimize highly complex operational processes and infrastructures, some of them in real time. To do this, PSI already uses various statistical methods and models (e.g. fuzzy logic) as well as mathematical optimization methods (e.g. higher quality decision optimization functions), making it a technological pioneer in the ERP market.
The existing cooperation between FIR and PSI has enabled comprehensive prototypes and products to be developed based on various research projects and use cases, and these are already supporting manufacturing companies in achieving extensive productivity increases. i4.0



The Aachen demo factory is used to research new solutions in the Industry 4.0 framework.

RWTH AACHEN CAMPUS
LOGISTIK

The Symbiosis of Product, Production and Corporate IT

The ideas born out of the Industry 4.0 vision of a smart factory, producing smart products and subsequent product-related smart services result in totally new requirements, for both the production systems themselves and for the IT systems used to control them.

➲ Karl M. Tröger
Head of Product Management
PSIPENTA Software Systems GmbH

The ability of products to be networked in the Internet of Things opens up completely new possibilities for providing product-related services. In the future, a product will no longer be defined by its physical and technical properties alone, but also by its representation and activity in the Internet of Things, not only as an end product but also on its way through the production systems prior to its completion.

Status Quo

Today's software environments reflect the current tendency to separate different IT systems according to their arbitrarily assigned task. The ubiquitous automation pyramid is one way of describing this separation. The corporate level, generally represented by ERP systems, provides the framework for order processing. These systems are primarily commercial in nature. The focus is on mapping the flow of value and products from the supplier, through the production process and ending at delivery and billing. When planning order situations, the schedule is often relatively general.

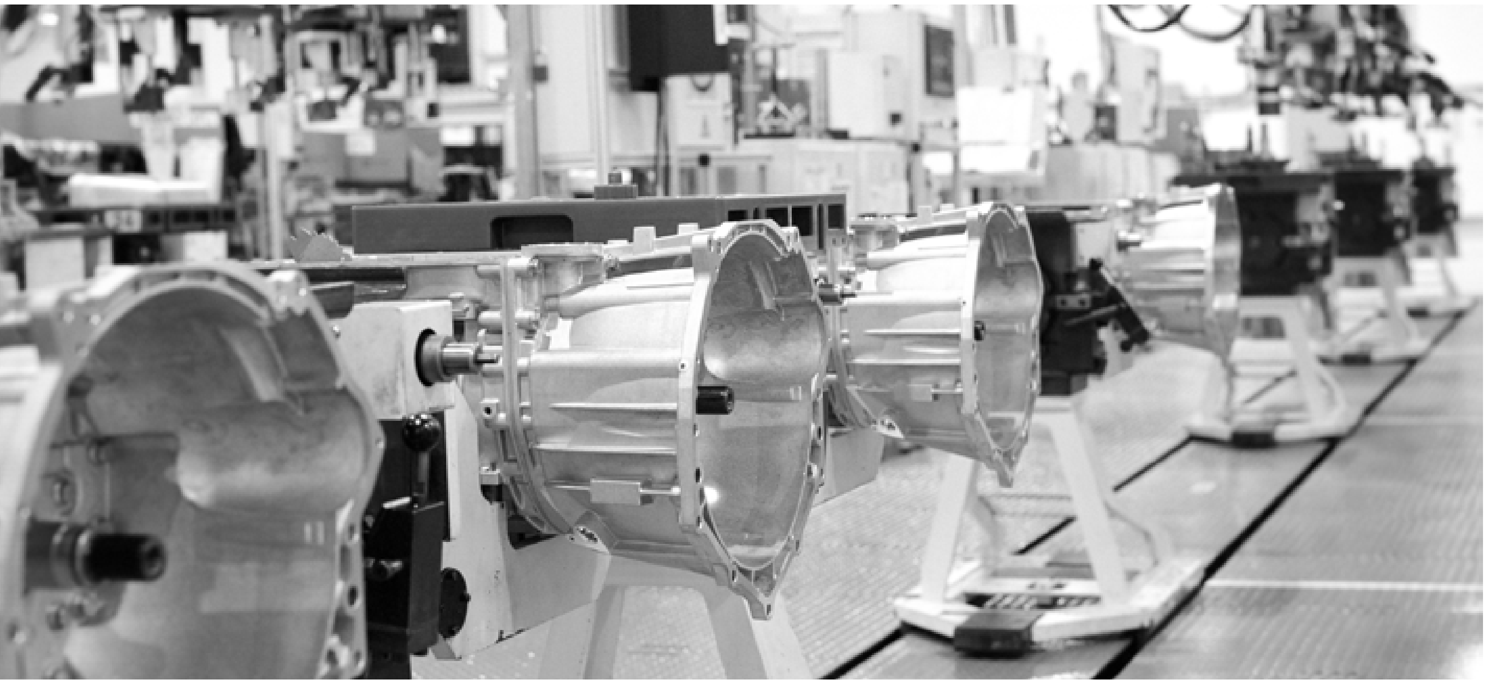
In many cases, planning is refined and actual production parameters are taken into account at the next level of the hierarchical automation pyramid – the operational level. This is where MES systems are used. These systems are capable of much more detailed production planning and, at the same time, are intended to ensure that the specifications from the corporate level are implemented. The interfaces to the next level down (process control level) and to the ERP world are not always straightforward, and involve a degree of complexity that should not be ignored. Suppliers who can offer both ERP and MES systems from a single source have a clear advantage here. There is much greater flexibility in implementing integration between the corporate and operational levels.

There is often an additional level between the operational level and automation technology. This level is essentially used to visualize specific machine statuses. These solutions are known as SCADA systems and are machine-specific, allowing current operating parameters to be influenced and monitored.

The control level is represented by the automation technology and the connected sensors and actuators. In most cases, there is no link between the higher-level planning systems and automation technology. Systems for the acquisition of machine data do not completely close this gap, as the data acquired is not – or is only infrequently – used to continuously influence the various planning levels.

IT Systems in the Smart Factory

The anticipated properties of the smart factory and the smart products manufactured therein call for a new approach to planning and controlling the production system. A strictly hierarchical and centralistic organization is irreconcilable with increasing decentralization and autonomy of production units. In particular, smart products, with their active communication capabilities, represent huge challenges for current systems. They will go way beyond the requirements currently placed on passive systems such as RFID technologies. There will be an additional IT system to be integrated into the system environment. The key is to break down the arbitrary boundaries between systems and to establish an integrated production control system that incorporates all components.



It is not just smart products that will bring new requirements for the software environment in tomorrow's factories. Increasingly sophisticated sensors will be able to supply data that will feed into continuous simulations of the production system. This virtual production map allows future statuses to be forecasted, and also enables the current performance of the entire system to be monitored continuously. In the future, it will be possible to use the results of sophisticated analysis for automated control of the entire production system or specific parts of it. The increasingly dynamic nature of the resilient factory will require an integrated approach to all the IT systems involved.

The existing and future communication capabilities of production systems are another element of the smart factory. Ongoing adjustment of material and product flows will be possible, or even essential, at machine level and, where necessary, also between companies. To cope with this, stable, robust and particularly secure communication channels need to be created.

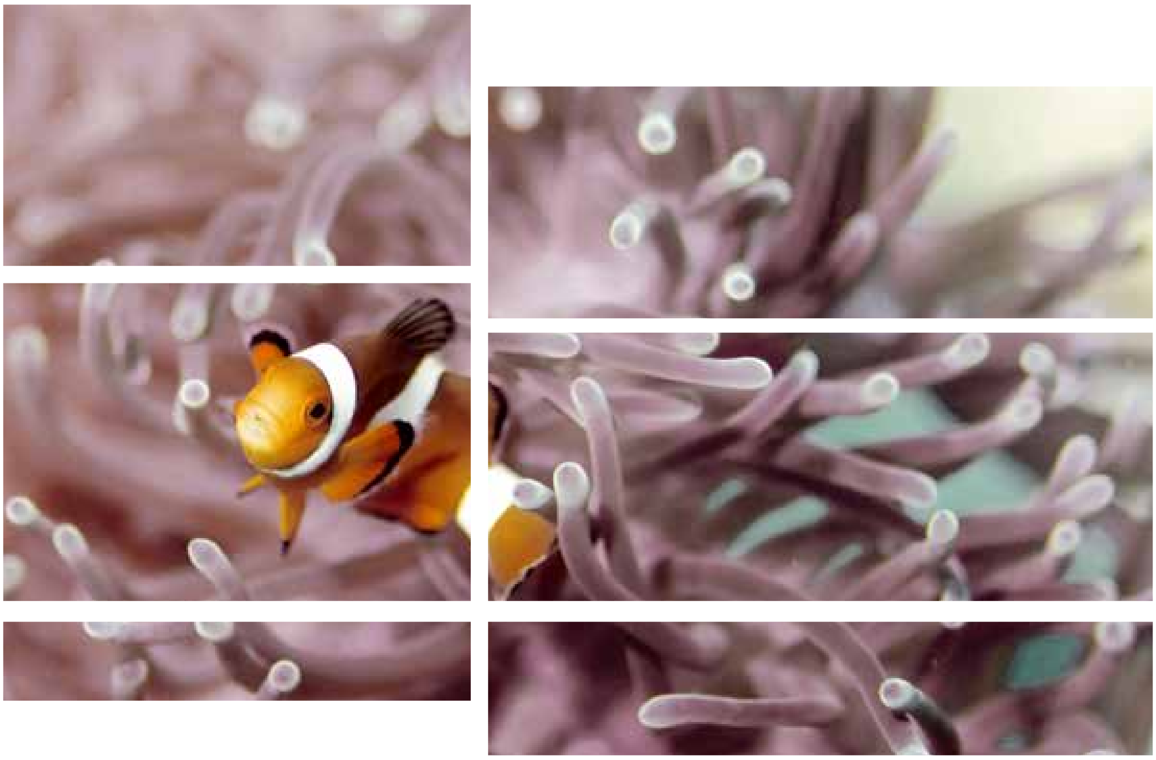
The ability to reconfigure a production system depending on the product mix, system availability and other parameters demands new capabilities from the IT systems involved. Production control systems need to be able to represent these dynamics and the communication capabilities of the products and machines. In the future, it may even be possible to directly derive the control model for automation technology during reconfiguration.

Integration at a Higher Level

Only smooth interaction between all components, based on flexible standards, will allow the resulting smart factory and smart service concepts to be implemented successfully. New business models will be developed. The integration of corporate, production and product IT at a new and higher level than today will be crucial. There will be a realignment of tasks and responsibilities. This approach, which is integrated without being restrictive, can be compared with the symbiosis between different organisms in nature. Symbiosis is all about mutual benefit and supplementing capabilities that are lacking – in a similar way, IT systems in the smart factory will need to complement each other and develop an almost symbiotic relationship. i4.0

This approach, which is integrated without being restrictive, can be compared with the symbiosis between different organisms in nature.
In a similar way, IT systems in the smart factory will need to complement each other and develop an almost symbiotic relationship.

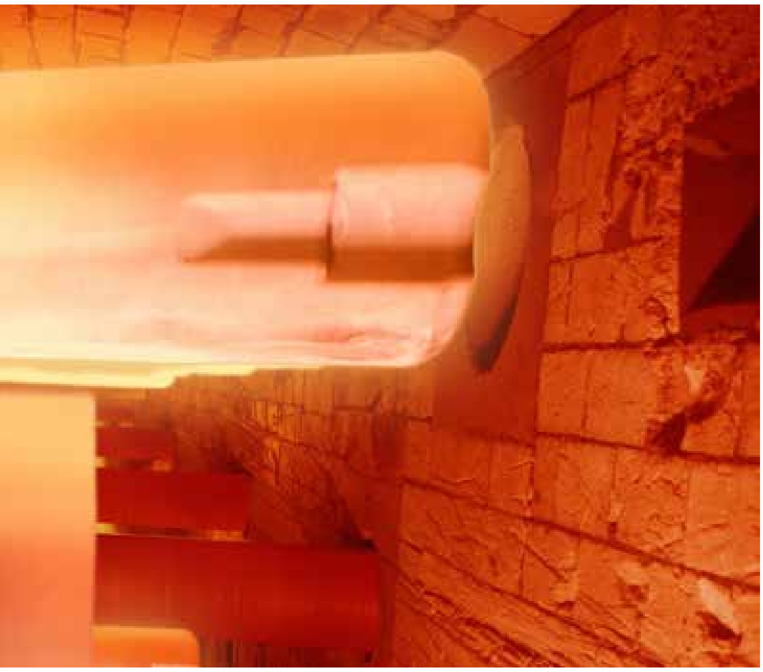
– Karl M. Tröger | Head of Product Management
PSIPENTA Software Systems GmbH



Hot Furnaces and Cool Chips: Data as the Basis for Industry 4.0

The fourth industrial revolution is not a new topic these days, even in a conservative sector like the steel industry. Producers and trade associations are outlining their ideas, while suppliers from plant engineering and IT are also sharing their vision of an Integrated Industry. So which concepts for the future project can (or could) be implemented in the harsh world of hot furnaces?

➲ Raffael Binder
Marketing Director
PSI Metals



To find out, we visited Karl König at the voestalpine Stahl GmbH steel company in Linz. König has worked at the Austrian steel producer for many years and, since 2010, has been the head of the „electrical and automation technology" committee at „Stahlinstitute VDEh", the technical and scientific organization representing the steel industry in Germany. He and his committee have been working intensively on the issue of Industry 4.0 and its importance for the steel industry. They are due to publish recommendations for members by the end of 2016.

The Internet of Things, virtualization and smart manufacturing are the buzzwords behind the idea, and none of the major players in IT or plant engineering tire of coming up with their own smart concepts. But is it all just a big marketing bubble? „It's about production and nothing else," König elaborates. „I've been working at voestalpine since 1974 and started dealing with automation early on. I've been involved in the issue of material monitoring since day one." In metal production, huge varieties of finished products are manufactured from a single liquid raw material. At each stage of the process, the number of product varieties increases. „Before a sheet or coil is finally produced, there are a huge number of operations between the individual stages. This process is what makes production monitoring so unique and difficult," König explains. It's a familiar problem that people are now attempting to solve with modern IT. It does not take long before the term „big data" comes up. „We already have to deal with a huge volume of data. The challenge is to link it in a meaningful way," says König

Big Data – Quality from Quantity

„Production systems are extremely expensive to buy and they are only profitable with a certain level of utilization. In addition, steel production and processing are characterized by variations in quality," König continues. This is precisely the challenge that the German manufacturer Saarstahl is trying to resolve.[*1] In conjunction with partners from research and business, Saarstahl's „iPRODICT" research project is aiming to create a system that can detect possible faults in production before they occur. All the data generated in the production process is analyzed to identify patterns, which in turn trigger an automated response in the event of variations in quality. In three years' time, we will see whether big data can actually deliver the quality improvements people are hoping for.

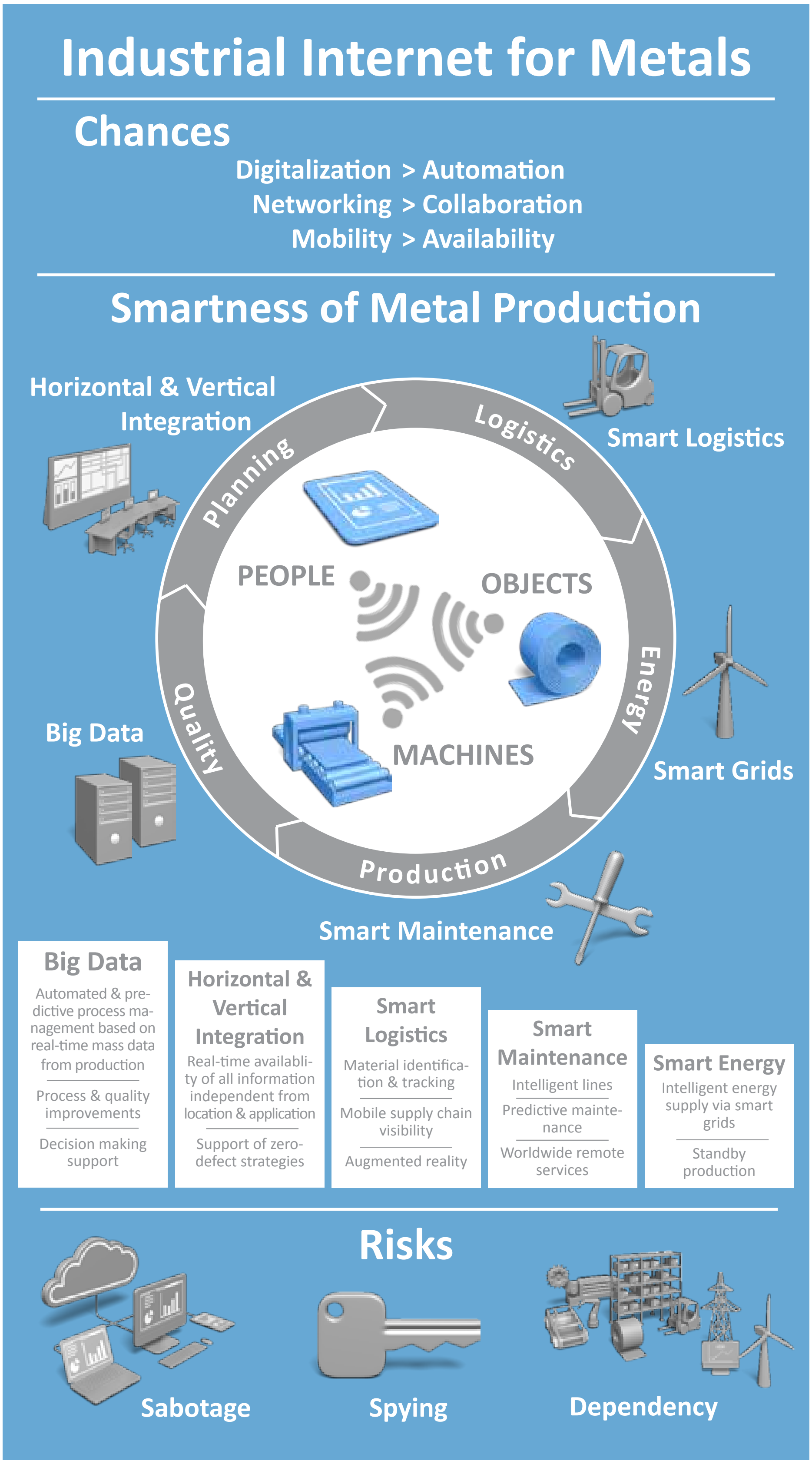
Smart Factory – Information in Flux

At the Düsseldorf steel conference, Stefan Meißner from Salzgitter Flachstahl explained that he believes that the real-time availability of any information across all levels represents a major opportunity for the steel industry.[*2] In the future, production information will be provided continuously to the operational and administrative levels („bottom up"). Conversely, administrative requirements will be fed through automatically to the production systems („top down"). Meißner believes that information should not only flow smoothly within a company – it is also important to connect „other parties involved in the value chain," such as logistics service providers, suppliers and customers, to the global smart factory network. So should we use cool chips to control hot furnaces?

Here, Karl König from voestalpine is sensing impetus from a completely different direction. „It's all about transparency.

*1 *Saarbrücker Zeitung, 01/29/2015*

*2 *Presentation: „Einführung in das Thema Industrie 4.0 – Informationstechnische Vernetzung als Zukunftspotential" („Introduction to Industry 4.0 – Future Potential of IT Networking") at STAHL 2014, Düsseldorf*


Industrial Internet for Metals
Chances
Digitalization > Automation
Networking > Collaboration
Mobility > Availability
Smartness of Metal Production
Horizontal & Vertical Integration
Smart Logistics
Planning
Logistics
Energy
Production
Quality
PEOPLE
OBJECTS
MACHINES
Big Data
Smart Grids
Smart Maintenance
Big Data
Automated & predictive process management based on real-time mass data from production
Process & quality improvements
Decision making support
Horizontal & Vertical Integration
Real-time availability of all information independent from location & application
Support of zero-defect strategies
Smart Logistics
Material identification & tracking
Mobile supply chain visibility
Augmented reality
Smart Maintenance
Intelligent lines
Predictive maintenance
Worldwide remote services
Smart Energy
Intelligent energy supply via smart grids
Standby production
Risks
Sabotage
Spying
Dependency

At present, producers only pass on as much information as is absolutely necessary, but customers are interested in getting much more detail. While people already work closely with customers in research partnerships, a genuine information culture is still lacking in day-to-day business in the industry.“ The mental walls need to be torn down before the global network can become a reality.

Automated Control: Selective Potential

According to Stefan Meißner from Salzgitter Flachstahl, there is the potential for major savings in areas such as intelligent power supply networks or a standby mode for production systems. This is where plant engineers come in. Intelligent, automatically controlled smart maintenance could make plant maintenance significantly easier. The idea is that smart maintenance plants automatically notify service personnel of current faults and any scheduled maintenance work. Plants and their operating status are fully mapped in the Internet of Things and allow intervention with worldwide availability. But is this a pipe dream? „Definitely not,“ says König. Plant engineers are already bashing down the doors of his VDEh technical committee with their latest solutions. However, steel producers first want to come up with an independent picture of Industry 4.0 and its applicability to their sector. Only then will the real discussions begin.

PSI Metals is paying very close attention to industry initiatives and believes that it is in a great position for Industry 4.0. Jörg Hackmann, Head of Product Management in the Metals division, believes that „intelligent material that routes itself through production“ is only possible where the external physical influences in the production process allow it, for example in the area of multilocation material logistics. Hackmann expects the real breakthrough for the metal industry to be big data, and he is fully behind the manufacturers‘ approach.

Making a Zero-Fault Strategy a Reality

Given that decisions can currently only be made after the production process (i.e. too late), the ability to make multicriteria decisions while a process is ongoing could be the „killer app“ of Industry 4.0 in the metals sector. The key is to integrate data from planning, logistics and smart devices in the relevant areas of the plant into the overall process control system. Linking plant status information with material-related historic and planned process data enables indicators of variations to be identified, thus paving the way for proactive production control. „This helps our customers to make a zero-fault strategy a reality – avoiding faults instead of correcting them, as quality variations remain the biggest trouble spot in production,“ Hackmann explains.

An integrated data basis, such as that provided by PSI*metals*, is the ideal framework. Whether it is comprehensive production monitoring or integrated energy management, it is already a reality in the PSI portfolio. „I think the ‚Industry 4.0 ready‘ label is a very good description of our current solutions. PSI AG‘s platform strategy also provides the perfect foundation. The issue is important to our customers and we will support them to the best of our ability in implementing it,“ concludes an optimistic Hackmann. i4.0

> **Avoiding faults instead of correcting them, as quality variations remain the biggest trouble spot in production.**
>
> *– Jörg Hackmann | Head of Product Management*
> *PSI Metals GmbH*

Continuous Monitoring in the Smart Factory Using Modern Machine Data Collection

A modern machine data collection (MDC) system is the link between manufacturing on the one hand and information processing and use on the other. MDC provides a basis for seamless production – a prerequisite for high production output. However, MDC is also the fundamental means to meet the demands for the individualization of large-scale production, the demand that led to the Industry 4.0 vision in the first place.

➲ Gerd Ludwig
Managing Partner
INTEC International GmbH

Revolutionizing Industrial Processes with the MEP®DataRecorder

The industry magazine „IT-Mittelstand“ recently reported that „Industry 4.0 means consistent industrial automation incorporating all relevant information that is available through global, open networks.“ The merging of the virtual and actual production worlds is replacing the previous central control with a decentralized, Internet-based model, and „cyber-physical systems“ are extending production processes. This term refers to intelligent devices and machines that communicate with one another independently to find the optimum route through production. The aim is to produce the finished product without the need for central control. At the same time, new materials or a service engineer can be ordered automatically. This kind of smart factory, which saves resources in manufacturing while simultaneously increasing productivity, delivers benefits by improving quality and increasing flexibility. But what role does machine data collection play?

MDC Is the Basis for Monitoring Industrial Production Processes

Central collection, monitoring and ultimately analysis of the operating and production data obtained from the running machine provide the necessary transparency for the analysis and optimization of production processes. MDC is also the fundamental means of meeting the demand for the individualization of large-scale production – the demand that led to the Industry 4.0 vision in the first place. Only the continuous monitoring of industrial production processes can then enable a company to check the status of an order at any time and synchronize production planning with goods receipt, simultaneously update the customer and adjust planning resources for the future order situation.

No Flexible Production without MDC Feedback

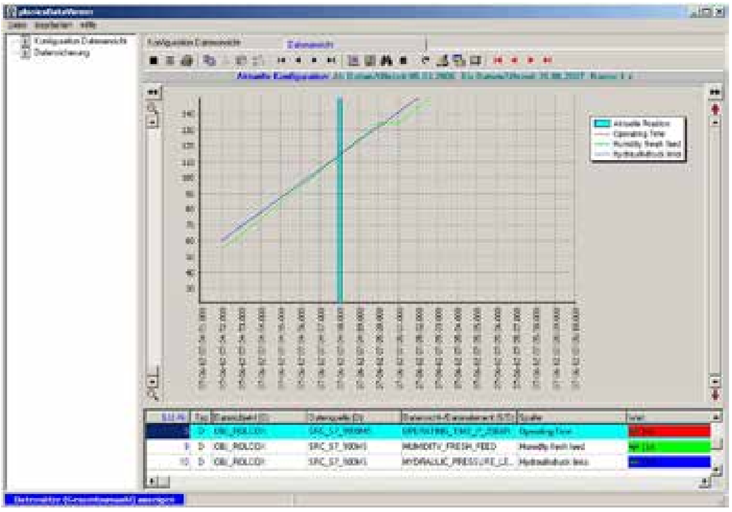
The principle of the company of the future – where everything from development, production and suppliers through to the customers is networked with no media breaks – is based on reliable and comprehensive machine data collection, because „just-in-time“ manufacturing depends on a more flexible utilization of production systems. However, there is no reliable way to achieve flexible control of machinery without feedback. How is a remotely issued operating command meant to be implemented by a production system that is currently being repaired due to a defect, but where the operational control system is not aware of this?

Actual Key Performance Indicators for Integrated Controlling Using MDC

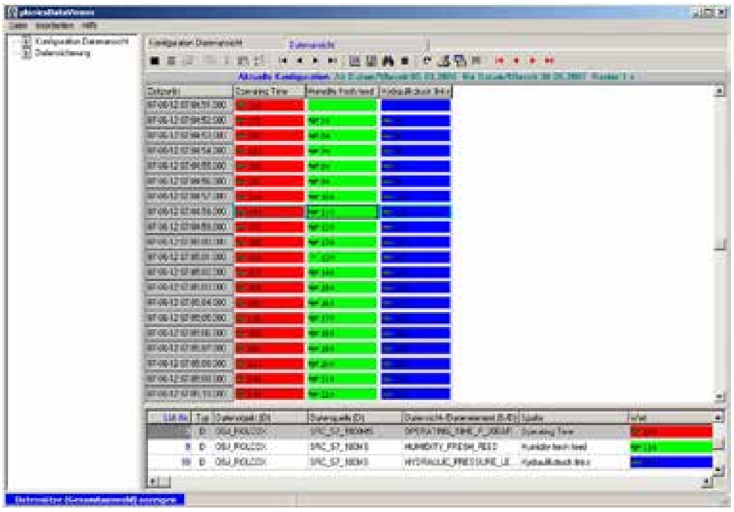
The MEP®DataRecorder, developed by INTEC International in Hechingen, Germany, is capable of monitoring up to 254 connected PLC machine control systems. Data such as on/off, exceeding and falling below threshold values and many other pieces of information can then be evaluated using visualization tools. These tools allow users to see at a glance the machine availability, any problems that may have arisen and the causes of the downtime.
INTEC also offers comprehensive online communication using standardized VPN connections. This means that INTEC customers are in constant contact with their machines, wherever in the world they are located. MDC facilitates the maximum availability of systems and is an essential basis for any increase in flexibility. The monitoring of process data provided by machine data collection is also the only way to create a continuous optimization process. Actual key performance indicators for runtimes, downtimes and productivity provide a reliable framework for preliminary, ongoing and post-costing in an integrated controlling system.

Cross-Generational MDC Possible in Modern Production Processes

As described above, and through a variety of ERP and MES systems, manufacturing and logistics generate more and more data every year. At the same time, in industry up and down the country, machines that were purchased and installed decades ago are still running reliably. The existing communication technology, hardware, software and all of the operating processes must be made ready for comprehensively networked automation. The drive to revolutionize industrial processes is coming up against control technology that was designed way before it was installed, a long time ago.
Industrial PCs for machine data collection require powerful voltage signals to be able to record and process data. However, many older production systems are unable to provide these. This makes comprehensive machine data collection impossible or very expensive. Weak signals first have to be prepared to make them usable.
With its I/O module, INTEC International supplies a device that can accept analog data. Counter readings and analog and digital measurements from sensors can be recorded as electrical pulses. The signal range for analog values is zero to 20 mA, not simply voltage-based values from zero to ten volts, as is otherwise usually the case. This means that comprehensive condition monitoring and machine data collection are possible even without high-quality voltage signals. There is nothing to prevent older machines from being capable of adaptation for the smart factory of the future in terms of machine data collection and tailored production control. i4.0



The MEP®DataRecorder provides actual key performance indicators for run-times, downtimes and productivity.



Integrated machine controlling is a prerequisite for Industry 4.0

Vertical Integration and the Visualization of Production Systems

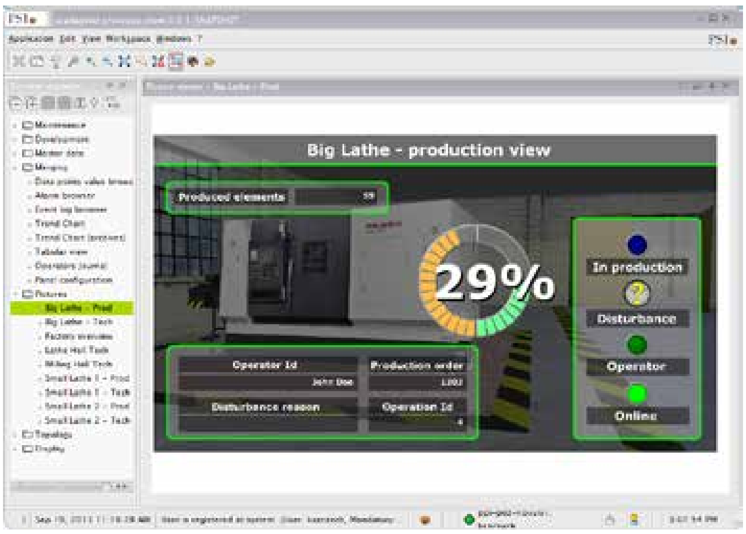
As production systems become more flexible and production units become increasingly autonomous, the IT systems involved have to meet a completely new set of requirements. There is a general assumption that manufacturing systems are becoming increasingly fragmented.
From the point of view of production planning and control, smaller units bring the advantage of a greater degree of flexibility and facilitate the local optimization of production. The integration of systems and standardized, automated communication are essential for such units to work in a comprehensive network.

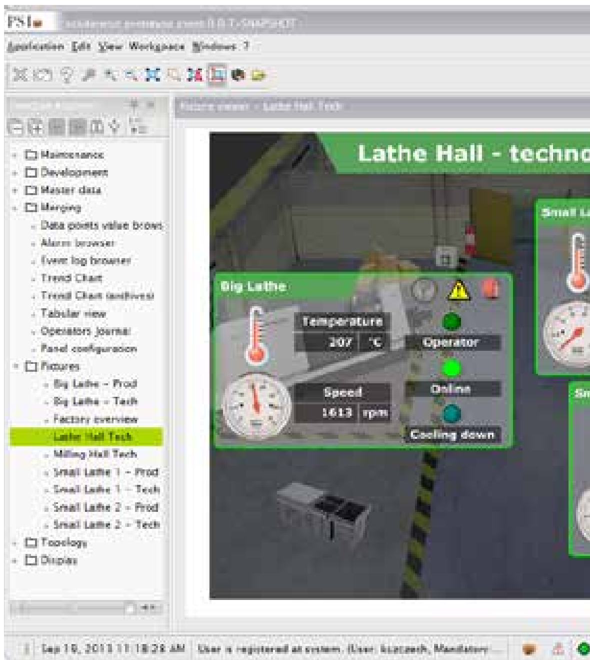
➲ Karl M. Tröger
Head of Product Management
PSIPENTA Software Systems GmbH

One of the key characteristics of the smart factory concept is the ability to reconfigure the production system. This results in changes to the properties and parameters of the manufacturing systems involved. To cope with this, the new production control system requires a constantly updated overview of the production system it is controlling. The results of this dynamic reconfiguration in what is known as the resilient factory have to be communicated to the people involved in the production process. This not only involves the individual components but also the entire production system or logical parts of it.

Visualizing Production Technology

One way to represent the current status of a production system in a straightforward manner is to use visualization systems. In the future, there will be a move away from visualizing system statuses and operating parameters locally toward communicating location-specific information and using it to influence processes in production.
The PSI SCADA (Supervisory Control And Data Acquisition) solution is a scalable tool to meet this challenge and visualize the status of production technology.





PSIPENTA solutions provide an appropriate visualization of current statuses in the production system.

The production topology can easily be modeled and represented according to the actual layout. The required connection to automation technology is based on a proprietary PSI machine data collection (MDC) solution. The link to the manufacturing process can be configured and is based on standard protocols and interfaces (e.g. OPC UA, web services and database interfaces). The data acquired (counters, measured values, status information, energy data or product data) can be prepared and linked using freely definable rules. Historic data provides information about the stability and availability of technical systems in production. Evaluation of machine data, either by sophisticated sensors or by the machine control system itself, allows manufacturing processes to be analyzed in a targeted manner. The focus is on aspects such as system availability, machine runtime or order-specific data, such as quantities, times or quality information. Continuous evaluation of this data supports the continuous improvement process (CIP). Signals from the production system can be used in the MDC or SCADA application to automatically trigger maintenance measures or to ensure that preventive maintenance is performed. The SCADA solution enables virtual data points to be defined which represent a link between multiple „real“ data sources. More complex relationships between process and shop-floor data for a system can therefore be visualized and evaluated. In the future, highly developed analysis features will also enable this data to be used to control the entire production system.

The MDC system links the order and process data. For example, it is possible to assign the operating parameters of a machine to specific products. Information about product quality in connection with the directly acquired process data allows targeted optimization of the production process from a quality and efficiency perspective.

Versatile Manufacturing Systems

Ongoing development of the SCADA solution is proceeding in two main directions – visualization of machine, process and order data in association with a machine-based 2D or 3D representation of production systems, and visualization of the positions of order and product flows in an actual factory layout. The expected ability to dynamically reconfigure a manufacturing system in future can therefore easily be communicated to the people involved in the process.

Separating the representation of the production system itself from the display of the data points allows for extremely flexible visualizations that can be adapted to different user groups. Based on a user‘s role, the information that the relevant user actually needs to perform his or her tasks in the specific context is displayed.

The functionality of the PSI SCADA solution goes beyond today‘s standard human-machine interface (HMI) by enhancing it with order-specific information. The visualization can not only be used for representing operating parameters, but also for replanning orders, manually resolving faults, displaying material stocks, and many other actions. One of the key drivers of future developments in the detailed production planning and monitoring segment will be the required depth of integration between the planning and process levels. MDC and SCADA components act as the man in the middle between planning and automation, and help to efficiently and effectively implement increasingly dynamic requirements for production processes. Atomized demand and batch sizes require totally new control concepts in manufacturing. Another trend is the transition from simple control to genuine production control systems, in which the current parameters in the production system are fed back into the planning process. This requires simple and, as far as possible, standardized interfaces between the process and the various planning levels. Adaptive solutions that take into account changing environmental and market conditions reflect the increasingly dynamic nature of production processes. i4.0

First Steps toward the Intelligent Factory: The ERP System Is and Will Remain the Data Backbone

PSIPENTA Customer GEMÜ Gebr. Müller Apparatebau GmbH & Co. KG from Ingelfingen, Germany, is one of the companies that have already taken some concrete steps toward implementing the vision of the intelligent factory. We spoke to project manager Matthias Fick about how GEMÜ is putting in place the framework for smart production.

➲ Matthias Fick
Head of Logistics & Supply Chain Management
GEMÜ Gebr. Müller Apparatebau GmbH & Co. KG

GEMÜ®

The past year has seen the theoretical hype about the opportunities and challenges of the fourth industrial revolution reach its high point. But critical voices could also soon be heard, questioning whether German industry is equipped for the future project. What is being done to implement the smart factory in practice?

Mr. Fick, there are widespread claims in the media that many German companies have never even heard of the fourth industrial revolution. That‘s not the case with you. How do you aim to tackle this project and what do you think is essential for it to succeed?

First of all, Industry 4.0 applications require investments that customers have to be prepared to contribute toward. They will do so only if they can see genuine benefit and added value in the supply chain. Without this benefit argument, the smart factory concept will fail in a similar way the idea of computer integrated manufacturing (CIM) failed some years ago. I also think that, in practical terms, moving towards the Internet of Things will happen only in small, incremental steps. Last but not the least, the security perspective is a major issue when it comes to communication on the Internet.

What do the first small steps at GEMÜ look like?

One of the major consumers of our valve, measuring and control systems is the pharmaceutical industry. In this sector, traceability is an essential issue. Therefore, our aim is to collect and provide process data all the way through production for these customers.

That sounds like machine-to-machine communication.

That‘s exactly what it is. For example, our products are installed in filling systems that generate a great deal of data. The more process data available to the user, the more reliably a system can be operated and faults can be diagnosed. The more process data available to us as

GEMÜ Head of Logistics and Supply Chain Management Matthias Fick (center) is already working on providing his customers with process data throughout production.

a component manufacturer, the more precisely we can tailor our valves and systems to the relevant application.

What role does the PSI*penta* ERP suite play in all this? What do you think is the importance of an ERP system in a smart factory?

The ERP system is and will remain the data backbone, the reservoir for processes and data, so to speak. Storing the data in the system is the only way to provide the relevant information for different contexts. The specific challenge in our project, for example, is the unique identifiability of the products in use. The precise product ID means that the serial number is unique. It has to be stored in the PSI*penta* ERP system along with the process information.

How much of the project has been implemented so far? Are further steps already being planned?

The project is still in its infancy. At the moment, it's all about establishing reference processes and discussing them with customers. This will be followed by intensive dialog. One of the areas where customers get the added value I was talking about is maintenance, as we can now provide a more transparent representation of which parts of the system need to be replaced during maintenance. At present, the customer obtains this information manually, which takes a lot of time and is susceptible to errors.

Thank you very much for your time, and we wish you every success in setting up an intelligent factory. i4.0

GEMÜ Gebr. Müller Apparatebau GmbH & Co. KG

Field of Activity

Leading global manufacturer of valve, measuring and control systems

Established

1964 by Fritz Müller as an independent family company

Directors

Fritz Müller, Gert Müller, Stephan Müller

Headquarters

Ingelfingen, Germany

Subsidiaries

25

Production Locations

Germany, Switzerland, China, Brazil, France, USA

Presence

More than 50 countries

Employees

More than 1400 worldwide, 800 of which in Germany (March 2014)

Background Information

GEMÜ is a leading global manufacturer of valve, measuring and control systems. For more than 50 years, the globally focused independent family company has established itself in key areas thanks to its innovative products and customer-specific solutions relating to the control of process media. GEMÜ is the global market leader in sterile applications for pharmaceuticals and biotechnology.

A broad-based, modular system and harmonized automation components enable GEMÜ to combine predefined standard products and customer-specific solutions to create more than 400,000 product variations.

Decentralized Production Control for the Automotive Industry

In the past, industrial production processes have generally been organized along hierarchical lines. Planning is carried out at the top levels of the organizational hierarchy. Decision-making involves a significant degree of freedom and a low level of detail. As a result, they are only networked from the top down, but not across hierarchy levels. The SMART FACE research project addresses this situation by working with companies from a range of industries to develop solution concepts.

➲ Dr. Rudolf Felix
Managing Director
F/L/S Fuzzy Logik Systeme GmbH

AUTONOMIK FÜR INDUSTRIE 4.0

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

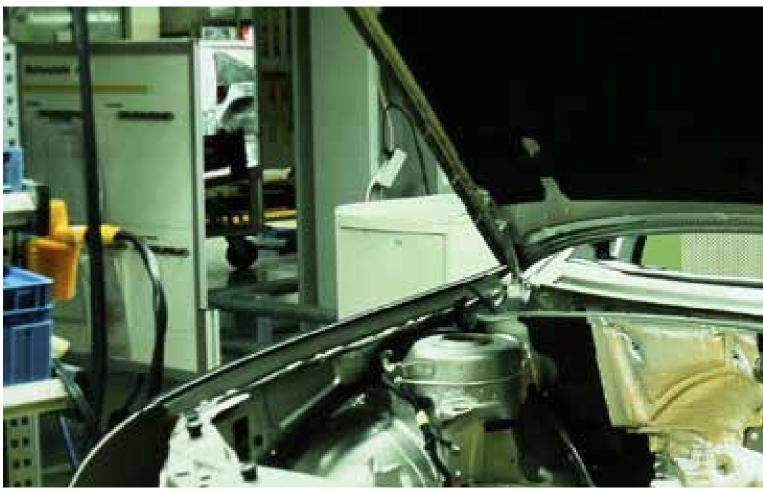
The significance of process key performance indicators (KPIs) is subject to continuous reweighting. There will be a much greater need for self-organizing adjustment of current objectives than is the case at present. The same is true for the planning and production process in the automotive industry, where no vehicle is the same as another these days. Optimization will be based on changing KPIs with a much greater degree of self-organization.

Linking the Physical World and Virtual World

The principle of the Internet of Things (IoT) will advance the creation of new organizational structures. To acquire the necessary information, individual things – known as cyber-physical systems (CPSs) – will perceive their environment using sensors. Cameras, distance meters and other sensors will capture their surroundings. The resulting information will either be processed on-board or transmitted to software services. This enables the CPSs to autonomously make decisions, including those based on KPIs, and to organize themselves.

Today's Internet is all about networking humans and IT systems. Tiny IT systems with the capabilities of earlier desktop computers can now be almost invisibly attached to objects. This enables any objects to be equipped with the computing power that allows the objects to be networked with one another.

Objects and IT Systems merge together. Provided that decision algorithms can be executed in the IT systems, it is possible for the objects to have local decision-making capability. In future, production processes will involve networked working by humans, IT systems and objects. This



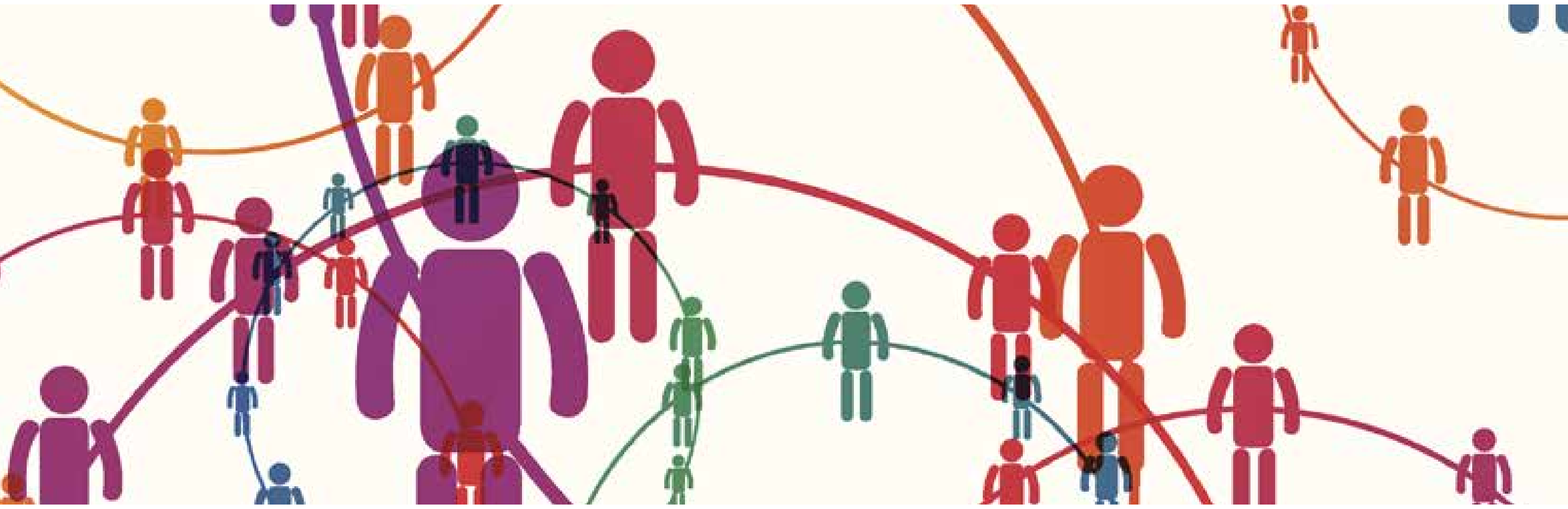
networking will help resolve the apparent contradiction between the variety of production orders and efficient organization of production processes.

SMART FACE Combines Industry, IT and Logistics

To prove that this is not just fiction, a consortium made up of automotive manufacturers and suppliers, logistics and IT providers and institutions involved in applied and direct research has set up the SMART FACE project. SMART FACE is a research project that is part of „Autonomik 4.0“, a technology program for autonomous systems backed by the German Ministry of Economic Affairs and Energy.

The Thinking behind SMART FACE

In the past, the planning process in automotive production involved several hierarchy levels. First of all, annual planning defines the planned figures for annual sales. These are used to derive the annual requirements for the parts and components that can be determined from the bills of materials. At this point, the planning scope is extensive, but starts to reduce at this level of the decision-making hierarchy. Monthly planning sets out the long-term delivery contracts and the delivery quantities for suppliers. At the same time, rough-cut planning of resources is carried out in the ERP system. At this stage, the possible planning scope is reduced again, although there is still a relatively high degree of freedom.
The next step is to derive the weekly planning from the monthly planning. This involves preliminary planning of the production sequence on production lines. The delivery calls at sequence and time slot level are then passed on to suppliers. Changes are still possible, but the amount of work involved increases. In the daily planning, the resources are then specified and frozen. The sequence of orders is specified in terms of time and location within a shift. All supplier processes are precisely scheduled. Any fault or the need to change a sequence requires a great deal of work, which can lead to stoppages of the production process.
The aim of the SMART FACE project is to replace the scheduling from daily planning with a self-organizing CPS. An order pool is processed autonomously within a time window. The result is a volume cycle (i.e. a production volume per time slice). This implements one of the key visions of Industry 4.0, namely „individualization (batch size 1) with the economic conditions of a mass producer.“ The planning scope in the production process increases again.
Series production based on the Internet of Things principle no longer has any production lines. Production and assembly stations are set up „in the open.“ Supply vehicles transport the components or parts to be fitted from a warehouse to the production stations. Depending on the assembly progress, part-finished orders are either moved on self-transporting platforms or by a driverless transport system. The numerous decisions that the autonomous units have to make are calculated based on KPIs using multicriteria decision optimization. The current KPI values are taken into account and decisions are based not only on the perspective of the global objectives of the production process but also on a local order, component and part view. Humans act as cognitive all-rounders that monitor the process and guarantee the flexibility of the entire system. i4.0



Aiming for Society 4.0

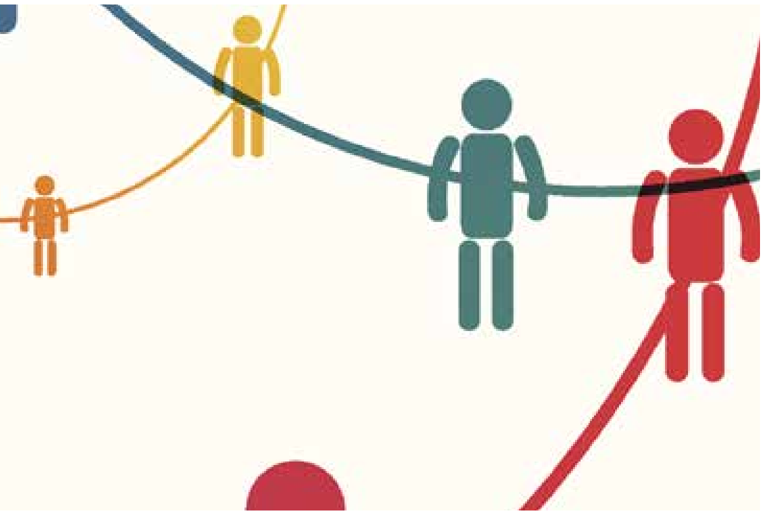
Critical voices on the issue of Industry 4.0 are getting louder. There is already talk of this future-oriented project failing in Germany, while the Industrial Internet Consortium set up by American companies is viewed as a more powerful and decisive alliance. The progress brought about by the „Industry 4.0 Platform" initiative is sluggish, and results are a long time coming. There is also a lack of political support and clearly defined standards.

Karl M. Tröger
Head of Product Management
PSIPENTA Software Systems GmbH

Activities geared towards modernizing the German economy have been underway for more than two years now. The „Industry 4.0 Platform" initiative, supported by the largest trade associations in the German economy covering almost three million employers, is intended to pool activities and develop with interdisciplinary, pioneering and realizable concepts.
However, the results are a long time coming. What is essentially a good idea seems to be getting bogged down in the complexity of existing organizations. To date, at least, the output is not measurable. The whole of industry is becoming increasingly frustrated. Manufacturing companies, software providers and infrastructure providers are not moving forward and there is a lack of support. The conviction that it is actually possible to tackle a challenge like this is declining rapidly, and the doubters seem to be winning.

Political Regulations Will Bring New Impetus

Politicians are now making more prominent contribution. The Ministry of Economic Affairs and the Ministry of Education and Research want to push the issue forward with parallel activities. It is hoped that these parallel efforts will not lead to interdepartmental coordination problems or a battle for competence, thus delaying the progress that is urgently needed. Politicians need to provide industry with targeted support. The third grouping making its presence felt in this area is made up of individual large



companies. Leading suppliers of automation solutions, and even some very large engineering companies, are tired of waiting and now want to approach Industry 4.0 in their own way. This is completely understandable. Transformation of the economy will be a drawn-out process. International competition is increasing, and further delays can no longer be accepted. But it will also be essential to ensure that German SMEs are not left behind. To achieve this, it may be necessary to simplify the financing of research activities and to create incentives for investments in this segment. One way to do this would certainly be tax incentives for development expenditure to supplement the current project-specific industrial application research, with its complex application and accounting procedures.

Deficiencies in Infrastructure

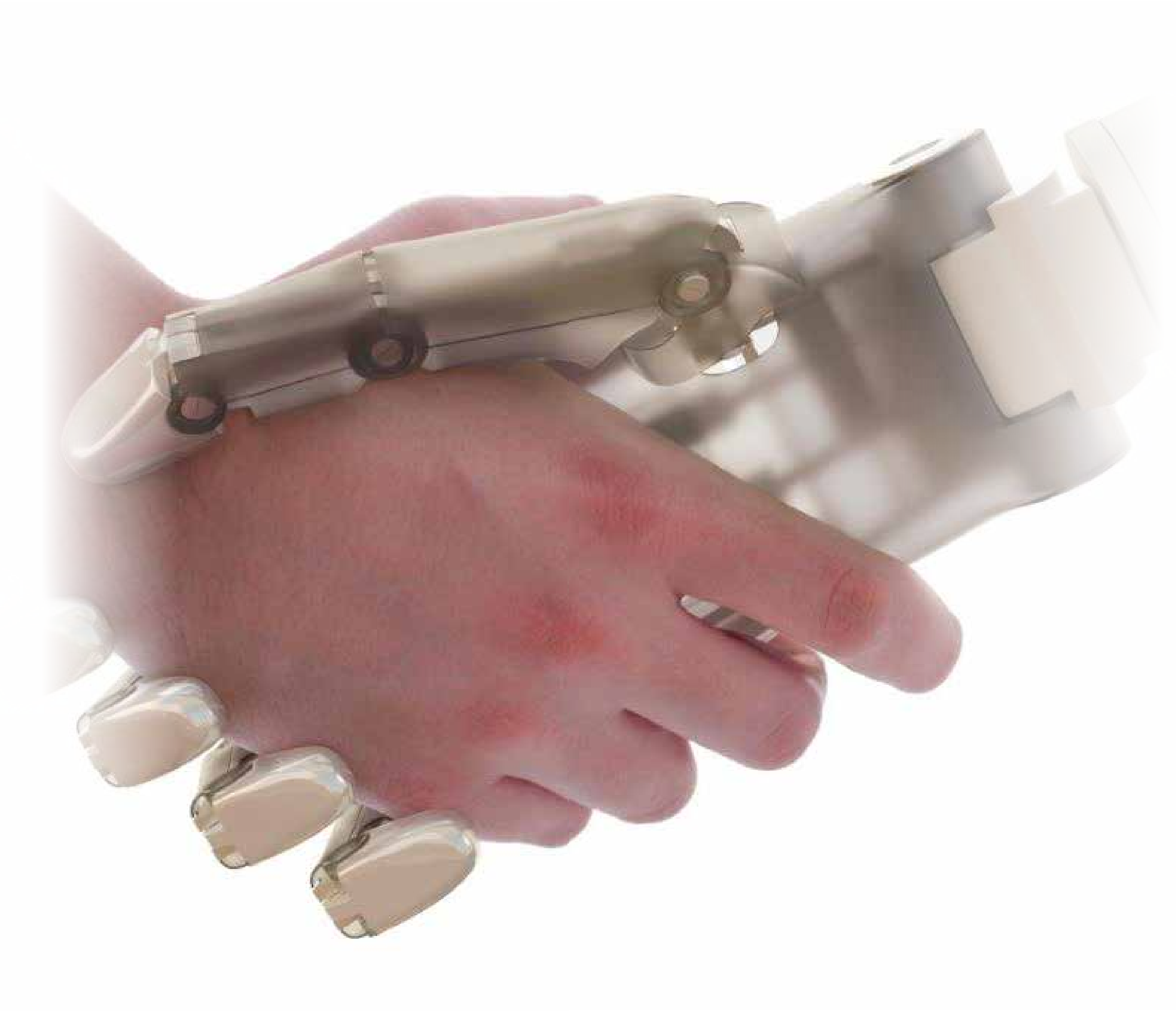
The objectives that are being aimed for can only be achieved with support from appropriate infrastructure. The medium of the Internet is hugely important as the central route for transferring information in the Internet of Things and Services. However, a look at the status of broadband expansion shows that Germany is as far away from across-the-board 50 Mbps coverage as it was some years ago. It is clear that support for expansion of the mobile Internet, for example in the long-range 700 MHz band („digital dividend 2"), has not been forthcoming. Rural areas, which many successful German SMEs tend to choose as areas for expansion, are still „black holes". New services that will result from the combination of a physical product with the opportunities provided by the Internet of Things will require this infrastructure in the near future, and it will need to support millions of users and to be mobile.

Pragmatic Solutions Have to Be Found

The gradual development of standards for intercompany order processing from a technical and logistical perspective has to be backed up by an appropriate legal framework.
Example applications for the use of new technologies and methods of controlling production and logistics help to provide a better understanding of the relationships and to move towards a solution. The results will not be conclusive, nor will they take into account every conceivable issue, and the „one" perfect solution may not even exist. Pragmatic, 80% solutions are needed. Existing technologies and market-leading systems, in new combinations and with further development, have to be used so that a „basic system 4.0" will gradually emerge. The lack of faith in the feasibility of the visions as a functioning example does not serve anything.

Join Forces and Press Ahead

We are not alone. And we still have an edge in many areas. We cannot allow ourselves to be held up by the perhaps typical German desire to get things 100% right, putting concepts on the back burner until every concern has been cleared up and an answer has been found to every bizarre question.
All of the necessary abilities to resolve these issues are available in Germany. The key is to pool the power of large companies and the flexibility of SMEs across industrial boundaries. Specific tasks need to be defined and solutions developed. The task of politicians is to synchronize all the measures and to recognize the importance of the „Industry 4.0" initiative in promoting Germany as a location.
We have to start working together and create the framework for sustainable success. The transformation, not just towards „Industry 4.0" but towards „Society 4.0" must succeed. Tomorrow's working environment not only needs networked machines and products in a smart factory – the „Industry 4.0" ecosystem is made up of humans, machines and software. i4.0



Humans and Labor in the Industry 4.0 Environment

It is becoming increasingly clear that Industry 4.0 will bring about a fundamental realignment in our economy that will move beyond local technological optimization. At the same time, there is a great deal of uncertainty surrounding the impact of 4.0, particularly when it comes to the role of humans and labor in the new production landscape.

➲ Dr. Winfried Felser
Competence Site Operator
Managing Director, NetSkill Solutions GmbH

While some believe that 50% of jobs will be lost as a result of the digital revolution [SVH], [OXF], others are rejoicing about the hundreds of thousands of new jobs that could be created by Industry 4.0 [BCG]. While some conjure up images of a new form of exploitation [SOC], others are enthusing about the humanization of work [IAO] and a world where work becomes enjoyment. While some see us working in teams with „social“ machines [BMW], [TRU], others see robots as our future managers [SVH].
But what will the impact of the revolution actually be for humans and labor? This article highlights the fact that, from a quantitative and qualitative perspective, practically anything is possible. However, going beyond a fatalistic technological determinism, there are calls to utilize the freedom we have in order to aim for a paradigm based on new forms of collaboration and partnership that focuses on skills and values. This paradigm is based on the shared creation of „added value“ in the network, rather than just on increasing efficiency and reducing human labor as a cost factor. It is not only humans and machines that have to combine their capabilities as value- added partners, but also employees, management, shareholders and the general public. To do this, we have to recognize and shape Industry 4.0 as a social issue. That‘s all very well in theory.

In Practice: Robots on the Advance

All theory is gray, my friend (Mephistopheles in Goethe‘s Faust). Just as I was finishing this article, it was reported in [WIWO], among other sources, that VW is undertaking a large-scale project to replace humans with robots. According to VW, this will reduce costs while eliminating unergonomic, strengthening qualified labor and safeguarding jobs
Volkswagen does not appear to be an isolated example of this decision calculus. Anyone wishing to understand the 4.0 revolution generally has to focus on the interests of those involved as drivers (pull factors) and also on technology as a system enabler (push factors).

Stakeholder Interests as Drivers of 4.0

The VW example provides particularly clear evidence of the key elements of realistic forecasts of our future if we move beyond the number games. Change will not happen randomly but will be the result of the interests of relevant stakeholders, particularly shareholders (and therefore also management).

VW shareholders in particular must be interested in cutting costs in order to ensure future competitiveness. If an hour of human labor amounts to costs of 40 and an hour of robot labor just 3 – 6, it is understandable that shareholders will want to see cost savings and will be calling for alternatives. This cost focus is a dominant future paradigm in many companies because it is so easy to implement (future = lower costs). A CEO may particularly tend toward this kind of focus if they worked as a CFO in the past.

However, employees and their representatives, such as workers councils and unions, are also stakeholders and will, of course, promote their own interests when it comes to determining the changes that occur. If current employees are not laid off and physically demanding activities are eliminated, changes in working practices will tend to be agreeable to the employees – this is true of VW and will certainly not be uncommon. However, future generations will suffer if the availability of work declines consistently with no alternative.

Technologies as the Enabler of 4.0

Does this mean that the end of labor as we know it is imminent, as Rifkin predicted in 1995 [RIF], and that there we are actually consenting to this? One stakeholder – the customer – opens up a totally new perspective here, but more about that later. To obtain the predictions we want, it is first vital to view shareholders as „drivers“ and to understand that technologies are „enablers“. The VW example suggests that the most important impact of Industry 4.0 is local substitution by automation. But automation has been around for a long time (since the inception of Industry 3.0!).

What is really new about the Industry 4.0 paradigm and its technologies is primarily the considerable increase in cost-effective, networked, decentralized intelligence and decentralized communication and collaboration capabilities. These new capabilities relate not only to traditional items such as RFID chips on products or semi-autonomous vehicles, but also to employees and social media, along with new control systems that allow humans and machines to work together more effectively than ever before. These fundamental capabilities result in an Industry 4.0 paradigm based on a new kind of collaborative productivity in the network (see [AAC]) and on value creation:

- New, improved (more agile, more networked etc.) services and products due to
- New, improved (more agile, more networked etc.) structures and processes!

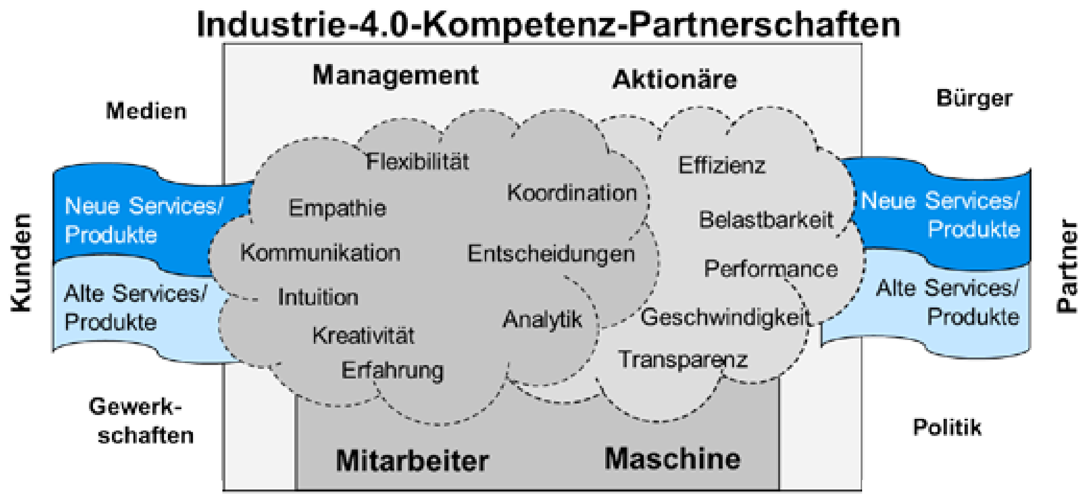
Quantitative/qualitative impacts of Industry 4.0 on humans and labor

Quantitative Impact

Aspect	Positive | „Utopia“	Negative | „Dystopia“
Change in demand	New services, value creation	Fall in income
Humans in production	Humans as guarantors of flexibility	Deserted factories
Location factor	Germany leading	Substitution by USA, China etc.

Qualitative Impact

Aspect	Positive | „Utopia“	Negative | „Dystopia“
Inclusion	Getting „everybody“ on board (older people etc.)	Exclusion of underqualified workers
Humanization	Consumerization, gamification	Excessive demands
Authority	Self-determination	Heteronomy
Flexibility	Work-life balance	Forced flexibility
Fairness	Participation, social economy	Dualization, servitude



Skills partnership between humans and machines for better/new services.

Therefore, when considering the future of labor 4.0, it is essential to examine the new opportunities to create value and not merely to get bogged down in static substitution scenarios. The skill will be in what Schumpeter calls „creative destruction“ [SCU] – balancing the destruction of human labor by automation with new kinds of value creation for the customer, and putting in place a framework involving elements such as training measures and fiscal policy that will make this kind of development likely. There is a good reason why the German government is now devoting a lot of attention to smart services [SMS] to complement „Industry 4.0“. Based on this analysis, the opposing quantitative and qualitative effects of Industry 4.0 on humans and labor can be examined in more detail.

Quantitative Impacts of 4.0

From a quantitative perspective, the total delta is made up of several factors, including changes in demand, the future human component in production and, on a national level, the advantages or disadvantages of the location. In a dystopian vision, all deltas are negative. Automation leads to factories devoid of humans, which in turn results in the dualization of society and falling income. Those who are pessimistic about Germany‘s chances fear that Silicon Valley (e.g. Google) and/or China are superior competitors for the future. The overall result of the three factors would truly be an apocalyptic scenario for labor in Germany. So far, so bad? And is this kind of situation inevitable?
Definitely not! If we in Germany do what is called for above and put all our energy into shaping the future by opening up new potential for value creation and positioning humans as guarantors of flexibility and satisfaction in Industry 4.0, there is no reason at all for us to fear competition and dehumanization. Any technological determinism that underestimates humans as creative forces is making a fundamental error. Of course, it is the net balance that ultimately counts. Whether or not automation will have an impact more quickly than new value creation and growth in demand is disputed, but one thing is certain: It will not be deterministic – we will be able to shape it.

Qualitative Impacts of 4.0

Similarly, the quality of new labor under 4.0 may or may not suffer. If we substitute or exclude all employees who are „underqualified“, if the new complexity overwhelms us, if humans become little more than subjects of machine heteronomy and flexibility primarily means forced flexibility, Industry 4.0 definitely presents a threat to the quality of labor.
But once again, this scenario is not the only possibility. You do not need to be a utopian to recognize that new technologies can be an aid to inclusion for older people or

Alternative scenarios for humans and labor 4.0

Design Scenario	Result	Focus	Human – Machine
Utopia 4.0	more value due to	„better + new“ due to	Collaboration
Dystopia	less value due to	„just cheaper“ due to	Substitution

those with disabilities, and a lack of qualifications can be compensated for through training, technology and networking. Humanization of the working environment can lead to work becoming more enjoyable, even if gamification is not seen at every interface. But, of course, modern mobile technologies are significantly superior to earlier systems and the demand for user centricity means that processes are also positively geared toward people. If we ultimately place humans in the center of how we shape collaborative productivity in networked systems, we can potentially succeed in achieving greater self-determination and authority, and a better work–life balance, than ever before.

An Optimistic View of the Future for Humans and Labor in Industry 4.0

Once again, there is clearly the potential for both outcomes. However, the things that will actually determine the future are our freedom to shape the future and our shared goals. If we can achieve collaborative productivity through new competence and a networking economy 4.0 where the focus is on people and adding value, and not only on cutting costs, a positive future is not merely a utopian vision. However, if we are unable to achieve this, Dystopia 4.0 is certain. The formulae for Utopia and Dystopia 4.0 can be found in the table above. We specifically choose „more value“, „just cheaper“ or „just more efficient“.
If we are interested in positive social outcomes (which is undoubtedly the case), we have to actively shape the future and the general conditions.
For example:

- A creative and collaborative working environment (management etc.) creates scope for innovation, particularly for the development of new products and services
- Training measures for employees ensure that the necessary old and new skills are in place
- For older people and the disabled, among others, technology can be a „skills partner“ that promotes inclusion
- More generally, and without any transhumanistic delusions, technology can empower „human“ skills such as communication, flexibility and decision-making (analytics) to reach a whole new level.

It is crucial to think about employees, but it is also essential to bring shareholders, customers and the state on board, and even make them drivers of the desired change. Because of their own interests, shareholders will not be in favor of any altruistic measures as an end in themselves. As a result, customers and the state are the driving stakeholders that will play key roles in the future.
If these ability-based measures lead to better services for customers and thus to increased turnover, and customers actually value and are willing to pay for this, and the state framework (promotion of training, new tax regimes etc.) no longer puts a strain on human collaboration but instead empowers it, then it should be possible to realize added value for all stakeholders in Industry 4.0 and, in particular, for current and future employees to benefit from the revolution. Fortunately, trade unions and consultants (Detecon) are increasingly adopting exactly this kind of service and ability-based approach (for example, see [IGM], [DTC]).

Summary and Appeal

The role of humans and labor in Industry 4.0 is a social issue in which we share a common destiny. In this regard, McAfee cites in [McA] a historical dialog between businessman Henry Ford and union leader Walter Reuther.
Henry Ford II: Walter, how are you going to get those robots to pay your union dues? Walter Reuther: Henry, how are you going to get them to buy your cars?

The aim should therefore be to build a skills partnership between all stakeholders which creatively generates added value for everyone in the network instead of merely focusing on cutting costs. As employees, customers, shareholders and citizens, we have the scope to shape events rather than just being powerless victims of apparent technological determinism. To paraphrase a famous futurologist from Trier: Philosophers have interpreted Industry 4.0 in various ways; the point is to change it [MRX]. i4.0

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