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WE CREATE SMART FACTORIES

MPDV NEWS

Edition 2021

BEYOND-MES
HYDRA of the future

PORTRAIT
MPDV's new executive board
Nathalie Kletti, Jürgen Petzel and Thorsten Strebel

PRODUCTION PLANNING
Spotlight on APS FEDRA

Snapshot

FACTORY PLANNING, EASY, DYNAMIC, REALISTIC, ADAPTIVE

In summer 2020, we have launched the next generation of planning solutions by introducing the Advanced Planning and Scheduling System (APS) FEDRA. It can be operated stand-alone or in combination with our Manufacturing Execution System (MES) HYDRA while the Manufacturing Integration Platform (MIP) is used as central foundation for operation. APS FEDRA can plan simple or complex production scenarios integrating even artificial intelligence.

Find out more about the APS FEDRA in the interview starting on page 36

Snapshot

PRODUCTION IT FROM THE COULD

The less a manufacturing company needs to concern itself with the operation of essential IT systems, the more resources remain for their core competence - production. With the Smart Factory Cloud Services providing Software as a Service (SaaS), the operation of MES HYDRA, APS FEDRA or the MIP can simply be outsourced to the cloud and consequently to MPDV. Economically speaking, Smart Factory Cloud Services also offer many advantages.

Find out more about production IT from the cloud on page 32

Snapshot

AI SUITE PROVIDES INNOVATIVE APPLICATIONS

Artificial intelligence (AI) is increasingly finding its way into manufacturing IT - also at MPDV. New applications are successively coming onto the market as AI Suite, which use AI methods to analyze data and predict results. Predictive Quality, Setup Time Prediction & Utilization Analysis for shifts are first products of the AI Suite. This gives manufacturing companies the opportunity to extract even more information from their data to be able to react earlier, plan more efficiently or optimize more specifically.

Find out more about artificial intelligence and the AI Suite from MPDV on page 28

EDITORIAL

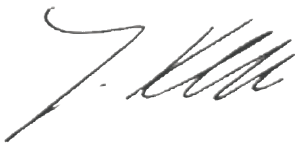
Dear Reader,

Currently, we at MPDV are going through a generation change. We have been preparing the change in our management board for a long time and have now embarked on the next stage. In this issue, we would like to introduce you to the new executive board.

A generation change is also pending in our product portfolio, which will further advance the ongoing development of all our products for the Smart Factory. After all, as our claim says: We create Smart Factories. The Smart Factory is not just a vision, but your guarantee for more productivity and competitiveness. Let's work alongside and turn your way to the Smart Factory into a complete success.

In this issue of our NEWS you will find a wide range of articles that deal, among other things, with what the future holds and the decisions that have led to success at other manufacturing companies.

Let's take the things that worked in 2020 - because they had to work - into the New Year and continue working on the digital transformation. Have fun browsing!



Yours sincerely,

Jürgen Kletti

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MPDV NEWS

Online HYDRA Users Group Conference

First Virtual HUG Conference Succeeded

Due to the uncertain Corona situation, the HYDRA Users Group Conference 2020 could not take place as planned in the Hockenheim city hall this year. "As a result of the pandemic, we decided back in summer to refrain from taking such a health risk for the participants and organize the HUG as an online event," says Mathias Schmälzle, HUG Chairman and CFO of RUCH NOVAPLAST, explaining the decision.

The focus of this year's 16th HUG Conference was, besides news on products and services of MPDV, the combination of logistics and production on the way to the Smart Factory, which was also the subject of one of the best practice presentations by Kevin Mahler of VACOM. The mix of product news, live feeds with best practices and video messages from partners in the MIP ecosystem made the online event a resounding hit. "We've made a virtue out of necessity", says Laura Kirstätter, Manager Research & Education at MPDV and HUG contact. "Digital media enriched the mixed bag of lectures of all kinds. The conference was spread out over two days and so the users could arrange their time well without missing a thing."

"Excellent digital realization of the 16th HUG conference. Once again, it was an informative and a varied event with different presentations and, above all, without travelling", reports one of 300 participants during the HUG conference.

mpdv.info/hug2020

Welcoming to the online user conference
Source: MPDV

SMA Information Dashboard extended

Absolute Transparency on the Shop Floor

Displaying key figures and crucial evaluations with the greatest flexibility – no problem. MPDV's SMA Information Dashboard visualizes data from production and quality management in a user-friendly and responsive way.

The application can show key figures such as OEE or scrap on the digital shop floor monitor alongside evaluations of downtimes and complaints. The dashboard can also be used interactively for regular team meetings in the production environment.

The SMA Information Dashboard has recently been extended and now offers, among others, the following evaluations:
- OEE report and OEE profile
- Different status reports
- Overview of all workplaces/machines
- Scrap statistic and scrap analysis

mpdv.info/smanews

Thanks to the highly configurable application profiles, the users are supplied with exactly the data they need in any given situation. For this purpose, users can run the Information Dashboard both on a mobile tablet and on a PC.

The data basis is provided by the Manufacturing Execution System (MES) HYDRA by MPDV, which is well established on the market.

Using the SMA Information Dashboard, all key figures and evaluations from production and quality management are available in your meetings.
Source: MPDV, Adobe Stock, Andrey Popov

New Version of HYDRA Dynamic Manufacturing Control

Increased Flexibility and Standardization

When it comes to modeling complex manufacturing processes and integrating them in the manufacturing IT, tools like HYDRA Dynamic Manufacturing Control (DMC) are indispensable. To achieve a comparable result, you could also program a PLC-based head control, which is simply outdated.

The new HYDRA DMC version offers an enhanced user interface for operators. Here, the latest technologies are used, which simplify the design of the user interface and provide ergonomic dialogs. Furthermore, the user interfaces can be displayed and operated on both normal PCs and mobile devices like Android tablets or iPads.

The new version also provides three additional standard components that can be licensed, if required:
- The Dynamic Workpiece Distributor provides the data collected for each workpiece in selected HYDRA applications.
- The Dynamic Workpiece Generator creates a process workflow for a work piece of a specific variant; this workflow is based on the process model created for the variant production.
- The Workpiece Assessment Manager supports the evaluation of automatically recorded quantities.

Just as importantly, the new HYDRA DMC version is provided as mApp for the Manufacturing Integration Platform (MIP) and can easily be connected to applications of other suppliers. The data recorded for each workpiece can be used in another mApp to perform a root cause analysis, for example. Or you use mApps of other providers to extend the operator guidance integrated in HYDRA DMC by innovative technologies, such as Augmented Reality. In short: Starting in spring 2021, HYDRA DMC users will benefit directly from MIP's steadily growing ecosystem.

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We are MPDV

"Coming together is the beginning. Keeping together is progress. Working together is success."
(Henry Ford)

The MPDV initiative "United Colors of MPDV" has captured Henry Ford's words in pictures in 2020. All departments were asked to express team spirit and creative powers. The employees of different departments met to take photos in the colors of MPDV reflected also in the polo shirts. Find here a small selection of the best photos.

Research Project PHI-Factory Successfully Completed

"At MPDV, the commitment to research and science projects is virtually part of our everyday life," says Laura Kirstätter, Manager Research & Education at MPDV. "This is how we ensure that our products continue to meet the zeitgeist." In the course of the recently completed research project PHI-Factory, the Manufacturing Execution System (MES) HYDRA of MPDV proved once more that interoperability with multiple systems is an important standard for a modern production.

Saving energy costs – securing grids

The research project had the objective to develop technical and organizational solutions for manufacturing companies to help them save energy costs and secure the power supply system at the same time. The project strived to implement a dynamic power supply for the factory geared to the grid and supplier capacity in order to support the local distribution grid.

MES as link to production control

MPDV largely contributed to the project's success by providing the MES HYDRA as a central hub for information and data. The MES collected the relevant data such as quantities and times during operation and evaluated this data in real time. Applications mainly used in the project were the HYDRA Machine Data (MDE), the Shop Floor Data (BDE) and the HYDRA Shop Floor Scheduling (HLS). One of the most important tasks of the Shop Floor Scheduling was to implement the suggested control measures in production. A JSON/REST interface developed by MPDV was used to link the MES-based data collection to the energy data collection.

Innovation as teamwork

The three-year research project was funded by the Federal Ministry of Economics and Technology (Germany) with almost 5 million euros. The project searched for measures optimizing the load management, improving the grid quality and perfectly integrating peripheral supplier and storage systems into the comprehensive and enhanced energy management.
Other partners of the research project were the technical university of Darmstadt, Rexroth, Software AG, Opel and Ökotec.

Expand Your HYDRA Knowledge

Keeping with the motto "Don't fancy a holiday either", users had the opportunity this summer to refresh or expand their knowledge at the Smart Factory Summer Camp 2020. More than 70 long-time HYDRA users participated in the online training sessions – a complete success.
In three-hour training sessions, the participants gained valuable know-how and useful tips from everyday working life. The focus was on issues such as machine and control connections, AIP collection functions or key figures and reports. Experts from MPDV showed in the sessions, amongst other things, how data collection functions can be optimized at the terminals of the MES HYDRA or what is important when creating evaluations with the system. "We received so many new stimuli for our work. It was just great," says one of the participants.
The successful format "Smart Factory Summer Camp" is now serving as a model for the new online training program "Live Classes".

MPDV NEWS

New Applications for the MIP

The ecosystem of MPDV's Manufacturing Integration Platform (MIP) keeps growing. We present four new partners as examples.

MPDV has gained an expert for connecting machines with RSConnect. RSConnect's solutions help manufacturing companies to gain an overview of machine capacity utilization and provide greater transparency in the shop floor.

With its UniversalPlantViewer software, CAXperts contributes to the MIP ecosystem a solution for the digital twin covering the entire life cycle of a plant. The software displays systems in 3D from all common sources and makes the information on the systems graphically accessible to employees on all end devices.

Using the cloud-based software cioplenu, MIP users can now digitally generate all their work instructions and checklists. Interactive elements such as target/actual value comparisons, multiple-choice selection, image or video feedback and many other functions increase process reliability on the shop floor and also the digital, systematic evaluation for continuous process improvement.

The specialists at Stego Elektrotechnik offer with the Smart Sensor CSS 014 IO-Link a solution for monitoring ambient temperature and humidity. The CSS 014 IO-Link Smart Sensor CSS 014 allows easy and precise implementation of (remote) maintenance concepts down to process level.

Information on further MIP partners can be found on the marketplace at mpdv.info/mipmarktplatz

mpdv.info/mipmarktplatz

New Training Format: Live Classes

"Let's Make Friday Morning a Live Class Day!"

"You are using HYDRA and already know a lot about it, but want to expand on your knowledge without spending too much time, then Live Classes is the right format for you", says Martin Geppert, Vice President Services at MPDV. Live Classes is a half-day online offer complementing the existing training program. The new format focuses on best practice methods and extends your knowledge.
Expert trainers will spend an entire morning to interactively explain specific topics in remote sessions. HYDRA users can ask questions at any time and help determine the course of the Live Class along with the other participants.

The benefits are obvious:
- More flexibility due to improved availability in terms of time and place
- More efficiency as travelling and overnight stays in hotels are not required

All in all, Live Classes is a simple and economic opportunity to build up or refresh practical knowledge. Best of all, users can conveniently book and participate online - even spontaneously.
Live classes take place every Friday. Topics change every week and MDPV constantly adds further ones.
MPDV's Live Classes are a continuation of the success of the Smart Factory Summer Camps 2020 and will also be available in English.

Find out more about Live Classes and register at:

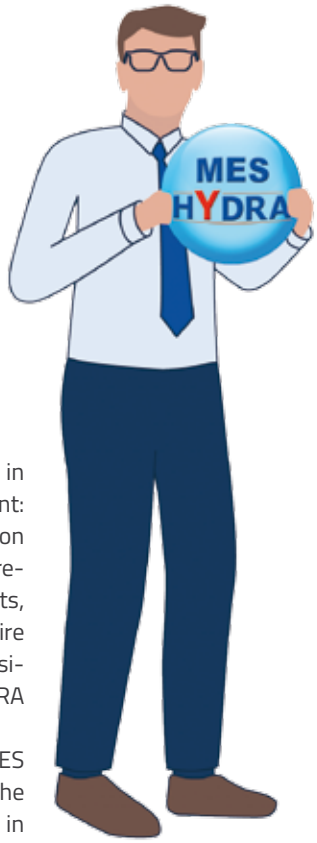
mpdv.info/liveclasses

10,000

CT-UMPS interfaces by WAGO have been installed by MPDV. CT-UMPS stands for Computer Terminal - Universal Machine and Process Interface. CT-UMPS is a hardware solution for easy recording of digital and analog signals. CT-UMPS can be used to connect each machine to the production IT in no time and with little effort. MPDV thereby supports the connection of heterogeneous machinery. CT-UMPS can also output digital signals, for example, to control a signal lamp. Using appropriate accessories, CT-UMPS can also collect energy data or process values automatically. Now CONN-IIoT (IIoT Connector) is the fourth generation of WAGO controllers.

MPDV NEWS

Meet our products:



Experienced All-rounder:

MES HYDRA

When it comes to keeping an overview in every situation, only one thing is important: experience. Our Manufacturing Execution system MES HYDRA has exactly this precious quality. Despite endless data sets, HYDRA always keeps an eye on the entire production process. Thanks to the extensive expertise as a production expert, HYDRA is highly versatile.

Like every experienced all-rounder MES HYDRA doesn't push itself into the spotlight, but pulls the strings carefully in the background. Each work step and each product is always thoroughly checked and continuously adapted and optimized. This prudent approach allows HYDRA to permanently improve production efficiency.

The Networker in the Background:

MIP

Dynamic, unique, flexible - this is how to initially describe the Manufacturing Integration Platform, in short MIP. The MIP is a trendsetter and loves the conviviality of the ecosystem. Not shying away from the unknown, she throws herself headlong into never-ending adventures and discovers other modern systems to exchange and connect with. Nevertheless, she always stays in the background and drives other systems to high performance.

The Mastermind - Always On Hand:

APS FEDRA

Endless to-do lists, total chaos and no idea what happens next? This is where our reliable and hard-working mastermind APS FEDRA steps in. The Advanced Planning and Scheduling System is meticulous, highly motivated and keeps on top of things in every situation. FEDRA is always on hand whenever you need help and advice. Her planning is well structured and neatly prepared in a way that is intelligible for everyone involved. Future planning based on past results is also no problem for our highly sophisticated FEDRA.

Digitalization of the shop floor for manufacturing SMEs

Our field engineers understand your production, machines and interfaces.

Proven solutions developed for small and medium enterprises
We developed an industrial IoT Platform with many digitalization solutions. Proven in more than 30 sites it is quickly deployed, affordable and designed for SMEs. Let us introduce to you: toii® our iiot platform.

Quick end effective start into shop floor digitalization
As an entry product we developed toii.Lights for you. It digitalizes your machines within days, not weeks. No matter the age, no matter which interface, this solution works with every machine. This entry into digitalization is not just quick but also highly affordable and pays off within months!

End-2-end digitalization of your production
We connect your machines, let them speak in one joint language and make them controllable with toii®. On top we integrate your ERP systems and, if available, also your MES. This way we achieve an end-2-end digitalization of your shop floor.

End-2-end service
We make digitalization easy and accompany you on every step – from the concept to implementation and operations thereafter.

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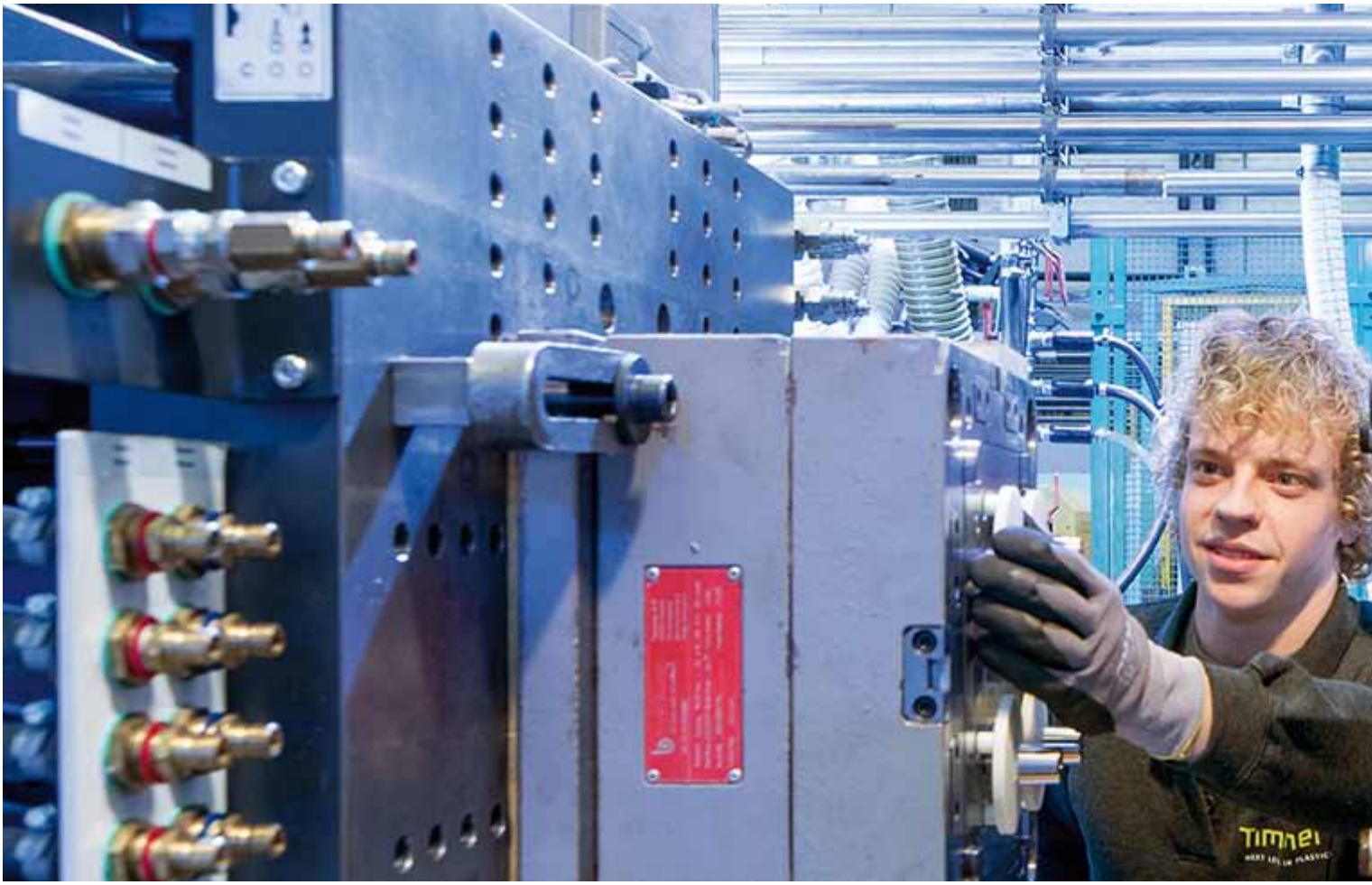
Timmerje

HYDRA Success Story about Timmerije

OBJECTIVE:

TO BECOME THE MOST POPULAR PLASTICS MANUFACTURER OF THE NETHERLANDS

In the run-up to the 85th anniversary of plastics manufacturer Timmerije in Neede, the Netherlands, a journalist phoned and asked if the company was a start-up, involved in 3D printing or marketing disruptive technology. When the employee at Timmerije denied everything, the journalist remarked that the company was probably not interesting and hung up. The fact that this assessment is a blunt misjudgment was not only made clear by the speaker in his welcoming speech at the anniversary, but also becomes apparent when one takes a look at both the success story of Timmerije and on how HYDRA is used in the company.



You cannot ignore Timmerije if you need plastic parts in the Netherlands. The company has approx. 130 employees and about 50 injection molding machines. They cater to the needs of diversified industries and produce goods like parts for heating and ventilation equipment, car safety seats, bicycles and truck interior. "Our declared goal is to become the most popular injection molding company in the Netherlands", explains Pim Peeters, Manager IT & Control. Timmerije has been using the Manufacturing Execution System (MES) HYDRA for several years now to achieve this goal and to meet all customer requirements as regards quality, prices and delivery time. The MES HYDRA collects production data, fine tunes planning specified by the higher-level ERP system, monitors and documents the entire manufacturing process.

HYDRA helps us achieve our objectives

"We need to know exactly what is going on in production to achieve and keep our objective", says Peeters. "This includes information about machine statuses, produced quantities, quality and the complete documentation of all material data and process parameters." This is the only way for Timmerije to guarantee both a high degree of efficiency and the necessary quality. Traceability of material and process data is particularly important to the automotive industry, as this is called for by the major manufacturers or is a statutory requirement. "But also other customers benefit from the documentation of manufacturing processes. If complaints arise, we can easily identify the reasons and if other parts are also affected", explains Emile van Wijk, MES Engineer at Timmerije. Emile van Wijk acts as project manager, administrator, trainer and power user and is therefore familiar with the IT world and the production processes.

More is more

At present, machine operators only log on the orders in HYDRA and confirm the produced quantities collected automatically. Scrap is classified and then sent to the recycling process. In other words, quality assurance focuses on the products manufactured. "That is why, it might take 200 parts before we detect that something goes wrong", explains van Wijk. "For this reason, we now want to monitor the whole process." Here as well, MES HYDRA supports its users with the automatic collection of process data. At the same time, Timmerije wants to automate the transfer of setting data to the

injection molding machines of different manufacturers and age. This saves time and increases process quality. "We want HYDRA to automatically transfer the setting data needed for the next order. This avoids errors that are due to manual entries", says Emile van Wijk about the new project. Peeters adds: "By monitoring process data, we notice much earlier if something is wrong and can respond before scrap is produced.

Everything under control

Timmerije leaves nothing to chance. Planning, production and delivery - everything is based on sophisticated processes and monitored. The complete production is planned in the ERP system and then transferred to HYDRA for detailed planning. "HYDRA knows the current machine statuses and can calculate the order progress and the anticipated order end using the collected data", explains Peeters. "If the order end is delayed considerably, for example, due to an unexpected malfunction, our planner will be in the position to react and to initiate measures to compensate for the delay." In order to meet these requirements, HYDRA also integrates the injection molds in the planning process. The molds are kept as resources in HYDRA and logged on to the HYDRA shop floor terminal with every order.

Green bridges

Timmerije has developed their own shop floor PCs for their operators. These industry PCs are bright green so no one can overlook them between all the machines. Altogether 18 touchscreen terminals bridge reality, i.e. the processes and humans, and the digital world of the MES HYDRA. Timmerije conducts regular training sessions and maintains close contact with operators to increase the workers' acceptance of the IT system. "Some people do not like the system, but I like it. The system provides me with all details about the machines I work with. A label printer is also next to my workstation. To me the system is quite perfect", explains an operator we meet while visiting the Timmerije factory hall. Van Wijk adds: "Acceptance is pivotal. What good is the best system if people do not use it? For this reason, we have slightly adapted HYDRA to make it look similar to our previous system. Fortunately, this worked with the visualization of our machinery.

KPIs help

Apart from the shop floor operators, about 30 other persons also work with the HYDRA office client. These include the planners and work schedulers on the one hand and the supervisors, the plant manager and controllers like Pim Peeters on the other. The controllers evaluate the data collected with HYDRA, use the calculated KPIs and report to the higher company levels. Important key performance indicators are, for example, the Overall Equipment Effectiveness (OEE), utilization efficiencies of single machines and the scrap rate. KPIs help Timmerije identify their economic efficiency and provide for continuous process improvement.

Focusing on people

To improve the planning process as well, Timmerije no longer wants to rely on its manual personnel scheduling using magnetic boards and wants to introduce HYDRA. The main objectives are to avoid fluctuations in capacity utilization and to better plan different requirements when processing orders. In this case, each employee can be planned on one or several workplaces according to their defined qualifications. This ensures that all required stations are assigned and processes are not interrupted due to staff shortages. For the existing magnetic board cannot meet the ever increasing complexity. Timmerije plans to introduce further HYDRA applications to increase planning reliability for staff, e.g. labor time collection in combination with access control and time management. These applications should then also be connected to the payroll system.

Consistent path

Timmerije also wants to add HYDRA quality management applications. Timmerije will then be among the users that use nearly all HYDRA functions. "With HYDRA we are taking a logical course of digitization all the way to the Smart Factory", explains Peeters, "HYDRA also helps us achieve our goal of becoming the most preferred plastics manufacturer of the Netherlands." To Timmerije this aim is also a means to an end. The injection molds are developed together with the customer but then they become the customer's property. Customers could easily take their molds and go to another manufacturer. "We must be the best to prevent this from happening", asserts Peeters, "and HYDRA supports us in achieving this goal."

Interesting, isn't it?

To come back to the beginning ... a company that supplies a wide market with high-quality plastic parts with the aim of becoming the most popular should not be interesting? This must certainly be a false assessment, because reality tells a completely different story. Timmerije is a successful company heading for the Smart Factory. "We cannot complain about a shortfall in demand," says Peeters, "but nowadays you have to keep moving if you don't want to be left behind. I think that MPDV and HYDRA are the right partners for us." We say goodbye and as Pim Peeters and Emile van Wijk return to the factory, the bright green shop floor terminals, numerous screens showing HYDRA evaluations and quite an interesting company linger on in our memory.

About Timmerije

Timmerije started as a forge more than 85 years ago. Now, the company has become an innovative plastic injection molding company manufacturing high-quality plastic products. Apart from its modern injection molding production, Timmerije also has its own engineering design department, tool shop and assembly department. With the slogan "Your ambition. Our Passion", the company has set itself the goal of being the most popular plastics processor in the Netherlands.

Talking to Bernd Berres

THE STORY OF HYDRA

"HYDRA had already been around when I started at MPDV and I vividly remember my job interview," Bernd Berres says. He has been with the company for almost 30 years and is currently responsible for product strategy and product marketing as Principal Product Manager. At the end of an all-day coordination workshop, we sit comfortably with a glass of wine and talk about the good old days.

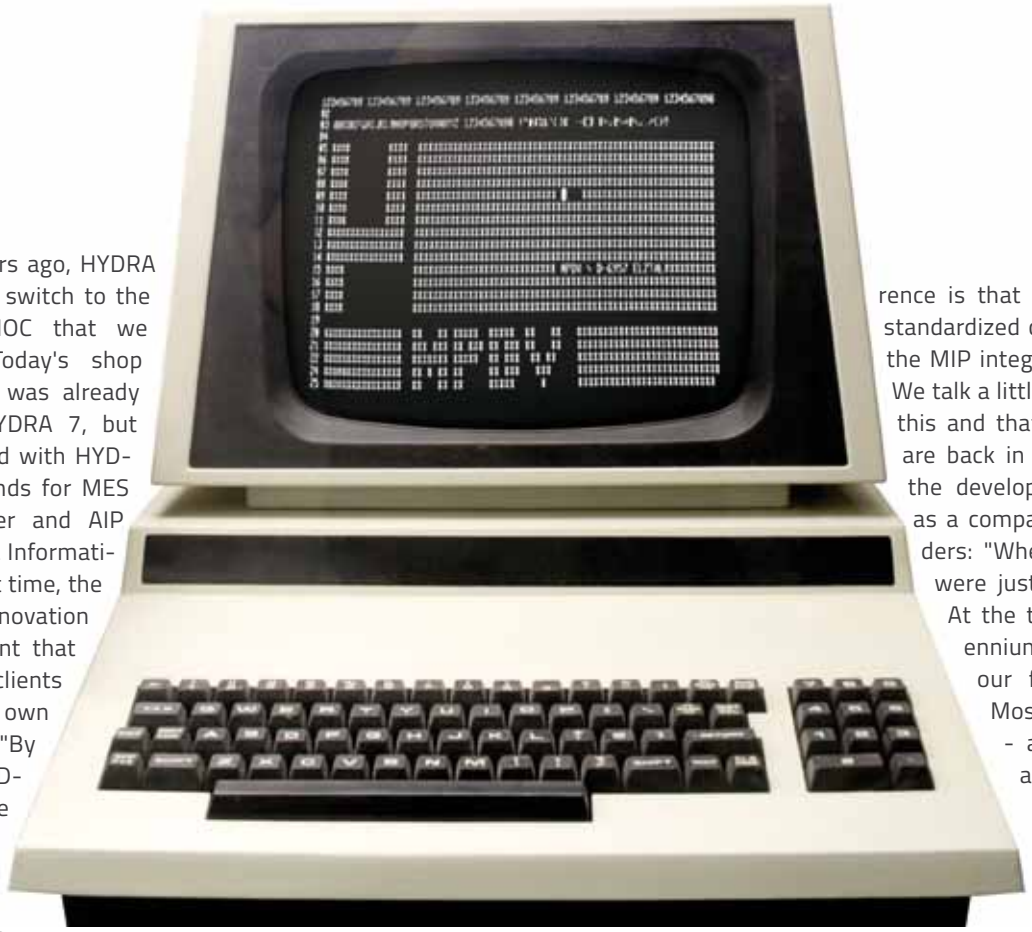
"Back then, in 1991, we were still in the industrial park in Mosbach, Germany, and during my first visit I saw a picture with three columns in the lobby: BDE, MDE and PZE", Berres continues. "These were the three products we were involved with. At the time I thought, what do we do when the three products are up and running? Nevertheless, we came up with more ideas about what we could do, and when I look at our company and our products today, my fears about a lack of work have proven to be unfounded." He gives me a mischievous look. At this time HYDRA consisted of the products Shop Floor Data Collection (BDE), Machine Data Collection (MDC) and Personnel Time Recording (PZE) in version 5.5. "After that came further versions of five, all of which were still based on a DOS client." For the younger generations: DOS stands for Disk Operating System and was the command line based predecessor of Microsoft Windows. Command line means that there was no graphic.

The computer was really an electronic typewriter with a monitor.

"Some of the terminals were even programmed in proprietary languages that hardly anyone knows today. The connection was made via field bus - a simple two-wire line - LAN did not yet exist in production. With version 6.1 came the first Windows client but initially nobody believed in this new, yet highly playful looking technology. However, our boss already had a clearer idea back then." By the boss we mean Prof. Dr.-Ing. Jürgen Kletti, who founded MPDV in 1977 and has played a major role in the company's success story to this day. "At the time we implemented customizations directly in the source code," explains Berres and sips on his wine.

"Next came HYDRA 7 and with it a big step towards flexibility.

The so-called MES Weaver enabled us for the first time to jointly operate individual modules of different versions and thus to further develop them independently. In doing so, we also achieved true horizontal integration as required by the VDI Guideline 5600 some years later. We were ahead of times even then. The first sheets of the VDI guideline 5600 were published in 2006 and are still relevant in newer versions for the tasks of a Manufacturing Execution System (MES) like HYDRA. "Even the terminals were now partly operated by Windows. However, at that time the multitude of server system was absolutely chaotic. Numerous Unix derivatives were more or less equally distributed on the market. This meant that we had to keep all systems available and also incorporate them during development and testing. With the advent of Linux, everything became easier and today we only support Linux and Windows for the server. How we were able to master this complexity back then is hardly conceivable today." Berres continues to talk for a while about technical details that I find difficult to understand totally. Meanwhile I take a swig of wine. However, he returns to the history of HYDRA: "We have done a great deal of work on HYDRA 7, also with regard to customizability. We moved away from the customizations in the source code to user exits, user fields and configuration option". At that time, MPDV already had several hundred customers and the quality demands on the HYDRA standard were significantly higher than in the early days. For example, the outsourcing of customizations in the form of user exits helped to make sure that changes did not have a negative impact on the standard.



"Around ten years ago, HYDRA 8 allowed us to switch to the office client MOC that we know today. Today's shop floor client AIP was already available for HYDRA 7, but became standard with HYDRA 8." MOC stands for MES Operation Center and AIP for Acquisition & Information Panel. At that time, the technological innovation was so important that each of the clients even had their own product logos. "By introducing HYDRA 8, we have further developed the underlying principle of the MES Weaver and have since expanded the product range enormously - even beyond the tasks of VDI 5600. That's why we are talking today about HYDRA being more than just an MES - in other words, Beyond MES!" Berres leans back and sips on his wine. "Thanks to the configurability developed back then, we can still handle many special cases today without changing the source code.

We are proud of this, because we have a standard software that can be used throughout industry.

However, the trend is now shifting away from this. In the future, we will talk increasingly about modeling - but more on that later." Bernd Berres pauses for a moment and then picks up the thread again: "Now we are in the present and sometimes it also affects tomorrow. The new MES Weaver 4.0pe brings HYDRA closer to the Manufacturing Integration Platform and turns it into a multi-app". Some of our HYDRA 8 users have already upgraded to the latest MES-Weaver 4.0pe and therefore have the opportunity to benefit from the MIP ecosystem. This means that HYDRA users can use third-party applications that are compatible with HYDRA. "However, by taking the step towards the platform, we have also heralded another important change - appification. FEDRA is a good example to explain this." The Advanced Planning and Scheduling System (APS) FEDRA is MPDV's new planning solution. He continues taking some peanuts from the bowl: "Here we have launched a new product in the form of mApps for the MIP." mApp stands for Manufacturing App - this can be any type of application that communicates with the MIP via specified services. "As an mApp, FEDRA can therefore be used independent of HYDRA. It seems a bit like closing the gap with the past." He smiles. "We used to have individual applications in form of isolated applications and now we have individual apps again. But the difference is that we now have a standardized connecting link - the MIP integration platform." We talk a little bit more about this and that. Eventually we are back in the past and in the development of MPDV as a company. Berres ponders: "When I started, we were just 18 employees. At the turn of the millennium we moved into our first building in Mosbach, Germany - at that time we already had two floors. Today, we have two further office towers.

We have subsidiaries worldwide and around 500 employees - nothing to do with the engineering office of yesterday.

This fact is also reflected in our product HYDRA. Back then, everyone was more or less in the loop and decisions were made practically across three desks. Today we have quite a few specialists focusing on a variety of issues. Looking back, a lot has happened in what felt like a short time." And with these wise words we finish our wine. Tomorrow is another exciting day at MPDV.

HYDRA X is Coming in Spring 2021

GENERATION CHANGE – ALSO IN THE SOFTWARE

There is nothing more constant than change, and that is why both the MPDV management board and the products are changing. However, major development steps are routinely called for allowing new market requirements to be identified in good time or even anticipated. Prof. Jürgen Kletti, Managing Partner of MPDV, points out: "With HYDRA X, such a substantial innovation stage is now coming – and for this reason we are speaking of a generation change also in this context."

Before evaluating how revolutionary a new product is, one should first understand what characterizes this product and what added value it brings to the users. A Manufacturing Execution System (MES) like HYDRA always seeks to increase transparency of production workflows and to thus pave the way for the Smart Factory. At the same time, an MES helps to improve machine utilization, optimize personnel deployment, shorten lead times, reduce production costs or even secure traceability and support the internal logistics. The VDI guideline 5600 describes ten MES tasks: order management, detailed scheduling and control, resource management, material management, human resources management, data collection, performance analysis, quality management, information management and energy management. These tasks have long been the measure of all things for the functional scope of an MES system like HYDRA.

Beyond MES – HYDRA of the future

HYDRA X, the innovative successor of the HYDRA family, offers a broad spectrum of supporting applications for modern production reaching clearly beyond the classic MES tasks. Among these applications are functions to control intralogistic processes or a step-by-step operator guidance for assembly processes. "The new application often reaches a depth in process control that goes far beyond the scope originally intended for a classic MES," says Thorsten Strebel, Chief Technical Officer at MPDV, "HYDRA X is therefore heralding the new Beyond MES era."

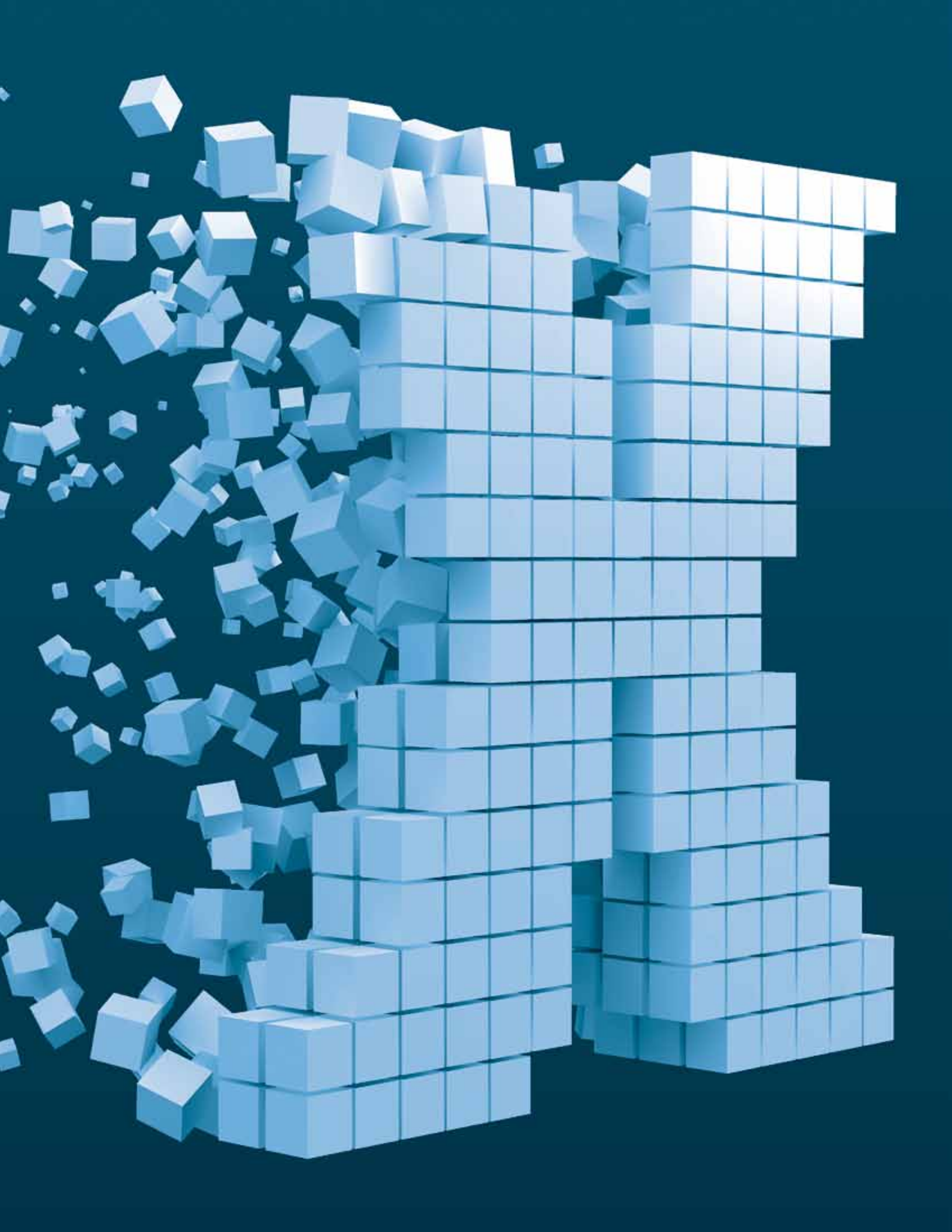
Another advantage is that HYDRA X is not a monolithic system like many other MES systems. It is much more a collection of user-oriented applications, which can be flexibly combined in a platform, in this case the Manufacturing Integration Platform (MIP) by MPDV. The Advanced Planning and Scheduling System (APS) FEDRA by MPDV has already implemented this approach. The result is an ecosystem of interoperable applications, even applications of different suppliers.

This kind of interoperability based on a platform is what the Smart Factory of the future needs. Today, all companies participating in the ecosystem benefit from the advantages provided by interoperability.

Jürgen Petzel, Chief Sales Officer at MPDV, adds: "With HYDRA X, we will soon have the first Beyond MES system based on the MIP that will lay the foundation for a future-proof manufacturing IT. Production companies without an MES should embark on this journey as soon as possible or they will be left behind by the rest of the market." The use of a forward-looking manufacturing IT is essential if only to integrate the often complex requirements of product variety and process quality. Companies with existing systems can use the new platform strategy to innovate and gradually introduce state-of-the-art applications.

"With HYDRA X, manufacturing companies are well-prepared for the future," says Nathalie Kletti, Chief Executive Officer at MPDV, "and MPDV is the right partner on the way to the Smart Factory." The proven combination of user proximity and a special feel for beneficial innovations will again be evident in the next product generation HYDRA X.

Thorsten Strebel summarizes: "Stay tuned and look forward with us to more flexibility, more interoperability and more productivity with HYDRA X."



Koziol

RUNNING LIKE CLOCKWORK

Special times require special measures. This is why Koziol, a company from Erbach, Germany, has been producing respiratory masks since April. Employees at Koziol use MPDV's Manufacturing Execution System (MES) HYDRA to plan and control production orders and thus guarantee a smooth production process.

Koziol normally manufactures drinking cups, mixing bowls or cutlery from 100 percent recyclable plastic. Following the corona crisis, the company has recently changed its production and now manufactures reusable respiratory masks made of thermoplastic elastomer. This is a special plastic that is particularly flexible and can be cleaned with soap and water.

Koziol produces more than 3500 respiratory masks daily in addition to its actual business. Goes without saying that every cog in the works must mesh perfectly. "We have no time for production downtimes." says Thomas Heidorn is responsible for order planning at Koziol.

Getting the most out of it

MPDV's MES HYDRA monitors the entire production process. For example, HYDRA shows exactly how many respiratory masks have already been produced in pink and when the next color change is due. With HYDRA Thomas Heidorn also knows when tools require maintenance. "This is a great advantage as the system enables us to plan in advance and use this time to service machines in parallel."

Special tools are used to manufacture the masks and only a limited number of them is available. After all, Koziol designed the masks within three weeks and at the same time built the tools themselves. Heidorn's task is to ensure that each tool is in the right place at the right time and that production does not come to a standstill. "Thanks to HYDRA we have a complete overview and the system allows us to make the most of our resources."

The engine for production

32 injection molding machines are connected to the MES HYDRA. Heidorn can see on the monitor in his office exactly how many parts are being produced by which system or are currently at a standstill. "This overview is great. HYDRA has increased the transparency in the shop floor enormously. The MES has also enabled us to smoothly convert our production to protective masks and to perfectly coordinate all processes. Now we can produce as many respiratory masks as possible in the shortest possible time. Without HYDRA this would certainly not have been possible", says Heidorn with great delight.

Koziol uses HYDRA for all areas. Their internal printing press is also connected to HYDRA. This allows Heidorn to see early on order gaps in the print shop and how he can use them effectively for other productions. The external installation service of Koziol will be connected to the MES HYDRA in the near future. "With HYDRA we keep an eye on all areas of our production and avoid idle times."

> "Thanks to MES HYDRA by MPDV, we have managed to convert our production to respiratory mask without any problems and to coordinate all processes optimally. Now we can produce as many respiratory masks as required in the shortest possible time".
>
> Thomas Heidorn, responsible for production planning

Plans for the future include the use of other MES HYDRA functions, for example monitoring temperatures during the processing of raw materials. After all, working with plastic is all about precision. Heidorn knows that very well. He has been working for Koziol for more than 21 years.

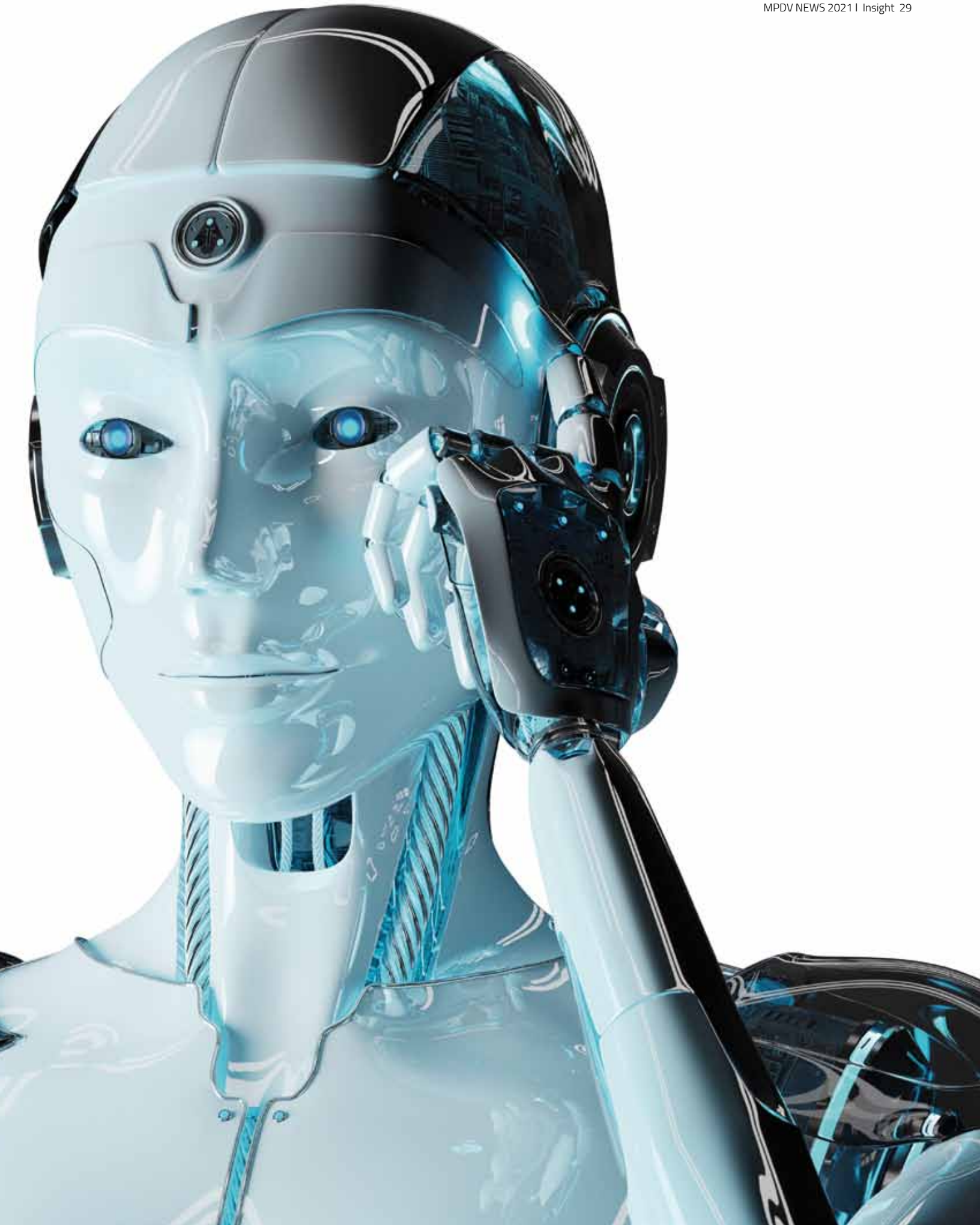
AI Suite

ARTIFICIAL INTELLIGENCE ON THE MOVE TOWARDS STANDARD SOFTWARE

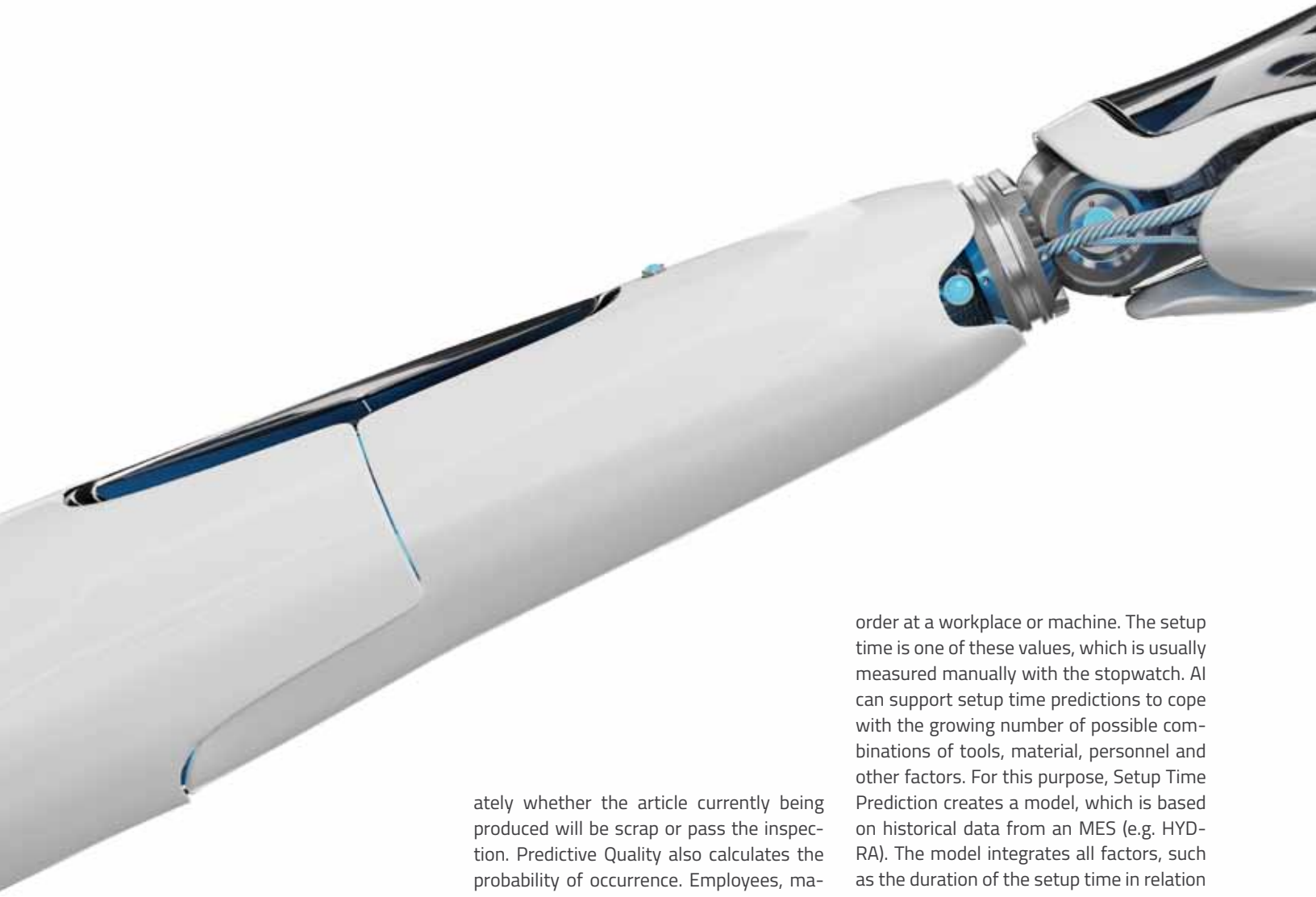
So far, only few companies use artificial intelligence (AI) in production and if they do, they are usually large groups. This is due to the fact that AI projects are costly and the benefits of standardization cannot be used. This will change with the AI Suite of MPDV.

The dream of an all-encompassing artificial intelligence will certainly not come true with the new MPDV solution. However, this product group includes innovative applications facilitating production routines significantly. The AI Suite focuses on the supply of standard software that can be used by small and medium-sized companies without the need for data scientists. Contrary to the classical approach of AI projects according to CRISP-DM, data mining is not necessary with the AI Suite. Instead, the integrated data model of the Manufacturing Integration Platform (MIP) ensures that data can immediately be used. We remember: the MIP is the central basis of all MPDV applications; be it the Manufacturing Execution System (MES) HYDRA, the new planning solution APS FEDRA or one of the new applications of the AI Suite. In the MIP environment, these applications are called manufacturing apps or in short mApps. The AI Suite includes different mApps that can be used as you like. The only condition is that the MIP must be used as shared data basis – which is already a standard if you use the latest MES HYDRA version.

When the AI Suite was presented at the HYDRA Users Group conference in September 2020, two applications were introduced: the Setup Time Prediction and the Utilization Analysis for Shifts. A third, already



AI Suite



known application is also part of the AI Suite: Predictive Quality. Let us briefly outline the different applications in the following:

Predictive Quality

Let us recall: Predictive Quality assumes that scrap or rework can occur even if all process parameters are within the valid tolerances. Complex correlations and interactions can cause these failures and very often the actual production technology is responsible. Predictive Quality addresses these correlations and gives employees in production the opportunity to see immediately whether the article currently being produced will be scrap or pass the inspection. Predictive Quality also calculates the probability of occurrence. Employees, machines, systems or other actors can therefore quickly decide whether it is worthwhile to continue investing in a part or whether to remelt it directly. This saves time and reduces costs, as potentially defective parts can be rejected at an early stage. Predictive Quality rests on the execution of a model that is created using machine learning or in other words artificial intelligence; this model processes recorded process data in real time.

Setup Time Prediction

In production planning, a number of standard values are used to predict the processing time of an operation and also the interim times between two operations of an order at a workplace or machine. The setup time is one of these values, which is usually measured manually with the stopwatch. AI can support setup time predictions to cope with the growing number of possible combinations of tools, material, personnel and other factors. For this purpose, Setup Time Prediction creates a model, which is based on historical data from an MES (e.g. HYDRA). The model integrates all factors, such as the duration of the setup time in relation to the different combinations of article, machine and tool. A conventional setup change matrix quickly reaches its limits, as there are simply too many possible combinations. However, the real highlight is the use of the generated model and, as a result, the prediction of the setup time. For instance, if an operation at a machine is scheduled to run at a specific time with a specific tool, this and other data is used to predict the probable setup time based on the previously created model. Using similarities, setup times can also be estimated for new combinations. AI mainly operates in the same way as manual maintenance would work: A technical expert draws conclusions about

the new combination from comparable articles, tools, etc. But AI can integrate all factors included in the data and use a significantly larger data basis.

Several real production scenarios were analyzed to find out what Setup Time Prediction can achieve in comparison with the conventional method. It turns out that AI-based prediction is clearly superior to conventional prediction mechanisms. This also means, that wasteful buffer times are eliminated. First analyses show that the use of AI systems releases about 20 percent of additional production capacity.

Utilization Analysis for Shifts

Utilization Analysis for Shifts clearly identifies shifts offering potential for optimization. The application provides a transparent overview of the resources that are responsible for low utilization. This enables you to take targeted action and increase utilization within a very short time. The application provides a tree view where users can quickly identify which shift or resource results in very high or low utilization rates.

In the background, the integrated artificial intelligence analyzes a wide range of data and identifies patterns and correlations. For example, the application can find out that a low utilization of a specific shift does not affect all machines. One machine stands out. But also at this machine, utilization varies when you have a closer look at the produced articles. If you then add other influencing factors, such as the material used, you can easily narrow down the causes of low utilization. Such an analysis is quite impossible without AI.

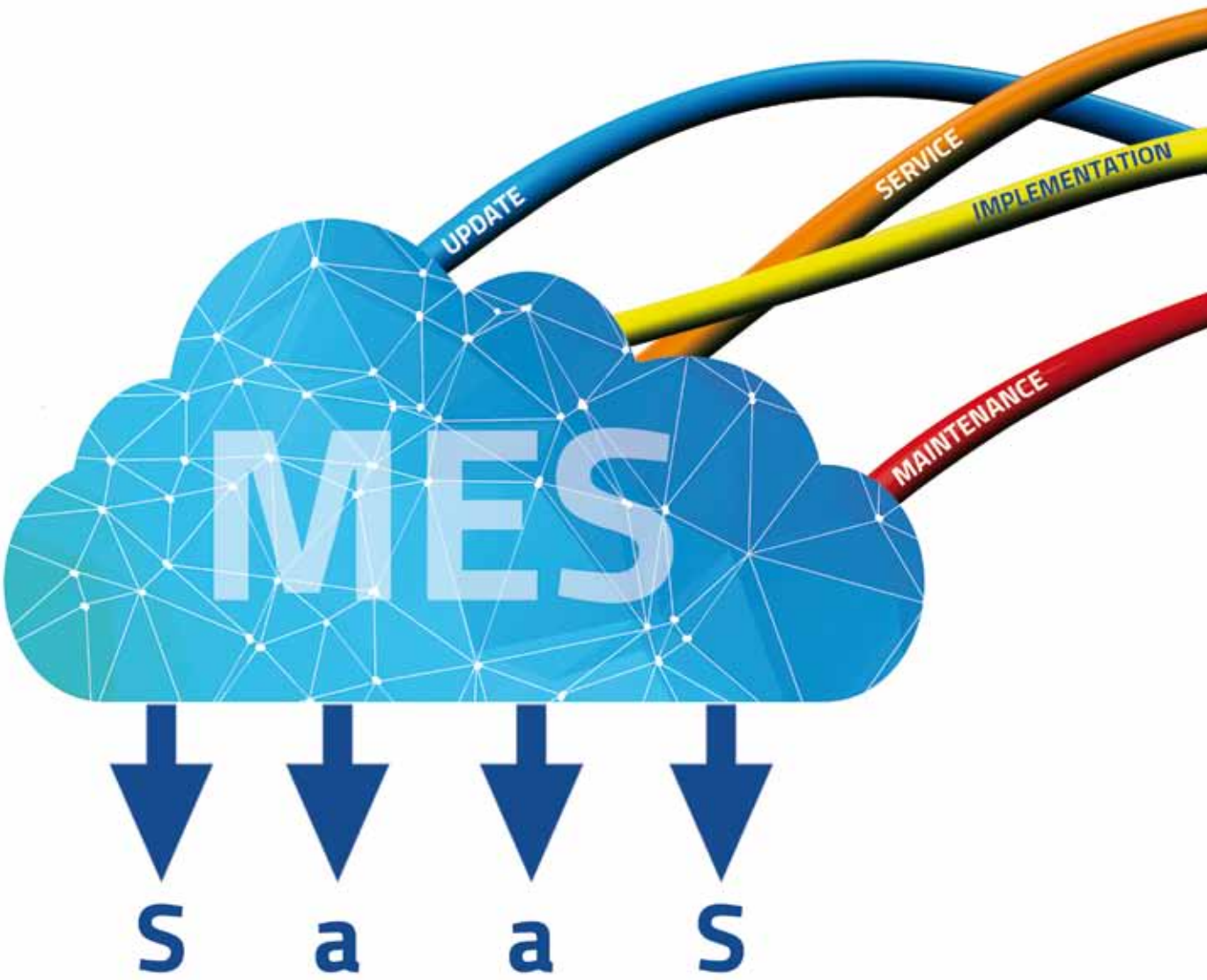
The application Utilization Analysis for Shifts displays all results in tables and graphic charts. This way, the user can understand the outcome of a specific result. Via drill-down, the user can trace back how an analysis result was achieved, even down to the collected data basis.

Increase Confidence in AI

One should not only consider the innovative possibilities the use of AI offers in manufacturing IT, but also the confidence of users in the results of AI. After all, what good is an excellent standard software if the users do not believe its results? In all applications of the AI Suite, MPDV not only shows the results, but also the way the results were achieved. In particular when starting with AI, this is very important, because at some point, AI should suggest measures itself. The results and suggested measures should not be questioned then, but regarded as a real support for the work in production.

SOFTWARE FROM THE CLOUD

Smart Factory Cloud Services is the new service offered by MPDV, making all products available as Software as a Service (SaaS). The offer includes operation, maintenance and updating of the systems as is typical for SaaS.



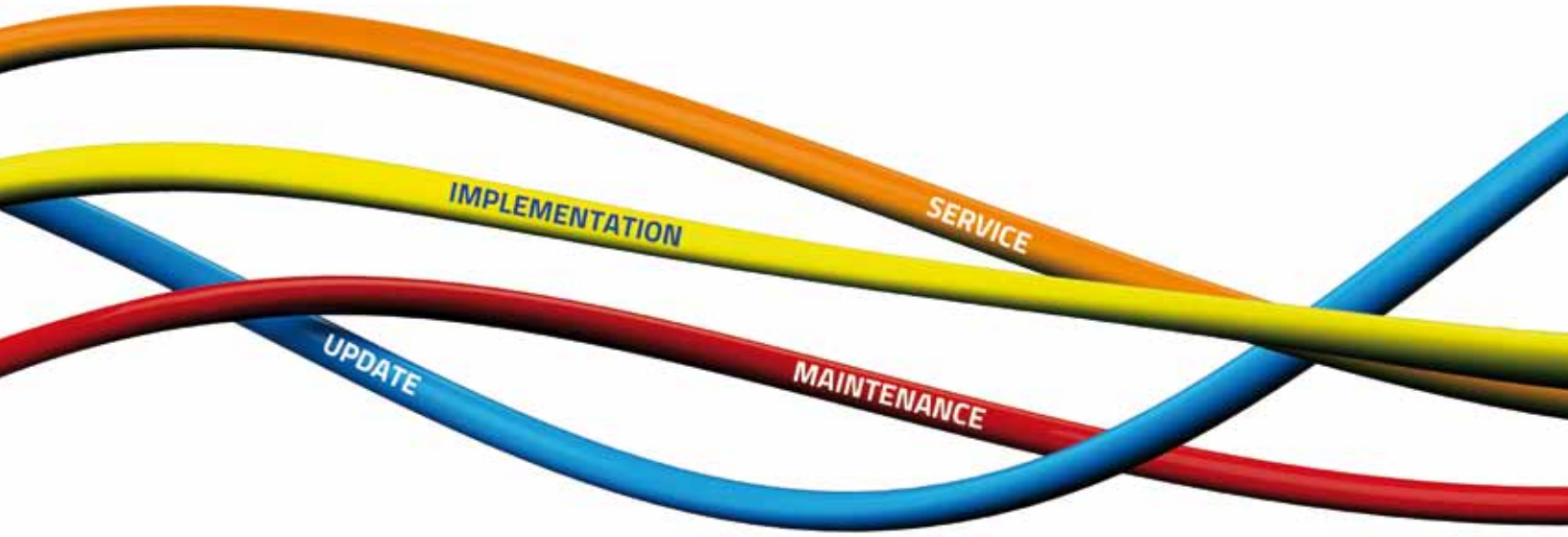
Operating your own servers is time-consuming and distracts from the actual value creation of a manufacturing company. After all, it takes some effort to keep the systems up to date. This involves, among other things, preventing system failures caused, for example, by an external attack. An attack could in the worst case paralyze the entire production line for days on end and result in considerable economic damage. That's why it is all the more important to keep the servers up to date at all times.

More security, increased flexibility

MPDV's Smart Factory Cloud Services also offer their own software products for the Smart Factory as SaaS solutions, thus meeting the market demand for more security and flexibility. The applications no longer run on your own server (on premise), but are accessed online. Deployment, maintenance and updating of the programs is done by MPDV.

Until now, users of the Manufacturing Execution System (MES) HYDRA in an on-premise version were responsible for the maintenance and updating of the system themselves. Smart Factory Cloud Services eliminate these tasks. "This allows the customer to concentrate on their production and work with the system in the shop floor. We do the rest," says Matthias March, Director Product Management at MPDV.

And this is how the SaaS offer works: MPDV provides the required system in the cloud together with partners like Microsoft. For the duration of the SaaS contract, MPDV will update the operating system and the database or install new service packs for HYDRA, for example. The customer can thus fully concentrate on the actual application of the manufacturing IT. The customer is only responsible for the operation of the clients in the company. This means, that they install shop floor clients such as the AIP or the office client MOC locally on their computers. MPDV is responsible for migration, operation, maintenance, servicing and the security of the server applications. This keeps the system always up to date and meets the highest security requirements. Due to a deployment time of just five working days, the services can be used very quickly," explains March.



Reduce fixed costs

Smart Factory Cloud Services also bring significant advantages from a business perspective. For example, fixed costs for special manpower to operate the servers can be saved. Studies have shown that IT costs can be reduced by up to 50 percent with SaaS solutions. Furthermore, companies no longer have to make large one-off investments, but pay smaller amounts on a regular basis and can choose the term and payment frequency. "Software licenses were often too expensive, especially for smaller companies. New licensing alternatives provided by the Smart Factory Cloud Services will result in more cost-effective models for this target group as well," says Holger Hartweg, Director Sales at MPDV.

Full interoperability for all products

Both MES HYDRA and the Advanced Planning and Scheduling System (APS) FEDRA as well as MPDV's Manufacturing Integration Platform (MIP) are available as SaaS solutions. Even if the systems run in the cloud, they can be quickly and flexibly connected to other applications via interfaces. "The servers that we operate for the customer are clearly addressable. We can use the interfaces to other systems as if they were installed on-premise," says March. Using MPDV's Cloud Connector, other cloud software systems such as an ERP can also be easily connected.

Reliable implementation partner

Microsoft's Azure Cloud can be used to serve as the basis for the Smart Factory Cloud Services. Users can freely decide in what region or in which countries the data should be stored. Microsoft, the world's leading manufacturer of software solutions and modern services, MPDV has found a reliable partner for SaaS.

"SaaS applications are the future. They offer more flexibility for users and open up new opportunities to use existing resources even more profitably," says Hartweg.

SOFTWARE AS A SERVICE

SaaS is one of the most popular forms of cloud computing. The applications don't run in your own computer center, but are accessed online via the Internet. Maintenance and updating of the programs is done by the provider. SaaS applications are particularly interesting for small and medium-sized manufacturing companies that only have a small IT department.

Companies are able to use IT services flexibly depending on their needs with SaaS and are thus well prepared for a rapidly changing market. Therefore, IT can react quickly and with great flexibility to new requirements in the corporate world. As a result, costs can be saved and resources used more effectively.

Interview

FACTORY PLANNING, EASY, DYNAMIC, REALISTIC, ADAPTIVE

The requirements for a planning solution in production have increased. This poses a challenge for software companies to develop suitable products and bring them to the market. MPDV's answer is the Advanced Planning and Scheduling System (APS) FEDRA which is a new planning solution that allows both simple operations and complex production orders to be planned quickly and flexibly. In this interview, Thorsten Strebel, CTO, and Jürgen Petzel, CSO, explain why MPDV decided to develop an APS and what benefits the system offers.

Mr. Strebel, what was the motivation behind the development of FEDRA?

Thorsten Strebel: Today, manufacturing companies have much higher demands on a planning software. It is no longer sufficient to be able to simply plan operations in production. Instead, the system must be able to integrate the complete production process, covering all divisions and plants. That is why we have developed many new functions for the shop floor scheduling of our Manufacturing Execution System (MES) HYDRA in the past years and expanded it step by step to an APS, which we are now bringing to the market.

What functions does FEDRA have?

Jürgen Petzel: FEDRA provides basic functions to plan operations, personnel and machines. If required, the system also incorporates consumption and newly produced parts in real time. As a result, users are always informed and have an overview of where materials are missing or whether there are gaps the in personnel planning.

PLAN AUTOMATICALLY

FEDRA has **functions** for automatic planning using rules, objectives or Reinforcement Learning based on artificial intelligence (AI). These functions help to implement complex planning situations quickly and flexibly at the push of a button. FEDRA permits a large number of operations to be perfectly distributed among the available resources. The system can also be used to simulate and evaluate various planning scenarios.

- **AI Planning** takes your automatic production planning to a whole new level by using Artificial Intelligence (Reinforcement Learning). The system questions decisions made and, based on this information, gradually opti mizes the planning result independently. Orders can therefore be pro cessed on time and setup and throughput times can be reduced.
- With **Rule Designed Planning** companies define the rules for automatic planning or use predefined standard rules for planning. For example, you can specify that the work orders with the shortest run time should be processed first or the ones with the highest priority.
- **Target Designed Planning** enables target-driven, automatic planning based on key figures.
- Use the **Simulation** function to compare different planning scenarios during operation.

OPTIMIZE PROCESSES

If you want to utilize your resources on the shop floor perfectly, you need to optimize your processes. APS FEDRA offers suitable functions for this purpose and helps manufacturing companies to **reduce their set-up times** and improve on-time delivery.

- **Campaign Planning** functions support the reduction of setup expenditure with a specified sequence of operations.
- By using **Connected Production Planning**, several operations can be planned in parallel on one workplace and thereby achieving higher machine utilization.
- Setup **Optimized Planning** calculates the setup times based on machine occupancy and helps to optimize the sequence. Overall, this makes planning more realistic and the planning result shows less setup expenditure.
- **Individual Verified Planning** ensures that your production specifications are included in the planning process.
- The **Operation Splitting** function closes gaps in the planning scenario more effectively and achieves higher capacity utilization in production.
- **Cross Order Planning** increases planning security and maps order interdependencies in production planning.
- **Multiple Resource Mapping** checks precisely the capacity of machines or workplaces in order to process planned operations. This function also makes it possible to assign resources several times.

The system allows secondary resources such as tools, material or energy to be planned precisely. FEDRA thus increases transparency in the shop floor, improves production planning and optimizes capacity utilization.

Thorsten Strebel: By using artificial intelligence (AI), companies can use FEDRA to automatically plan highly complex scenarios and even quickly carry out multi-stage production orders. For this purpose, Reinforcement Learning is used, a well-established AI method that allows an accurate distribution of a large number of work processes among the available machines. No matter how complex the planning situations are, our system finds the best planning solution at the push of a button and within no time by using AI.

What is so special about FEDRA?

Thorsten Strebel: The great flexibility.

What exactly do you mean by flexibility in this case?

Thorsten Strebel: FEDRA can be used as a stand-alone system. This means that our APS can be used independently of other planning systems in production. On the one hand, this makes FEDRA suitable for companies that want to introduce a pure planning solution and on the other, FEDRA can be fully integrated as it is based on our platform solution - the Manufacturing Integration Platform, in short MIP.

MIP users can choose from a variety of so-called Manufacturing Apps (mApps) with different functions and combine them in any way they want. All FEDRA functions are available on the MIP as mApps. Users can decide which functions they want to use depending on their needs. Thanks to the interoperability of the MIP, FEDRA's individual mApps can be easily combined with each other. This makes production planning easy, dynamic, realistic and adaptive.

Jürgen Petzel: Another factor is that FEDRA is particularly easy to use and can be operated in combination with systems such as an ERP or an MES like HYDRA. Information such as machine or order status can be fed into the planning process by exchanging this data between the systems. In doing so, the user has always a total overview.

FEDRA has various functions for personnel deployment planning. What's the big deal here?

Thorsten Strebel: Companies can use FEDRA to synchronize their order planning with

EASY PLANNING

FEDRA supports the systematic planning of operations and machines. The system allows **resources to be used to full capacity**, reduces throughput times and improves on-time delivery. In addition, FEDRA gives employees the opportunity to create evaluations within a very short time. Interfaces to the ERP system and the shop floor permit direct data exchange.

- Thanks to **FEDRA Interactive Planning**, manufacturing companies can replace their analog planning solution with a digital display and intuitive drag-and-drop operation.
- **Assisted Planning** contains functions providing transparency and helping you to plan efficiently. The system identifies and avoids conflicts at an early stage in the planning process.
- **Integration Services** secure the communication with other systems, which include both the ERP and the shop floor connection.
- **Workload Analysis** allows planners to see immediately how busy production is. As a result, they know immediately where the gaps are and can also easily squeeze in short-term orders.

their personnel planning. For example, the system considers personnel requirements that arise as a result of orders to be processed or workplaces to be assigned. Also, all available personnel capacities including staff qualifications are used in the planning. This ensures that the right resources are available at the right time and that all orders can be processed on time.

What manufacturing companies and industries is FEDRA particularly interesting for?
Jürgen Petzel: FEDRA can be used for all sectors of industry. Here it does not matter whether the company is a campaign producer or a series producer, whether small batches or large ones are manufactured: FEDRA fulfils all the requirements of different industries and manufacturing processes! For this product, too, we remain true to our strategy of creating added value with our solutions for all industries and company sizes.

PLAN COMPLEX SCENARIOS

APS FEDRA can be used to plan **secondary resources** such as tools, materials, personnel or energy. Users can now synchronize their planning processes, reduce setup costs and avoid unnecessary waiting and idle times.

- **FEDRA Workforce Planning** lets companies implement their personnel deployment planning irrespective of machine utilization.
- Secondary Resource Planning includes tools and auxiliary means in the planning and provides greater transparency.
- **Integrated Workforce Planning** brings production planning in line with personnel deployment. Planers use it to ensure that enough personnel are available at all times to process planned orders.
- With **Predictive Material Planning**, indirect order dependencies can be mapped by checking material relationships and thus enable employs to keep an eye on production at any time.
- **Energy Demand Planning** helps companies to manage peak loads and avoid penalties for energy procurement.

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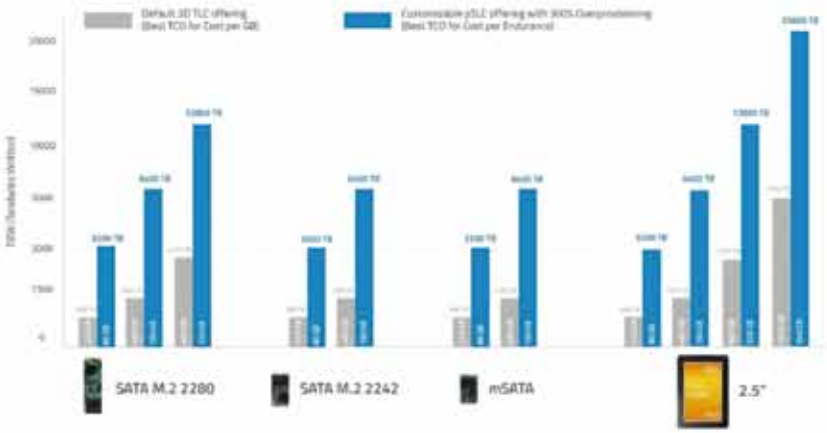
ATP Electronics' Premium Line uses advanced controller and firmware technologies to make sure that the offerings meet and even exceed the endurance requirements of demanding applications.

Premium Line storage solutions are purpose-built for applications that require uncompromising endurance and reliability at lower user capacities. These embedded flash storage devices are configured with pseudo single-level cell (pSLC) to extend the general endurance to more than 10 times of the same triple-level cell (TLC) products. The pSLC technology dramatically improves the sustained write performance and reliability of the drives, making them suitable for write-intensive applications. By storing only 1 bit per cell, Premium Line solutions drive down TCO with longer service life using the most cost-effective NAND flash technology available.



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A Question to Steffen Münch

HOW CAN A HETEROGENEOUS IT INFRASTRUCTURE BE INTEGRATED INTO A COMMON DATABASE?

When we visit manufacturing companies and go through production, we usually find that disparate systems are in use at different locations. This is particularly the case in large corporations, which have grown strongly as a result of acquisitions. A Manufacturing Execution System (MES) is already in use at one location, while another site is working with an alternative solution to record machine and shop floor data or for quality inspection. The big challenge in such cases is to create a common data basis so information can be exchanged and transparency created.

In such situations, some companies decide to phase out their existing systems and introduce a uniform solution. This is certainly a viable option, but this approach is highly complex and very costly. On top of this, a great deal of new solutions have been introduced to the market with Industry 4.0, which is why today hardly any providers are left who can supply the necessary degree of expertise in all areas.

In my opinion, the best way is to network existing systems in such a way that critical data converge at one point. And that is where our Manufacturing Integration Platform (MIP) steps in. The MPDV platform enables the exchange of information between the systems of different providers. A variety of applications can be connected very quickly to the MIP via standard interfaces in the form of so-called Manufacturing Apps (mApps). The mApps access a common digital image of production (digital twin). Unlike many IoT platforms, the MIP not only manages data, but also creates a useful image of production reality using mApps.

In order for the solutions of different providers to interact smoothly, it is essential that not every developer has to define and implement multiple interfaces. To meet this requirement, the MIP has a common, uniform and integrating information structure. Meaning, all systems speak the same language. For instance, information on the

current state of production can be exchanged flexibly. Each recorded value has a defined meaning. In this way, applications and users alike know whether a piece of information is about scrap, downtime or temperature.
By using the MIP, companies save time and money needed to replace existing systems with new ones and employees no longer need to be trained on the new systems. On the contrary, thanks to the MIP it is possible to intelligently network existing systems and share information specifically.

Focus on user requirements

Our MIP focuses on the user and their requirements. With the platform, users can select the most suitable product from a broad portfolio of different providers. Alongside hardware and software providers, system integrators, developers and machine manufacturers are among the players in the MIP ecosystem. Together they make a substantial range of products possible. Experts from different fields and industries meet at the MIP marketplace and together generate the best possible solution for the user. Users have the greatest degree of flexibility in selecting and combining solutions. For example, if a metal processing company changes their strategy and buys an injection molding plant, they can use the MIP to easily add new solutions that are specifically designed to meet these new requirements.

Wide range of functions

All objects used in production are stored together with their data in a common database. Users can access these objects and their data via standardized services. The functional range of the MIP therefore far exceeds the scope of a current MES. Interoperability enables users to integrate any applications and systems via the platform and exchange information.
The MIP's openness and the virtual integration of the manufacturing process break down previous system boundaries and unify application functionalities via a common and consistent database.

ABOUT THE PERSON

Steffen Münch is Key Account Manager for the Manufacturing Integration Platform (MIP) of MPDV. He is responsible for the development of the ecosystem and the collaboration with MIP partners.

„Experts from different fields and industries meet at the MIP marketplace and together generate the best possible solution for the user."

ADGA

FROM TREE TO YARDSTICK

The ADGA team is driving digitalization in its production with great enthusiasm. The company relies on MPDV's Manufacturing Execution System (MES) HYDRA and uses the system to record machine data and optimize its processes for the production of yardsticks. This is a first step on the way to the Smart Factory.

No matter whether you call it a folding rule or yardstick - no household or workshop can do without it. ADGA specializes in the production of yardsticks, which they produce in a beautiful spot called Mainhardt in Germany. The long-established company produces several million folding rulers annually.

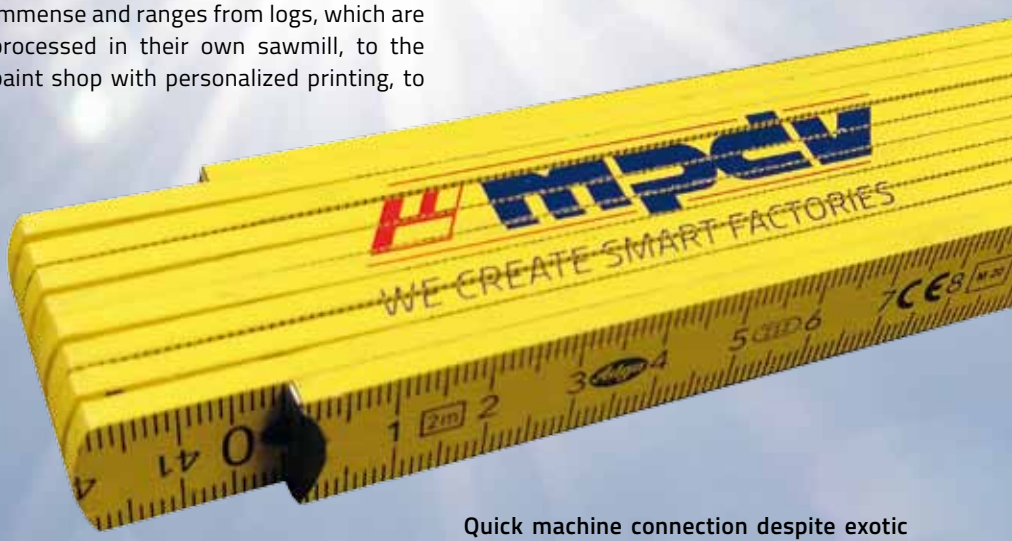
ADGA leaves nothing to chance in the selection of beech wood. The company processes only the best knot-free beech and hornbeam trunks from domestic forests into yardsticks. Working with natural products requires a high degree of precision. The logs are sawn and dried expertly. Meticulous further processing guarantees top quality and a maximum precision down to the last detail. The team designs and builds the necessary special machines themselves to fulfill high quality standards in series production. More than 50 years of engineering experience contribute to the long lasting success.

Since last year, the company has been using MPDV's MES HYDRA to monitor the manufacturing process. "HYDRA has shown us that there is room for improvement. Thanks to the system, we can now optimize processes on the basis of real-time data and know exactly the real potential in our production to increase our efficiencies," says Michael Weingart, Managing Director at ADGA.

Setting the right wheels in motion

The vertical production range at ADGA is immense and ranges from logs, which are processed in their own sawmill, to the paint shop with personalized printing, to the ready packed yardstick. This is why the company has separated the production in different areas. HYDRA is currently used in the wood processing for the collection of machine data.

The project team has already connected twelve systems to HYDRA. "Now we can see the hidden potential in our machines at once and can improve the overall capacity utilization," says Weingart. For example, with HYDRA the employees know that certain installations have a key role in the wood processing. If there's a snag here, the entire production process comes to a halt. Prior to this, the project team was not aware of it. The focus was still on completely different machines. "Here the system has made a decisive contribution to ensure that we are setting the right wheels in motion."

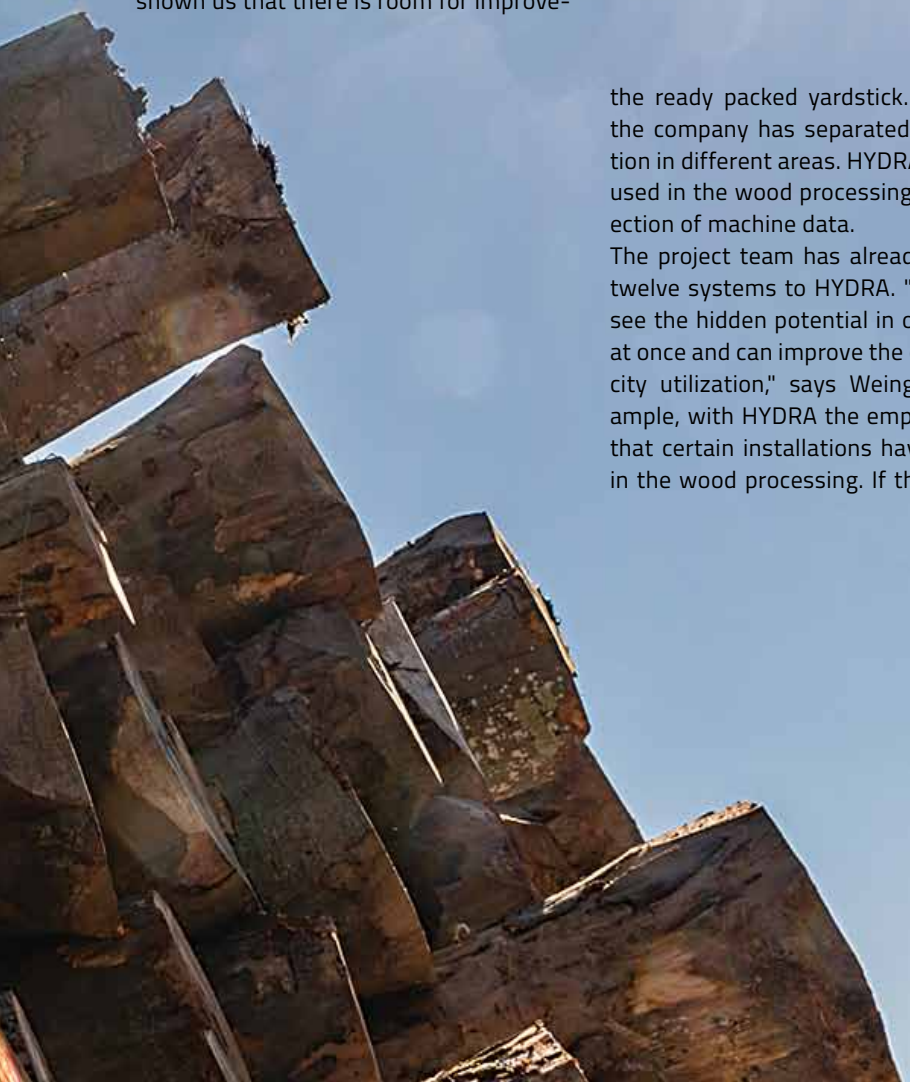


Quick machine connection despite exotic controls

Every machine at ADGA is unique. ADGA hardly uses any standard machines. They have built and programmed all the machines themselves. This is rather unfavorable for the process. The systems have no standard machine control. "We use Mitsubishi to a large extend which is really uncommon. Nevertheless, we connected our machines to HYDRA within a very short time." A little programming on the machine side has helped. It's just fantastic how quickly we were able to find a solution to this problem thanks to the support of MPDV".

ADGA plan in the near future to also collect shop floor data with HYDRA. ADGA wants to improve its on-time delivery performance, reduce throughput times and provide even more transparency in the company's own production processes.

"We are at the beginning on our way to the Smart Factory. I am looking forward to mastering all the challenges ahead together with MPDV and optimize our production step by step," says Weingart.



MES Solution for the Pharma Industry

QUALITY RISK MANAGEMENT AND OTHER REQUIREMENTS

The pharma industry and other regulated industries face two key challenges: producing efficiently while complying with a wide range of requirements, including data integrity. The use of suitable software is almost compulsory. Industry solutions such as HYDRA for Life Science from MPDV or PILOT:Pharma from FELTEN support regulated manufacturing companies to overcome these two major challenges.

MES industry solutions like HYDRA for Life Science and PILOT:Pharma offer a wide range of standard functions for regulated manufacturing companies (Source: MPDV, FELTEN, Adobe Stock, Gorodenkoff)

Apart from the regulatory requirements, most pharmaceutical manufacturers are ordinary manufacturing companies - they process raw materials into components and make products that meet high quality standards. Therefore, it is hardly surprising that a Manufacturing Execution System (MES) is perfect to integrate and comply with standard production requirements. An integrated MES also meets additional requirements such as traceability, data integrity, special processes and terminology. However, the number of providers is dwindling when it comes to providing actual standard applications.
At the same time, the validation of process software, which also includes an MES, with ISO 13485:2016 has become a mandatory requirement. Regulated manufacturers must run a quality management system complying with this standard in order to pass the usual audits of FDA inspectors.

Process software for pharmaceutical manufacturers (Part 1)

The MES business solution HYDRA for Life Science is based on the globally and industry-wide used MES HYDRA by MPDV. Many of the available MES functions can be configured or parameterized so flexibly that it is also possible to implement requirements that usually only occur in regulated industries. These requirements include the Audit Trail and the integrated authorization concept, which enables manufacturing companies to guarantee data integrity across the entire value chain. HYDRA for Life Science also provides the necessary software support for the CAPA process (Corrective and Preventive Actions) and helps to manage the qualification of employees in production. With an integrated FMEA module, HYDRA for Life Science also supports the risk management.

HYDRA for Life Science supports regulated manufacturing companies in terms of quality risk management (Source: MPDV, Adobe Stock, Gorodenkoff)

Quality risk management with FMEA

The Failure Mode and Effects Analysis (FMEA) is a specific method to identify potential failures at an early stage. HYDRA helps the user to achieve this by providing failure nets. Risks arising from failures can be assessed using key figures that specify the severity of the failure sequence, the occurrence probability of the cause and the probability of detecting a failure. Counter measures can also be defined and traced. FMEA analyses of this kind can be created for both products and processes. Therefore, the FMEA module makes a substantial contribution to the quality risk management of regulated pharmaceutical manufacturers.

Corrective actions / preventive actions

Furthermore, both FDA inspectors and ISO auditors monitor whether companies are using a CAPA process to identify, analyze, correct and eliminate quality problems in the long term. Manufacturing companies can at the same time reduce the amount of manual rework and scrap.
MPDV's CAPA Management featured in the industry solution HYDRA for Life Science allows for a detailed recording of problems. In-depth analyses can be used to identify problem areas and initiate measures. The traceability function supports the user perfectly in their efforts to remove and stop the cause of problems. The MES can use workflows to notify the relevant persons about the measures generated, including deadlines.

Process software for pharmaceutical manufacturers (Part 2)

FELTEN likewise offers an innovative technological solution with PILOT:Pharma supporting production management in improving efficiency. After all, with PILOT:Pharma, companies reduce their production costs in the long term, increase their performance capacity significantly and generate noticeably higher quality by exploiting the entire efficiency potential. More flexible process models also make it easier for companies to react to changing market requirements. GMP-compliant documentation is equally a matter of course as is the detailed Audit Trail Function (CFR 21 Part 11) and Corrective and Preventive Action Manage-

PILOT:Pharma offers important functions for digitizing regulated manufacturing processes (Source: FELTEN, Adobe Stock, dusanpetkovic1)

ment (CAPA) as well as complete Electronic Batch Record Management (EBR). For example, the weighing module of PILOT can be used to digitize weighing processes and document them automatically and completely. Among the most important features are the option to weigh orders and raw material, fully automatic weighing including tare function or partial weighing when changing container or LOT numbers. Plausibility checks support the operator and guarantee the machining quality.

Benefits of a standard software

In addition to the functions configured specifically for the regulated market, MES solutions such as HYDRA for Life Science or PILOT:Pharma offer a wide range of applications that are used in different combination and thus comply with the VDI Guideline 5600. These applications are employed by companies worldwide. The function portfolio ranges from data collection in the shop floor to detailed evaluations of all kinds and the planning of orders, resources and personnel deployment. The documentation of the complete manufacturing process in line with traceability is also part of the standard range of functions. When combined with applications for quality assurance and personnel management, such systems make an enormous contribution to greater transparency and efficiency in the shop floor. Both systems, HYDRA and PILOT, can be easily combined with each other by using MPDV's Manufacturing Integration Platform (MIP). The integrated semantic information model ensures that all important data can be used in both systems. Thanks to the large customer base and the configurability of HYDRA and PILOT, these systems can be considered as standard software. Therefore, the software can be classified in the GAMP software category 4 "Configured products" (Fig. 7), which greatly simplifies the standard procedure for verification as a GxP computer-aided system compared to the verification of customer-specific applications (GAMP category 5).

Support during validation process

The two software manufacturers also provide a comprehensive package of documentation and specifications of standard software to the MPDV Group, which has branches and subsidiaries in Germany, China, Luxembourg, Malaysia, Switzerland, Singapore and the USA. The functions include GAMP-5 requirements and therefore support the manufacturing companies in the validation process. The experts from MPDV and FELTEN have successfully supported such validation processes for various MES users worldwide.

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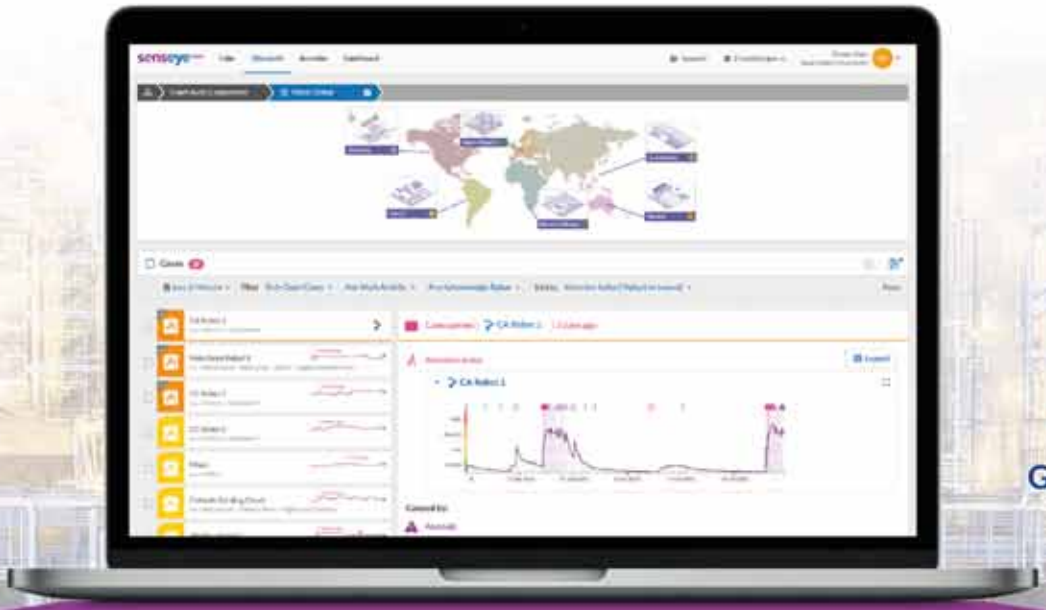

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Interview

THYSSENKRUPP IS A MIP-PARTNER

The mApp toii® simplifies communcation on the shop floor

thyssenkrupp Materials Services and its subsidiary thyssenkrupp Materials IoT GmbH, the largest materials broker and service provider in the western world, is a new partner in MPDV's Manufacturing Integration Platform (MIP). In an interview with MPDV, Pascal Frank, Sales and Project Manager at thyssenkrupp Materials IoT GmbH, explains which solution the company is using to contribute to the MIP ecosystem and what added value it generates for users.

thyssenkrupp is a new MIP Partner
Source: thyssenkrupp, MPDV

thyssenkrupp introduced their manufacturing app (mApp) toii® to the ecosystem of the MIP. What does the mApp do?

Pascal Frank: toii® was developed especially for medium-sized manufacturing companies, regardless of whether they are involved in plastics or metal processing. The aim was to create a very robust, modular and complete system to digitalize production for thyssenkrupp. As of this year we are also offering this tried and tested solution to customers outside thyssenkrupp.

Completely different ERP/ MES systems, machines and production equipment from different manufacturers communicate with each other via toii. We therefore offer solutions for transparency in production performance as well as semi and full automation of processes.

Application examples are paperless processes, OPX Performance Dashboards, automatic parameterization of machines based on production data provided by the ERP/ MES, fully automated quality assurance, benchmarking of production sites against each other.
Thanks to highly intuitive user interfaces, toii® follows the trend of supporting automated machine guidance in terms of processes, whereas in the past machine operators designed the process.

Software is only part of this solution. The solution is enhanced by an end-2-end service from our team. We take special care to ensure that our employees understand production processes, machines and software codes. In this way, we provide competent support to our customers from the concept phase, to implementation and all the way to operation and service of the digital solution.

Why did you decide to become a partner of the MIP? What were the primary reasons?

Pascal Frank: Networking systems can act in a highly targeted fashion and deliver significant added value to the user. The aim should be to unite diverse technologies and applications on one platform. This is exactly what the MIP can deliver.

What effects do you envisage from the partnership?

Pascal Frank: Networking of systems in the partnership provides the user with new functions and an easier access to the technology. MPDV and thyssenkrupp Materials IoT are two strong partners with a distinct technological expertise. These competences can especially support small and medium-sized enterprises in Germany in their digitization initiatives.

Why will MIP revolutionize the market for manufacturing IT?

The MIP unites IT technologies close to production. In this way, a variety of individual solutions can be turned into a complete system. Simply ingenious, because this eliminates unnecessary interfaces and we can standardize isolated applications.

ABOUT THE PERSON

Pascal Frank, Sales and Project Manager at thyssenkrupp Materials IoT GmbH, a subsidiary of thyssenkrupp Materials Services, shows how the new mApp toii® simplifies communication channels on the shop floor.

Image: thyssenkrupp

Unique MES Requirements in the Process Industry

TRANSPARENCY FROM RAW MATERIAL TO THE FINISHED PRODUCT

Small batch sizes, more product variants and new legal requirements to document the production process: The demands on production companies are enormous and will continue to increase! How can companies overcome these challenges successfully?

Manufacturing companies must document precisely the raw materials they use to make a product. Thanks to a Manufacturing Execution System (MES) such as PILOT from Felten, a subsidiary of MPDV, it is possible to quickly trace material used, workplaces, machines and, if required, employees involved in the production of a specific product. Who has carried out which quality inspection? What quantity has been produced so far (pieces, kilogram, liter etc.)? How to label products? These are all everyday and important questions that need to be answered promptly.

"Complex processes in industry make digitization in manufacturing indispensable. Using an MES, the vast amount of data that is generated in the production of shampoos, perfumes or food can be processed as efficiently as possible and utilized profitably," says Martin Seer, software consultant of the Felten Group.

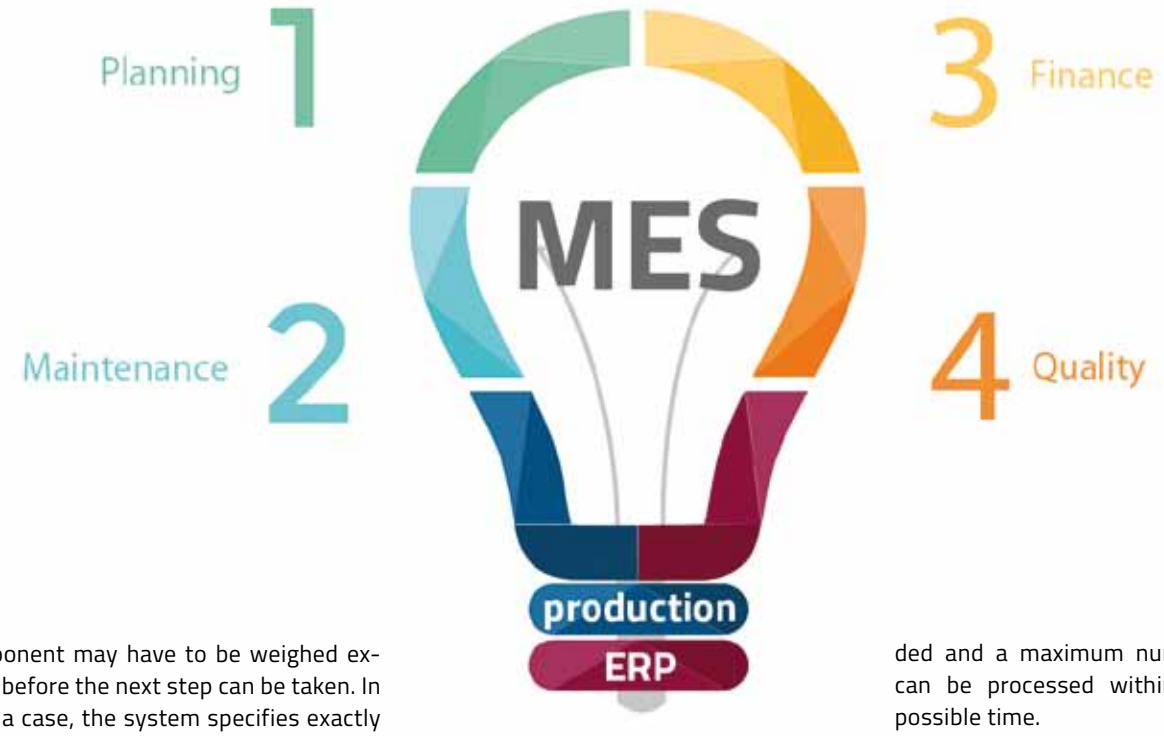
Operator-guided systems for a smooth process

Many companies still work with Excel, paper and pen and each department has another list. This leads to media disruptions and the loss of information. On top of this, a great deal of time is spent on recording data manually and collecting the relevant information from the departments, which is normally done by email, telephone or verbally. "An MES makes all this information digitally accessible to every single employee, thereby achieving transparency everywhere," says Seer. For example, if using an MES, employees in quality assurance have essential production data at their fingertips at all times and can make informed decisions.

The increasing demand for more individual products and smaller batch sizes also poses special challenges for businesses. Ultimately, this means that more setup processes are required and settings systems have to be changed frequently. This in turn leads to a high workload. Operator-guided systems from FELTEN help employees to perform individual process steps at the right time and in the right order. Let's say, at the beginning of a production process, a certain

ABOUT THE PERSON

Martin Seer has been working as a software consultant for the FELTEN Group since 2017. The graduated business information scientist advises companies on how to introduce Manufacturing Execution Systems and holds workshops on digitization in production.



component may have to be weighed exactly before the next step can be taken. In such a case, the system specifies exactly what has to be done and when.

Digital checklists such as those from FELTEN are very effective for quality inspections. They are highly configurable and can be used depending on product and material. For example, random samples of shampoo bottles can be taken off the conveyor belt during such tests to check whether the lid can be opened easily, or whether the barcode is in the right place or whether a bottle has dents. The information gained can then be entered simply in the digital checklist.

Detailed planning systems for more efficiencies

MES systems also play a decisive role in detailed production planning. If a system fails, orders must be produced immediately on another machine. Planning with an Excel spreadsheet doesn't really enable you to quickly find the best solution in such a situation and reschedule orders.

Using an MES like PILOT from FELTEN, production planning can be changed within seconds at the push of a button and adapted to the new conditions while considering various parameters. For instance, employees can immediately see which raw materials are available and in what quantities. PILOT can also be used to plan mixers, scales and other equipment. A detailed planning system can automatically find the best possible and most cost-efficient way to determine which product is to be made when and where. The system not only provides for optimized setup time planning, but can also retrieve material qualities such as white products or black products in order to schedule the necessary cleaning and other intermediate steps efficiently. This reduces cleaning efforts and thus lowers the production costs considerably. In this way, redundant work steps can be avoided and a maximum number of orders can be processed within the shortest possible time.

Discover new potential with key figures from the MES

PILOT users can also record and evaluate important key figures in production. The system thereby helps to make production transparent and shows how productive individual systems are. In this way, companies can identify new optimization potential in order to produce their goods even better and more economically. The key figures and evaluations are available for specific users and serve as a basis for decision-making for employees at different hierarchical levels.

"The challenges in the industry are manifold. A modular MES like PILOT offers companies the opportunity to tackle and successfully master these challenges step by step. This will help businesses to remain competitive in the long term and make their processes even more efficient," says Seer.

viastore SOFTWARE

INTEGRATED PROCESSES IN LOGISTICS AND PRODUCTION

viadat warehouse management system (WMS) with standard interface to the HYDRA MES

Industry Solution PILOT:Food in Milk Processing

THE WHITE GOLD OF THE FOOD INDUSTRY

Milk is one of the most versatile foods we know. The processing from raw milk to the end product can be very complex. It is therefore all the more important to support the production process by a suitable software like the MES industry solution PILOT:Food by FELTEN.

The food industry is generally a highly competitive and very price-sensitive market. These conditions alone make it necessary to ensure an efficient production. Furthermore, the food market undergoes a continuous process of change and the production must adapt to the ever-changing nutritional and consumer behavior.

A company focusing on milk processing, whose name cannot be mentioned for reasons of competition, has decided in the course of 2019 to digitize the existing production processes step by step in order to face growing competition. The company processes raw milk into different substances such as whey protein concentrate, whey protein isolate and caseinates, which are used in various areas of the food industry as important basic substances.

From workshop to implementation

After a concept workshop to start off, the manufacturer commissioned the FELTEN Group to implement the MES solution PILOT to optimize their workflows in production. In the course of the workshop, first analyses showed that the ERP software used was capable of integrating the supply chain processes, but they also revealed that the internal warehouse and production workflows were only covered to a small extent by the functions of the ERP software. As a result, these workflows were mainly controlled manually and on paper. A digitization was indispensable as there were additional challenges like the constant milk delivery and its instant processing. After delivery, the milk must be processed as quickly as possible in a consistently high quality. The aim was to considerably increase productivity by a higher degree of automation and a flexible production control. This was achieved with the introduction of the industry solution PILOT:Food as a lower-level MES including different modules.

A concept with several stages was developed and an initial workshop defined how the workflows should be implemented. The implementation then got underway with a solution for the incoming goods inspection. The processes of incoming and outgoing goods were digitized and the data exchange with the ERP was automated for orders and deliveries.

Workflows in milk processing

In the raw milk processing, the MES divides an order into different sub-orders and assigns them to the relevant production areas. In addition to the traditional workflows of the pure milk processing like heating, homogenization and cooling, parts of the whey are used to produce whey protein concentrate and whey protein isolate via filtration and spray drying tower processes. These products are filled into big bags and sacks for further processing at other sites. Here, the MES identifies type and volume of the orders and controls whether the products are packed on pallets or filled in big bags or sacks. For the production of other products like cream cheese in different flavors, the raw materials are put into the mixer with a weighing system for small components. The MES manages all weighing orders and supports the operator by

Not all intermediate products are fluid in milk processing. Powder products are often filled into big bags. (Source: Adobe Stock, Syda Productions)

means of an operator-guided dialog.

Ensure quality

FELTEN's profound industry expertise and the field-tested approaches in the digitization of production processes convinced the responsible persons to opt for the industry solution PILOT:Food. With the introduction of a Manufacturing Execution System, the current utilization of the site became transparent and the milk processing and distribution could be managed flexibly. Also the capacity used could be increased thanks to digitization. The system supports the operator in working efficiently and guides them safely through the process. Manual errors like the mix-up of a milk package are virtually impossible. Data collected also provides information for the management dashboard and hence the management can see at an early stage if measures are required and counteract.

The MES consistently collects and stores the order, material and equipment data in the system to ensure traceability of the finished products. After processing, the milk products are moved to the finished goods warehouse. All operations from beginning to end are closely documented. For this purpose, mobile devices (PDAs) are also used enabling an easy and flexible operation and user guidance. If necessary, one click is enough to provide all relevant information and to detect possible causes of irregularities.

The production manager of the user company confirms: "There are no compromises in food production. All production processes are subject to strict regulations and controls. PILOT:Food shows us in real time where we can improve things. The MES has become an important tool for us."

The way to real time

Up to now, the milk processor was only able to look into the past with the data available. With the MES PILOT:Food, they now have the means to evaluate real-time data. The company has made the first step towards artificial intelligence and preventive measures. This ensures competitiveness and enables the company to quickly respond to constantly changing market requirements.

The modular MES platform PILOT is designed for a fully digitized future and Industry 4.0. It integrates optimization, quality and energy management in production on a high-tech platform and can easily be adapted to any requirements. Production thereby achieves a maximum degree of flexibility and business processes are truly integrated. Another unique selling proposition of PILOT is its design including a consistent Production Intelligence approach (PI). Thanks to this best practice method with individual design, PILOT:Food proves to be exceptionally innovative, cost- and future-oriented when applied by customers.

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HOW TO SUCCEED INTRODUCING ARTIFICIAL INTELLIGENCE IN PRODUCTION

Artificial intelligence (AI) can support people in production in their work even today, but many companies are still hesitant embracing the new technology. This article outlines the most important AI basics and application areas in production and gives recommendation for a long-term introduction to AI.

Forecasts indicate that the use of artificial intelligence (AI) in the manufacturing industry offers great economic potential. For instance, a study commissioned by the German Federal Ministry of Economics and Energy (BMWi) shows an extra gross value added of EUR 31.8 billion by 2023. According to an AI study by the Fraunhofer IAO, only about 16 percent of companies have a real AI application in use, 59 percent have planned to use AI and 25 percent have not yet done so. Frequently seen as obstacles are the lack of know-how in companies, not enough cooperation partners, an ambiguous added value as well as the absence of a database.

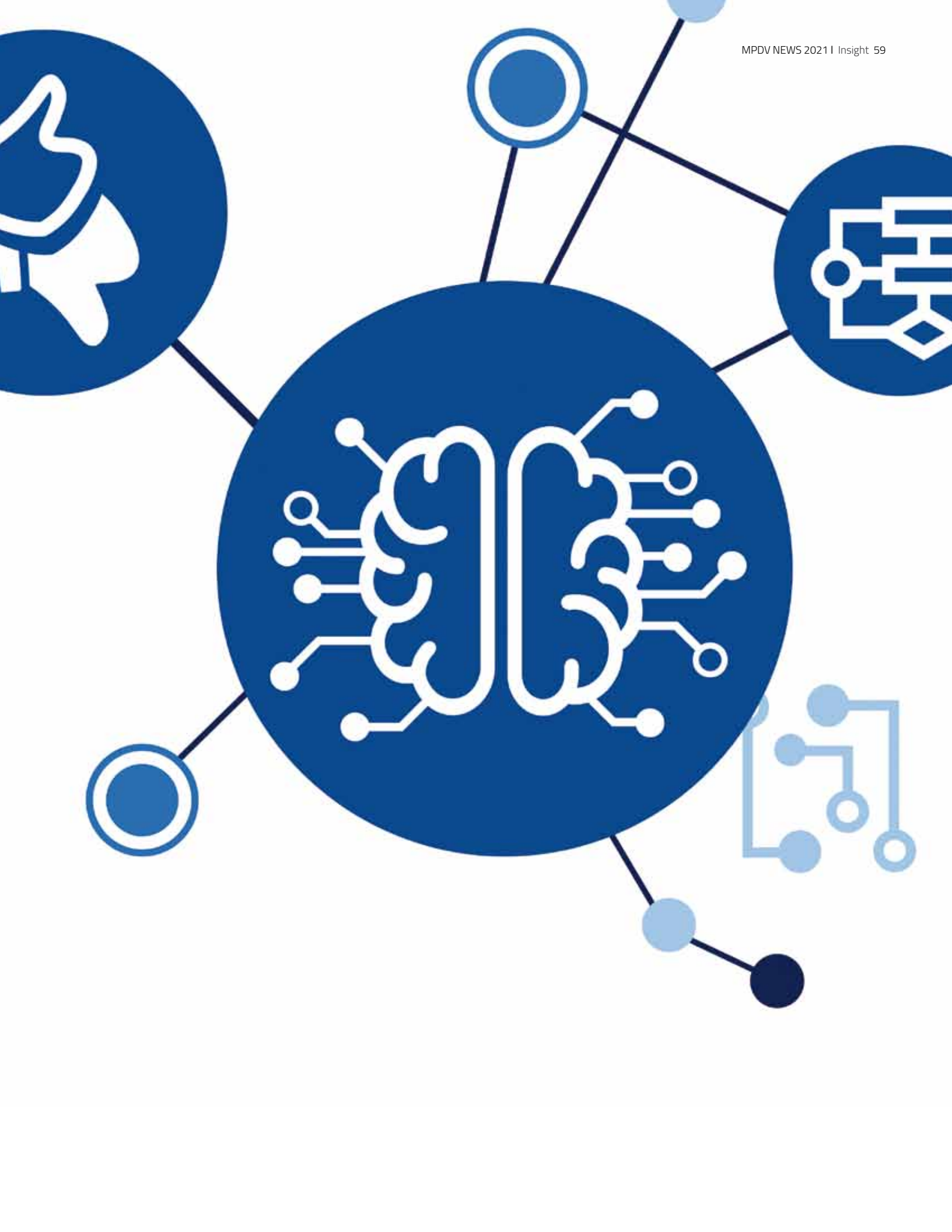
AI in brief

The objective of artificial intelligence is to give machines (computers) the ability to improve their behavior based on experience, similar to what humans do. A distinction is made between Machine Learning (ML) and Deep Learning (DL).

Today's industry mainly uses Machine Learning (ML), where the computer learns from data without being specifically programmed for the task. This is accomplished by a neural network with a hidden intermediate level that generates the desired output signals from various input signals. The learning process is performed by setting the input and output signals ("supervised learning"), by setting the input signals and evaluating the output signals ("Reinforced Learning") or only by setting the input signals ("Unsupervised Learning"). Deep Learning (DL) is a subcategory of Machine Learning (ML), where several intermediate levels can lie between input and output signal.

Use cases in production

The following examples show where AI is used in production and what advantages it offers. Even the simple form of Machine Learning (ML) provides AI with important skills that can already be applied in production today:



Detecting anomalies

AI can detect anomalies in sounds (machine noises), images (product surfaces) and data (temperature, pressure or power consumption) and signal them to humans. Typical use cases are in the field of worker assistance, maintenance and quality assurance, where a quick reaction to deviations is required.

Classification

Classification by AI is often used for quality assurance to classify products (pass, scrap, rework cat. 1, rework cat. 2). But there are also practical examples such as the identification of products/product groups for worker assistance and intralogistics.

Prediction

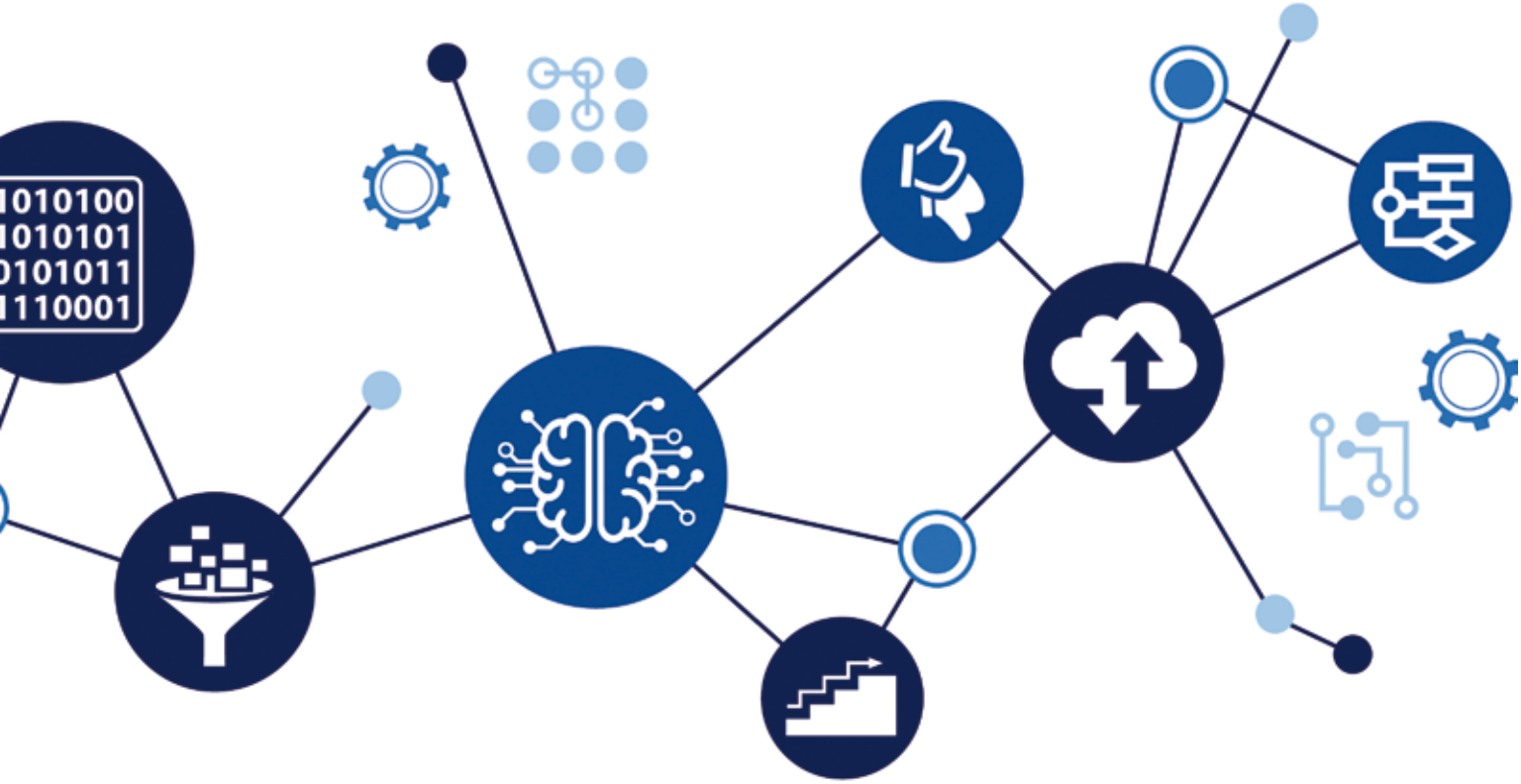
Prediction is one of the main accomplishments that can be achieved through AI. AI prediction can mainly be found in maintenance (predictive maintenance) or quality assurance (predictive quality). However, prediction is also used for resource planning (predicting order deadlines, setup times, machine and staff availability).

Self-organization/optimization (autonomy)

Self-organization and optimization are no longer just future scenarios according to Industry 4.0. Several use cases are available for process optimization (automatic optimization of machine setting parameters), resource planning (autonomous detailed planning of production) and intralogistics (autonomous control of driverless transport systems).

AI introduction in the company

Many companies are still hesitating to introduce AI in production because employees and management lack the necessary knowledge. Direct contact with a data scientist is usually not helpful either, since the data scientist can model AI solutions, but usually does not have the necessary production know-how. A more holistic approach is therefore recommended.



Management AI workshop (executed by an AI expert from AIMES)

An introductory management workshop, moderated by an AIMES AI expert, is designed to bring the entire management team to the same level in terms of AI knowledge. This gives the management an improved direction and decision-making reliability. The improved know-how also helps to minimize project risks. Unless management stipulates a concrete AI use case, the next step should be an AI potential analysis.

AI potential analysis

The AI potential analysis serves to identify possible AI use cases together with experts from AIMES and Perfect Production as well as employees from production and production-related areas. It also provides the opportunity to evaluate these cases with regard to their economic benefit for the company, data availability and the expected realization costs. This leads to a ranking of the most "mature" AI use cases for implementation. Implementation can start after selecting a pilot application and defining targets.

Implementation and allocation

During the actual implementation, the use case is first analyzed in detail. The next step is to develop the solution and collect and process the necessary data. As soon as the final data set is available, the actual implementation of the solution can begin, which means the selection and modeling of suitable AI procedures. After functional testing and successful alignment with the project goals, the solution can be deployed in production. Now you have entered AI - an important basis for the continuous development toward the Smart Factory.

Interview with Prof. Dr.-Ing. Jürgen Kletti and his daughter Nathalie Kletti

FROM MES GURU TO BEYOND MES

Prof. Kletti, they call you in the press the MES Guru. Where does it come from and what does it have to do with MPDV?

Jürgen Kletti: That's actually quite simple: I have been involved in coining the term MES - not least by developing the VDI guideline 5600. At that time I was one of the instigators of the MES working group and also took over its chairmanship, which I still hold today. At some point, the press started calling me by that name. Indeed, as a leading provider of manufacturing IT, MPDV naturally benefits from standardizing terminology and also from defining the MES task fields. Ever since MES has been perceived as a strategic application in industry, the demand for MES solutions has increased enormously. Equally positive is the development of the market and our company.

If I am informed correctly, MPDV once started very small. What was it like?

Jürgen Kletti: When I founded the engineering office MPDV Mikrolab GmbH in 1977, our company had its first headquarter in an apartment on the top floor in a village near Mosbach - at least it was better than a garage as in the case of some other successful software companies. Back then, we were programming microcontrollers - hence the company name - and developing customer-specific hardware and software systems. We had really unusual projects such as a control system for greenhouses. As early as 1984, we realized our first projects for machine data collection and then gradually focused on the development of production schedulung systems as well as systems for recording personnel time, shop floor and machine data. In 1988 we introduced the first standard software for production management: The MES HYDRA. So far, HYDRA has been installed more than 1,400 times.

Mrs. Kletti, which event in the history of MPDV do you remember most fondly?

Nathalie Kletti: In 2017 we celebrated our 40th company anniversary - that was a real highlight for us and the whole company. Since that time, a great number of innovations have also been introduced on the product side in a short time. Key milestones include the Manufacturing Integration Platform in 2018 and the Advanced Planning and Scheduling System FEDRA in 2020. Needless to say, that we continuously developed HYDRA further.

And in 2021 the product is still called HYDRA, but the range of functions has evolved. How did the expansion of the portfolio come about?

Jürgen Kletti: A great deal has changed since the first release. It has always been a concern of mine to design our software as user-friendly and practice-oriented as possible. Owing to my activities in professional associations and intensive contacts to research institutions, we were always at the cutting edge with our solutions and often even years ahead.

Nathalie Kletti: Gradually, the functional range of HYDRA has developed far beyond what was once specified as tasks of an MES in the VDI guideline 5600. Now, with the upcoming generation change, we are finally heralding the "Beyond MES" era.

Generation change is a great cue. On October 1, 2020 the management of MPDV was expanded as part of the upcoming generation change. How do you handle the change, especially since you are not retired yet??

Jürgen Kletti: I am delighted that MPDV can look back on such a history and thanks to the new management we are well equipped for the future. The team spirit is to us a priority. The lone wolf doesn't succeed as proven in history! On the contrary, it is a team that ensures progress and further development. This is true not only for MPDV, but also for other companies that have a similar market share.

I understand you both like classical music very much?

Nathalie Kletti: Yes, that's right. In recent years we have frequently brought great musicians and orchestras to Mosbach following the motto "MPDV Classics". The complexity of IT systems and that of classical pieces by great composers bring together these two very different areas. I am very proud that orchestras such as the Berlin Symphony Orchestra or the Russian National Philharmonic Orchestra have already been guests in Mosbach. Experiencing two fields as different as IT and music working together is a real pleasure. But the promotion of young talent is also important to me. To this end, we sponsor several First Lego League teams each year and also participate in the regional competition by providing financial support and volunteer jurors.

You are also strongly involved in other areas. Why do you attach so much importance to this support?

Jürgen Kletti: We sponsor different areas ranging from sports to schools and culture. For me it is not only about the matter itself, but also about regional ties. MPDV's regional ties in particular are a positive signal for our employees.

MPDV now has around 500 employees. Mrs. Kletti, how do you deal with the responsibility that you and your colleagues have assumed for these people?

Nathalie Kletti: MPDV employees are our greatest asset. That is why it is very important to me and my colleagues to create good working environments and to ensure a constructive atmosphere in the company. This is why I like to talk to employees in the corridor or in our canteen about private matters and also about projects - completely informal. Many of them I have known since my childhood and youth, so every encounter is like a good conversation with friends. I attach great importance to have a good personal rapport with our employees. It makes me feel like I'm right in center of things and and lead the way at the same time.

"Lead the way" is also a good catch phrase. You were also ahead of the times with the MES and the idea of an integrated production management system. How does this drive for innovation translate into the rather conservative manufacturing industry?

Jürgen Kletti: Innovation and future visions are one thing - the ability to establish them as a trend on the market is quite another. I always wanted to create hands-on solutions. That was already the case in the early days of MPDV. The requirements of our customers are a good guide, but this alone is not enough. I think it takes a healthy mixture of pragmatism and vision to succeed in a highly competitive market like the manufacturing industry.

Many thanks for the interview.

Nathalie Kletti, CEO

THE 10,000-HOUR RULE AND THE FUN OF IT.

Most people have heard of the 10,000-hour rule. It was coined by the US psychologist Anders Ericsson and his German colleagues Clemens Tesch-Römer and Ralf Krampe in the early 1990s. The rule became widely known 20 years later when the book "Outliers: The Story of Success" by Malcolm Gladwell was published.

The 10,000-hours rule states, in simple terms, that success is not innate. Instead, you have to invest a lot of hard work to succeed. Following this rule, a minimum of 10,000 hours is required before you are really good at something. Naturally, talent is helpful, but in the end, diligence and continued effort will decide whether you will be successful with your abilities and talent. According to Gladwell, this rule applies to geniuses, artists, entrepreneurs, chefs, painters, musicians – simply to everyone who achieves something special. Even Wolfgang Amadeus Mozart was not born a wunderkind; he also was not spared many thousands of hours of practice. When asked about this, Nathalie Kletti laughs: "The first 10,000 hours with MPDV were probably reached before I was even 18."

Even a wunderkind has to practice

This is how things are when you grow up in a family business. The company is part of the family and each family member is part of the company. As a small child, Nathalie Kletti played in the rooms of MPDV (admittedly quite modest at the time). So she experienced the entire development of MPDV at first hand. After studying economics in Trier in Germany, she started her professional career as a trainee in the marketing department. After that, she gained in-depth knowledge of all divisions of the company. She worked in the sales department, project management, customer consulting and customer service center and also became familiar with the MPDV subsidiaries abroad.

Being this close to one's own family business can be a mixed blessing. Not all children of company founders follow in the footsteps of their father or mother. Some want to be as far away as possible. How did Nathalie Kletti experience this closeness? "All positive. The company has always struck me as very exciting and thrilling. I had great fun there. As a little child, later when I was jobbing, after my studies and during my stays at our subsidiaries in Chicago, Singapore and Shanghai. The better I became acquainted with the company, the more I enjoyed it. I never followed a master plan, it just turned out this way." Has there never been a time when she just had enough and wanted to see something different?

Intuition comes from expertise and experience

Nathalie Kletti laughs again: "In all these years I have always had a great time, there have been new and exciting tasks, I know and like the team and I am interested in our products and customers – there has never been much to think about."

The 10,000-hour rule and the fun of it

"I could not spend 10,000 hours on something if it wasn't fun. Perhaps not every single of the 10,000 hours, but I think that even Mozart sometimes didn't feel like practicing. Besides, I don't live and sleep here. I also have another life." More seriously, she adds: "I find it an invaluable advantage to know a company so well. When you are so closely involved, you grasp developments by intuition much earlier and faster. I often have a feeling for things before I become aware of them. Especially when you face very complex challenges, intuition arising from a mixture of expertise and experience can be an essential factor. Just try to explain a complex production system to a newcomer. At MPDV, there are some experienced colleagues who arrive at a production site and and know 80% of the ins and outs of the factory before you even start explaining things to the newcomer."

Since October, Nathalie Kletti is one of MPDV's three new Executive Directors. Together with Thorsten Strebel (Products & Services) and Jürgen Petzel (Sales), she has set out to continue MPDV's success story. Her focus is on the company's strategic development and among her responsibilities are the cooperation with universities, marketing issues or strategic acquisitions like the recently acquired Felten Group.

And Action!
Nathalie Kletti

Coffee or tea?
Coffee and tea. Why decide? Diversity is trumps.

Are 10,000 hours enough?
With continued effort. And discipline. And diligence. And talent. If you are lucky.

Together or alone?
Together in a team. The typical lone wolf is long gone.

Fun or effort?
With effort, there's more fun.

Wild West or Wild East?
East. My husband and I, we love Asia.

Jürgen Petzel, CSO

HIGHER, FASTER, FARTHER - BETTER

In the last millennium, Jürgen Petzel sat alone in his home office in the beautiful town of Hamm in Germany and did something that was back then usually called "teleworking" or "telecommuting". 22 years later, "telecommuting" is usually called "home office" and Jürgen Petzel sits in his office at the MPDV location in Hamm and is responsible for overall sales as Chief Sales Officer.

When you ask Jürgen Petzel about his impressive career from the first German MPDV telecommuter to Chief Sales Officer," he laughs: "When you're in the midst of it all the time, it doesn't seem that impressive. You don't constantly think about your own career, but about the next project, the next challenge. That's a trait of mine: I want to get ahead. I always want to take the next step..."

To seize the opportunity

It all began in the late 1990s, when Jürgen Petzel's eye caught sight of the bright yellow MPDV booth during his tour of the CEBIT in Hannover. There was a sign on the counter saying "We are looking for employees in North Rhine-Westphalia (Germany)" and the business administration graduate did not hesitate for long and seized the opportunity: he applied and was promptly invited to a job interview in Mosbach. Shortly afterwards, Jürgen Petzel started in his home office as the first sales employee in Hamm and everything gathered momentum. Back then, you could add up the customers in this region with your fingers. But Jürgen Petzel came to change this and a few months later, the first project came to fruition. Then the next one. And another one. From then on everything evolved rapidly. New employees were hired, the first office was opened in Hamm, and bit by bit the Petzel teleworking office became an entire floor and later a whole building complex. In the meantime, more than 30 colleagues work at the MPDV location in Hamm. "When I started out in the home office, I never dreamed that we would one day have our dedicated offices here."

Petzel is proud of what he has accomplished. After all, it was him who "founded" and established the location in Hamm. He has now been a member of top management for almost three years and, as Chief Sales Officer, is now responsible for the further development of sales for products, services and solutions. If you ask him what drives him, he smiles and says: "My life motto is higher, faster, farther. I want to make a contribution to help companies produce efficiently. Just a few things can unleash a great deal of potential. We just have to tackle it."

75% can be better than 95%

In Petzel's view, the biggest challenges facing most manufacturing companies are still in the early stages of digitalizing their production. Everybody has lots of great ideas what they want to change - in theory, but it is vital to do it and to do it with the necessary pragmatism. You don't need to know everything at the start. What you need is a goal. Then you can go ahead, as you know what you want and where you want to go. A great deal of things can be clarified on the way. It is crucial to start. Only the ones who start can make it and transform their company into a Smart Factory. As I always say: it is better to be happy with 75 percent than to dream of 95 percent and not to start at all. If you in this mindset, you have lost."

Dreams are here to be fulfilled

In his spare time, Petzel works on his oldtimer, a BMW 2002 built in 1974. "Not everything needs to be faster, better, farther," he laughs, "I am simply fascinated by the old technology of cars. Petzel gets his passion for old cars and the BMW from his father. He worked as a workshop manager for the BMW group and his brother also works there. For Petzel himself, a large corporation would be out of the question as an employer. "I feel quite at home at a family-run company like MPDV. I like the down-to-earth attitude and the appreciation, the short communication channels and that I can move something."

And Action!
Jürgen Petzel

Coffee or tea?
Coffee, no milk or sugar - dark and strong.

Your favorite activity while driving a car?
If I don't conduct any business calls, I love to listen to audiobooks. The last audiobook I listened to was "An Innocent Abroad" by Mark Twain.
I prefer to listen to lighter things. Easy listening doesn't distract you on the road and relaxes me.

What's your take on life?
Higher, faster, farther!

Thorsten Strebel, CTO

DON'T SIMPLIFY COMPLEXITY. MASTER IT.

A popular question in a crossword puzzle asks for "an energetic, enthusiastic person" with 8 letters: Live Wire. Thorsten Strebel is not a native speaker, but he has an inkling what it means.

"I am not into crossword puzzles and didn't know the word before," laughs Thorsten Strebel, "but I can certainly relate to the origin of the word. And it is true, when we develp new solutions or innovations, I am getting into it with bundles of energy and enthusiasm that seems to have a catching effect on my team." He translates this energy into a drive for innovation and is constantly setting new goals.

Standstill is regression

Thorsten Strebel is convinced that everything not in motion and not constantly changing will become inflexible and flat over time. His credo is: "Standstill is regression". He is well aware that continuous change and movement are very exhausting and often meet with resistance. "Even if one has understood that change is vital: change will always cause uneasiness and insecurity. The habitual is familiar, the new is by definition unknown and unsure. Not everyone is good at dealing with insecurity," he accurately analyzes the situation he often encounters in his professional life. "In the end, keeping the balance between continuity and dynamics is what we seek. If no stone is left unturned, if everything is constantly changed, then at some point people will no longer keep up," is his experience. "All the more important are people who are not only concerned with detailed questions, but are willing to accept responsibility." Thorsten Strebel is a person who is ready to assume responsibility and has this drive for change. He has known MPDV from the very beginning. When he started his studies of Information Technology with a focus on manufacturing IT at MPDV in Mosbach, Germany, they were about 10 employees only – not in his department, but in the entire company. After his studies, he left MPDV (change is good!) and gained professional experience in the sector of consulting and the conception of software for large companies in the South of Germany.
During this time, the contact to MPDV remained close and positive. In the late 1990s, he finally got the offer to return to MPDV where he engaged in structuring and organizing the product management in the early 2000s.

Specialists and generalists in the same boat

"I have become acquainted with many different sectors in my career," outlines Thorsten Strebel, "hardware development, software development, preparing requirement specifications, consulting, technical project management – actually everything." Naturally, this broad wealth of experiences helps him today. "I can understand the specialists and their problems and they accept me. At the same time, I have the overall picture in mind. This is a crucial aspect for our customer projects: specialists and generalists must work hand in hand." Since October, Thorsten Strebel has been one of the three new Executive Directors and is responsible for the entire product division: product management, further development of the product portfolio and strategic expansion of the service offering for companies on the way to the Smart Factory. He cannot hide his enthusiasm for his work: "The world is complex and so is IT. It is not our task to simplify or reduce complexity in the world. On the contrary: we must not simplify the world until it fits us. We must learn to deal with the complexity as it is and master it. At MPDV, we try to understand the complexity with the help of data and thus make it transparent. The decision-makers need not make the world simpler. Instead, they can take the right decisions based on facts in a complex world. Even if we integrate more and more AI into our products, our systems will not take the decisions in the end. But our systems can learn from past decisions, evaluate them and develop ever better proposals for future decisions. However, in the end people will decide."

And Action!
Thorsten Strebel

Coffee or tea?
Tea for breakfast, afterwards coffee. At the weekend, my favorite is fresh brewed coffee from Cuba.

What distinguishes a good company?
The ability to criticize itself.
The ability to constantly change.
My goal is to arrive at a different company every morning while driving to the same address.

Your motivation?
Someone has to explain to the market how to build workable solutions from all these innovative ideas!

Interview with Wolfhard Kletti

NEVER LOSE THE CHILD LIKE CURIOSITY

In the early 1980s, when Wolfhard Kletti started to study computer science, not even the students knew exactly what computer science is and what would become of it. Back then, IBM still believed that the only real purpose of software was to sell more hardware. Wolfhard Kletti did not agree with his former employer and started developing software in his brother's company. 35 years later, one thing is certain: computer science has turned out to be something, software is more important than hardware and is driving the digitization of the world. Wolfhard Kletti was always in the thick of it and after almost 4 decades he will retire from MPDV on April 1, 2021. High time to talk to him again.

Together with your brother you have set up a successful business. What was it like when you started at MPDV?

Wolfhard Kletti: My brother founded MPDV on his own and I did my first internship required for my computer science studies in his company. At the beginning, MPDV was located in a former bank in a German village in the countryside. One of my first jobs was to solder heat sinks on circuit boards. At that time we had the order to deliver computers for a university in Germany and we built them.

Although MPDV didn't start in a garage, but your story from a few people soldering circuit boards to a globally operating company with more than 500 employees is also an extraordinary success. Was this the plan from the beginning?

Wolfhard Kletti: No, that wasn't the plan. I really don't know whether you can plan such a development over 40 years. We simply continued to plan and work from project to project. Obviously, we made more right than wrong decisions along the way. For us, one of these right decisions was to focus on standardizing our software at a very early stage. That was very unusual at the time. The decision to integrate consulting, service and support into the project management was also a smart move from today's perspective.

When you say "from today's perspective", you were not sure back then?

Wolfhard Kletti: You can never be sure, if you are among the first ones to enter a new path. That's the essence of innovation: You never know whether it will work or not. I once heard the following, beautiful phrase: If Henry Ford had been asked beforehand what he should make, the answer would probably have been: a faster horse. From today's point of view, his crazy idea with the car wasn't so crazy after all. And we also had a few crazy ideas in the last 40 years, which turned out to be great.

Which aspects of your work did you enjoy most?

Wolfhard Kletti: I have actually always enjoyed the versatility of the job. Of course, sometimes you prefer to do one thing over the other, but I'm interested in a lot of things and I enjoy doing them very much. But, if I had to single out one thing, it would probably be this childlike curiosity I have at work.

What do you mean with childlike curiosity?

Wolfhard Kletti: When you start a new project, you often get a tour of production. That's when you start to understand what is actually going on. I've always found it exciting and I'm still fascinated to see how something is made and produced. I have never lost this childlike curiosity, this natural interest in the world and how it works.

Can you give us an example?

Wolfhard Kletti: Well - when whole tree trunks enter a factory and out come these small wooden sticks, which are needed to make popsicles. Or when you see how thousands of fresh flowers are auctioned in Holland in one day - incidentally, this was one of my first projects as a software developer for MPDV.

Do you miss this direct contact that you had?

Wolfhard Kletti: Later on, when I became less involved in consulting and more concerned with organization and management, factory tours became less frequent, but it makes no difference to me. In the end, it's about understanding how something works and being able to influence and control it. That's something that has always interested me. Whether it's to do with wooden sticks or MPDV.

Letter From the Future

"LET'S HAVE A LOOK WHAT THE SMART FACTORY WILL REALLY LOOK LIKE IN 30 YEARS"

Dear Ancestors,

I am writing to you from the year 2050 to prepare you for what will inevitably come. Treat it as a chance to make fewer or maybe just different mistakes than us at some point or another. I myself am 38 years old and head smart factory engineer in a medium-sized metalworking company. The job of "Smart Factory Engineer" has been around for almost 15 years and been favored by both men and women. The job entails a broad field of technological knowledge about machines, computers, networks, artificial intelligence, but also about organizational and personnel issues. Good old Lean Manufacturing hasn't run out of steam and is now an integral part of the training to become a smart factory engineer.

Just to be clear, no, we don't have a fully automated and deserted factory - but we do have the odd amenity that you might not even dare to dream of. However, I read about future visions in historical documents such as the Industry 4.0 Implementation Guidelines from 2013 and many of them have come true - others have turned out to be complete nonsense. In any case, one thing is very important to us: We humans are still in charge and can always intervene in the production process. However, the smart factory supported by artificial intelligence (AI) usually runs so smoothly that intervention is rarely necessary. Let me just tell you about my everyday life...

Today, only a few of our employees have regular working hours - fortunately, I am not one of them. Naturally, some service functions such as maintenance must be staffed around the clock, but even here several employees share flexibly the 24 hours to be covered. We use a kind of marketplace to regulate the demand and supply of working time. All employees have an app on their private smartphone if they want to apply for a particular shift. We have made classic shift work more flexible to such an extent that we can now offer shifts of four, six or eight hours. A working day must be completely staffed at least 72 hours before the start of the first shift to ensure smooth operation - this works very well most of the time. Frequently, we even have more employees to choose from than we need. An AI application guarantees that no one is preferred. The high complexity of assigning shifts is also handled by an AI system. The system simultaneously transfers the hours worked to the payroll accounting program. Making working hours more flexible means in social terms that both men and women are much better equipped to combine work and family life. As a result, we are more relaxed about the lack of skilled workers that you so often complain about - after all, harmonious family life now ensures that we have a sufficient number of qualified young people :-)

When I come to the factory once a day, I am immersed in monitors that show me machines that currently run, what has been running for the last few days and also what is still to come. The transparency in the shop floor that you so much praise has been turned into a standard at the highest level. The smart factory is now transparent - but the employees are not. This is something our works council attaches great importance to. A kind of role principle supports us thereby. Wherever people emerge in evaluations and planning, we work with anonymous ava-

tars that take on the respective roles. Obviously, when I go down to the machine, there is a real person standing there, but their name is not visible in the evaluations. However, if you search for the operator of a certain machine, you will get the actual contact - but never linked to evaluations. Here, too, the AI helps us to keep track. You already noticed that I always come back to the human factor. This aspect is essential to us - after all, we are the ones who are alive and the machines are just machines that support us in our work.

In the production process itself, we are assisted by a large number of early warning systems that continuously collect data and make predictions with the data for the near future but also for the medium term. With a lead time of one day, we can predict a tool breakdown to the nearest minute. But usually this does not happen, because we react before time runs out. We thereby reduced unplanned machine breakdowns to nearly zero. Also, we hardly struggle with rejects anymore. Wherever cost-effective recycling is possible, we apply a closed loop recycling system. For example, we instantly remelt metal components as soon as the probability of a defect exceeds five percent. Our AI algorithms are actually always closer to reality than what we have read in your historical records like in the prediction of setup times. You could easily say that looking into the future for us has nothing to do with crystal balls or tea leaves, but with AI and a very high hit rate. That's certainly true for the smart factory - the weather forecast is probably still as lousy as it was 30 years ago. Thanks to the high prediction quality in the smart factory, we can also meet delivery dates by almost 100 percent, which also has an impact on the supply chain. The largely autonomous logistics make an important contribution to this. By autonomous, I mean that both the vehicles on the road and the material trains in the factory floor are completely self-propelled. Finally no more traffic jams - neither at work nor on the way to your holiday.

Speaking of holidays - we now have 50 days a year. We can easily afford this thanks to the flexible working hours and the enormous productivity of our factories. When I'm not around, my colleague Erwin takes care of the tasks that we virtually share.

Sharing is also an exciting key word! We share our production IT with our suppliers as well as with production companies that process our metal parts. To do this, we use a widely accessible Cloud platform, where many software developers offer their apps, and we can decide which ones to use. The supply chain virtually penetrates the walls of our factory buildings and leaps over the fences of our factory site. This makes everything much easier for us - especially availability of information about material deliveries, but also about the needs of our customers. All the data is transmitted via secure lines and encrypted data packets to the platform and from there is sent right to where it is needed. To achieve this, we use the successor of a technological concept that you would probably call "BlockChain". We still use protocols for data transfer such as OPC UA - and thank you for that, it was a really good investment in the future. The number of proprietary protocols has decreased significantly in recent years - but there are still a few providers resistant to advice. However, for us the fact that OPC UA alone is no guarantee for interoperability is almost part of our general education. Semantics in information processing has long been one of the subjects taught in the first year of training.

Perhaps I can give you some motherly advice from the future: invest both time and money in the development of semantic platforms. What you call the Internet of Things is not even the tip of the iceberg with respect to what we understand by semantic networking today. Our AI algorithms would not produce such good results without semantics and working out new systems would take much longer. We have really learned the hard way, but now everything is self-explanatory in the truest sense of the word. A sensor of the latest generation not only returns a value, but also a description of what the value means, the conditions under which it was measured and the reliability of the value. We simply connect components such as sensors, conveyor belts or handling systems to the production network via a standardized connector, and as a smart factory engineer I can configure everything else online on the system - by drag & drop. Source code is no longer our concern - there are plenty of specialists at the software providers. We have exhausted to the full what you call "Low Code" or "No Code". A child could operate and most likely configure our manufacturing IT without instruction after completing the fourth grade. It goes without saying that you still need to know about the processes on the shop floor, but pupils also learn about these processes in elementary school. After all, we have understood that the manufacturing industry is an important source of our wealth. For this reason, we called our production employees "Smart Worker". Smart Worker is a dream job for us because you contribute to the welfare of society. That's why I first did an apprenticeship as a Smart Worker before I studied. The apprenticeship helped me enormously as I had first-hand experience to see workflows in the factory.

As already mentioned, I usually come to the factory once a day to meet with colleagues and occasionally get things done. Most of the time I work from home and can dial into the various smart factory

systems using video glasses. This is also no problem due to the widespread availability of fast network access. We don't have "dead spots" and even in the tiniest village in the countryside you have really fast Internet connection. However, the high degree of Internet coverage has also led to an increase in cybercrime. Our company alone employs a whole department of specialists who are responsible for the security of our factory networks. Nowadays it is easier to break into a bank than into the networks of a smart factory. Every time I log on with the video glasses, my retina is scanned to make sure it's really me. We have got used to the fact that nothing works without a password or identification code. But every now and then the luxury must be paid for. I would also like to advise you to think about IT security at an early stage - ideally before you put all your machines on the net. In recent years there have been one or two dramatic attacks on production facilities. These attacks range from simple failures to abnormal alterations of manufactured products to really dangerous incidents where people got injured as well. A rather funny episode was when a toilet paper manufacturer printed a competitor's advertising message on the back of the paper without being noticed. You have to know that printed toilet paper is very hip at the moment - especially if you can define the message yourself. The case in question involved a prankster who had manipulated the production of the standard product, damaging one manufacturer and putting the other in the limelight. Since then, all manufacturers of toilet paper check both sides of the product prior to rolling it up to verify that the print is correct.

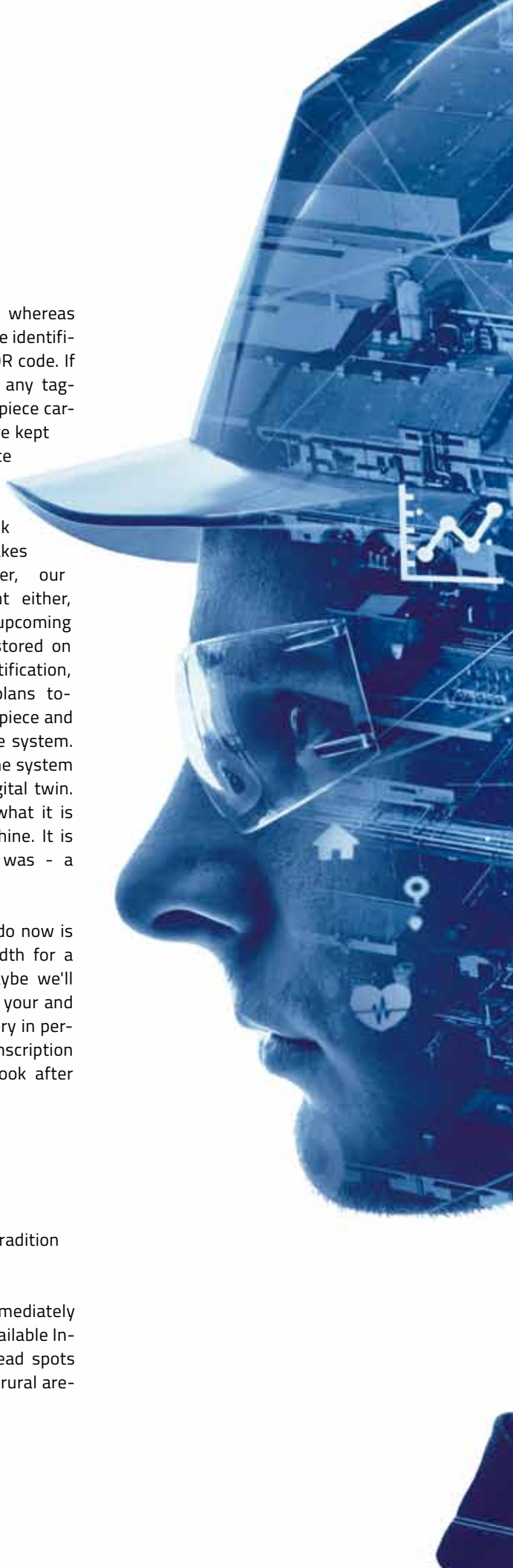
Oh, one more thing: Our products don't find their way through the production process themselves and my toaster doesn't talk to the refrigerator - what should they talk about? We have solved the control of specific, mostly customized products by the smart factory, whereas each workpiece is given a unique identification using RFID, barcode or QR code. If the workpiece does not allow any tagging, then we identify the workpiece carrier and make sure that both are kept together. Each time a workpiece or carrier is identified, a history entry is generated on the system. As a result, we can track the path that the part takes through production. However, our workpieces are not intelligent either, since all information about the upcoming processing steps is centrally stored on the system. Based on the identification, the workstation brings the plans together with the particular workpiece and then updates the status on the system. We have the digital image on the system which is also known as the digital twin. The workpiece doesn't know what it is going to be, nor the next machine. It is and remains what it always was - a rather stupid piece of metal.

So, all that remains for me to do now is to wish you adequate bandwidth for a trouble-free production IT. Maybe we'll meet in the future and discuss your and my ideas about the smart factory in person. I now put my digital transcription dictation machine aside and look after my family again.

Regards,
Dagmar Markgraf
Chief Smart Factory Engineer

Peter Voigt Metals - Smart by Tradition

P.S.: By the way, you should immediately invest in fast and universally available Internet. Slow ISDN lines and dead spots do not work at all - not even in rural areas!



Trends of Manufacturing IT 2021

APPIFICATION AND OTHER PARADIGM SHIFTS

2021 will be another year characterized by paradigm shifts, also when it comes to manufacturing IT. Many changes and trend reversals have become apparent in recent years, but now it is time to tackle the one or other issue head-on. And we are not just talking about artificial intelligence (AI). Of course, new technologies will play an important role, but also organizational issues are gaining relevance. Changes of this magnitude should always be supported by a change management – but this is not part of this article.

Some of you may wonder why we need paradigm shifts at all. Let it be said that there are many reasons, but the only real one is the need to face other changes. Because there is nothing more constant than change. Only those who are willing to embrace this change will have a chance to survive in the market in the long term. Let us therefore take a closer look at some of the upcoming paradigm shifts.

1. Appification and ecosystem

Today, we mostly speak in terms of systems. The market availability of more or less monolithic applications reflects this fact. Such solutions are usually made by one supplier or one source. Modern expressions like 'modular' or 'open' imply that you can decide yourself which parts of the system you want to use and that you can add or change features yourself. However, the circle of those responsible for the overall system is often relatively small. The classic example of such a modular system is the Manufacturing Execution System (MES) according to VDI guideline 5600.

While complexity increases, also the requirements for manufacturing IT grow. We also observe a rising number of specialized software solutions being offered to the market. And this is where the paradigm shift towards appification is required to avoid new interfaces and media disruption. Appification means that functions, which used to be offered in bigger packages, for example modules, are now divided into smaller units, so-called apps. The users can then flexibly decide which functions they really need. However, appification requires a platform. The platform provides the framework to execute apps or to exchange data between apps. This way, the former monolithic system of one supplier becomes an ecosystem integrating many suppliers, users and service providers. We also call this a platform economy. Ideally, users can pick the apps they require, developers can specialize in developments and system integrators can offer custom solutions using a combination of available apps. For this to work, an integrative platform with a semantic information model is needed. One example is the Manufacturing Integration Platform (MIP) by MPDV.

MPDV has already applied the principle of appification using some of their own applications. For example, the functions of the shop floor and personnel scheduling were detached from the established MES HYDRA, and new features were added. Several so-called manufacturing apps (mApps) were generated integrating these functions and were altogether transformed into the Advanced Planning and Scheduling System (APS) FEDRA. The most important advantage is that FEDRA can now be used stand-alone without the MES HYDRA. FEDRA is based on the MIP and its semantic information model. The MPDV planning solution can be combined with other order management systems (e.g. BDE system) or machine monitoring systems (e.g. MDE system).

2. Process thinking and workflows

Rethinking is required in many areas. Workflows in production are increasingly complex because products must be manufactured with a growing number of variants. A traditional work sequence according to a work plan is often not possible. Thinking in terms of flexible workflows is what is needed. The supporting manufacturing IT must also keep pace with this paradigm shift. Today, MES modules or other isolated solutions offer function packages integrating the standard. The modules are able to plan order and operation sequences, collect quantities and machine statuses and perform the relevant evaluations.

These structures no longer fit, in particular in a series production with many variants where usually small lot sizes are produced or where each piece manufactured is different. It is not enough to just record quantities here. Instead, applications are needed that integrate the production process as a whole and also take organizational support processes into account. These include, for example, intralogistics, quality assurance, maintenance, but also the documentation of production for traceability at a later date. At the same time, the reference object must change. While we still emphasize on the order and its operations today, it is the single workpiece, which must be focused in series production with many product variants. The impact on manufacturing IT and the associated applications is significant. Classic evaluations like an order time profile or an OEE report for specific machines or machine groups often miss the mark. In fact, evaluations are required that address the individuality of the manufactured products. Average times for certain work steps or typical failures associated with specific materials are then more likely to be targeted by evaluations and dashboards. Also the times between the different stations will be considered because these times can have a significant effect on a product's lead time.

Manufacturing IT requires tools that depict both the processes as a whole and the separate work steps in detail. A

workflow management can handle unexpected deviations. One example to integrate every detail of complex production processes in the system is the HYDRA Dynamic Manufacturing Control (DMC) by MPDV.

3. Low code or no code

Until recently, a supplier was considered flexible if they could integrate special customer requirements into the system by simple programming. A system is even more flexible if customers can make changes on their own. Many providers therefore offer a so-called software development kit (SDK) or development suite. It is then up to the provider to specify the programming language that is used or not. In view of the growing need for customization and the still unresolved shortage of specialists, it hardly makes sense to hire a programmer for every customization, no matter how small.

A contemporary answer to this requirement is low code or no code. These are methods for modeling workflows and dependencies without using a programming language or source code. Instead, graphic modeling tools help to arrange different elements using drag and drop and to connect the elements via operators. For example, a clock signal from the machine control can easily be connected to the quantity counter of the manufacturing IT. The number of parts a tool produces per clock is then added as multiplier and the modeled quantity recording is finished. This method can also be used to model entire production lines or flexibly networked assembly cells. Naturally, a specialist is needed from time to time to connect special periperals, but the actual application logic does not require any programming in the classic sense.

A look into kids' bedrooms who are technology buffs shows us the way. Many construction kits of programmable toy robots already rely on the low-code principle. The separate blocks of a sequence are combined via mouse-click on the laptop or even with the finger on the tablet to build complex models of a specific robot workflow. Clearly, a Smart Factory is much more complex than controlling three motors and connecting two sensors. However, the principle of low-code modeling is increasingly important in the environment of manufacturing IT. MPDV applications also include low-code approaches, for example the modeling of production lines with the HYDRA Dynamic Manufacturing Control (DMC). See also dmc.mpdv.com

MPDV also offers a flexible workflow management for the MES HYDRA. It is a tool to easily standardize and model maintenance processes or the complaint management.

4. Individual standard software

Flexibility and customization are good as long as there are no problems with the software or the provider does not offer an update. The truth is that customizations and specific software are high-maintenance. Each change must be documented and checked – especially if other program parts could be affected by it. As a result, the operating costs of customized software rise significantly with each new function. Standard software, on the other hand, has much lower operating costs because it is largely distributed and the manufacturer documents and checks the software. Unfortunately, standard software does not cover all requirements of a user. A combination of both worlds would be perfect – in other words an individual standard software.

Considering some of the afore-mentioned trends like appification, platforms and modeling, the way to the individual standard software is not so far. A key element here is global interoperability. This is only possible with standards, for example semantic information models. Separate functions can then work with the same data independent of each other. The dependencies are reduced to a minimum or completely avoided. So each app can be regarded as standard software, which becomes an individual solution when interacting with the platform and other apps. And there you have it: the individual standard software with all advantages of both worlds. MPDV has been in the process of developing an ecosystem based on the MIP for some time now, which is the foundation for such an individual standard software.

5. Machine Learning

5. Maschine learning

One of the most prominent paradigm shifts is machine learning. Admittedly, this change is already in full swing. It involves replacing the former rigidly programmed structures with self-creating models for AI systems. Too complicated? No problem, again in plain language: input data used to be processed by a program specially developed for this purpose. Data that the program does not expect cannot be processed. Machine learning has a different approach: both the input data and the corresponding results from the history are read into an AI system. The AI system learns from this data and develops a program. After some time, the AI system is able to predict the result of new input data. This kind of program is also called model in the AI environment. The handling of unexpected input data is less critical, since the model can adapt much better than a classic program. If you have a well-working AI system, you only have to take care of modeling – low code again. By using machine learning and other AI methods, completely new applications are being created now and in the near future. A rising number of results or events can be predicted with high reliability. This affects the principle of reactivity and even prevention. Examples might be the Predictive Maintenance or Predictive Quality applications by MPDV.

Keep moving

What's the essence of this? Very simple: constant changes make us rethink existing concepts and structures. Ideally, we identify the paradigm shift at an early stage and begin evaluating the effects on our specific application field – for example the manufacturing IT. You should not forget here that not every technological innovation will have a new or increased benefit. You should stay critical and search for the technologies that best fit a specific use case. The focus should still be on the benefit of an application.

In the end, it is like a wheel that never stands still. You must keep moving, watch the trends, assess innovations and decide according to your requirements which technologies you want to use. Fortunately, the innovation cycles are much longer in the manufacturing environment than in the classical IT. However, the pace of innovation will increase with the growing influence of classical IT. Concepts like the Internet of Things (IoT) or Cloud Computing contribute to this development. As a result, you should permanently check what you need and what the market currently offers. In short: If you rest, you rust – and no company can afford that.

Portrait MPDV Asia

THE LION CITY

Singapore is considered the most important business location in Asia after Hong Kong. MPDV is also locally represented with a subsidiary. A peek behind the scenes.

Sascha Graef, Director Asia at MPDV

Singapore's population has drastically increased in the past 60 years. The number has grown from fewer than one million people to six million. Singapore is almost as large as Hamburg, covering an area of around 730 square kilometers. By the way, Singapore is also called the Lion City because of its origin from Sanskrit. The culture in the island state is very diverse. Chinese, Malays and Indians form the largest part of the population. "Singapore is the springboard to the countries of the Association of Southeast Asian Nations (ASEAN) or the entire Asia-Pacific region. My family and I actually live in Singapore but I travel a great deal throughout Asia on business. That makes life here very exciting. Even after all these years", says Sascha Graef, Director Asia at MPDV.

The native German has been living and working in Singapore since 1999. At that time Graef was still self-employed and acquired his first projects as external MPDV representative. Subsequently, MPDV opened their own location in Singapore in 2007. Graef took on the role of managing director for MPDV in Asia and further developed the business locally. "A great number of major companies are based in Singapore. Legal and financial systems here are very secure and efficient. Singapore's trade relations and excellent connections to other Asian countries provide for excellent market access throughout Asia. These were the main reasons why we decided to start here".

Meanwhile MPDV has three own corporations in Asia. Besides MPDV Asia in Singapore, the group also includes MPDV China in Shanghai and MPDV Malaysia in Kuala Lumpur. MPDV's Asian customers are well-known companies from the medical, life science, automotive, toolmaking, food and beverages, household appliances and textiles industries.

Arriving in China

The Chinese branch was opened by MPDV in 2012. "One of the reasons for this move was the increasing number of rollout activities from Germany to China. By the way, Singapore is also home to many companies that have their headquarters in Singapore but produce in China. It was obvious to us right away that we needed a permanent office locally. We also wanted to approach the local Chinese manufacturers directly", explains Graef.

Shanghai was quickly found as a suitable place. After all, this is where the transformation of China into an economic power is particularly evident. Within just two decades, the seaport on the east coast of the People's Republic has become a Mecca for IT, biotechnology, automotive, financial and microelectronics companies.

Successful one-man-show

Graef placed his trust in the hands of Dr. Haiyong Cao to set up business in China. He was the man of the first hour in sales for MPDV in China. Cao remembers the beginnings well. "I started as a one-man show and did pioneering work but I thrive on challenges like it! That spurs me on", says Cao, who is now Chief Sales Officer responsible for sales and marketing for MPDV in China.

Mingfeng Li has had overall responsibility as the general manager for the site in China since 2019. In his role, Li is responsible for communication between the different locations in Asia and is helping to drive forward strategic development.

Growth, growth, growth

Now, MPDV Asia employs 50 people. "We plan to grow further and develop new markets in Vietnam, Thailand and Indonesia", says Graef. That's why he is currently intensifying the expansion of the MPDV partner network in Asia. "We are searching for companies who can support us as agents, especially in the pre-sales phase, and later on also assume responsibility for their own project implementations as trained value-added resellers".

In retrospect, the decision to go to Asia more than 20 years ago was the right one for Graef. He now lives together with his wife and two children in a very diverse environment and has many Western but also Asian friends. They travel together as a family to the neighboring countries. "We are delighted to see how our children are developing an ever-growing interest for all things Asian. Nevertheless, we are still emotionally very much connected to Germany. As a native of the Odenwald region, I also enjoy being at our headquarters in beautiful Mosbach", says Graef.

Dr. Haiyong Cao, Chief Sales Officer for MPDV in China

Mingfeng Li, General Manager

Dr. Haiyong Cao reveals the city in China that you should definitely visit:

My favorite city is Suzhou. Suzhou is located near Shanghai and is also called the Venice of the East because the city is criss-crossed by canals. Due to its good connections and short transport routes, Suzhou is one of the booming cities in modern China.

I especially like Suzhou because of the many enchanting Chinese gardens, ponds and pavilions. That makes it simply idyllic. The old water villages with bridges, canals and old houses create a very special atmosphere and the numerous historical sites such as the buildings from the Ming and Qing dynasties round off the picture. I myself am not surprised that in an old Chinese proverb Suzhou is also referred to as the paradise on earth.

Suzhou is one of the oldest cities in the region with a history of over 2500 years.

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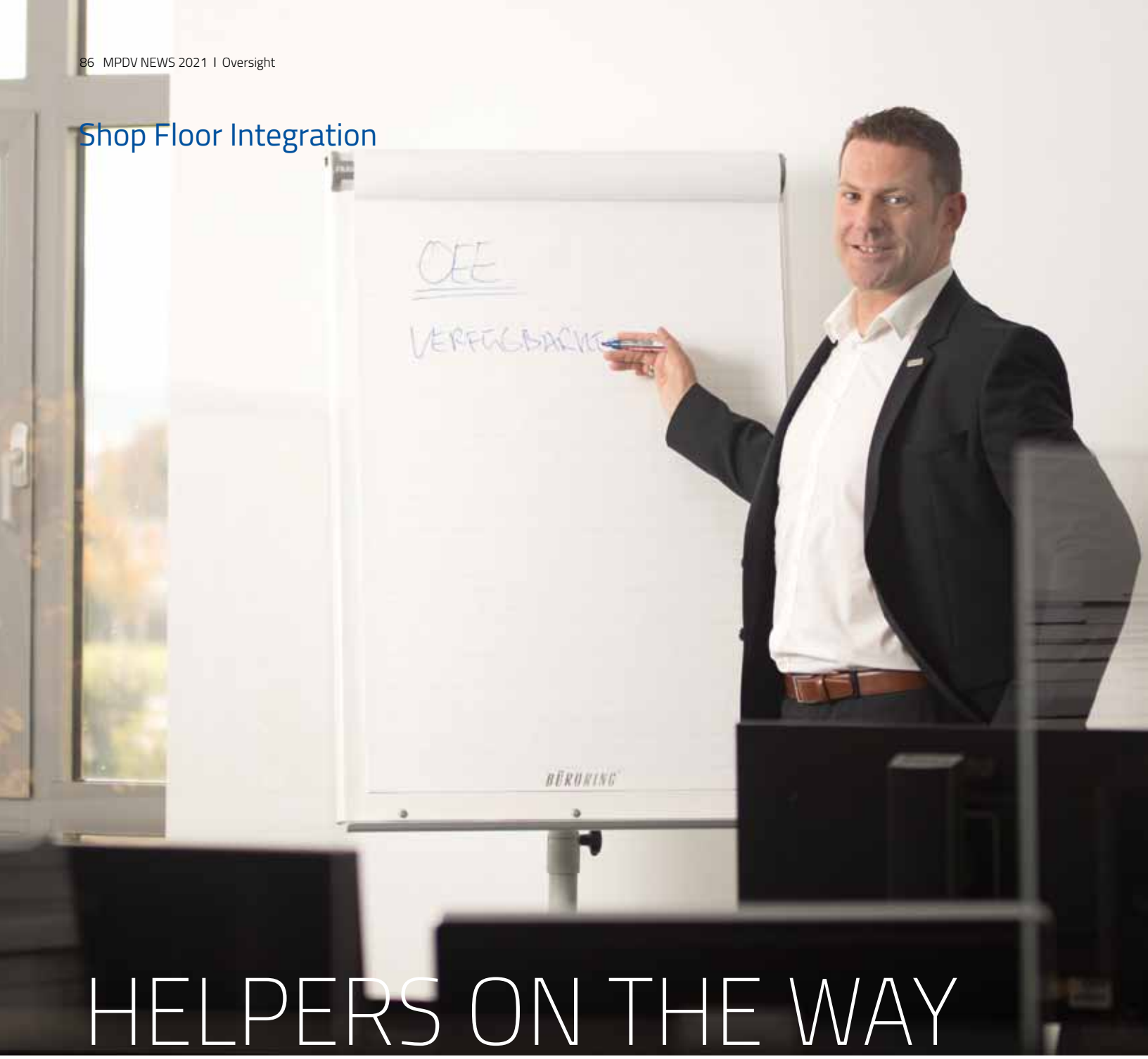
Shop Floor Integration



HELPERS ON THE WAY TO FULLY NETWORKED PRODUCTION

According to the German Engineering Federation (VDMA), 85% of existing production plants in Germany are not yet networked. MPDV offers different services that support manufacturing companies in connecting their plants to the Manufacturing Execution System (MES) HYDRA as economically as possible and in the shortest time.

Most manufacturing companies have a large variety of machines in their portfolio. The spectrum ranges from older installations to state-of-the-art machines. "It is not uncommon for us to first receive a list with detailed information on the machine manufacturer, year of manufacture, control system or interfaces when starting a new project," says Alexander Lubianski.

As Senior Consultant at MPDV with focus on shop floor integration, Lubianski's mission is to advise users of MES HYDRA on how to connect the systems. "We find the type of connection that best suits the customer's requirements. We focus on what the user has at hand: interfaces, controls, PLC programming experience, programming environments or specific licenses. The result is an individual recommendation based on costs and benefits," explains Lubianski.

In the center are questions like: What data and information does the customer need? Which interfaces best meet the requirements? What can the customer do themselves or where do automation partners and/or the machine manufacturer need to be involved?

Solutions for simple and more complex interfaces

One of the most common ways to connect a machine is by digital signal. Here, data such as operating signals, failure reasons, counters or cycle times can be derived. "This type of machine connection is mainly used for machine data collection or for older systems, but repeatedly we come across more complex connection. For example, when we transfer setting data. In this case, several interfaces are often required for one system. If you take metal processing, it is standard practice for the machine to be controlled by a program that specifies exactly which tool is to move which coordinates on a part and when, and how deep to drill. Digital signals are not sufficient to transfer these programs. Therefore, a number of different or more intelligent interfaces are required for file transfer."

In addition to connecting machines, Lubianski also helps with the development of security concepts, the layout of installations and with hosting. "The issue of security in particular is gaining attention. Here, too, we are in demand as experts," says Lubianski, who has been working at MPDV for more than 19 years and has extensive experience. After working in both internal IT and product management, he has been a consultant for nine years now.

How to connect machines

- As part of the Machine Installation Consulting, an MPDV employee checks all machine controls during the MES implementation and makes a recommendation on how best to connect the systems to HYDRA.
- Depending on factors such as reporting frequency and usage, an expert from MPDV provides support during Terminal Installation Consulting and advises where terminals should be located and how they should be networked.
- The Smart Factory Readiness Check provides a status quo on the connectivity of machines and systems and highlights opportunities and potential.
- MPDV also offers Individual Consulting on issues such as highly integrated data flows, plausibility checks and interlocking between MES and the control system or special requirements for data integration or security in communication between the control system and MES.
- The issue of security is becoming increasingly important. As part of the service Security for Manufacturing IT, experts analyze how MPDV systems communicate with other systems in manufacturing and make a recommendation which security measures users should implement.

Visiting Henry Eckardt

URBAN EXODUS - FROM THE CITY TO THE COUNTRY

19 years ago Henry Eckardt moved from Berlin to Mosbach to write his dissertation at MPDV. Today, as a Senior Product Manager, he pushes the strategic development of the product portfolio.

When you talk to Henry Eckhardt about his work at MPDV, he has a smile on his face: "I deal with new issues and find out what is behind them and what it means for MPDV. It sounds odd in the first instance but for me it's a bit like as if I was assembling Lego blocks. Sometimes I get to the result faster, sometimes I take everything apart and re-assemble it again.
Eckhardt, in his function as Senior Product Manager, further develops MPDV's product portfolio along with his colleagues.

"It is a matter of reviewing which new products we should bring to market or which existing ones we need to further develop and in what way.

Henry Eckhardt, Senior Product Manager

His task is to observe the market, pick up innovations and analyze to what degree these issues could become significant for MPDV. "It is a matter of reviewing which new products we should bring to market or which existing ones we need to further develop and in what way. We take a close look at when the right time has come to release a new solution. The timing plays a very decisive role. After all, the market must be ready for the innovation".

From the idea to the product line

The 44-year-old played a key role in the development of the Manufacturing Integration Platform (MIP). He worked intensively on the concept for months and made his contribution to turning initial ideas and fragments into a new product line. "It is always exciting, because we enter new territory every time. I can come up with new ideas, but there is no such thing as an off-the-cuff answer. It is a mental development process, which involves a lot of trial and error and learning. This versatility is what I love about my job."
He never in a million years thought that he would one day move from his home in Berlin to Mosbach. He visited the CEBIT in 2001 as a student. By chance, he happened to pass the bright yellow MPDV booth. Following a brief discussion, it was clear to him that he would like to write his dissertation at MPDV. And so fate took its course. Following his graduation as industrial engineer, he joined MPDV as a consultant and supported companies in connecting the Manufacturing Execution System (MES) HYDRA to the ERP system.

Up hill and down dale

He is not homesick for Berlin. He has settled in the Odenwald and feels very much at home. In his spare time he likes mountain biking or hiking. "I really enjoy living in the country." He especially likes to go hiking on the Katzensteig, which leads from Eberbach over the Katzenbuckel to the Höllgrund. "This is one of the most beautiful routes in the area to me. This is a hike going up hill and down dale - narrow paths through the middle of untouched nature. Just wonderful."
Why is it so exciting to work at MPDV? "It is never boring. It is still fascinating after almost 20 years with the company to support other companies in the digitization of their production and to further develop our products to this end." What Eckhardt also particularly appreciates about MPDV is the loyalty among the colleagues and the down-to-earth approach.

Column

CORONA AS A TASKMASTER?

The Corona virus has different effects on the production of tomorrow. Renationalization of system-relevant industries or redefining supply chains is not the primary focus of this column. Instead, the fundamental change in the working world of production will be highlighted. Here, Corona can be a prolific taskmaster.

1. Corona as a Taskmaster: Everythings is possible!

You probably also know the Internet meme that not the CIO or the CDO, but Corona is the best accelerator of digitization. Naturally, this applies especially to specific areas such as mobile working. Where Corona accelerated, it suddenly became a reality what had been unthinkable for a long time. Even teachers sent homework via PDF and occasionally ZOOM meetings were held (up to the ban!). It is not surprising that Amazon & Co. enjoy special economic growth in Corona times.

2. Blessed were those whose infrastructure and mindset came prepared!

It must also be pointed out that rapid digitization was possible above all in those areas where at least the infrastructure was either already available or could be provided at short notice. The Chinese demonstrated on the Internet, even on Facebook, how entire mines, trucks and excavators can now be remotely controlled using 5G technology. Life punished latecomers and rewarded the ones who were prepared!

However, hardware and software infrastructure were only necessary, but not sufficient to battle with Corona. Normal productivity often failed due to unfamiliar working environments and management challenges. Self-organization or leadership from afar did not work for everyone and so one could sympthasize with some people who wanted to get back to Old Normal. The new collaboration logic was not an immediate goal for everyone.

3. Production in a remote mode during Corona

It was quite remarkable that even parts of the production could be handled remotely or even moved to the home office faster than expected. That is, if companies had a powerful production IT at their disposal. In the case of office work, such a high degree of transferability to the home office is expected. Insiders are not surprised that systems such as HYDRA allow the shop floor to be controlled from the home office by means of digital visualization. Man-machine communication is then not an issue in remote mode. Although many companies are not at HYDRA level, as a quote from Industryweek shows: "While office workers and knowledge workers are changing and can work mobile by default, most factories are not designed to be remotely controlled". The required digital tools and infrastructure for such work are missing. With the right tools, "digital" production meetings or other meetings and agreements in virtual space often reached better than expected results using appropriate apps. The exchange worked despite the fact that participants were not actually facing each other. MPDV could also support digital

Dr. Winfried Felser

work with other applications such as mobile time recording or electronic leave applications. It might still take a while until your own avatar is in production, but all these solutions and successful forms of a Next Normal gave hope.

But this is just the beginning. "Given the dilemma faced by manufacturers, we will witness the rapid introduction of remote diagnostics, management and collaboration tools. This will lead to the emergence of a "virtual shift": a team of specialists connected by remote access and constantly online to guide and support the reduced "physical shift" of on-site personnel". That's what we could read in the Industryweek.

4. Practice what you preach – MPDV as a role model

By the way: MPDV itself lived up to what they preached! The changeover from classroom training to online training took place virtually overnight and information events and workshops were also converted to webinars in the shortest possible time. Participants could even marvel at an online live recording of the software hard at work at a customer.

What is Second Life anyway?

5. Lessons learned – beyond remote work

Corona simply shows that much more is actually possible than we ever thought. One HYDRA user even changed the production completely over to manufacture face masks (see success story in this issue). While it would be cynical to see Corona as a (partial) blessing, the pandemic has unleashed potential beyond remote working that we would never have dreamed of before.

So we should not only see the personal constraints and individual fortunes that come with the pandemic, but also, without wanting to be cynical, opportunities. Quite unintentionally, the world has become a huge "sandbox" where you could and had to try out new things. How much better will the future be if we can manage this without a pandemic?

ABOUT DR. WINFRIED FELSER

Since 2000, Dr. Winfried Felser has operated the Competence Site, a network of several thousand experts from science and industry who focus on the digital transformation for management, IT and technology sectors. He is editor of the Competence Report and Books and author for the Huffington Post, LinkedIn Pulse, The European, Absatzwirtschaft and other specialist media.

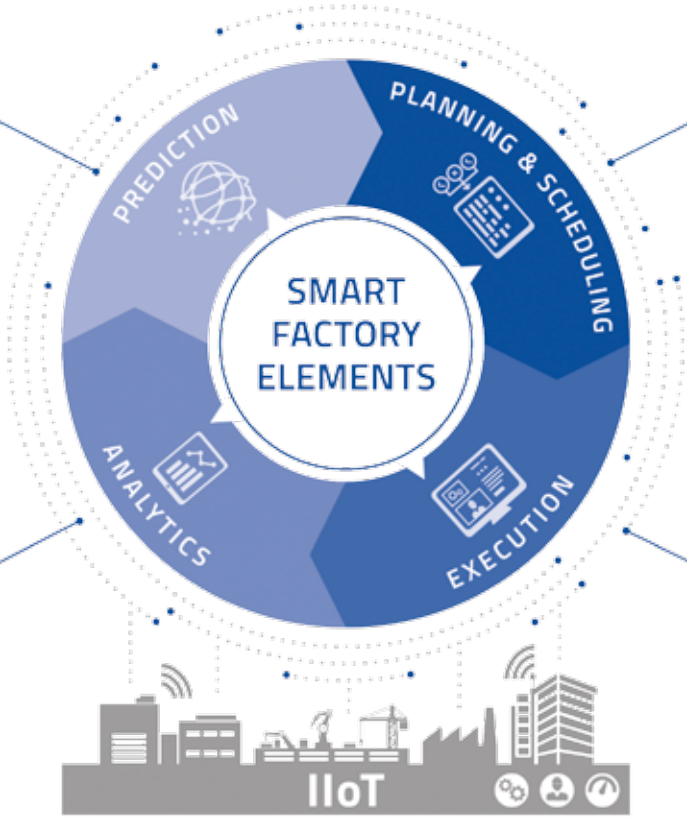
SMART FACTORY ELEMENTS

PREDICTION

enables the prediction of events based on executable models and artificial intelligence.

PLANNING & SCHEDULING

includes standard tasks of work preparation.



ANALYTICS

uses statistical methods and innovative algorithms to prepare collected data.

EXECUTION

ensures that specifications are implemented and documented efficiently and correctly.

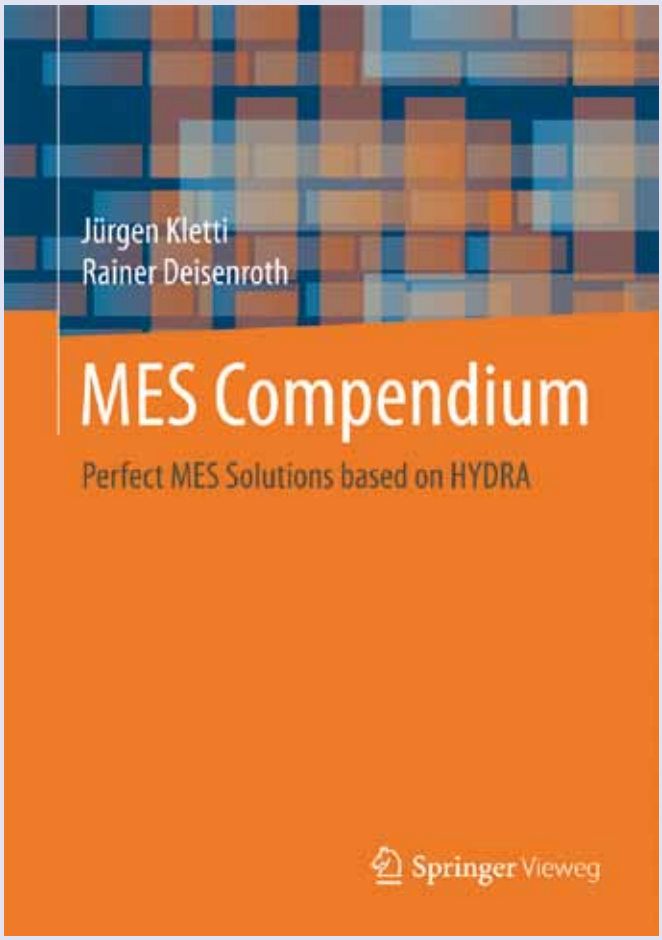
INDUSTRIAL INTERNET OF THINGS (IIoT)
connects the operator and the real world of production with the digital image of the Smart Factory by means of networking and edge computing.

Requirements such as a large variety of product versions and smaller lot sizes up to lot size 1 considerably increase the complexity of production processes. In times of Industry 4.0, this is truly a case for the Smart Factory, which in turn needs certain processes and functions to meet these increasing demands: the Smart Factory Elements.

Make use of the Smart Factory Elements model and expediently formulate your requirements for the manufacturing IT. Combine applications of all elements and make your production a Smart Factory!

mpdv.info/sfe

KNOWLEDGE IS POWER!



MPDV is regarded as a pioneer in spreading the MES idea and contributes with extensive know-how to the development of market trends. In addition to numerous publications in the trade press and the generation of its own white papers, MPDV publishes its own text books on MES and efficient production.

mpdv.info/publications

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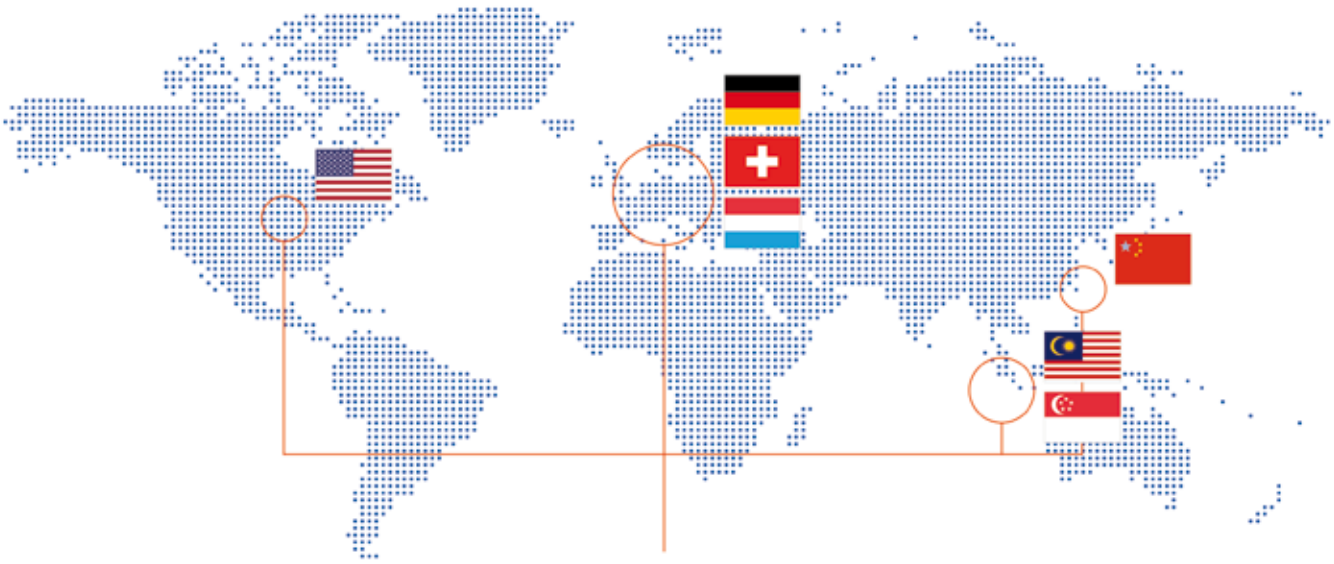
Also available as eBook



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