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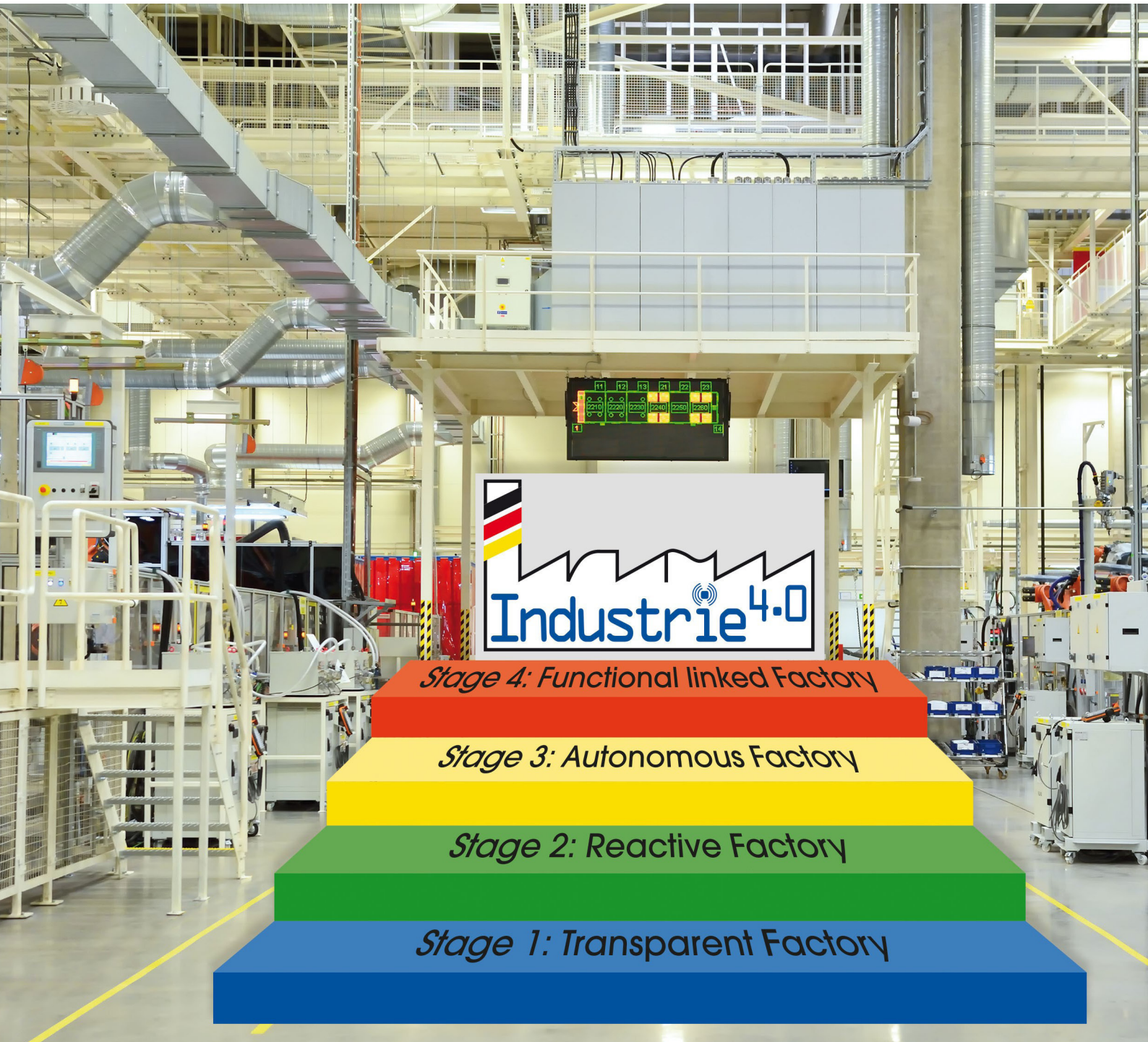
The MES Experts!

Industry 4.0 - disarmed

„Smart Factory“ in four steps



Introduction

Industry 4.0

In Germany we know it as “Industrie 4.0” (Industry 4.0) but the rest of the world calls it IoT (Internet of Things), Advanced Manufacturing or even Smart Industry. We shall call it „Industry 4.0“ in this White Paper as the original term stems from Germany.

By now the whole world talks about the fourth industrial revolution. The following table provides an overview of generic terms that different countries use in association with the challenges and technologies of Industry 4.0:

Country	Initiative	Content and direction
Germany	Industrie 4.0	Derives from the high tech strategy 2020 by the German government. A platform called Industrie 4.0 was established in 2013. Strong efforts towards standardization.
Switzerland	Industrie 2025	Referring to the German platform Industrie 4.0. Defined targets for companies in Switzerland.
Austria	Industrie 4.0	Scattered flagship projects in association with Industry 4.0. No other initiatives known.
France	Usine du futur	Roughly orientated on Industrie 4.0. Concept and guidelines to increase competitiveness. Initiatives mainly undertaken by industry.
Netherlands	Smart Industry	"Action Plan" available to digitalize and network production processes. Setting-up field labs to speed up innovation.
Sweden	Made in Sweden 2030	Pragmatic pursuit of a future production. Cooperation of universities and federation of machine and electrical industry called "Teknikföretagen“.
European Union	Digital Agenda for Europe; Horizon 2020	Setting up a task force "Advancing Manufacturing - Advancing Europe" with focus to modernize European industry and prepare it for global competition.
USA	Industrial Internet Consortium	Broad observation field to utilize Internet of Things (IoT). Fusion of large IT companies. High incentives from the government. Focus on "test beds", international approach and not striving for standardization.
China	Industry 4.0; Made in China 2025	Inspired by Industrie 4.0 in Germany. Initiative for digitalization of industry driven by government. Also, to improve quality, efficiencies and competitiveness.
Japan	Industrial Value Chain Initiative	Merging local companies with the target to set up standards for digitalization. To create a network of factories to spread industrial standards worldwide. The utilization of robots shall also be enforced using the buzzword "Robot Revolution".

„Smart Factory“ in four steps

Industry 4.0 - disarmed

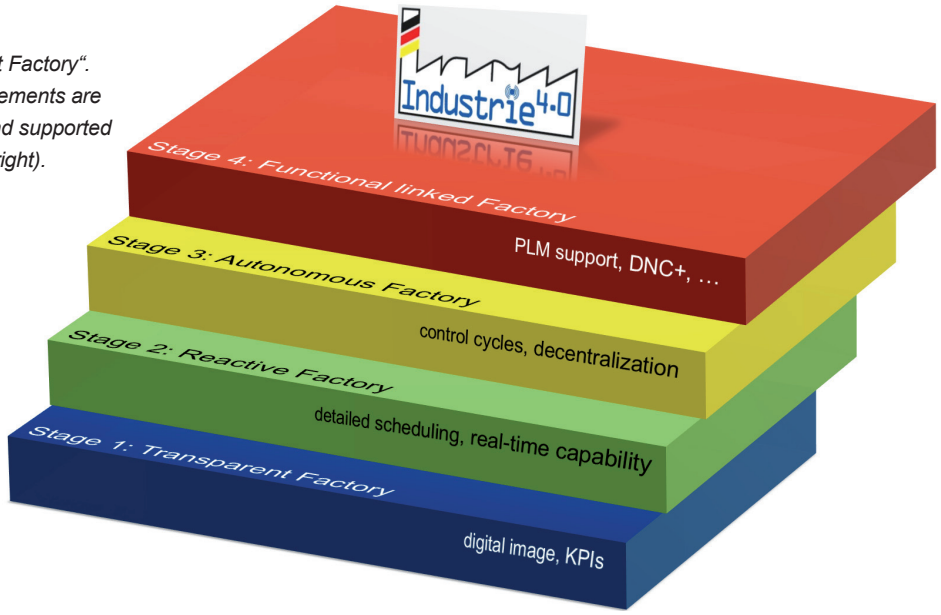
The industry experts continue to have complex discussions about how to implement Industry 4.0. One result of this discussion was RAMI 4.0 (a reference architecture model [1]). In the current version of Industry 4.0 what can production companies take advantage of? Do businesses know how to achieve Industry 4.0? The new White Paper by MPDV tries to explain these questions and how a Manufacturing Execution System (MES) can facilitate the way to implement Industry 4.0.

An increasing number of companies are looking for the perfect way towards Industry 4.0. In many cases there is no urgent action needed due to procedures working sufficiently. So why make a change? Some companies who have already invested in Industry 4.0 are uncertain if making this change will offer a return on their investment. Industry 4.0 can only be successful if the process is individualized for every company and then systematically implemented. A radical implementation approach which requires all new technologies is not really a realistic option. Companies need a new, contemporary way of thinking about adopting Industry 4.0 concepts into their facilities and have a phased approach to slowly achieve each milestone.

Step-by-step towards Industry 4.0

Today, businesses face many challenges including increased global competition as well as customers and legislators imposing higher demands. Examples of this are as follows: Traceability/ quality requirements, on-time delivery or elaborate logistics solutions like Just-in-Time and Just-in-Sequence (JIT/JIS). Adding to the above are increasing complexities arising from a wide variety or individualization of products and decreasing life cycles. In terms of economics, companies have to master the balancing act of choosing the right method and technology for Industry 4.0 to achieve their targets. The VDMA (German Engineering Federation) suggests in their guideline for Industry 4.0 to develop two separate ways to achieve

Picture 1:
The four stages to the „Smart Factory“. Company (the factory) requirements are separated into four stages and supported by defined functions (on the right).



[1] RAMI 4.0 equates to the reference architecture model of the Industrial Internet Consortium (ICC). Currently attempts are made to align both models.

the target and, therefore, defined two „tool kits“: product and production. This White Paper focuses on production and proposes a simple four-stage-model to reach the „Smart Factory“ (picture 1).

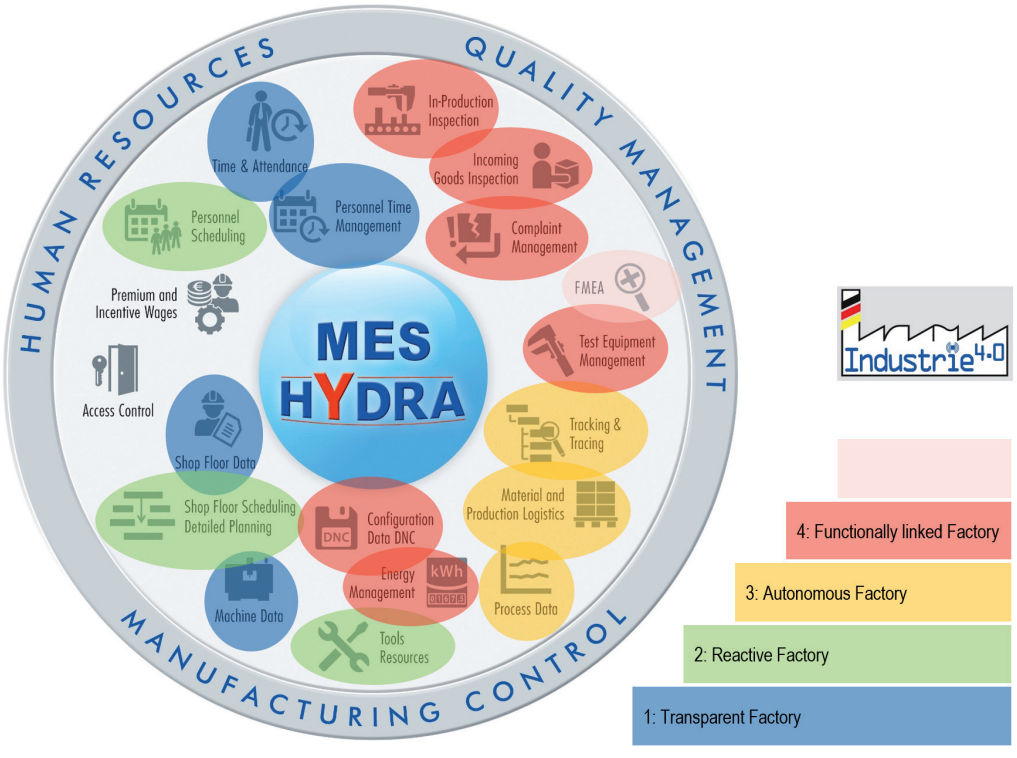
The different stages need to be completed in chronological order due to the inner dependency on the last stage to complete the next stage's functions. For example: You can only reach stage 2 if step 1 has been completed successfully. In plain language, if the factory is not transparent, it cannot react.

Almost all essential functions deal with IT systems close to production as the stages above show. Thus it is not surprising, that an integrated Manufacturing Execution System (MES) is the ideal tool to cover all stages of the model. In some cases an MES is a critical tool in order to complete each stage towards the „Smart Factory“. Required MES functions to cover individual stages are shown in picture 2.

Optional functions can offer additional benefits to companies, especially when looking at personnel management. For example, if a company introduces incentive pay, employee's motivation can increase. You require complex collection and calculation rules to ensure that the variable remuneration amount has been calculated fairly. An MES system can also support you in this effort.

Stage 1: Create transparency

In line with a reliable database, transparency is the foundation for all additional functions in the “Smart Factory”. Transparency allows a company to be sufficiently informed about their operational processes through all their various technologies and software to have one cohesive image. Many companies have operational processes implemented and even have software in use, but due to the lack of transparency and the lack of all systems talking they cannot have a full image of their facility.



Picture 2: Suitable MES applications to cover different stages of the „Smart Factory“

MES systems bring transparency to every level and increase efficiencies.

Missing uniformity of machinery is one reason preventing companies from collecting all sorts of data. The newer the machines and facilities are the easier it is to read out large amounts of data in real time. It works sometimes for middle-aged machines by recording simple operating and cycle signals. Older machines are a real challenge. You can make it work using external collection devices with a digital real time interface.

Variety of interfaces

Machineries have a variety of interfaces and standardizations and can be problematic when trying to connect your facility to allow for transparency. Often, OPC UA is proposed as a universal fix. It is true that you can connect various machines to an MES system with this communications protocol, but OPC UA only covers the transport layer. This means it is only the container for the communicated data. The application layer, data itself, is defined by a companion standard - and there are many! Until a machine communication standard for Industry 4.0 is developed, companies are faced with the challenge to supply machine data into the MES with the least possible effort.

The whole process of connecting machines, facilities, sensors and test equipment to an MES is simplified by an intuitively operating Shop Floor Connectivity Suite. A central body specifies why data is collected (selection of MES applications) and how to tap a data source (selection of interface and assignment of data content). Previously, complex configuration or programming defined interfaces. Now with a few clicks, the Shop Floor Connectivity Suite provides a nearly effortless method to connect machines. The tool accesses existing interfaces which can be upgraded using new driver components. Therefore, the functional scope increases with every new connection. Tried and tested functions like wizards, together with an intuitive Drag & Drop operation considerably reduce times needed to connect a machine. This used to take a whole day but with the Shop Floor Connectivity Suite the job is done in a few minutes. This efficiency is crucial as the number of machines, facilities and sensors is increasing.

Utilize collected data

In the end data is not collected for the sake of it but to safeguard transparency. Initially the entirety of all collected data and their relations create a digital image of reality. We have to keep in mind though who or what is using that image - an IT system or a human being. Both target groups require an image with a different level of granularity.

IT systems profit from large and detailed amounts of data. People on the other side prefer less data but reliable key indicators and evaluations. Both requirements must be considered during data collection and processing.

Supporting MES functions

The most important functions to increase transparency in production are the MES applications Shop Floor Collection and Machine Data Collection. Two factors are in focus: first, an efficient utilization of machinery and, secondly, to align automatically transferred machine data with manually recorded order postings. However, do not neglect tool and material data! If everything is considered you can detect relations and transfer these into optimization processes. Thus, recalculation of production orders can also be supported with reliable data.

Due to the large amounts of recorded data, the MES also compresses and aggregates data as most ERP systems cannot process delicate raw data from the shop floor. An MES, functioning as a central platform for information and data, connects management, in this case the ERP system, with production. This again provides more transparency.

Stage 2: Safeguard reactivity

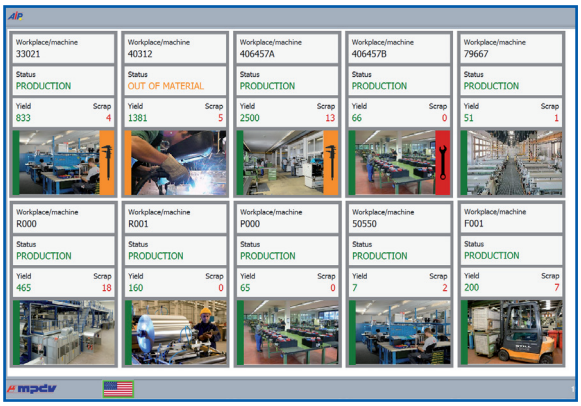
On the basis of data gained during stage 1, you can identify interruptions and also introduce realistic detailed planning. The more precise and comprehensive this planning is executed, the easier it is to transfer the plan into a real-time and reactive production control. Apart from machines, other resources need to be considered, including the end users as the most vital part. An MES is a suitable and powerful tool for planning and controlling activities.

Stage 3: Distributing and delegating tasks

Processes stabilized during stage 2 can now be made autonomous by defining a closed cycle. Also, decentralization of tasks including relevant responsibilities is viable but only if synchronized. The ultimate aim is an autonomously working factory.

Stage 4: Functional networks

A functional network for all areas becomes even more relevant considering ever decreasing product life cycles and increasing product individualization. There is an increasing emphasis on the exchange of data between product development and production as digitalization is on the rise and the design engineer is forwarding information directly to the machine. The interface between product development and production is normally a Product Lifecycle Management system (PLM), which in the future must communicate directly with the MES. Further fields of interests for functional networks include an integrated quality management, an energy management close to production and a comprehensive look into supplier and customer - the complete supply chain.



HYDRA Shop Floor Client: intuitive user interface for the visualization of machine and shop floor data.

Consider the human

Putting technical innovation aside, the role of the human in production and the company must be looked at separately. On the one hand, the human is incorporated in the production system as a „resource“, and on the other stands above the processes being the „designer“. In the end all technical systems serve one purpose: to simplify work for humans.

If you look at a human as a „resource“ in production, then the MES focuses on the „non-functional“ needs of employees. These include, apart from personnel management and time management, incentive pay concepts based on MES data. The objective is to maintain high levels of employee satisfaction and motivation while fulfilling working conditions regulations.

Further stages

Our model contains only four stages but conquering these does not mean you have reached your target. In the course of time we will encounter new steps which we will have to master. One fact remains, referenced architecture like RAMI 4 (Platform I4.0) sets visionary targets but the presented model shows you defined stages towards Indus-

try 4.0. Manufacturing companies may gradually draw nearer to their ideal of a „Smart Factory“ if further stages are defined in more detail. For this reason manufacturing companies should not be deterred by theoretical images but systematically advance step by step towards Industry 4.0.

What to do? Wait and see? Or take action?

You may ask yourself what to do? Does it make sense to act if Industry 4.0 leaves many questions unanswered? Companies may shed a light using the Four-Stage-Model.

In order to conquer individual stages the MES experts from MPDV recommend the following:

- Invest in an integrated Manufacturing Execution System (MES) and eliminate all isolated IT solutions.
- Use Lean Management and Lean Production principles to streamline processes.
- Incorporate all employees in the transition to make them feel part of the transition and cohesive in the overall goal.
- First, define the task or application and then the IT infrastructure.
- Look into communication capabilities when purchasing new machinery, facilities and sensors.
- Keep an eye on research activities, professional associations and organizations like the „Platform Industrie 4.0“ in Germany or the Industrial Internet Consortium (IIC) in the USA to identify the challenges you face and to find out about new trends and technologies on the market.
- Finally, think globally but start with a manageable number of tasks!

Comment Prof. Dr.-Ing. Jürgen Kletti

„Smart Factory“ in four steps using an MES

Prof. Dr.-Ing. Kletti, CEO MPDV Mikrolab GmbH, explains how companies move their production into the new era of Industry 4.0 supported by state-of-the-art production IT like an MES.

Many companies are heading towards Industry 4.0 but the management‘s immediate euphoria is dampened by the complexities and uncertainties of the issue. An additional obstacle is the multitude of terms like CPS, Internet of Things or „Smart Factory“ which leaves people guessing how to pursue Industry 4.0. It becomes clearer if you proceed systematically and step by step.
Therefore, I would like to suggest a simple plan containing four steps:

1. Make your factory transparent by comprehensively collecting and evaluating data with a Manufacturing Execution System (MES).
2. Transform your production planning and control into a reactive tool by integrating collected data into the MES planning process and subsequently reducing waste.
3. Incorporate your findings to create control cycles in production, which leads to an autonomous factory.
4. Functionally link all departments, resources and systems involved in the production process. This includes a direct connection from product development to production.

This means specifically that production companies can still use existing facilities, on the one hand, which also reduces investments and, on the other, employees benefit from a systematic approach.

As you know, qualified personnel are an asset to any company. It is crucial to retain employees in the business, to integrate them into changes and to take them along to the era of Industry 4.0.

We need support from IT systems to transform production into a „Smart Factory“. Integrated MES systems have proven to be the most suitable tool according to the IEC 62264 because they provide, collect and process all relevant data. An MES serves as a central data platform for production and other departments and as an interface between the human being and the factory.

This leaves us with the question: When should we begin to implement the „Four-Stage-Model“? The earlier the better! I am sure that you can only transform your production into a „Smart Factory“ and thus managing Industry 4.0 with an integrated MES. Therefore, companies should start with the introduction or extension of their MES system as quickly as possible.

Extended future concept MES 4.0

In order to cope with requirements deriving from Industry 4.0, MPDV Mikrolab GmbH has developed the Future Concept MES 4.0 and identifies areas of activity. The new four-stage model is based on the findings and results of this concept.

- **Management Support:** Decisions based on reliable KPIs
- **Big Data:** Converting mass data into useful information (Smart Data)
- **Mobility:** Utilization of mobile MES applications for smart processing
- **Unified Shopfloor Connectivity:** Standardized connection to machinery
- **Flexibility:** Configuration, instead of elaborate programming
- **Horizontal Integration:** Avoidance of interfaces and non-integrated solutions
- **Integrative Data Management:** Central and interdisciplinary archiving of data
- **Interoperability:** Standardized synchronization with other systems
- **Security by Design:** Online validation, high availability, authorization concepts
- **Online Capability:** Real time capability and back-up supplies in case of network failures
- **Decentralization:** Flexible handling of intelligent and autonomous systems
- **Human Factor:** Ergonomic system operation and integrated HR functions

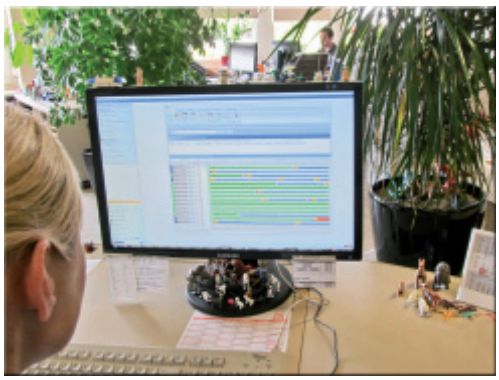
MPDV: The MES Experts

MPDV Mikrolab GmbH has been developing Manufacturing Execution Systems (MES) for more than 35 years and offers services to implement MES solutions. Services also include application consultancy, implementation and customizing, project management, training, support. Additionally our Lean Production Consultants support you with an „Actual Analysis“, suggestions where to use MES and ROI assessments.

With HYDRA MPDV supplies a modular MES solution which complies to VDI 5600. It is a win-win situation for medium sized to international global players, involved in rubber and polymer processing, automotive suppliers, food and beverage industry, production and mechanical engineering, furniture manufacturers, primary processing industry, printing and packaging, steel processing, optical industry and precision engineering, medical and pharmaceutical industry, electronics and electrical industry. MPDV has eleven subsidiaries worldwide in Germany, France, Switzerland, Singapore, China and the USA employing 325 people.

Awards given to MPDV vouch for the role as a market leader: Frost & Sullivan decorated MPDV with the MES Best Practice awards but also with the Global MES Award. As a TOP 100 business, MPDV is one of the most innovative medium-sized companies in Germany. MPDV is a pioneer in the propagation of the MES philosophy and is committed in organizations such as VDI (The Association of German Engineers), VDMA (German Engineering Ass.) and MES D.A.CH and MESA.

Manufacturing Execution Systems



Manufacturing Execution Systems (MES) make production processes more efficient and increase productivity. Data from production, quality and HR are collected, evaluated and displayed in real time.This enables responsible staff to react to interruption immediately during production and opens potentials for long term increases in profitability.

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