White Paper | December 2018

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Industry 4.0 disarmed

The functionally linked factory

MPDV white paper
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The topics of the MPDV white papers:

- Manufacturing Integration Platform (MIP)
- The functionally linked factory
- The autonomous factory
- The reactive factory
- Smart Factory in four steps
- Industry 4.0 needs Horizontal Integration

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Stage 4 on your way to the Smart Factory

Functional linking and the Digital Thread

Buzzwords associated with Industry 4.0 become increasingly diverse. Every idea, however basic and simple, needs an innovative name. For functional linking it is the Digital Thread. The term stands for the attempt of merging data from different IT systems to gain new insights to optimize the manufacturing process. The Digital Thread also expands the Digital Twin by another dimension – the time. But what have Manufacturing Execution Systems (MES) got to do with it?

Looking at today's manufacturing industry shows that MES systems are still of pivotal importance. Different committees and experts confirm again and again the necessity of an MES and its benefits. But more than ever, the MES must take on its intended role as the central information and data hub in the company. Stand-alone solutions for production data collection, CAQ (Computer Aided Quality assurance) or traceability no longer meet these requirements. You need an integrated and interoperable system to realize the Digital Thread.

The Digital Thread

The Digital Thread is about merging data from different IT systems for the purpose of enriching information - i.e. broadening the horizon beyond the MES. Based on this, you can use the knowledge to optimize production processes and fulfill requirements (e. g. traceability) much easier. Data comes from different areas of the value added chain or indirectly involved systems (e. g. logistics, facility management,). This is why we speak here of the Digital Thread, which runs virtually like a thread through the entire manufacturing landscape and brings together important information from different IT systems.

Smart Factory – the functionally linked factory

Functional linking in the sense of the Digital Thread, i. e. bringing together applications, functions and especially data that have not yet been considered or used collectively, is becoming increasingly important. As a result, functional networking also leads to a whole new level of complexities - both technically and organizationally. This makes it all

Four-stage-model „Smart Factory“

Stage 1 is intended to make the entire production landscape transparent to ensure and improve responsiveness in stage 2. Based on the above, the 3rd stage is all about integrating control loops and self-regulating mechanisms. The role of the human being in the factory is by no means to be replaced, but is to be adapted to today's conditions. In the end, all three stages ensure that stage 4 can be successfully implemented using functional linking.

the more important that both the manufacturing staff and the management understand and live such things as transparency and responsiveness, the cornerstones of the Smart Factory. This is the only way to ensure that the functional networking creates new potentials for optimization or even new business opportunities and does not end in a hopeless chaos.

Horizontal integration – correlation – interoperability

As already explained in previous contributions on horizontal integration (see white paper), the correlation of data often brings new and valuable insights. But the horizontal integration is restricted to the application in a system. Beyond system constraints, one speaks of interoperability. Further relevant issues have to be observed: In addition to the required security mechanisms (e. g. encryption), this essentially involves a common understanding of data and their meaning – a common „language“ so to speak. We often come across the term “semantics” in this context. Common semantics ensure, among other things, that the transmitted data is generally understood and not interpreted differently by the receiving system. All systems involved should also agree on differences and connections between orders and operations.

Targeted networking

To ensure that functional networking also leads to the desired optimizations, the requirements should first be specified, the necessary structure defined and then selected interfaces implemented. The following examples of functional networking represent a selection that might be of relevance depending on the size and type of manufacturing company.

Linking production and logistics

MES systems themselves offer solutions to digitally integrate in-house logistics. By connecting

Figure 1: Functional linking brings more efficiency to production

Figure 2: Increased efficiency in the production routine by linking production and logistics

to a so-called Warehouse Management System (WMS), the existing functions can be extended and thus become even more powerful. For example, MPDV's MES HYDRA monitors defined stocks of material and intermediate products – WiP material – as part of the MPL (Material & Production Logistics) application. At the same time, HYDRA works with current buffer stocks in production and has much more detailed information than an ERP system, which usually only knows stock levels that are booked at the end of the order. HYDRA can also project the expected range of selected materials. If HYDRA is connected to a WMS, the improvements can be significant. You can then not only monitor stocks of specific material buffers, but merge information about storage bins in production with the data from other storage locations managed in the WMS. This means, you can early detect material shortages and delays with minimal efforts or even avoid it completely. By means of a functional networking, the MES knows the exact material location and can display it on the shop floor client.

Another example: For some time now, HYDRA MPL has had an integrated transport management system on the shop floor. With HYDRA MPL, you can automatically generate transport orders if material is required for a machine or if finished material can be removed. Transportation management can also support setup of machines by automatically requesting required resources (such as tools) via transport order. The combination with a WMS would also enable the automatic control of transport vehicles (e. g. a driverless transport system) including automatic route planning. By transferring transport orders from HYDRA, important supply processes could be generated completely automatically.

MPDV's MES experts are currently analyzing further opportunities with the viastore software, the leading provider of software for logistics processes.

Linking production planning and facility management

There are production processes where existing ambient conditions are relevant or even critical. In this context, the linking of production planning and control incorporating a facility management system would be an obvious solution. For example, temperature-critical processes can be scheduled for times when the facility management can safely control the temperature. Or alternatively, the air conditioning of the factory hall can be changed in good time before such process steps begin. Dynamic restrictions during planning can also be controlled by information from the facility management: e. g. limiting the number of simultaneously running furnaces during hot days at lunchtime or blocking certain doors on cold days while temperature-critical processes are running.

Also, to network the energy supply with production can be advantageous – especially for energy-intensive production processes. For example, operations with particularly high energy consumption can be carried out at times when energy procurement costs are low or for which low-cost energy quotas can be acquired. The prevention of peak loads and therefore the reduction of unnecessary costs also plays an ever more prominent role.

MPDV participates in different research projects in the field of linking production planning and energy management. Future findings will successively be incorporated into the MES HYDRA.

Traceability and linking across the supply chain

In some industrial sectors, production processes for each article must be completely documented. With a raising individualization of products, this requirement will become all the more important for an increasing number of companies in order to provide targeted services and support for their products at a later stage. Whereas it was

Figure 3: MES and facility management exchange information regarding an optimized production planning

previously sufficient to document which raw materials were used, production companies will in future need additional parameters. Not all the information required can be directly captured by the MES. Therefore, it is crucial that IT systems are networked in order to supply this data. For example, values for room air conditioning (facility management), used transport routes or equipment (logistics), data from upstream suppliers (supply chain management) or other data from the Industrial Internet of Things (IIoT) can be consolidated in the MES.

A specific application example is the connection of IT systems across the supply chain using the BALLUF Mold-ID and HYDRA WRM (tools and resources management). This combination can monitor injection molding tools, even if they are used by a subcontractor. Here, the main focus lies on complying with defined service intervals and also documenting when the tools are used. The local acquisition of relevant data is performed by Mold-ID on an RFID chip located on the tool. As soon as the tool is back, this data is transferred centrally to the MES. That means, there is no information gap between both systems. By merging data with the batch-related information on articles from the subcontractor, the data entered locally can also be used for traceability.

Linking of design, production and quality assurance

A particularly illustrative example of functional networking is the use of model data from the design department (e. g. CAD model) to define characteristics that are recorded during the quality inspection in production. This makes the so far manual inspection planning much easier, since many parameters of the characteristics to be inspected (e. g. target value and tolerance) are transferred directly and automatically from the CAD model. Planning efforts are reduced and the probability of typos are eliminated. The recorded test results are not only used for quality assurance in production, but are also fed back to the design engineer. This, in turn, enables the engineer to make improvements to the product, which results in a higher product quality in the design phase and at the same time relieves production by reducing rework.

HYDRA has recently been offering the first functions for importing inspection characteristics from CAD models. We are already discussing whether to even extend this function. Another application which we have developed some time ago, is the transfer of NC programs from a Product Lifecycle System (PLM). With HYDRA DNC, the data can then be used directly on the machine depending on the pending job. HYDRA DNC is already widely used in production companies.

Figure 4: Long-term increase in quality through linking of design and production inspection

From the Digital Twin to the Digital Thread

All previous examples for networking are based on merging data from different systems – in line with the Digital Thread. In particular, connecting the design area to the MES expands the overall perspective on the complete life cycle of a specific article. For this reason, the digital production twin or specific products get a timeline. This benefits both manufacturers and future product users. Particularly in times of ever shorter life cycles and a constantly increasing product variety, such feedback is important in order to learn quickly and sustainably from the experience gained. Thanks to functional networking and the Digital Thread, all parties involved can benefit from the shared knowledge and immediately learn from errors that have occurred.

Future

Learning from mistakes will remain a true human domain for some time, but here too, there are attempts to automate this. Under the buzzwords „machine learning“ and „artificial intelligence“, intensive research is being conducted into how to further tap production potentials based on the enormous amount of data and information – even without people having to worry about tedious data analysis. However, one thing is for certain: far-reaching decisions will always be made by humans in the foreseeable future and they will define the scope of discretion for everyday decisions. Hence people remain conductor of production. At the same time, machines and IT systems will take over tasks that they can increasingly master. But nobody needs to be afraid of empty factory floors. People are still much more flexible than machines. This makes it all the more important for people to retain an overall control despite all automation and functional networking. After all, this is the only way people can continue to play the central role that Industry 4.0 has assigned them since the first publications.

Targeted functional networking also promotes the further expansion of all previous stages of the Smart Factory: transparency, responsiveness and self-regulation. This turns the 4-stage model itself into a control loop for production optimization – entirely in line with Industry 4.0.

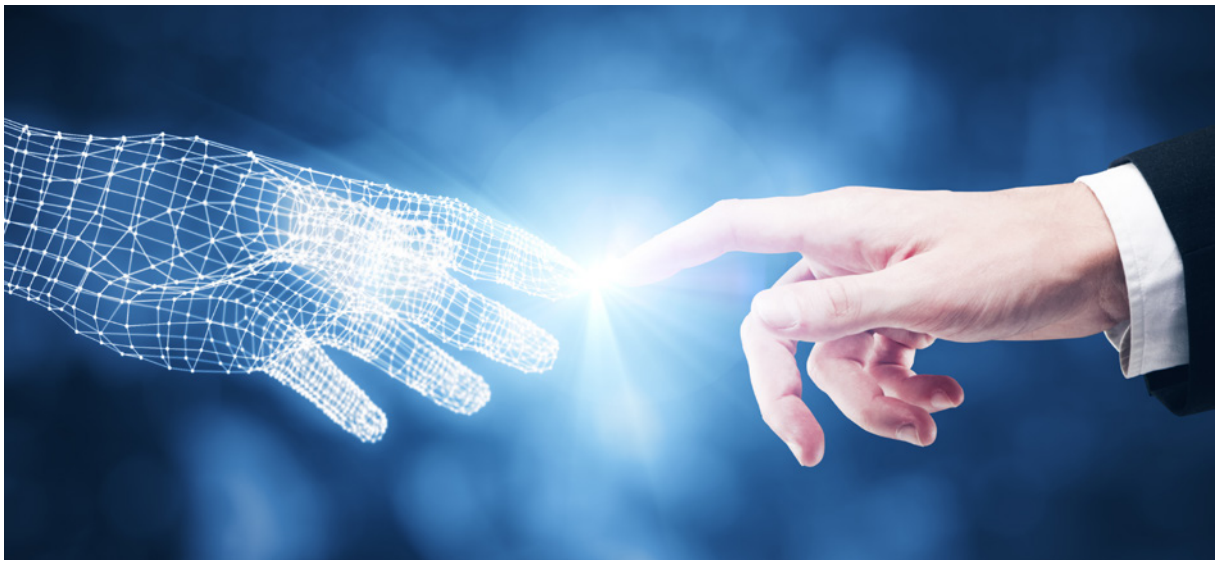
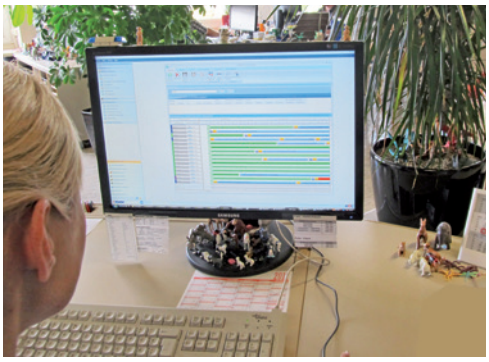


Figure 5: The Digital Thread extends the Digital Twin with a time dimension

MPDV Mikrolab GmbH

headquartered in Mosbach/Germany is developing Manufacturing Execution Systems (MES) and is looking back on 40 years project experience in the production environment. MPDV's product portfolio comprises of MES products, services, and entire MES solutions for the MES environment. MPDV currently employs more than 380 people across ten sites in Germany, Switzerland, Singapore, China and USA. Customers from different industry sectors, ranging from metal processing to medical engineering, benefit from more than 1.000 installations of MPDV's MES solutions. These include medium-sized companies to global enterprises. Being part of the TOP 100 businesses MPDV is one of the most innovative medium-sized companies in Germany.

MES HYDRA



Manufacturing Execution Systems (MES) support production companies to improve efficiencies in their production processes, increase productivity and thus to secure or enhance their ability to compete. A state-of-the-art MES puts companies in the position to record and evaluate data along the complete value-added chain in real-time. People in charge can therefore react instantly to unforeseen events in the daily production routine and put in suitable measures.

The MES supports on all levels short-term and far-reaching decisions by providing a reliable data basis. HYDRA, the modular structured MES by MPDV, features an extensive functional range and meets all requirements stated in the VDI guideline 5600. Individual HYDRA applications based on a central MES database can be combined without the use of interfaces. Thus, HYDRA guarantees a 360-degree view on all resources in production and can incorporate overlapping processes. Powerful tools for configuration and customization ensure that HYDRA can be modified in order to cater for company and industry specific requirements. HYDRA can be integrated into existing IT landscapes and is used as a link between production (shop floor) and the management level (e. g. ERP system). Production companies are particular reactive using an MES system like HYDRA and therefore remain competitive – especially looking at Industry 4.0.

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The MES Experts next to our customers.

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Doku-Ident: White Paper EN 12/2018