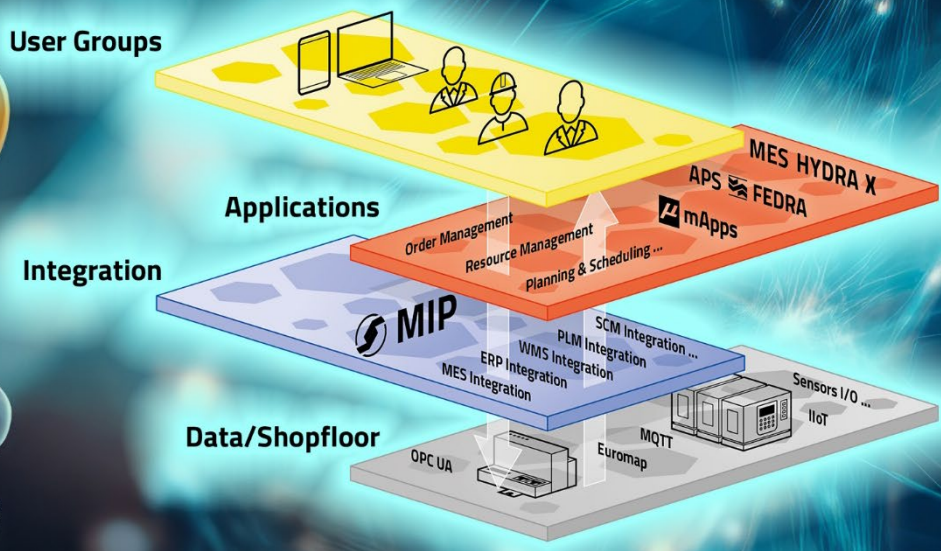


Innovative successor for the classic automation pyramid

Smart Factory Hive



Motivation

The classic automation pyramid was the benchmark for production environments for a long time. But it is becoming increasingly difficult to map new IT architectures in it. It is therefore time to adopt a new perspective. As pioneers and trendsetters for the Smart Factory, the experts at MPDV have developed an approach that embraces this vision. MPDV calls the new model the **Smart Factory Hive**. Find out in this article how this name came about and what honeycombs have to do with it.

The first question that arises is why a new model is needed at all. Surely the automation pyramid has proven itself over many years. Peter Hofmann, Manager Innovation at MPDV, can tell us more: A significant disadvantage of the pyramid structure is that only directly neighboring layers communicate with each other, which usually occurs in proprietary protocols. Nowadays, networking has increased significantly, so this communication principle is no longer effective. Even in the trade press, headlines such as "The automation pyramid has had its day" or "The end of the pyramid" have been appearing with increasing frequency over the past few years.

„The Smart Factory Hive catapults manufacturing IT into a whole new era. The new visualization gives providers and users alike a fresh and future-oriented view of IT in the Smart Factory. It seems like we have opened a window into the future. The manufacturing IT of the future is no longer just a concept — it is here and opening doors to greater efficiency, better connectivity, and continued innovation.“

Nathalie Kletti, CEO

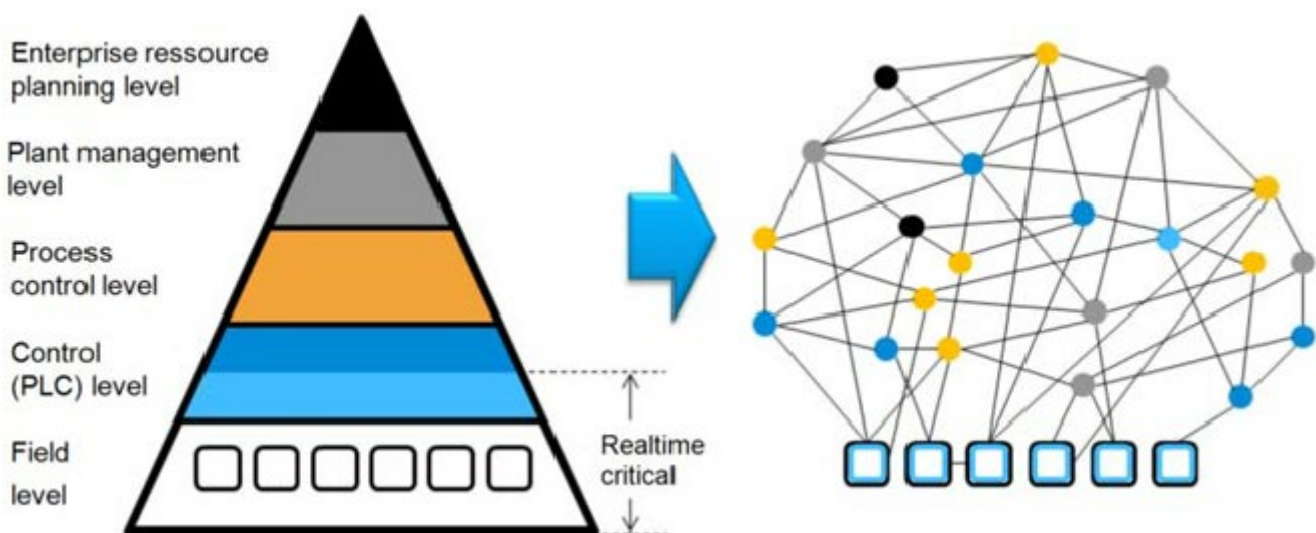
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The pyramid has become flat

Experts therefore suggest that the pyramid should be followed by a network where everyone talks to each other. The objective of non-hierarchical communication is thus achieved. However, a new challenge arises. The number of interfaces increases exponentially. If every system and device is connected to every other system and device, the number of connections required is immense. The number increases with each new device. To make matters worse, the dream of an omnipresent standard protocol is still wishful thinking. This means that the more connections that are made, the greater the variety and complexity.



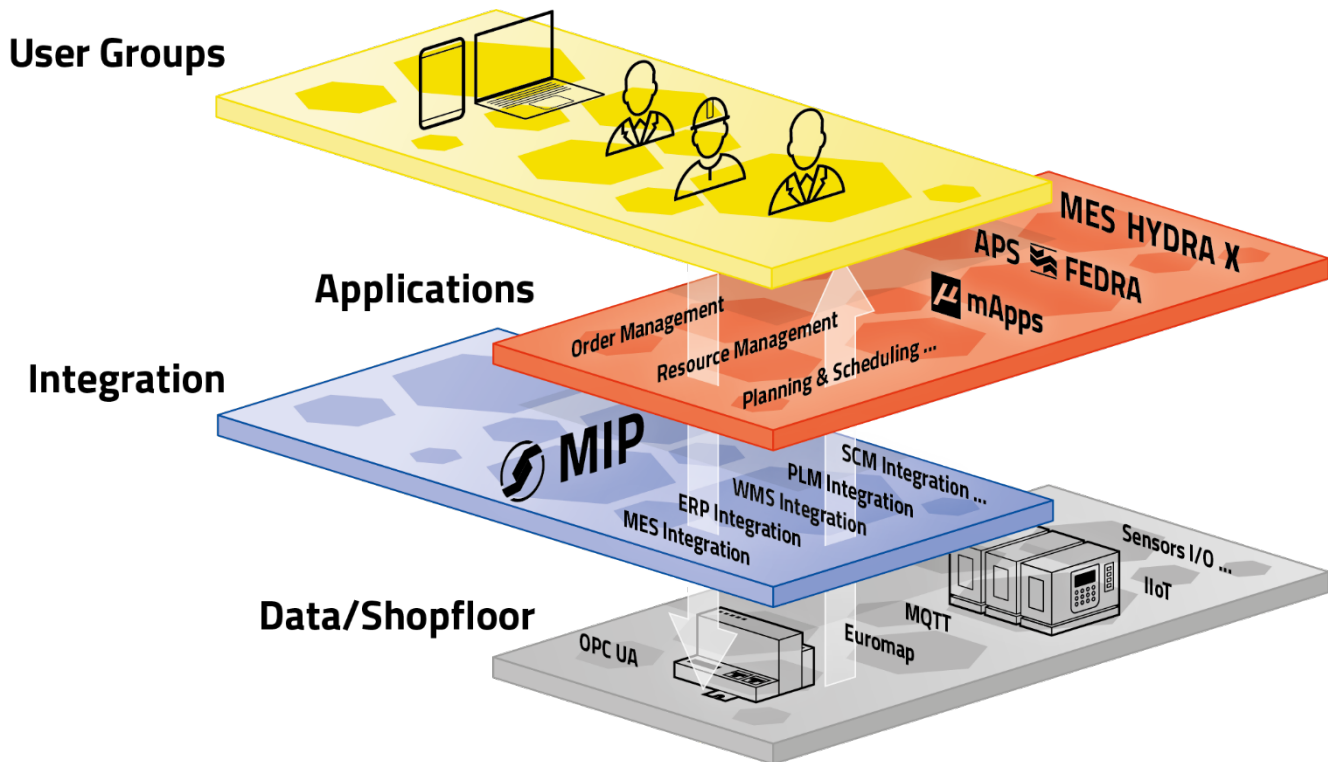
From the pyramid to the network (Source: VDI, Theses and fields of action: Cyber-Physical Systems)

All this goes to show that it is not enough to simply connect all systems and devices directly with one another. It will not work without a central platform to which every system and every device can be connected. An integration platform is an absolute must. MPDV has been pursuing this path for years with the Manufacturing Integration Platform (MIP). Peter Hofmann explains: "The principle is simple yet ingenious: all systems and devices communicate with the MIP. So, there is only one interface, and it is standardized." If another system or device is to be connected, only a single additional interface is set up. This helps keeping complexity at bay.

Why a honeycomb presentation?

As an alternative to the network, the experts at MPDV chose a honeycomb structure. We are familiar with the honeycomb from nature, most notably from honeybees. The compact design also helps to reduce the number of interfaces in the manufacturing IT. To do justice to the complexity of today's IT architectures on the one hand, and to maintain clarity on the other, MPDV decided on a multi-layer honeycomb model — a kind of beehive.

Smart Factory Hive



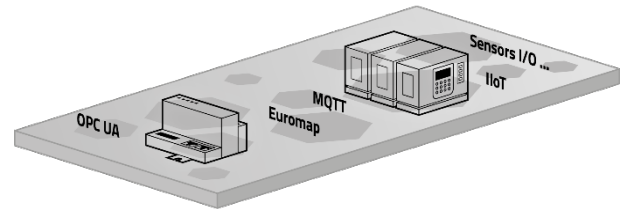
The Smart Factory Hive initially consists of four layers:

- **Data/Shop Floor:** This is where all data suppliers are located. Such platforms could also be aggregation platforms, for example, systems based on the Industrial Internet of Things (IIoT).
- **Integration:** If data is to be processed, distributed, or analyzed, an integration platform ensures that everyone has the data they need and for which they have the appropriate rights.
- **Applications:** Every type of manufacturing IT application is at home at this layer. If data is required or results are provided, this is handled by the integration layer.
- **User Groups:** The individual user groups in the company are assigned to the top layer. Each user can access their applications and the data assigned to them.

The four layers are each made of a flexible honeycomb structure that contains the individual components of the layer. Different types of components are grouped together depending on the layer.

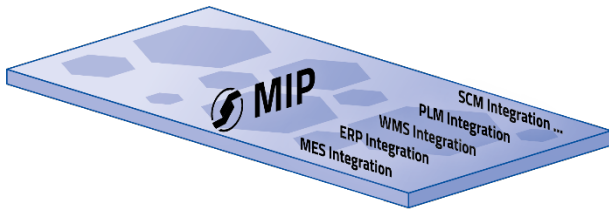
Data/Shopfloor

You will find here physical devices such as machines, controllers, (PLC), robots and tools, as well as communication protocols such as OPC UA, MTconnect or MQTT. Automation platforms from different manufacturers and IIoT platforms as data aggregation systems also communicate with the other components at this layer.



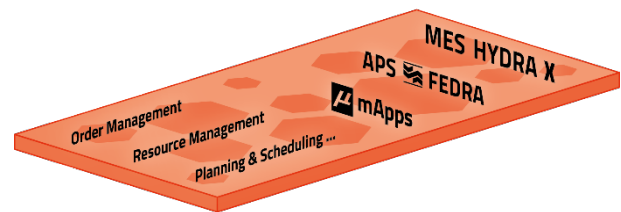
Integration

The centerpiece of the integration layer is an integration platform such as MPDV's MIP. This is where all the data from the Data/Shop Floor layer converge. With the integration platform, the previously mentioned interface chaos can be avoided as it is the only point of contact between the shop floor and the applications that run above it. Alongside the integration platform, this layer contains a variety of integration modules for other systems. These include, besides the ERP system, for example, the product design (represented by the PLM system), the supply chain management (SCM), the (intra-) logistics (represented by the warehouse management system) as well as the sales and controlling (represented by a CRM system or a business intelligence system). The integration modules serve as an extension of the integration platform and ensure standardized communication. It goes without saying that typical MES applications are also linked to the layer above via the integration platform.



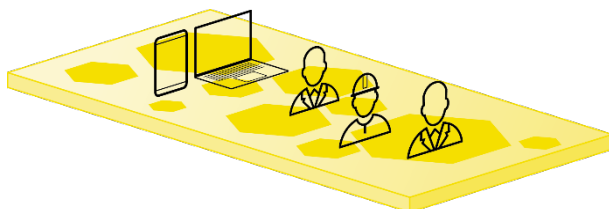
Applications

Manufacturing IT applications include all types of apps, programs, and IT solutions that process data from the shop floor and visualize it for a user depending on the application. The honeycomb model initially incorporates classic MES tasks in accordance with VDI guideline 5600 but expands on these with new fields of application such as assembly management or analysis using artificial intelligence. This layer is particularly suitable for a very detailed presentation as the variety of applications is constantly increasing in the course of application. The higher the granularity of the functions divided between individual apps, the more detailed the presentation of the application layer.



User Groups

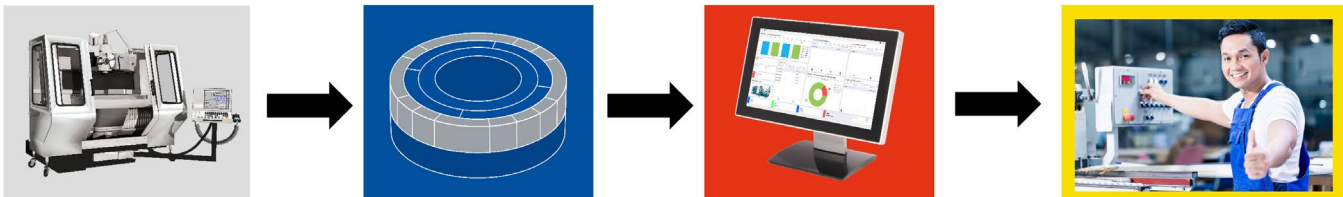
The group of users of manufacturing IT is just as diverse as the range of applications. Included in this group are the classic roles in a manufacturing company, such as operators, supervisors, planners, or production managers, as well as departments and their employees tasked with keeping business processes running. The latter group includes, among others, controlling, purchasing, management, but also the development department or a process manager. In the end, all user groups benefit from the combination of shop floor data and business management data, although this data need to be prepared in different ways.



Interaction of individual layers

An example will explain how the layers work in the Smart Factory Hive:

A logged-on order is running on a punching machine. Each stroke produces five identical parts, which drop into a pallet cage. The machine control system (**Data/Shop Floor**) records every single stroke. Communication with the PLC is performed via a OPC UA information modeling framework. The DEC (**Integration**) Edge component records the cycle signal and transmits it to the MIP integration platform via a web service. The Manufacturing App (mApp) Machine Monitoring (**Applications**) visualizes the cycle counter and the resulting quantity on the shop floor terminal. The operator (**User Groups**) can view the order progress. The order progress is forwarded via an integration module to the ERP and CRM system (Integration) so that any delays can be relayed to the customer.



From the machine (data/shop floor - gray) via the MIP (integration - blue) to the application (applications - red) - so that the worker can make well-founded decisions (source: MPDV)

At the same time, the machine control system (**Data/Shop Floor**) supplies the punching machine's energy consumption data to the integration platform via the DEC (**Integration**). The energy data is immediately forwarded to the facility management system via an integration module. Furthermore, the mApp Maintenance & Service Management (**Applications**) compares the recorded energy consumption with the target data. If the energy consumption is too high, maintenance of the punching machine is automatically scheduled. The maintenance is stored in the integration platform. An mApp with a connected smart watch visualizes the upcoming maintenance for a maintenance technician (**User Groups**).

A similar chain of data collection and the resulting activities can be outlined for every type of order, event, or company. The process is always the same: the data collected is available on the integration platform for every application. The **Smart Factory Hive** illustrates the route of data from the shop floor to the user. As a result, the hierarchy of individual applications, barely visible today, becomes transparent and the user can find their way around more easily.

Smart Factory Hive for different target groups

The benefits of the new model for various target groups in a manufacturing company are described in detail below:

Top management — working with aggregated data

Top management always has the big picture firmly set in sight: the company must be running and generating revenue. For this to work, production is the single most important factor in a manufacturing company. However, management is not interested in the readings from individual machines. Instead, higher-level key figures, reports, and evaluations are used to give management an impression of how efficiently production is running. The best way forward is a dashboard with a few meaningful key figures and charts showing the progress over the last few days.



For this, management (**User Groups**) employs an **application** that is part of a manufacturing execution system (MES) such as HYDRA X. The managing director does not need to know how the data enters the application or which machine is connected via which protocol as they are only concerned that the data is reliable. As a member of this user group, they only need access to **applications** that display data for their area of responsibility. A list of individual measured values for quality inspection would serve no purpose at all. Higher-level key figures such as Overall Equipment Effectiveness (OEE) or current sick leave are exactly what a business manager is interested in.

Members of the management team would therefore primarily see the top two layers in the Smart Factory Hive: **User Groups** and **Applications**.

Production planner — distribute orders perfectly

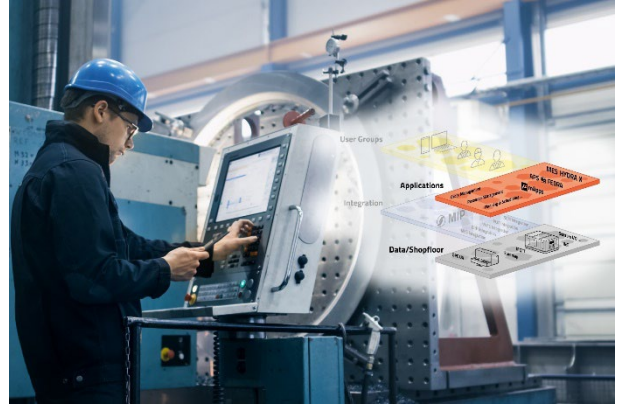
The aim of a production planner is to distribute all the upcoming orders among the available machines in the best possible way. At the same time, they should make the best possible use of the existing machinery. However, machines alone are not enough these days — the right tools, materials, energy and, of course, qualified personnel are also needed. An Advanced Planning and Scheduling System (APS) like FEDRA is the ideal tool here. But the best planning tool cannot work without data. It is therefore essential for the planner to know whether an order has just been transferred from the ERP system or has already been logged on to a machine. In other words, the planner is interested in the origin of the data they work with. As they are in the User Groups layer, the planner needs access to **applications** that allow them to schedule orders on resources, as well as information on the current production status. An integration platform like MIP (**Integration**) ensures that real-time data from the shop floor and orders from the ERP system can be processed in planning application (**Applications**). The planner is not interested how data is transferred from the machine (**Shop Floor/Data**) to the integration platform. Here, the focus is on the reliability of data.



The three top layers in the Smart Factory Hive are most relevant for the production planner, which are **User Groups**, **Applications**, and **Integration**.

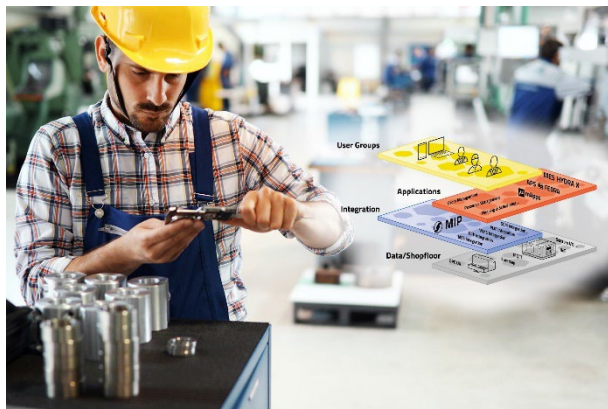
Operator — emphasis on the here and now

A machine operator must concentrate fully on doing everything right because every wrong move can lead to rejects or even be dangerous. The machine operator needs data that help them to perform the tasks efficiently and flawlessly. Applications for employees in the shop floor are entirely different to those used in the office. Shop floor employees tend to wear gloves and the area around the machine is on the rougher side. That is why the IT equipment used in such conditions must be easy to operate and able to withstand harsh environmental conditions. Large buttons and clear user interfaces with essential information are therefore the order of the day. Nevertheless, operators (**User Groups**) use applications of a manufacturing execution system (**Applications**). It is important for them to see the status of each machine and the exact location where a particular measurement was taken (**Data/Shop Floor**) but how this data is supplied via the integration platform (**Integration**) is of no interest to the operator.



If an operator is at all interested in an abstract model like the Smart Factory Hive it would be the layers: **Applications** and **Data/Shop Floor**.

Quality manager — comply with specifications and minimize scrap



Quality management is set up as a cross-departmental function in many companies. Experts in this field ensure that the complex requirements of legislators and customers are met, as well as providing specific quality assurance. Quality control can be divided into three segments: inspection planning, execution of inspections, and evaluation of recorded measurement data. Depending on the organization of the manufacturing company, part of the tasks is assumed by the operator, which is the inspection itself. Consequently, a quality assurance officer also determines which **applications** should be used by which user group (**User Groups**). They also need to know where measurement (**Data/Shop Floor**) result is coming from. Finally,

inspection planning also requires information from neighboring systems such as ERP or PLM, which are connected via an integration platform (**Integration**).

A quality assurance officer should be familiar with **all layers** of the Smart Factory Hive.

Industrial electrician — easily connecting machines

One of the tasks of an industrial electrician is to connect machines digitally. They can do this either via standardized protocols such as OPC UA or MQTT, or by installing their own sensors and feeding the data into the system. What happens to the data collected later is usually of little interest to an industrial electrician. Electricians are rated on how quickly they can connect new machines and on the reliability of the data recorded. Tools to connect machines are manifold. For modern machines, it is usually sufficient to plug in a network cable and set an IP address. Older machines or self-built systems usually do not have a dedicated access point for data or do not even collect it.

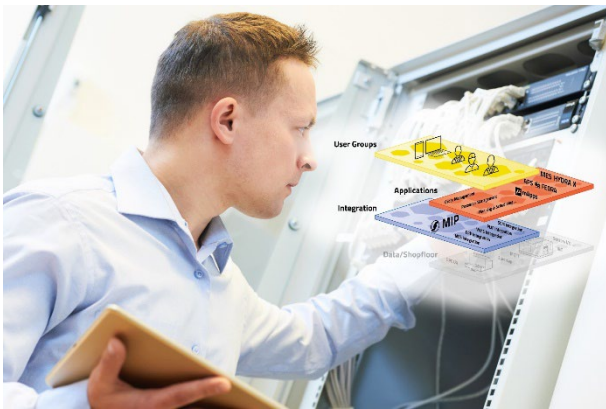


Sensors (**Data/Shop Floor**) can be retrofitted to supply data to a data collection module in the shop floor or in the control cabinet. This edge device (**Data/Shop Floor**) is then in turn connected to the integration platform as the data source (**Integration**).

The focus for the electrician is on the bottom layer of the Smart Factory Hive: **Data/Shop Floor**. Depending on the distribution of tasks, the second layer may also be a relevant one: **Integration**.

IT manager — ensure interoperability

Employees of the IT department or even the IT manager themselves see the Smart Factory Hive as a terrific opportunity to revitalize the topic of interoperability. After all, the IT manager is responsible for ensuring that all applications and systems function properly and reliably. Fewer interfaces and standardized access methods make life easier for them. This is why we think that an integration platform can be a land of milk and honey for IT departments. New devices or systems are simply connected to the integration platform and all applications can access the data. Even changing one of the systems has no effect on other ones, as only the interface to the integration platform is affected. While an IT employee does not care about the technical content of **applications** or the meaning of the data collected in the shop floor (**Data/Shop Floor**), interoperability of all applications is key.



That is why the IT department is focusing on the most important layer in the Smart Factory Hive: **Integration**. Needless to say, that the two upper layers are also crucial for application administration: **User Groups / Applications**. Depending on the arrangement with the site electrician, the bottom layer can also be interesting: **Data/Shop Floor**.

If you would like to find out more about the **Smart Factory Hive**, please contact us:
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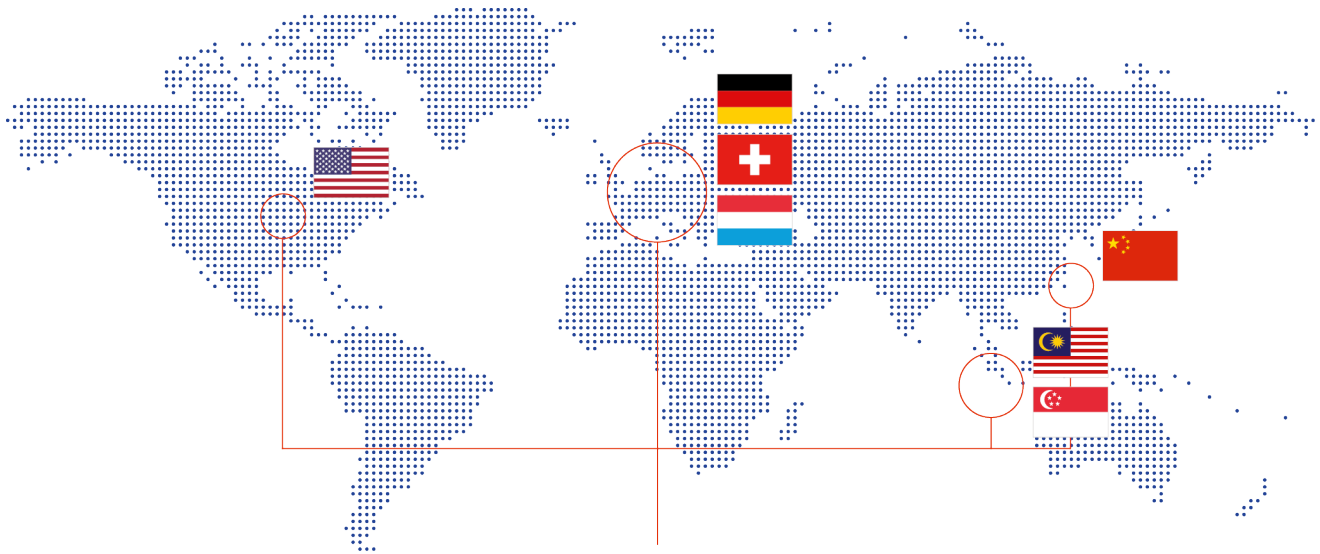


MPDV Mikrolab GmbH

headquartered in Mosbach/Germany, is the market leader for IT solutions in the manufacturing sector. With more than 45 years of project experience in the manufacturing environment, MPDV has extensive expertise and supports companies of all sizes on their way to the Smart Factory.

MPDV products such as the Manufacturing Execution System (MES) HYDRA, the Advanced Planning and Scheduling System (APS) FEDRA or the Manufacturing Integration Platform (MIP) enable manufacturing companies to streamline their production processes and stay one step ahead of the competition. The systems can be used to collect and evaluate production-related data along the entire value chain in real time. If the production process is delayed, employees detect it immediately and can initiate targeted measures.

Users of MPDV solutions include well-known companies from all industries. MPDV was founded in 1977 and is active worldwide at locations in Germany, China, USA, Malaysia, Singapore, Luxembourg and Switzerland.



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