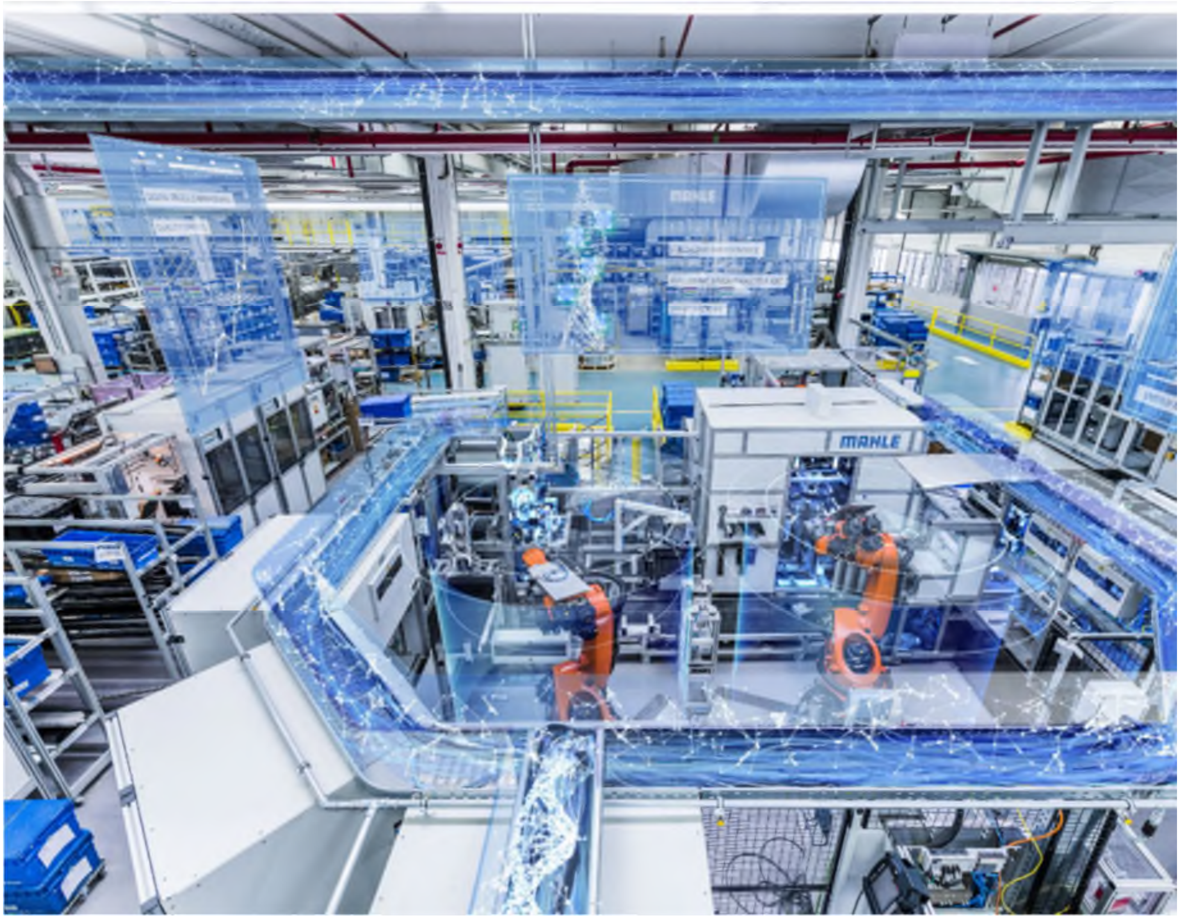
Smart data in automotive production

Verband der Automobilindustrie

VDA 6100, Version 1.0, Berlin, November 2020



Source image: MAHLE International GmbH

Table of contents

Introduction

The study at hand on "Smart data in automotive production" is based on experiences, assessments, and internal developments in VDA member companies. This document serves to classify the topic in the overall context of automobile production and shows the potential for both VDA member companies and their partners in the supply chain.

Our working world is in the midst of very rapid development from analog to digital tools. This change has been taking place for about a decade and is creating opportunities for everyone involved. This evolution is also known as digital transformation.

Working methods, practices, organisation and tools of the analog world are constantly being expanded through technical product developments of sensors, computers, software and the exchange of information. The main drive of this development and thus of this transformation from analog to digital is the increase in efficiency while reducing waste in social and economic processes. This change considered to be an improvement in social performance.

A key user and driver of this digital transformation is industrial production, which ensures competitiveness through a constant increase in efficiency.

In order to optimally use the advantages of this development, openness, willingness to learn and cooperation with other companies are important prerequisites.

The following chapters are intended to help towards understanding and improving a smooth and reliable exchange of information/data as an element of cooperation between different companies and organisations.

.

1 Industry 4.0 from the automotive industry viewpoint

Digital transformation is a logical step in industrial history. Industrial transformations or revolutions denote upheavals in working methods and have been known since the invention of the steam engine (Industry 1.0), the introduction of assembly line production (Industry 2.0), computer-aided machines (Industry 3.0) and currently with the data-based networking of machines towards autonomous production as Industry 4.0[1].

The term Industry 4.0 originated in Germany in 2011 and is used for all digital products and new technologies in the production environment. In other countries, terms such as “Smart Factory”, “Intelligent Manufacturing” and “Industrie du futur” are also commonly used. This also makes it clear that this evolution does not stop in any country or continental border, but rather follows the networked global economy and enables data and work processes to be interconnected worldwide.

With the advent of Industry 4.0 and digitisation in production, there are growing possibilities for acquiring data in processes and making it available to the production process. Due to a high level of efficiency, previously limiting, structural restrictions are no longer valid. In this way, production can be digitised and intelligently networked – not just comprehensively, but also in a continuous and overarching manner

Due to the increased use of sensors and analyses in production plants, a large number of company- and product-specific data is acquired, such as the status of the production plant, the process, the product and the production order. At the same time, detailed data from product development and all data for quality control are available in production. The correlation of this data opens up possibilities for optimising the control of the production process, the production method and the product quality. Digital tools enable real-time-based data analysis, visualisation and thus very fast decisions across continents.

In the field of information and communication technology, there is a further improvement in the ability to store large amounts of data and to exchange data quickly over the internet. As a secure, fast, powerful, and constantly available connection, the internet forms the basis for the networking of data.

The identification, use, and processing of the available plant- and technology-relevant data are currently inadequate and entail failures due to a lack of harmonisation. These failures have a particular impact where data is exchanged across the entire value-added chain between OEMs, parts suppliers and plant suppliers.

Examples of the application of data in the context of Industry 4.0 are plant status data for the prediction of machine failures (predictive maintenance), AI in the recognition of quality features in image processing or the flexibility of production control with decision-making aids based on real-time data.

1.1 Purpose and effectiveness of data

With the implementation of Industry 4.0 and digitisation in automobile production, it should be possible to respond as best as possible to the requirements of customers and the changing market with faster, shorter product cycles. This calls for flexible production that can be adapted in a short time for planning and construction, together with all partners involved.

A data-centric approach provides, among other things, the basis for:

- Fast response times to changes (time to market)
- Increase in process stability
- Optimisation of availability
- Error-free plant planning and commissioning

Only together with all partners involved, such as product developers, service providers, subcontractors, production planners, suppliers, plant construction firms, maintenance engineers, plant operators etc., can the stated goals be efficiently achieved as a win-win.

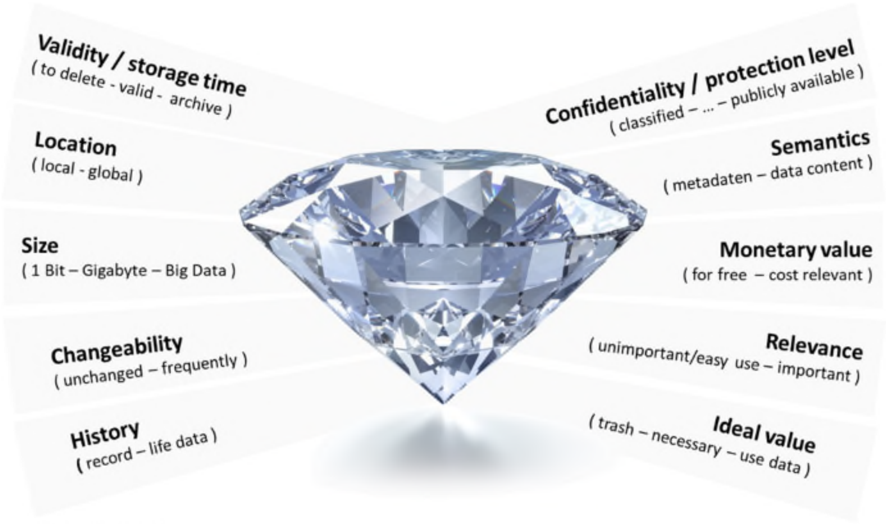
The focus here is on the effort required for the generation, use and secure, reliable usability of data on which the cooperation between the partners is based. Optimal data consistency is required for this.

[1] For further information and explanations on Industry 4.0, see: www.plattform-i40.de

1.2 Features of data in automobile production

Data is varied and large in volume. For this reason, the great and constantly increasing power of digitisation is so helpful and useful for data acquisition and processing. Data is the epitome of transparency of the technical world and Industry 4.0.

With various facets, data can be categorised or classified in a specific visual appearance.



Source: Volkswagen AG

The following characteristics of data in automobile production are of particular importance:

- Data should be accessible via IP (internet protocol) and internet technology.
- The significance of the data should be clearly determined in the context of value-added chains.
- Data should be both interpretable and processable in a formal manner for humans and machines alike. Clear terminology and semantic modelling are used for this.

In the context of Industry 4.0, data together with its descriptive models represent a (non-physical) asset.

1.3 Data flow

For data acquisition, data exchange and data use, it should be possible to identify, gather and validate data according to the models that describe it. The processes required for this must be defined and also described in models. This is done to safeguard data quality and achieve horizontal as well as vertical integration and interoperability.

In the context of a defined complete model such as the Asset Administration Shell or by a digital name plate of any asset, data and areas of validity should be able to be processed in a uniquely identifiable context.

All data producers and consumers (providers, consumers, prosumers) should be self-auditable (introspection) and should be able to provide suitable mechanisms that they offer or expected data and models offered by them.

1.4 Storage of data and IoT platforms

Industry 4.0 has an impact on the integrity, security and availability of data. The use of IoT platforms offers the following opportunities:

- Connection of any sensors and end devices
- Reduction of singular data interfaces between applications
- Reuse of data
- Use of data e.g. via partner clouds between cooperating companies.
- Cross-company, cloud-based solutions with a service-orientated approach

However, these opportunities require standardised data descriptions and exchange formats as well as clear agreements on data security. The VDA supports standardisation in these fields and makes a recommendation with this paper.

The modelling and structuring of data continue to apply and is essential. Industry 4.0 means that data structuring and uniform designation of data types are required more than with legacy systems with singular interfaces.

- Software-based systems: A software-based, data-centric approach is increasingly used for planning new production systems. Standardisation of data exchange formats and interfaces for hardware (robots, conveyor technology, signal converters, PLC, plant components) are of absolute priority. The hardware itself is configurable and becomes functional via firmware and software.
- Networking of data / Connectivity: The amount of data and, in some places, the quality that results from digitised assets in production inherently creates the need for local buffering, aggregation and further calculation before the results can be sent to a connected cloud platform.

Comprehensive and efficient data acquisition, storage and provision is the prerequisite for big data and comprehensive, useful data analysis.

The use of the data is decoupled from its acquisition (Data as a Service). Big data applications are developed that understand the mountain of data in fully networked automobile production – through the use of advanced algorithms to make predictions and identify potential problems at an early stage. With this in mind, a new data culture is required that aims for high quality but also focuses on the plausibility of the data.

2 Use of standards

The goals described in Chapter 1 require efficient transmission, storage and evaluation of the necessary data. The entire life cycle must be considered.

The use of uniform, industry-wide or cross-industry standards enables a fast and cost-reduced connection of various elements in the complete tool chain across the different phases. In concrete terms, standards are needed for the:

- Description and exchange of engineering objects
- Digital logbooks
- Transmission of process data
- Description and exchange of quality data
- Safe transmission of data between companies

Some of these standards exist, but they are not yet complete or are not used consistently.

2.1 Definitions

2.1.1 The digital model

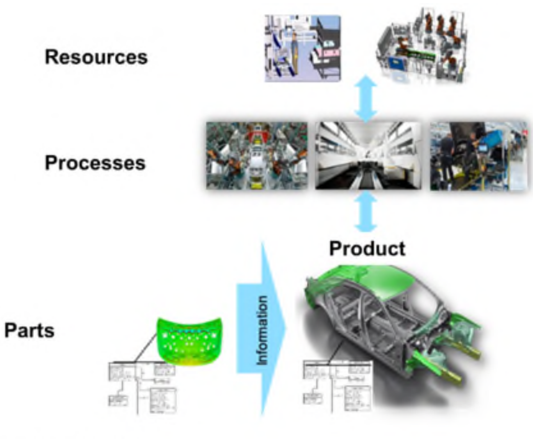
The digital model, which is created at the beginning of the engineering phase and is enriched with information over the entire life cycle, plays a central role.

A digitisation of processes requires the adoption of the digital model much more than in the past, which is classified in later phases of the life cycle using attributes and, from the perspective of the respective processes, is increasingly enriched with further data. Standardisation, wherever possible, reduces the effort involved in data transfer.

The representation of these objects in their entirety in a production system is the challenge for a comprehensive digital representation.

2.1.2 Data classification

The requirements for "production data" from the viewpoint of digitisation entail the need of a "common data model" – a logical data model that works across processes and even across companies.



Source: Mercedes Benz AG

Data classification is based on the terms: Product – process – resource and their combination.

- Product example: Vehicle, engine, motorbike, battery, cable harness
- Resource example: Human, machine, robot, building (hall), factory premises

The information is generated, processed, relayed, or used in the processes. In the life cycle of an IT object, the information content is always enriched with new attributes and versions thereof. Examples: 3D dimensions, construction of a machine, sales contract or maintenance protocol of the machine.

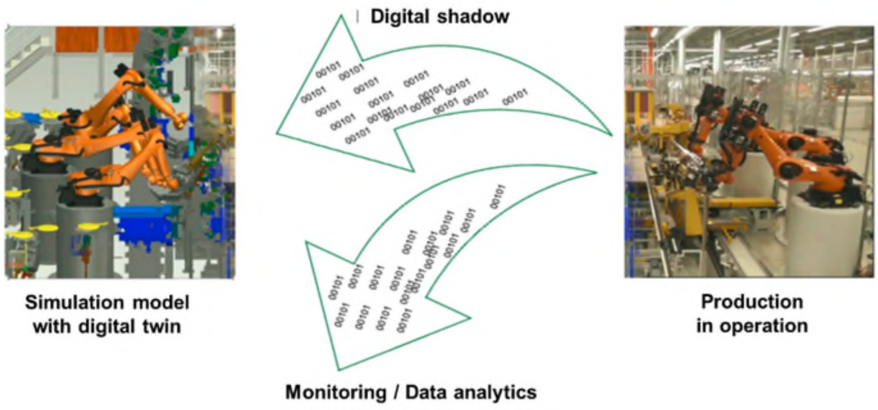
The product determines the process. The process determines the structure and the resource.

2.1.3 The digital twin

Essentially, the focus on Digital Twin is based on three terms: the digital model that runs through the planning process, the twin and the shadow.

The Digital Twin describes the complete virtual instance of a physical component (asset).

This includes all information that is necessary for design, commissioning, operation and maintenance. The flow of information between the physical and virtual world is implemented exclusively in an automated manner.

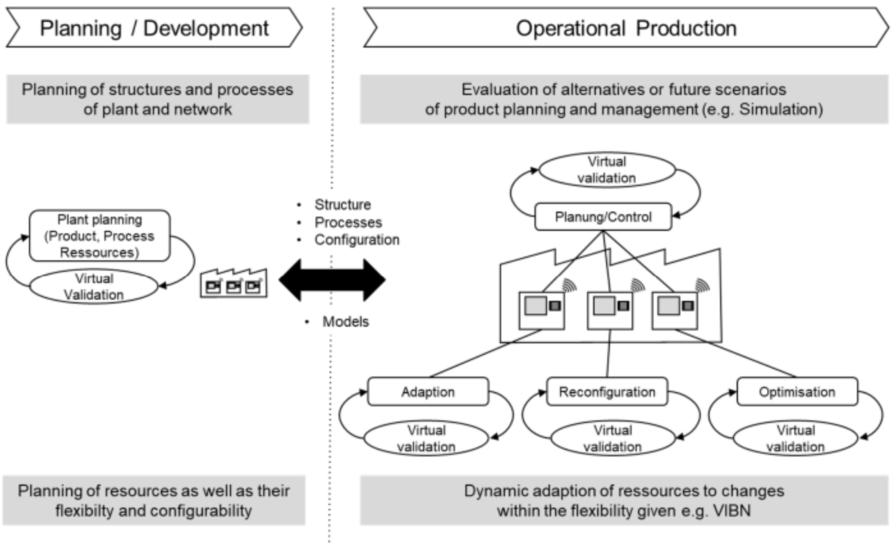


Source: BMW AG

The flow of information from the virtual to the physical world is also possible in an automated manner. This provides a complete information model for an asset, which is gradually filled over the history from planning to re-tooling.

A digital shadow describes the processing of the status information of the shop floor. This includes the preparation and interpretation of the real production data and describes the return from the physical to the virtual world. The digital shadow includes the operational use of the live production data, in other words, it is a live image of the state of the plant. The direct use of the data in a simulation environment enables a digital loop from production to engineering.

With regard to factory planning, the digital model is extended to the production buildings, their structures and the physical arrangement of the production plants. Process scenarios can be planned and evaluated virtually (see also Processes).



2.2 Processes

The following processes are characterised by intensive interaction with business partners, suppliers and service providers. Digitisation in these processes must inevitably lead to standardisation if both sides do not want to digitise with complex individual agreements.

2.2.1 Application view: Engineering

The aforementioned logical data model enables data to be networked comprehensively. A coupling of the data from planning and production offers the possibility of virtual validation and simulations.

Sequence simulation, physical process simulation and virtual commissioning of control systems and plants contribute to efficiency and cost savings when data is automatically transferred in the tool chain and is also fully networked.

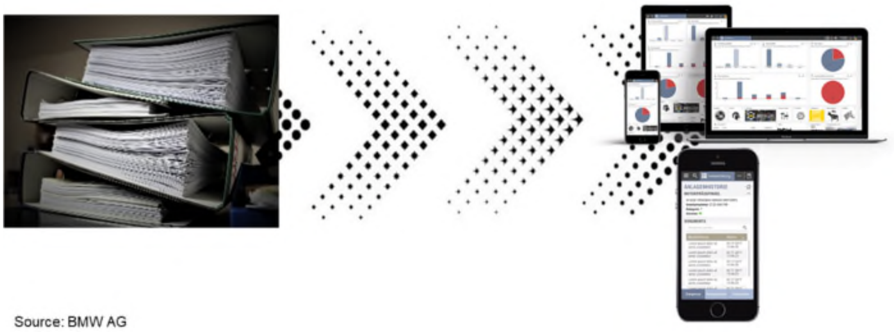
In addition, a high degree of standardisation and the networking of the digital models with the structure of a layout enable the automated creation of simulation models. In the phase model of the engineering process, the data models can even be used sequentially.

Various use cases show that the granularity of the digital image, the accuracy and the level of detail of the data must be adapted to the needs of the application.

2.2.2 Digital history

Based on a product history file, a large amount of documented information is also created in the history of a technical plant. This overall documentation can be very extensive and is managed in a history file.

Keeping a history file is generally recommended for all technical plants for which a structured methodology for information acquisition, use and exchange accompanying the history is necessary. The history record can be used consistently across all phases of the life cycle.



Source: BMW AG

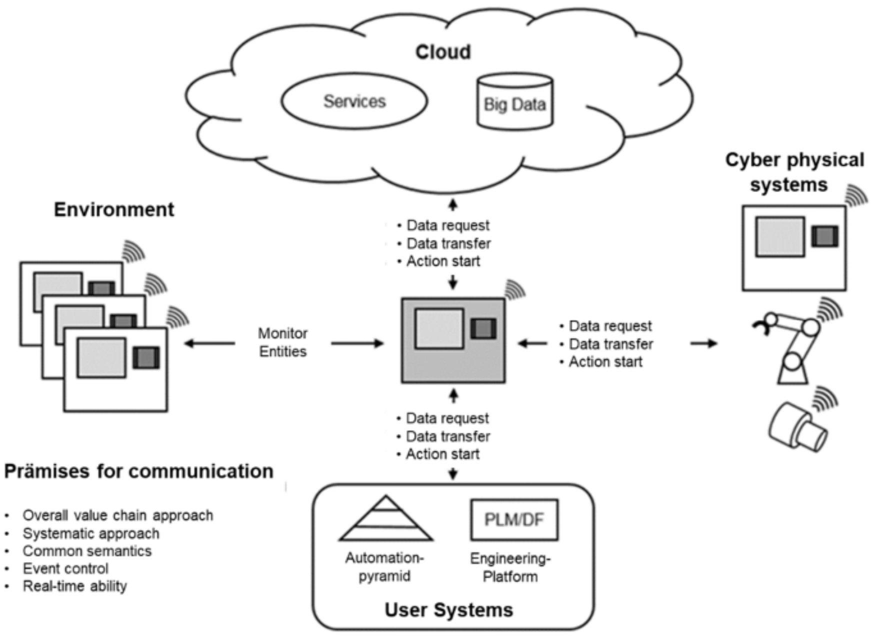
It serves as a central knowledge artifact and regulates the management of plant-related information as well as its internal and external exchange. Based on the DIN 77005-1 history record for technical plants.

In order to achieve a win-win situation between manufacturers of production equipment and their customers, but also to enable the machine to fill the history file for the first time, the standards VDI 2770 have been developed (see Chapter 2.3.2.).

Advantages for both partners possible only when the supplier, in their role as the "technical editor" of their products, can deliver data containers to several customers,

2.2.3 Data acquisition in production

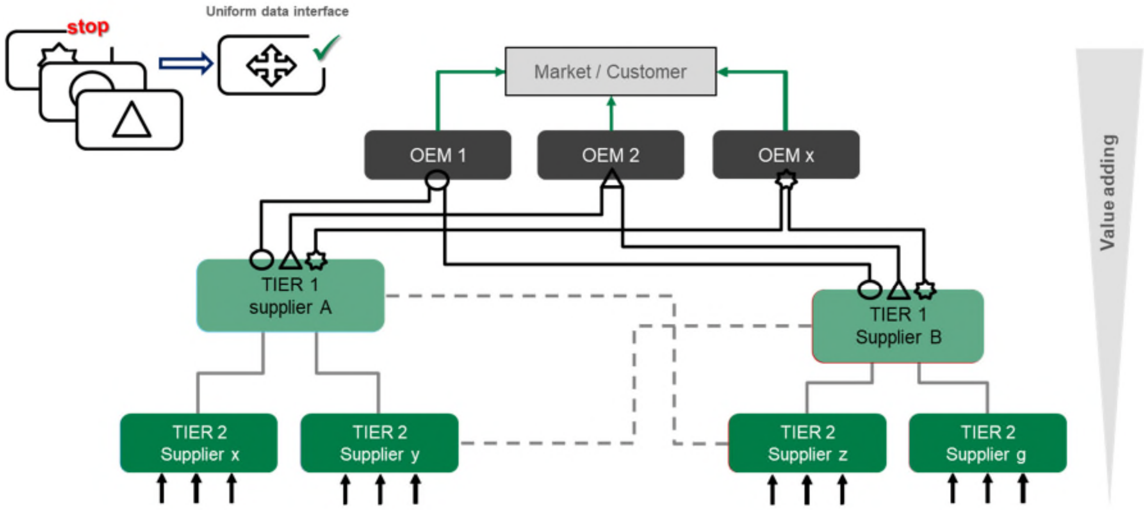
In the past, only switching signals were transmitted from sensors to higher-level control systems; but new technologies also enable access to additional data for identification, diagnosis and parameter settings of the corresponding sensor.



In conjunction with the available data from the production plants and quality data on the products, analyses and findings can be obtained from the entirety of the production data. Applications give prognoses for maintenance, but also possibilities for process optimisation.

2.2.4 Exchange of cross-supply chain product components

Since value in the automotive industry is not only created at the respective OEM, but also via a broad network of different partners, this is also a key topic with regard to the acquisition and exchange of data.
Awareness for complexity across the entire supply chain must be considered – from raw material suppliers to component and assembly suppliers as well as machines and service providers to automobile manufacturers and their customers.



Source: MAHLE International GmbH

Data acquisition, storage, management and provision of data for use with partners create demands for IT infrastructure, software maintenance and support by professionally trained staff.

For many components, such as headlights and windows etc., a number of other parameters are important in addition to geometric information, depending on the problem.
The potential, efficiencies and findings described in the previous chapter *Purpose and Effectiveness of Data* can often only be achieved if data is available across the entire process chain.
These are often measurement or quality data, but can also go beyond this as required. A minimum degree of standardisation is necessary for all partners involved in order to share the expenditure in an economically justifiable manner.
In contrast to engineering, no uniform data interface has yet been established as a standard for exchanging such data with partners.

2.3 Data standards in the processes

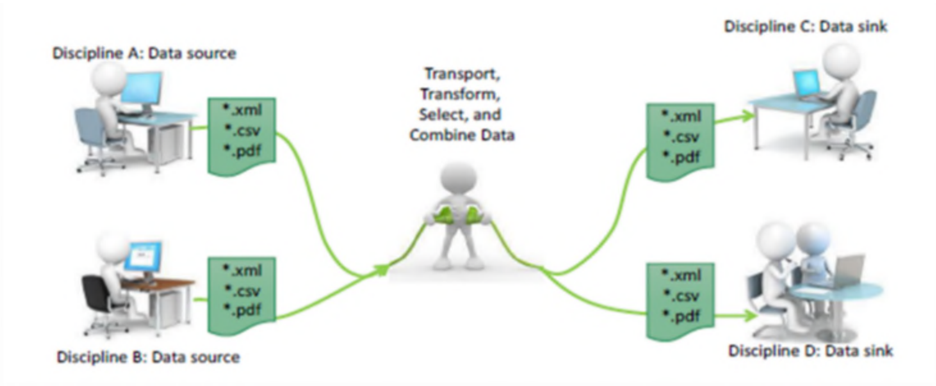
2.3.1 AutomationML in engineering

AutomationML has established itself as the previous standard as a data exchange in engineering. Here, a modelling of the resources must be used as the basis of a continuous engineering process across all phases and all disciplines of plant planning. This also includes the data exchange between comparable tools within a phase.

Objectives of AML e.V.:

- Openness: AutomationML should not incur licence costs.
- High degree of coverage: AutomationML should be able to describe both simple plant components and complete digital mechatronic models.
- High market penetration: AutomationML should be attractive for market-leading tools and, above all, bridge gaps in today's tool chains.
- Use of tried and tested data formats.: The best-possible exchange that are already established should be integrated for individual disciplines.

- Expandability and standardisation: With regard to long-term resilient, industrial and widespread use, AutomationML should be expandable and also be assigned to a recognised standardisation body.



Quelle: Automation ML, A. Lüder, J-L. Pauly, K. Kirchheim, F. Rinker, S. Biffl: Migration to AutomationML based Tool Chains – incrementally overcoming Engineering Network Challenges, 4th AutomationML user conference, Oct. 2018, Gothenburg, Sweden, Proceedings, www.automationml.org

2.3.2 VDI 2770 as history file

The guideline describes the standardised nature of manufacturer information. These manufacturer documents contain information that is required for correct design, installation, commissioning, stocking spare parts, operation, cleaning, inspection, maintenance and repair.

In addition, there are legal provisions that stipulate the availability of certain manufacturer documents, such as CE declarations of conformity, ATEX certificates or material certificates. The transmission of this information to the IT systems of the plant operator is standardised by the guideline in order to minimise the effort for manufacturers and operators.

Owing to this standardisation, each piece of information can be clearly identified in the future and thus accessed in all IT systems. This means that resource-intensive searches in the manufacturer documentation are almost completely eliminated. With the same use of resources, this enables a significant intensification of the use of technical information to improve processes in production plants.

2.3.3 Data connection from production

Machine-to-machine communication (M2M) using OPC UA (Open Platform Communication Unified Architecture) is already considered by many to be the most important standard for non-deterministic industrial communication. The transition from the previous company-specific standards to OPC UA is thus available as one of the overarching standards.

A special feature of OPC UA is standardised information models that are based on one another. The OPC Foundation defines a basic model for this, which all servers should/will provide. On this basis, providers can provide their own or comprehensive standardised information models (e.g. for industrial robots). This means that the descriptions from engineering are also implemented in the communication software of the plants and machines.

Further developments expand the communication architectures of client-server connections with more efficient connections based on publish-subscriber protocols such as (Messaging Queuing Telemetry Transport) . The methods and standards for description and integration via engineering and implementation will be further developed in the context of OPC UA.

2.3.4 Data availability for cross-supply chain product components

The requirements for data exchange for the purpose of the business relationship should be standardised, both between individual projects/products of a client (OEM) and in the industry/market among different clients (OEM).

As mentioned in the chapter *Exchange of cross-supply chain product components*, no standards have yet been established in this field of application.

2.4 Conclusion

With AutomationML, win-win situations can be created for all partners involved in engineering and the software tool manufacturers also receive significant motivation to offer AML interfaces as standard integration.

Standardisations are possible with OPC UA as the communication architecture and the use of MQTT as a protocol. Further development in both directions is recommended.

In the field of data exchange along the production chain, a standard for data transfer between different partners is considered appropriate.

3 Data use and security

3.1 Use of production data

Production data is not a designated part of the company's balance sheet, but it is an asset.

Production data is created through the application of technologies within production processes. Both the individually used technology and its combination with other technologies and their integration into the overall process of value added determine the productivity and profitability of production and thus ultimately its contribution to overall profitability.

Through targeted analyses of production data, conclusions can be drawn about the production system as well as its individual elements and process parameters. As a result, it is in the company's interest to restrict access to production data.

In light of the often unclear situation regarding the use of production data, the following principles should provide guidance:

1. Violations of commercial property rights must be avoided as a matter of principle.
2. Additional agreements must be made between the parties involved, and if necessary with the assistance of legal advice.

We consider uncoordinated access to production data to be fundamentally problematic. Access to production data can only take place with mutual consent and prior coordination.

The level of detail of the production data and the duration of their storage require coordination and joint determination of those involved in the process.

3.2 Data security

Data and information, especially what can be assigned to the company's production and process knowledge, are subject to special protection. This data contains a part of the company's value, which must be fundamentally protected against access from outside, or to which access must be controlled. In principle, data security must be ensured on the company side; TISAX certification (Trusted Information Security Assessment Exchange) is recommended. TISAX is a standard for information security defined by the automotive industry.

This is a task for which the head of information security or the CISO is responsible. By taking appropriate measures within the company, they must be able to consistently enforce the requirements formulated by the company for the control of access to production data.

Different international requirements can be placed on data protection and data access. Data relating to individual employees is subject to strict regulations and can vary from country to country; these differences need to be taken into account.

Due to the high share of production in value added in the automotive industry, there must be no special regulations or statuses for production data within IT security.

We understand production data as all the data that is generated by machines, plants and people and also by systems involved in the value-added process (e.g. AGV, buildings, suppliers).

3.3 Structure and classification of production data

In principle, the generation, storage and transfer of production data within a company should follow an identical structure and system.

Systems structured in this way enable production data to be exchanged across plant and national borders and ensure that production data can also be used elsewhere for an economic purpose in the future.

A general approach for the storage and exchange of data must be defined within the company boundaries, but also beyond them. "Public" and "internal" areas must be defined, and need to be equipped with the necessary security features.

A clear definition of the protocols used for the transfer, processing and storage of production data simplifies internal implementation.

The more uniform the structure used is and the further it extends into the production processes, the less effort is required for later collaboration, data analysis and the learning process based on it within the company and beyond its borders.

3.4 Conclusion

The use of production data to optimise the value-added process will gain in relevance and develop to form the basis for decision-making processes within production and logistics, but likely also in areas such as corporate strategy. In order to be able to make better use of the advantages of digitisation in the field of production, the permeability of data between the actors involved in the value-added process in the automotive industry will continue to increase.

The basic handling of the security and structure of production data as well as the property rights associated with these must be regulated on a company-specific basis.

The VDA Information Security has issued the VDA ISA 27002 standard for uniform auditing of information security. VDA ISA 27002 is the basis for TISAX certification in the automotive industry.

4 Requirements for employee competencies

Digitisation is not only changing our consumer behaviour, business models and the associated production processes. The way in which we work, how we work with one another, communicate and learn is also strongly shaped and changed by digitisation.

When we talk about how digitisation affects our work environment, companies, training institutions and those responsible for transformation have to deal with the following topics:

- Knowledge: New technologies, adaptive processes and constantly evolving tools require new knowledge.

- Qualification and further training: Companies in the automotive industry operate in an increasingly dynamic, highly competitive environment. In order to be successful, and in addition to requiring the right "infrastructure" (future-proof technologies and digital tools), they need employees who use the technology correctly but also recognise and make the most of the opportunities that arise from it.

- Leadership: Other leadership skills are also required: special emphasis is placed on the ability to inspire and empower teams to take on the challenge of continuous learning and make good decisions about the use and implementation of technology.

4.1 Requirements for scope of training / Changes in job profiles

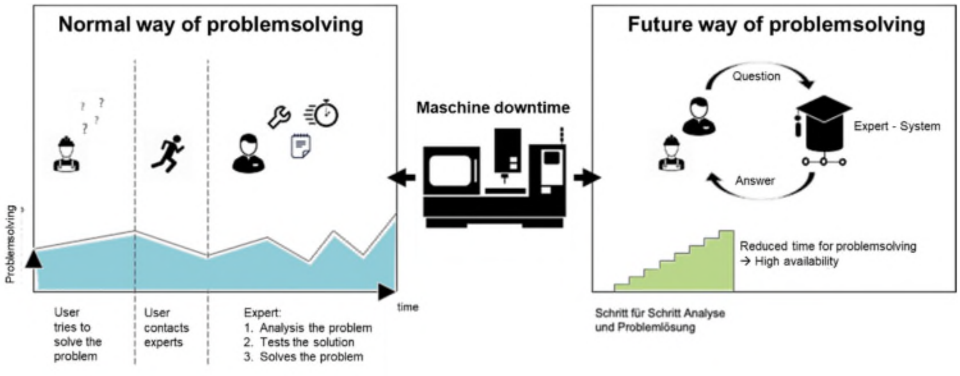
Due to the speed of technological change and the resulting need for employee qualifications, measures must be defined in organisations.
The influence of data and machines (will) have on the daily volume of work in the production and production-related environment.

Relevant scope of training includes:

- Analytical skills
- Data literacy – this comprises
    - The ability to acquire and collect data
    - Appropriate data management
    - The ability to analyse and correctly interpret data
    - Appropriate data visualisation
- Knowledge of statistics and mathematics
- Programming skills
- System architecture expertise, including knowledge relating specifically to big data applications
- Data modelling, semantic classification and description of data

The mentioned scope of training is the prerequisite for the qualification of employees in the field of data engineering/data science. The potential of AI/ML applications for problems has to be identified in the company. The requirements and restrictions of AI/ML applications must be worked out and presented in a structured manner. The resulting potential solutions must be evaluated, implemented and put into operation.

Furthermore, in the field of education, measures to ensure the availability of the right skills and talents on the job market must be defined and implemented. Particularly in early school education, it is important that creativity and data-based decision-making are promoted at the same time. Partnerships between schools and businesses can be a suitable means of achieving this goal.



Example Maintenance / Source: Schaeffler AG

4.2 Internal responsibility

For companies however, the aforementioned scope of training results in various tasks on the subject of employee development. These tasks should be consolidated in upskilling programmes.

Upskilling means giving employees the opportunity to acquire the skills and qualifications to integrate and apply advanced and constantly changing technologies in the workplace. An important part of this is that one's own managers are competent to recognise the opportunities and risks of digital transformation and to use or counteract them accordingly.

Gaining experience in upskilling entails learning how to think and act in a digital world and how to sustainably develop oneself and the work environment. It is less about direct application of one or the other technology and more about gaining an overall understanding and the ability to transfer performance.

An upskilling programme can also help assess employees' basic understanding of digitisation issues. Here, further training needs as well as focal points of interest and, if necessary, skills that were previously unknown to the company, can be detected, strengthened and thus also be implemented in a useful way in everyday work.

In addition to employee development, there is a need in companies to check to what extent organisational structures and working methods need to be adapted and further developed in order to provide maximum support for digital transformation.

4.3 Ensuring professional appeal in the automotive sector

Digitalisation increasingly supports employees in production in carrying out their production activities and in quality assurance. New digital skills are required, especially in the production-related area.

At first glance, the production task itself seems less attractive than pure office work on the PC. This entails the risk that fewer and fewer people will have a job in the production workplace.

With Industry 4.0 and the increasing digitalisation of production, appeal can be noticeably increased. It is a challenge to use the "digital experience", which employees experience in their everyday work, profitably in their work environment.

Another challenge is to make the production workstation modern, clean and with optimal digital support. Simple design and usability of the systems are of decisive importance. HMIs (Human-Machine Interfaces) along with user interfaces must be "state of the art" and easy to use.

4.4 Conclusion

Measures to develop future-relevant qualifications and skills, such as understanding and managing technologies that will emerge today or even in the future, must be defined. A further goal is to achieve a common understanding of language and terms. Commitment to further developing job profiles or commitments at universities etc. must be regulated on a company-specific basis.

5 Summary

Data forms the basis of flexible production that can manufacture customer-specific products with ever shorter product cycles and with changing boundary conditions.

With Industry 4.0 and advancing digitisation, there are new possibilities for acquiring, correlating and evaluating data for data-based planning and control of production in real time. The efficient, shared use of data by partners (OEMs, subcontractors, plant suppliers) requires the use of common standards and partner platforms.

It is idea for the entire production to be mapped in the digital model over the entire life cycle. AutomationML has become established for data exchange in engineering. Here, the VDA and its members will work together to continue standardisation; plant manufacturers, suppliers and software providers are increasingly supporting the standard AML.

The guideline VDI2770 is used for the history file. As a result of the standardisation, every single piece of technical information can be retrieved from manufacturer documentation without an extensive search and used without additional interpretation.

The use of OPC UA and MQTT is being further developed as a standard for communication between machines.

In principle, access to data must be coordinated between partner companies. The handling of the security and structure of production data as well as the property rights associated with these is generally regulated on a company-specific basis.

The development of future-orientated competencies and qualifications in the areas of data analytics and artificial intelligence is a major challenge. It is necessary to provide these competencies in school education as well as in production-related occupations. Measures for the development of future-proof qualifications and skills must be determined.

6 Directory of abbreviations and terms

Abbreviation/Term	Meaning
OPC UA	Open Platform Communication Unified Architecture – standard for data exchange between platform-independent, service-orientated architectures
MQTT	Message Queuing Telemetry Transport – open network protocol for machine-to-machine communication, standard for communication with IoT platforms
History file	History file – for technical systems in accordance with to DIN 77005-1 for use on various technical objects
Asset	Description of the assets of a company, here: Core components and digital description of a production system
Automation ML	Automation Markup Language – a neutral XML-based data format for storing and exchanging plant planning data, standardisation in IEC 62714 by the AML initiative

Contact person in the VDA

Management
Dr Joachim Damasky
joachim.damasky@vda.de

Head of Production and Logistics
Robert Cameron
robert.cameron@vda.de

Consultant Department Production and Logistics
Jörg Walther
joerg.walther@vda.de

Consultant Department Production and Logistics
Dr Peter Miltenburg
peter.miltenburg@vda.de

Legal notes.

VDA Verband der Automobilindustrie

Publisher	Verband der Automobilindustrie e.V. (German Association of the Automotive Industry) (VDA) Behrenstraße 35, 10117 Berlin www.vda.de
Copyright	Verband der Automobilindustrie e.V. (German Association of the Automotive Industry) (VDA)
Date of publication	Version 1.0, November 2020