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NETWORKED, ADAPTIVE PRODUCTION IN THE SMART MANUFACTURING NETWORK

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Nowadays, manufacturing companies operate in two distinct worlds: a physical world in which parts, tools and machines actually exist and – quite separately – a virtual world in which process and part data are stored. In order to match each part to the correct data, employees have to know exactly where the relevant data is stored. It is envisaged that this gap between physical data and the digital world will disappear with the adoption of Industry 4.0.

The overriding aim in the production environment is always to manufacture a given part, taking care to meet all tolerance specifications. It is therefore important to record all data which can provide information about the state of the part at each point in the process chain. Sensors within the manufacturing machines provide valuable information relating to vibrations, machining forces and process temperatures which allow the user to see whether or not there is a risk that the tolerance limits will be breached.
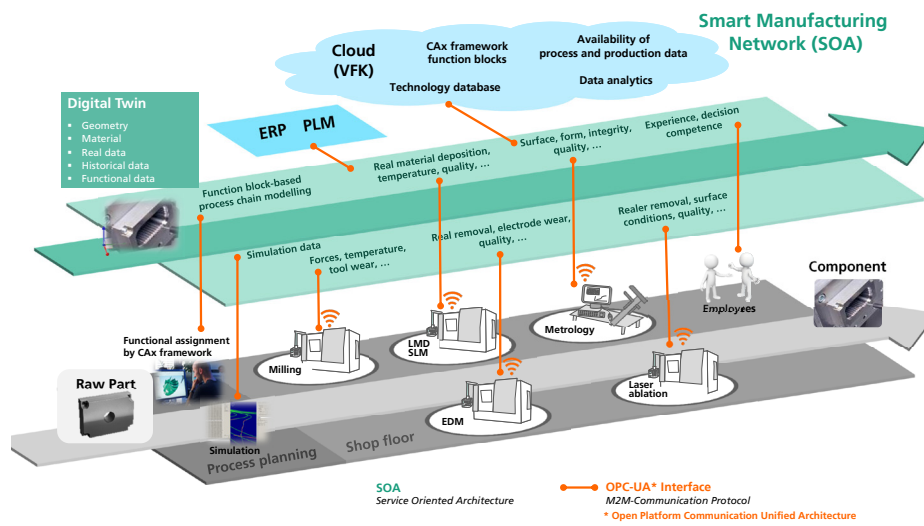
The prerequisite is the full networking of all machines, sensors, simulation tools and databases containing the history of manufactured parts. In the »Smart Manufacturing Network«, a software system for the networked, adaptive production, all components offer their data and services in a service-oriented way. This enables to flexibly compose process chains and the product can self-reliantly find its way through the required stations.

Digital twin describes the manufacturing history

Using all of the data recorded as part of the manufacturing history – including project and order data – a digital twin is created which can be linked via identification

Smart Manufacturing Network (SOA)

Cloud (VFK)

CAx framework function blocks

Availability of process and production data

Technology database

Data analytics

Digital Twin
- Geometry
- Material
- Real data
- Historical data
- Functional data

ERP   PLM

Function block-based process chain modelling

Real material deposition, temperature, quality, …

Surface, form, integrity, quality, …

Experience, decision competence

Simulation data

Forces, temperature, tool wear, …

Real removal, electrode wear, quality, …

Realer removal, surface conditions, quality, …

Component

Metrology

Employees

Functional assignment by CAx framework

Raw Part

Milling

LMD SLM

EDM

Laser ablation

Simulation

Process planning   Shop floor

SOA
Service Oriented Architecture

OPC-UA* Interface
M2M-Communication Protocol
* Open Platform Communication Unified Architecture

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systems to the individual part concerned and by this is available for any process step in the Smart Manufacturing Network. These extended product data models contextualize and supply relevant data from the manufacturing history when required, thereby accelerating process development and optimization in single part and mass production environments. The challenge here is to add a clear information about the location and time to each data record in order to ensure that diverse sensor data such as shop-floor temperature, machine vibrations or process parameters can be correctly linked.

Assistance systems and apps support the user

Digital assistance systems in a networked, adaptive production situation help employees to keep an eye on the data and flag up instances automatically in which the pre-set process conditions are overstepped. In this way, technology apps enable process developers as well as machine operators to use their expertise to even greater effect. Suitable visualization tools such as smart phones or smart glasses can supply the information at once, enabling appropriate action to be taken without delay. The manufacture of premium-quality components for sectors such as the aviation, energy technology, tool and mold making industries in particular, will profit from networked, adaptive manufacturing.

Simulations supply information for swifter decision-making

Model-based simulations can provide crucial information which feed into decisions regarding optimization. A straightforward software app, for example, can recognize in virtual terms and tag critical situations which occur during milling within a simulated milling operation. This enables the process planner to achieve a high level of optimization even before the first physical machining test commences. At the process development stage, too, engineers have to make a fair number of adjustments before a top quality, 5-axis milling operation which is at the same time economically efficient, can be achieved, for example. Comparison between actual data from the machine and data from the associated simulation provides a powerful tool which accelerates the process enormously.

Fraunhofer High Performance Center Networked Adaptive Production

Industry 4.0 requires a holistic view of production systems including all process chains involved in process development. The Fraunhofer High Performance Center for Networked Adaptive Production is a joint initiative of the state Nordrhein-Westfalen and the Fraunhofer-Gesellschaft and is actively supported by industry. It was started in Aachen at the end of 2016 with an overall budget of 6.4 million Euro. The

Center offers the industry an open research platform and test environment in which new concepts for digital production within the Smart Manufacturing Network can be explored and road-tested. Companies with special interest in this field are welcome to join us at any time.

About the Fraunhofer Institute for Production Technology IPT

Following the guiding principle of "Networked Adaptive Production" the Fraunhofer Institute for Production Technology IPT in Aachen develops manufacturing processes, associated production systems along with the metrology required and connects all of the system components to one another. With many years of experience in production technologies, the Fraunhofer IPT provides companies with a solid basis on which to develop digital production processes, machines and systems. New methods of production organization in conjunction with forward-looking design of industrial software systems complement technological expertise. The portfolio of the Fraunhofer IPT ranges from assessing and designing technologies and process chains through planning and control concepts to quality assurance control systems.