Product Services in the digital age (Industrie 4.0)

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1. Change of the industrial system

In the last twentieth century: the system boundary of traditional industrial manufacturing was defined by process-chains from product development (birth) to delivery of products to customers (sales). Manufacturers optimized their business processes by application of new methods of management like lean production and innovative technologies - e.g. flexible Manufacturing - for highest productivity and quality. They used electronics to make manufacturing system more productive and flexible and changed their manufacturing from mass to customized production. Industry changed their core business by core technologies. The logistic-system for supply of materials reached a rate of high perfection and just in time performance. The variants of products increased und the logistic was oriented to short delivery and throughput time. There was a structural change in all sectors of industry - influenced by application of IT and integration in all processes (3. Industrial revolution).

Now we have a new industrial revolution – called Industry 4.0, which may be characterised by:

- global IT-Networks, which allow the connection of products in their life between manufacturer und user with global standards;
- (real time) availability of information and data of product usage and environment everywhere and at any time;
- new business models for generating adding value in the life cycle;
- New IT hierarchical architecture from process chains to sensors and actors including visualisation and interaction in cyber-physical-systems
- new IT-Services for data-management, data analytics, process modelling and tools for operational support (Apps).

Multiple innovation in methods and technologies accelerate the enlargement of the manufacturing system (**Figure 1**) from conventional boundaries towards a holistic system for adding value

- from birth of products to end of life;
- from home oriented management of resources (in the factories) to integration of all actors in the periphery with regional or global actors;
- the backbone of this system is the communication-network with internet and many software services in the infrastructure.

Manufacturers can apply knowledge and best practices to optimize operations and change the system if required from market or customers (**Figure 2**, **Figure 3**). The industrial system of industry 4.0 has functions to collect, store and analyse data und support the humans with actual knowledge so that they are enabler for operations in best "process rooms" at any places.

The industrial requirements for this future vision are:

- operational availability, security, reliability and trust of the IT-Network;
- high performance data communication with new standards (G5);
- software services like clouds or software supply;

- management methodologies for event driven operations;
- embedding, multiple sensor technologies and mechatronic solutions.

The vision has the potential to change industrial operations and win adding value especially in the sector of product-oriented services, but also some threats like terrorism, spying, disruption and many others. It seem to be necessary, that governments and policy implement a comprehensive, high speed internet together with a set of laws, regulations and instructions to open the economic opportunities for adding value based on internet-technologies.

2. Strategic options for developing services in industry

2.1. Virtual and knowledge based engineering of services

The relation of customer and manufacturer in the industry 4.0 age opens the potential to create new customized products services by application of systems for digital engineering. There are 3 Areas of service which may be supported in a global communication system. The process of service engineering (**Figure 4**) should include the definition of the business in after sales. The first area encompasses common WEB-service support from marketing, configuration and specification of products, animation of product-function to useful help and information supply as a package of competences. In the second area, we find the technical support like implementation instruction, maintenance support or the management of spare parts for repair. The third area is characterised by **e-services**, which need the link of products with the Internet for process oriented tasks like real time monitoring, or remote services.

By the way, it seems to be advantageously for companies, to develop strategies for the service support system by taking into account virtual engineering and knowledge management.

2.2. Visions of real time process control

The link of products with the internet allows the realisation of different internet-technologies in the chains of manufacturing (**Figure 5**). Like logistics. Some call it the "Internet of Things", where locations und situations are in the view of manufacturers. It is a part of future logistic management with high quality of service for parts, components and goods, including services at place of customers on demand. Examples are the logistic systems of Amazon or new business in configurable consumer goods or home services.

The connection of users and manufacturer has the potential of new dimensions of customization in the business. To know more about the behaviour of their products in practical usage offers possibilities to create additional turn over for both the customer and the manufacturer. Sensors to supervise machines or processes help to find know how for optimization and operation. The visions of services are ranking from machine and process diagnostics up to remote operations. The customers get in principal the full support from experiences and process-parameters of best practices. Therefore it is necessary to offer technical solutions with embedded sensors and software for signal analytics to find indicators for deviation or defects **(figure 6**). There are many developments of technical solutions, which store process data in clouds and even ideas to bring historic data to application, some call this as smart technologies and offer technical support by transfer of knowledge to customers.

2.3. Technical intelligence and application of machine learning

At the long end of these developments, we see a kind of technical intelligence (**Figure 7**). Technical intelligence let machines and systems operate in a room of parameters, in which processes are capable and full controlled. They can reach this by the application of artificial intelligence or machine learning

in combination with a knowledge system. Such solutions are a field of future flexible automation and find their fields of application in human operated processes. They take advantageous from learning methodologies and distributed sources.

In the future, it seems to be possible, to implement a kind of real time simulation to look ahead and avoid deviations or operate in dimensions outside of the human sense.

Industry 4.0 offers manufacturer a wide range of solutions and a new dimension of future industry in nearly all sectors. It is essential for services of industrial factory-equipment supplier and offers a growing market for future IT-solutions and Apps. I call this the soft machines, which should be - customized - integrated in a public (industrial) infrastructure and interface standards. It requires engineers with interdisciplinary competences in process technologies, communication technologies and mechanical or electrical engineering.

3. Economic aspects

Product oriented services have reached a share of round about 30 % of the turnover of machine industry. Tendency growing. The cause if this development is the fact of customizing and specialisation of technical solutions in view of customer requirement. The service is a critical success factor, because of its long-term relations between customer und users. Industry 4.0 gives this a new dimension because of the rapid response and reaction on time with digital information. All indicators show the increasing potential and the demand of efficient digital services in the future:

- complexity of technical systems;
- knowledge based diagnostics;
- demand for high utilization and capability of technical systems;
- cost of services;
- qualification of technicians.

The business model of manufacturers follows the enlarging System-Boundary along the life cycle of products. The management have to change the control system (**Figure 8**), which usually has the objective of maximum efficiency of resources for production. New methods are required to realize successful life cycle and add value with best processes. "Life Cycle Control" is one of the most important to maximise the profitability of operations in Industry 4.0.

4. Conclusion

This presentation is a contribution for future strategies of manufacturing industries in next decades. Visions, which take into account the actual discussions of innovation for technical intelligence and integration in IT-Environment. Some main conclusions are:

- the growing potential of digital services in the future world of Industry 4.0;
- the system architecture in "enlarged manufacturing" follows the product life cycle;
- technical solution are influenced by Internet-Technologies, sensor-integration and have the perspective of technical intelligence;
- it requires interdisciplinary engineering competences to realize concepts for new business models and customer specific solutions based on innovative communication technologies and standards;

- Industry 4.0 is a general vision, whose application depends on the availability of secure, reliable, cheap and high speed information transfer (public infrastructure);
- the potential if adding value of product oriented services is extremely and a strategic option of manufacturing industries;
- there is a new field of IT-tools to support services by Apps.

The transformation of "Industrie 4.0" is a clear revolution, which will change the management and will have winner and looser in all sectors. It requires new qualification of employees, new methods of economic control and changeable structures of organisation.

References

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FIGURES

Figure 1 - Enlarging the system of manufacturing

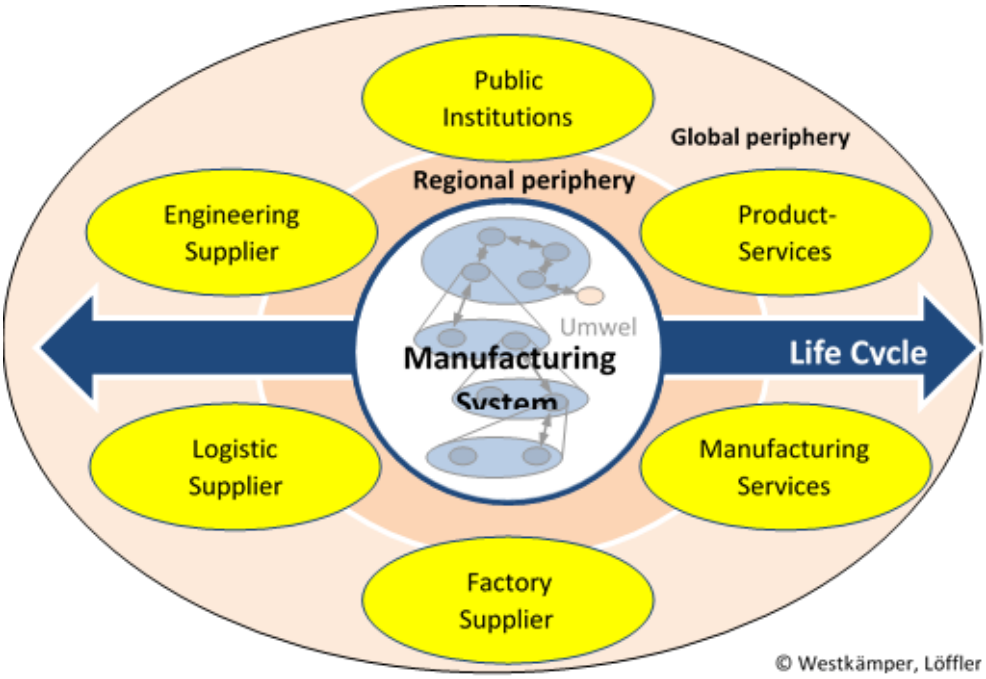

Figure 2 – Remote Services in global IT-Network

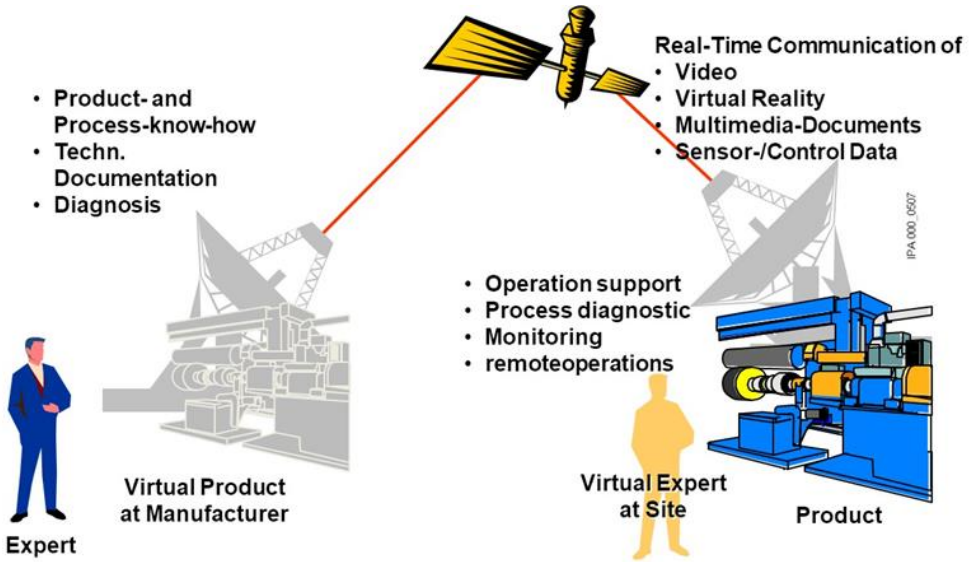

Figure 3 - The Concept of "Industrie 4.0"

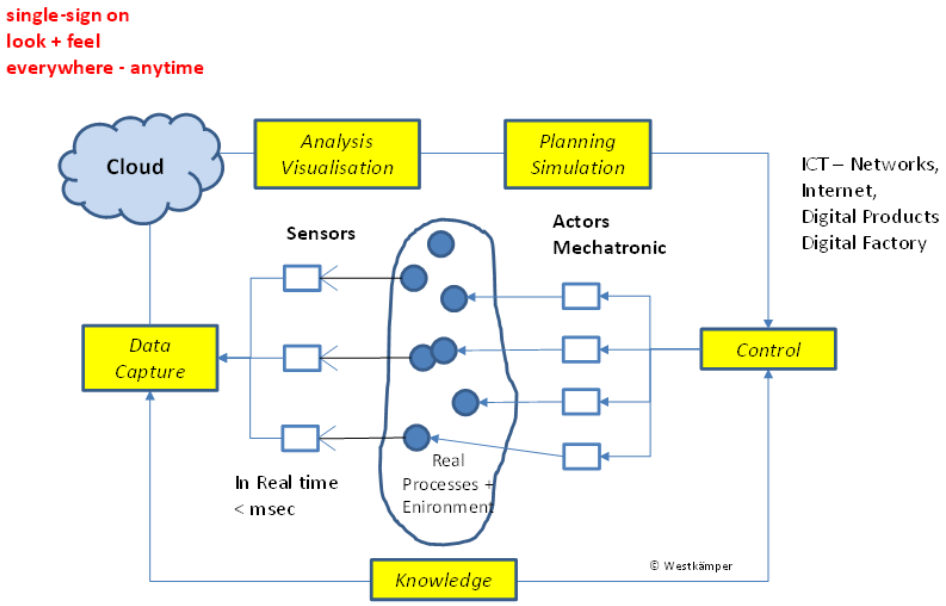

Figure 4 - Action fields of Internet based Services

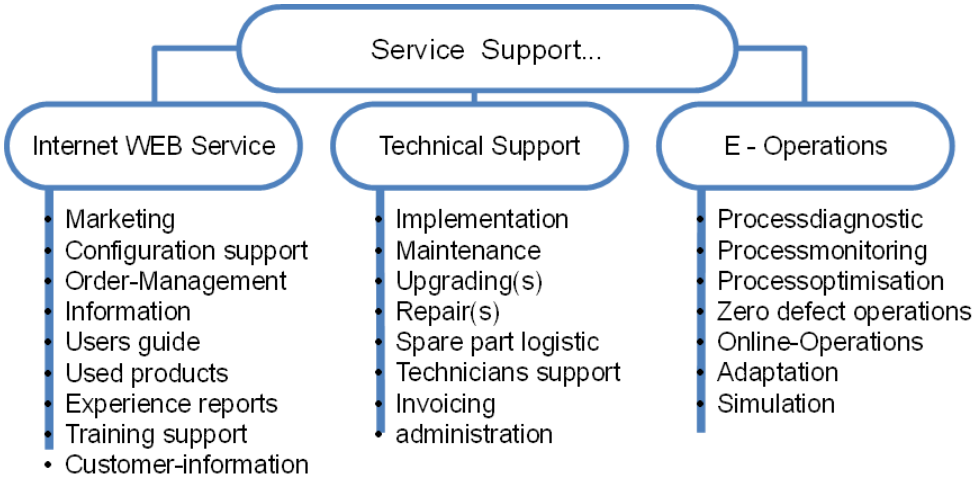

Figure 5 - Interaction in virtual environment

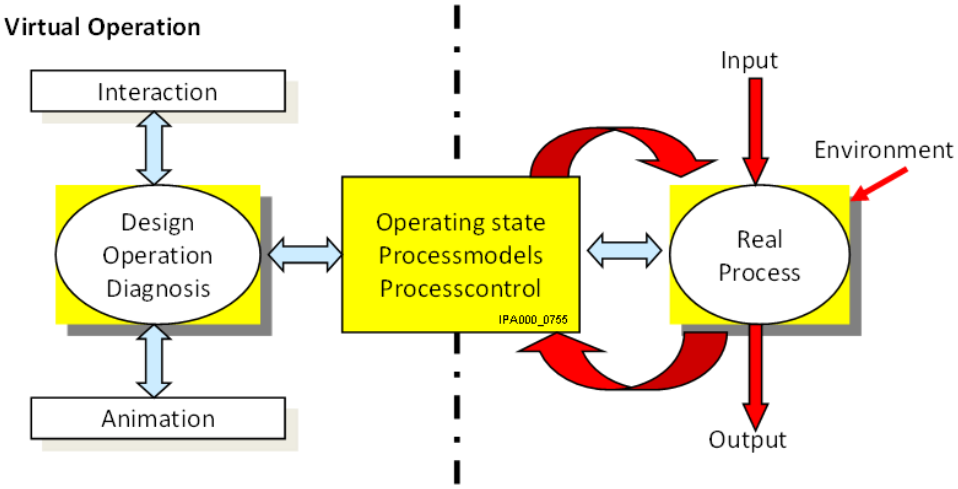

Figure 6 – Sensor application

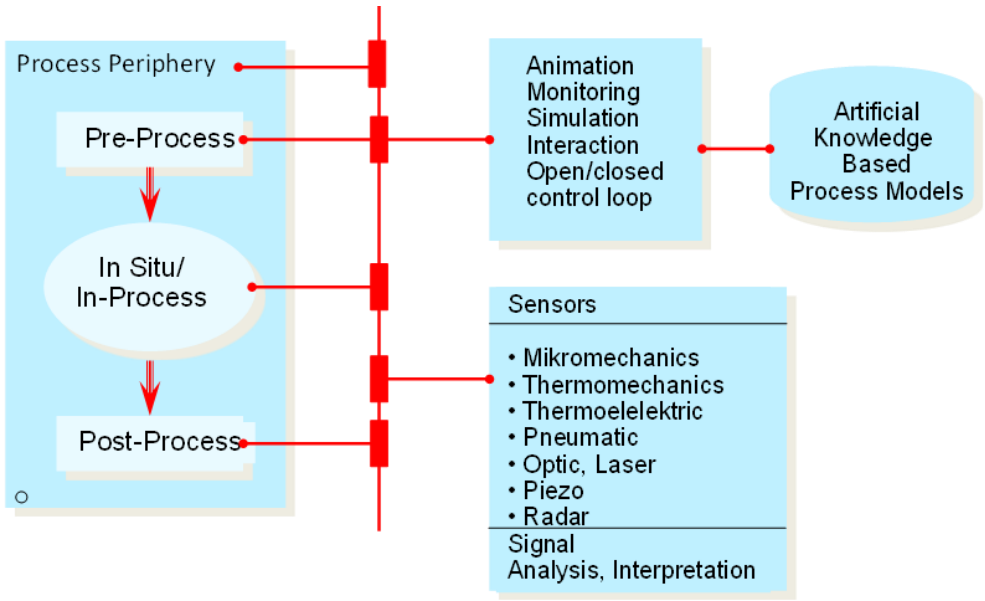

Figure 7 – Machines with technical intelligence

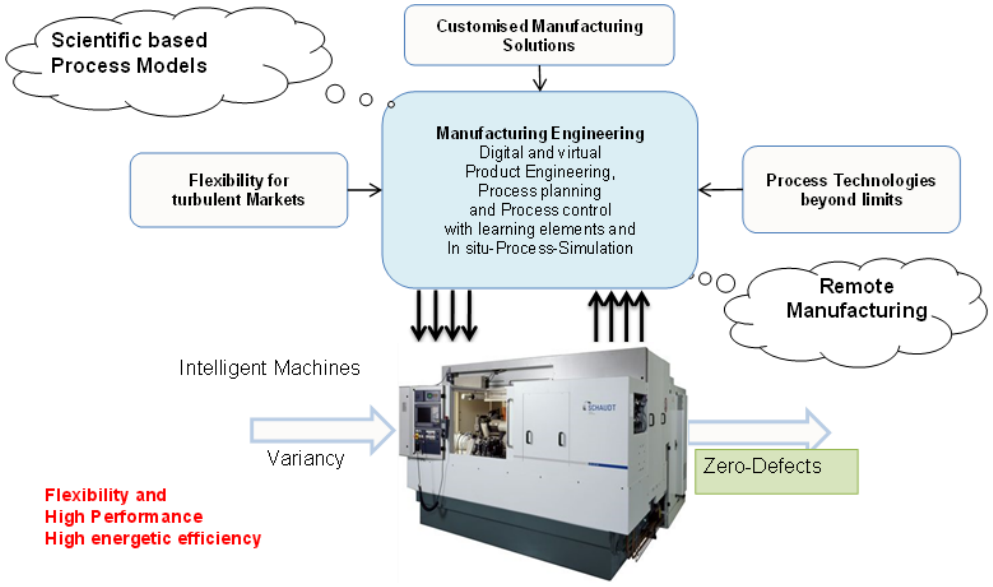

Figure 8 – Costs and benefits in the product life cycle