巻/頭/言

The Digital Factory Based on Cyber-physical Systems

サイバーフィジカルシステムに基づくデジタルファクトリ

Joachim Seidelmann

One of the major challenges for manufacturing industry in the well-developed countries like North America, Europe, and Japan for the next decade will be the transformation from mass production into a production environment which enables manufacturing of highly customized products at the cost the consumer is used from mass production(mass customization). The trend of individualization of products is even accelerated by the appearance of cyber-physical products(Internet of Things, IoT), where a major part of the individualization is done by customer itself via software. Additionally, the manufacturing industry is still driven by the need for more efficient production becoming more sustainable, with regard to energy, material, and work force(mass sustainability).

To tackle the challenges of mass customization and mass sustainability, it seems obvious to apply the concepts and technologies of cyber-physical solutions also to production systems to build cyber-physical production system(CPPS) the basis for the Digital Factory. Digital Factories, as well as Connected Digital Factories or digital value chains, need a high degree of IT-integration in basically three dimensions. The first dimension is the horizontal integration along the value chain, the second dimension is the vertical integration from Enterprise Resource Planning(ERP) level down to the sensor on the shop floor, and the third dimension is the consistent integration of the digital engineering from design, via the manufacturing, the operation and the recycling phases of the life cycle of (cyber-physical) products.

To enable the high degree of IT-integration and communication new types of IT-architectures has to be deployed to the manufacturing industry. The usage of service-oriented architectures(SOA) on all levels of the ISA 95 pyramid for enterprise control systems integration(ERP level, MES level, and PLC/sensor/actor level) will enable data and service integration overcoming conventional architectures implementing multiple data silos in manufacturing networks. Additionally, applications will be split into more granular services and provisioned out of IT-cloud infrastructures enable the implementation and operation of highly flexible manufacturing IT solution at lower cost. This IT-architecture concept, also used in open source robotics control(industrial ROS) and IoT-platforms, also driven by major players from the IT industry like Google, Intel, and Microsoft with the goal of directly getting access to the data of the end customers shop floor, will enable the data-and knowledge-driven manufacturing needed for mass customized production.

Several national and global initiatives have been started by the industry and the national governments to support the digitalization of the manufacturing industry. Two major tasks have to be fulfilled by these initiatives. The first task is to work on a common understanding of the scope of Digital Factory on a global level. A good way to do so is to develop reference architectures as a basis for the discussion of different concepts and solutions. Based on these discussions standards can be easier developed and implemented into the industry. Second task is to mobilize small and medium sized enterprises(SMEs) as the benefits of the digitalization can only be leveraged in total when all involved parties in manufacturing industry support it.

《概要》

大量生産からマスカスタム生産への変革が製造業における主要課題の１つとなるだろう。マスカスタム生産では，大量生産と同コストで高度にカスタマイズされた製品が生産される。エネルギー，資源，労働力等を対象とする包括的持続可能性の実現も課題である。

マスカスタム生産と包括的持続可能性の実現に向け，サイバーフィジカル生産システムをデジタルファクトリの土台として構築することが望まれる。デジタルファクトリは，バリューチェーンの水平統合，ERPレベルから現場までの垂直統合，製品ライフサイクルに沿ったデジタルエンジニアリングをITとの高度な統合によって実現される。

ITとの高度な統合実現には，製造業向けの新しいITアーキテクチャが必要である。サービス指向アーキテクチャをERPレベルから現場まで適用し，適度な粒度のサービスをクラウド基盤から提供することによって，高度に柔軟な生産ITソリューションが低コストで実現可能となる。

製造業のデジタル化を推進するための取組みが多数行われている。デジタルファクトリに対する共通理解の醸成と，中小企業を含めた全ての製造業関係者の結集が，これらの取組みによって実現されることが望まれる。

◆Head of Competence Center Digital Tools for Manufacturing, Fraunhofer Institute for Manufacturing Engineering and Automation