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Intelligent Industry: The Next Era of Transformation

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A BLUEPRINT FOR FACTORY DIGITALIZATION AND A MORE SUSTAINABLE FUTURE

SIEMENS

Dr. Gunter Beitinger heads factory digitalization for Siemens AG, supporting 121 factories on their transformation journey. As Senior Vice President Manufacturing, Dr. Beitinger is also responsible for the manufacturing element of the Factory Automation business unit, which is part of Siemens's Digital Industries division. He joined Siemens in 1999 after five years as a research collaborator at the University of Erlangen.

The Capgemini Research Institute spoke to Dr. Beitinger about how Siemens responded to the unprecedented market changes of the pandemic environment and the drive to ensure supply chains, factories, plants, and networks are more efficient, intelligent, and sustainable.

THE COVID-19 PANDEMIC AND THE MANUFACTURING SECTOR

The past year and more had an unprecedented impact on the manufacturing sector. How did Siemens navigate through this disruption?

— The COVID-19 pandemic emphasized the importance of automation in the manufacturing sector. Due to the high degree of digitalization and automation in many of our factories, people from maintenance or from quality could observe the situation in near-real time, even in the pandemic. With access to our systems and dashboards, they could identify abnormalities and provide remote assistance. Although, in the first week of lockdown, we came down to 85% productivity output, after just six weeks we were back to 95% productivity.

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Another aspect that helped us to overcome the situation was the fact that we have a "market-oriented production" concept in our factories. This means our China factories are mainly producing what is required for the Asian market, and our European factories are mainly producing for the demand in Europe or the rest of the world. The impact was therefore limited because we didn't have an interconnection between the factories – we had one product in many plants, and they were mainly meant to serve their region. We will continue with this market-oriented production concept and now insist on producing more closely to the market we are supplying.

SIEMENS AND INTELLIGENT OPERATIONS

Recently, Siemens Electronics Works in Amberg – which is regarded as a digitalization hub for its work demonstrating the potential of future technologies such as artificial intelligence – was nominated as a "Lighthouse Factory" for the World Economic Forum, recognizing its role in systematically implementing Industry 4.0 technologies. Can you tell us more about your "Lean Digital Factory"?

— The journey to become a lean digital factory always begins with becoming a lean factory first – focusing on eliminating waste from processes. We have had continuous improvement, lean management, and process optimization activities running for a long time in our factories. As a result, we saw that the amount of shop floor productivity projects increased dramatically over the years. To take this productivity level to the next step, we realized that we had to actively support our people by adopting new technologies. So, our "Lean Digital Factory" (LDF) program was initiated to strengthen the focus on automation, digitalization, and shop floor productivity from data and analytics based on the lean production philosophy. Alongside that, we wanted to focus on employee engagement, plant network design, supply chain design, and supplier collaboration.

> **"[Our] digitalization roadmap consists of five work streams [including] digital twins, AI, robotics, big data and analytics [as well as] new ways of working."**

The overall digitalization roadmap consists of five work streams. First, is digital twins, which focuses on digital twin of product, production, and performance. Second, processes, which looks at autonomous end-to-end coordination of supply chain resources based on AI. Third, is big data and analytics, which covers smart algorithms and AI for decision making as well as for preventive or prescriptive maintenance. Fourth, is robotics – focusing on cooperation of digitally guided workers and interlinked autonomous production systems to enable efficient, flexible, and easy-to-scale-up manufacturing. Finally, we have new ways of working, which looks at the skills and competencies required for digital efficiency and the sustainable factories of the future.

We started with these five areas in 2016, and since then we have been driving and implementing them in 30 factories worldwide. Besides a significant productivity increase, the major benefits are synergies, balanced workforce and capacity, speed learning, and a reliable supplier base.

The Siemens Electronics Works Amberg (EWA) was founded in 1989 and manufactures a range of products, including type Simatic programmable logic controllers (PLCs). Over 1,200 product variants are manufactured in Amberg.

The Amberg plant has 99.9999% perfect quality daily, a 14x productivity increase since 1990 (70% less downtime) in the same footprint with 120 variations per day, 1 product per second (17 million product per year), and 350 changeovers per day to handle 1,200 different products, and 200 new products per year.[1]

The production functions here are largely automated, with 75% of the value chain handled independently by machines and robots.

A "lean digital factory" with smart robotics, AI-powered process controls and predictive maintenance algorithms has helped EWA to achieve 140% factory output at double product complexity without an increase in electricity or a change in resources.

1 Control Engineering, "Digitalization, automation advice, benefits," March 2021.

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What is the "recipe" for scaling smart factory initiatives?

— When one use case is implemented in one factory, it can have a great impact as the use case was customized for that particular factory's IT environment. But, when we are looking at scalability, we focus on having a reference architecture defined from the IT aspect. That doesn't mean that all factories are able to immediately implement this reference architecture, but this acts as a north star.

The second aspect we look for is accessibility to our data. We came up with a need for a standardized data lake where different factories are able to store data, access the data, and do data mining in a structured way. We came up with solutions such as a "data-lake-to-go" – where factories can immediately start to collect the data from edge devices and have accessibility because there is already a standardization coming up with this.

And finally, it is about collaboration. When one factory comes up with a solution or with an idea that has the potential for scalability, we bring the other factories into the program. So, it is like the musketeers with "all for one and one for all" - where one does it for the others and the others do it for the one.

What advice would you give to business leaders who want to use a digital twin?

— We focus on digital twins, as it allows us to automate the simulation and it also drives further productivity – leveraging synergies with new technologies and data analytics while reducing IT and software investment risks. We aim to align digital twins to the ECLASS cross-industry standard – which contains all levels of detail to automize the process from product design to production on the shop floor.[2] This means that the product knows in which order it wants to be produced, on which machines or with which technologies it wants to be produced.

2 The worldwide ISO/IEC-compliant data standard for goods and services: https://www.eclass.eu/en/index.html

Secondly, our machine providers receive a very detailed requirement from us based on simulation and drawings. They are able to integrate these in the digital twin, and we are able to simulate material flow and all the logistics aspects, including the potential to feed in real data later. The performance model – along with real-time data – is shared back to our engineers for further improvement for new lines.

So, a key learning from this is that we get better and better by feeding information on areas such as design for manufacturability or design for testability back to our engineering team. This will help to enable a closed loop manufacturing process.

SUSTAINABILITY: A LIGHTER CO_2 "BACKPACK" FOR PRODUCTS

Siemens is pioneering an approach to determine its product-related carbon emissions. Can you tell us more about this?

When you think about a "carbon neutral" product, you realize that the steady globalization of product supply chains has made it increasingly difficult for manufacturing companies to actually determine a product's "CO_2 backpack." More than 95% of the carbon emission impact of a product lies in the supply chain, with tremendous potential for optimization.

> **"Steady globalization of product supply chains has made it increasingly difficult for manufacturing companies to actually determine a product's CO_2 backpack."**

For example, we wanted to identify the product carbon footprint (PCF) of our controller SIMATIC S7-1500, which is manufactured in our Amberg factory. We could almost completely determine our product-related Scope 1 and 2 carbon emissions, by applying our own products such as Energy Management and Industrial Edge. However, understanding Scope 3 emissions is more difficult than it sounds – mainly due to lack of reliable and secure data transfer across the supply chain ecosystem.

So, we developed an ecosystem using cryptographic encryption within a blockchain, where verifiable certificates and proofs can be forwarded to the next company in the delivery chain along with the product's carbon value. This distributed ledger technology allowed us to generate and forward a product's real data, including its PCF. And this required very low energy consumption – as it has nothing to do with crypto mining – it is just sharing data with verifiable and cryptographic credentials over an ecosystem.

And this is what we are now developing and are also planning to bring this into an open source, so that anyone can participate in this ecosystem because we really want to make an impact in carbon emission reduction.

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