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Industrie 4.0 by Siemens:
Steps Made Next

Diana Cozmiuc, West University Timisoara, Timisoara, Romania
Ioan Petrisor, West University Timisoara, Timisoara, Romania

ABSRACT

This article describes how digital disruption transforms all industries, leading to new business models based on the new technologies. In manufacturing, one model for digital disruption is Industrie 4.0, supported mainly in Germany. Proposals for Industrie 4.0 involve the virtualization and vertical and horizontal integration of the value chain, digital services, the digital transformation of products, the digital transformation of production equipment, the digital transformation of factories and supply chains. Whereas the former two are already in place today, the latter is researched and developed. Products and production equipment will be transformed from physical to cyber-physical. Together, they will negotiate as peers over the Internet of Things and form smart factories. Via the Internet of Services, the entire supply chain will be integrated. The most popular business model is mass customization, according to which the customer order triggers production and logistics in the entire supply chain. Siemens intends to use information technology to migrate customers to tomorrow's digitalization.

KEYWORDS

Cyber-Physical Systems, Industrie 4.0, Internet of Services, Internet of Things, Smart Factories, Smart Production Equipment, Smart Products, Smart Supply Chains

INTRODUCTION

Within the context of digital disruption, Industrie 4.0 is a vision for the digital disruption in manufacturing. This vision involves a proposal of technology to be developed, cyber-physical systems, which form the Internet of Things and the Internet of Services. Cyber-physical systems will be products, production equipment, storage, transportation, energy grids or buildings. They will negotiate decisions as peers forming smart factories and smart supply chains. In the following, a large body of literature pertaining to the Industrie 4.0 proposal is reviewed, according to its original authors, to leading consultants, to research articles and to Siemens' strategy. This article traces the key elements of Industrie 4.0, the transformation of products into cyber-physical products, the transformation of equipment into cyber-physical equipment, the transformation of factories into smart factories and the transformation of supply chains into intelligent supply chains according to the cited literature. It explores the details and the overall picture, shaped by Siemens' intention to generate a shift in the return on investment pattern for its customers.

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The goal of this article is to trace the key points of Industrie 4.0 in the original proposal, in the work of consultants that describe the overview, in the work of research articles that build the technology, in the research and development work of Siemens. This article relies on literature review and data analysis pertaining to these sources. The findings are that a new technology, cyber-physical systems, is being proposed, researched and developed. Cyber-physical systems as products or manufacturing equipment negotiate production process scheduling. They from smart factories. New business models, the most popular of which is mass customization, involve the integration of the entire supply chain.

Whereas the first step towards Industrie 4.0, Product Lifecycle Management for cyber-physical systems, has already been made, the following step is a proposal for the future made by the authors of the vision, by consultancy companies, by technology researchers, which involves new technology with new functionality. Product Lifecycle Management forms the core of the digital enterprise and makes it possible for smart products to know their required design and their required processes; production equipment to know its required processes; products to negotiate production scheduling with production equipment as a decentralized process. The article has identified a large body of literature that pertains to consultancy companies and journal articles and the strategy of Siemens that proposes the transformation of products, production equipment, factories and supply chains based on cyber-physical systems. This article is grouped according to these findings. This transformation sits on Product Lifecycle Management software and is upgraded by digital services, and completes the Industrie 4.0 vision which is another stage in manufacturing technology. In the future, when this is achieved, top-down automation will be replaced with decentralized peer-to-peer negotiation enabled by artificial intelligence. Production will change to new functionality and capabilities that are not possible today, and will enable new business models that make manufacturing in high cost countries create value.

BACKGROUND

The Industrie 4.0 proposal is considered a revolution in industry, based on cyber-physical systems, and the fourth such revolution in history. This revolution succeeds the first industrial revolution, steam (1700 – 1860); assembly line (1870-1969); automation (1969-2020). Industrie 4.0 is scheduled from 2020 onwards (Kagermann et al., 2013; Toro, Barandiaran, & Posada, 2015). Industrie 1.0 consists of water and steam powering mechanical manufacturing facilities. Industrie 2.0 comprises the assembly line and involves the introduction of electrically-powered mass production based on the division of labour. Industrie 3.0 involves automation and uses electronics and information technology (Kagermann et al., 2013).

The term Industrie 4.0 originates from a German government high-tech strategy project, Zukunftsprojekt Industrie 4.0, which promotes the computerization of manufacturing,. The term Industrie 4.0 has been a buzzword since 2011, as an approach to strengthening the competitiveness of the German manufacturing industry (Kagermann et al., 2011) called Industrie 4.0. Industrie 4.0 has also been a topic of display at the Hannover Fair since 2011 (Kagermann et al., 2011). In 2011, the German federal government promoted Industrie 4.0 as one of its key initiatives in its high-tech strategy (Kagermann et al., 2013, p. 7). The German federal government supported the idea by announcing that Industrie 4.0 would be an integral part of its high-tech strategy for 2020. This is an ambitious strategy for Germany, which aims at technological leadership. The Industrie 4.0 working group was formed afterwards. The working group's first recommendations for implementation were published in April 2013 (Kagermann et al., 2013). Industrie 4.0 was proposed and adopted as part of the German Government high-tech strategy action plan for 2020. The key promoters of Industrie 4.0 are the Industrie 4.0 working group and Plattform Industrie 4.0. They describe the Industrie 4.0 vision, the inherent basic technologies, and scenarios for its implementation (Kagermann et al., 2013, p. 5; Plattform Industrie 4.0, 2014). The working group's first subset of recommendations for implementation were published in April 2013 (Kagermann et al., 2013, p. 77). Industrie 4.0 is "a