World Academy of Science, Engineering and Technology
International Journal of Industrial and Manufacturing Engineering
Vol:8, No:01, 2014

How Virtualization, Decentralization, and Network-Building Change the Manufacturing Landscape: An Industry 4.0 Perspective

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Abstract : The German manufacturing industry has to withstand an increasing global competition on product quality and production costs. As labor costs are high, several industries have suffered severely under the relocation of production facilities towards aspiring countries, which have managed to close the productivity and quality gap substantially. Established manufacturing companies have recognized that customers are not willing to pay large price premiums for incremental quality improvements. As a consequence, many companies from the German manufacturing industry adjust their production focusing on customized products and fast time to market. Leveraging the advantages of novel production strategies such as Agile Manufacturing and Mass Customization, manufacturing companies transform into integrated networks, in which companies unite their core competencies. Hereby, virtualization of the process- and supply-chain ensures smooth inter-company operations providing real-time access to relevant product and production information for all participating entities. Boundaries of companies deteriorate, as autonomous systems exchange data, gained by embedded systems throughout the entire value chain. By including Cyber-Physical-Systems, advanced communication between machines is tantamount to their dialogue with humans. The increasing utilization of information and communication technology allows digital engineering of products and production processes alike. Modular simulation and modeling techniques allow decentralized units to flexibly alter products and thereby enable rapid product innovation. The present article describes the developments of Industry 4.0 within the literature and reviews the associated research streams. Hereby, we analyze eight scientific journals with regards to the following research fields: Individualized production, end-to-end engineering in a virtual process chain and production networks. We employ cluster analysis to assign sub-topics into the respective research field. To assess the practical implications, we conducted face-to-face interviews with managers from the industry as well as from the consulting business using a structured interview guideline. The results reveal reasons for the adaption and refusal of Industry 4.0 practices from a managerial point of view. Our findings contribute to the upcoming research stream of Industry 4.0 and support decision-makers to assess their need for transformation towards Industry 4.0 practices.

Keywords : Industry 4.0., mass customization, production networks, virtual process-chain
Conference Title : ICMIE 2014 : International Conference on Mechatronics, Manufacturing and Industrial Engineering
Conference Location : London, United Kingdom
Conference Dates : January 20-21, 2014