Production Networks meet Industry 4.0

Asst. Prof. ***Marko Mladineo****, Ph.D.*

FESB, University of Split, Croatia

Contact: mmladine@fesb.hr

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Mladineo, Marko

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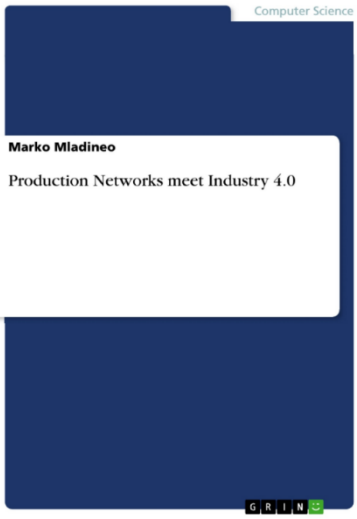

Summary

In the era of globalization, on the one hand, and shortage of resources and climate changes, on the other hand, the manufacturing industry is looking for new sustainable production paradigms. The production of the 21st century should be based on efficient use of resources without threatening the environment and social stability. It means it could be reasonable for society to dislocate production from one industrial area to some other less industrial area with less manufacturing waste, or to search for free capacities in other factories, instead of purchasing new equipment to extend capacities in its own factories. This kind of production outsourcing or manufacturing outsourcing can be presented as the Production Network, which represents a special case of the Virtual Enterprise.

In the past, some enterprises literally outsourced their manufacturing, like for instance Apple Computer Inc. in 1996. Today, Apple Inc. kept similar practice, so most of its smartphones are manufactured and assembled in China, but *"Designed by Apple in California"* as it is proudly stated on their products. This trend is followed by other US enterprises, as well.

Europe has a different strategy. The leading European industrial countries want to keep the remaining manufacturing in Europe and they want to bring back some of the manufacturing from China and other Eastern countries. They believe it would be possible through development of the new industrial platforms like Industry 4.0.

There is an interesting fact that Production Networks are seen as one of the important aspects of Industry 4.0. Namely, with Industry 4.0, the Production Networks have an opportunity to finally show their true potential. The introduction of Internet of Things and Information and Communication Technology into manufacturing environment enables the creation of Cyber-Physical System for agile and short-term production planning and control inside the Smart Factory. However, Cyber-Physical System can be extended outside of the factory and used to connect with other factories thus creating Cyber-Physical Production Network of smart factories. Since unique ID for each product (barcode or RFID tag) enables the traceability, the production network management could be done with ease.

This textbook represents the collected works of 10 years of the author's original doctoral and post-doctoral research about the Production Networks and application of the multi-objective optimization to Partner Selection Problem, which has been published in form of scientific papers in distinguished scientific journals. Therefore, it can be stated that content of the book passed rigorous scientific review by dozen of reviewers from the world-wide academic community. One of the main contributions of the author's research, presented in this book, is the design of the HUMANT (*HUManoid ANT*) algorithm for *a priori* approach to the multi-objective optimization. The author managed to combine Ant Colony Optimization and multi-criteria decision-making PROMETHEE method and used it to solve one of the most important optimization problems in production networks – the Partner Selection Problem. So far, HUMANT algorithm is the only fully operational algorithm which combines Ant Colony Optimization and PROMETHEE method. The author also contributed to *a priori* approach to the multi-objective optimization by designing its special case: the phenomenological approach. In the real-world application, the author contributed by designing the concept of Smart Collaborative Platform VENTIS, which is very close to the idea of Social Manufacturing. Furthermore, an anthropological analysis of the problem of trustful collaboration among enterprises is addressed, which is one of the main obstacles of the real-world application of production networks.

At the end of the book, perspective of production networks in the digital era is given, emphasizing new trends and concepts like Smart Enterprise and Lean Automation. Additionally, the main guidelines for the development of the enterprise toward the Smart Enterprise are presented. The remaining research challenges are automated negotiations and automated optimization algorithms for solving Partner Selection Problem and similar problems, but there is also the question of the cyber security and trust among partners. However, with establishment of collaborative platforms and systems, the future of Production Networks, especially within Industry 4.0, looks bright, very bright.

Keywords

Production Network, Industry 4.0, Cyber-Physical System, Social Manufacturing, HUMANT algorithm, PROMETHEE method, Phenomenological Method

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