Complexity

Special Issue on
Complexity in Industry 4.0 Systems and Networks

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Complexity has been studied under the perspective of both physical and functional domains. In the former one it takes into account aspects of the system structure and configuration, the variety of products it can process, the system's components, such as humans, machines, buffers, and their interdependencies, and the system's behavior. In the latter case, complexity is considered as a measure of uncertainty in achieving functional requirements, taking into account aspects of manufacturing system design, its states, and the degree to which it can handle the variety of demand.

Today manufacturing enterprises are often facing the challenge of having to manufacture highly customized products in small lot sizes. One solution to react to the rapidly varying demands and make the use of resources more flexible lies in the digitization of the manufacturing systems; this still remains a major challenge in industry. Information and material flow over the production and distribution are becoming increasingly complex. The advent of Industry 4.0 initiative and the modern technologies, such as Cyber-Physical Systems (CPS) and Internet of Things (IoT), open new horizons towards the industrial digitalization by enabling automated procedures and communication by means that were not available in the past. The increased connectivity and interaction among systems, humans, and machines support the integration of various automated or semiautomated systems, increasing flexibility and productivity. This will also lead to interconnected Industry 4.0-enabled manufacturing systems and networks that will constitute an integrated whole that provides the needed products to the right place, at the right time taking into consideration a number of newly created parameters and factors.

Although the adoption of Industry 4.0 and IoT paradigms in manufacturing reveals great potential; however, the increased complexity that may occur in different areas, including product, information, machine, shop-floor, and enterprise, as well as network levels, is a main challenge. The technology foreseen in the context of Industry 4.0 paradigm aims to reduce the complexity of the systems; nevertheless managing great amount of generated data, dealing with the increased number of variables, and integrating different tools are fields of further investigation. More specifically, how the generated data and information from the different sources and levels can be integrated into methods and systems for adaptive and effective decision-making needs to be further analyzed, aiming to manage the different and conflicting decision variables. From Industry 4.0 system to Industry 4.0 network, where advanced monitoring techniques and novel automation systems are considered, complexity is highly influenced. Existing approaches and methods including chaos theory, nonlinear dynamics theory, and information theory as well as hybrid approaches (Heuristics-Indexes) need to be further enhanced, taking into consideration the increased number of parameters and variables of Industry 4.0 systems and networks.

Therefore, the main objective of this special issue is to collect and consolidate innovative and high-quality research contributions mainly focused on methods and tools to model, quantify, and control Industry 4.0 complexity. This special issue will provide insights on how and whether Industry 4.0 technologies will support effective decision-making and reduce systems' and networks' complexity through the submitted scientific contributions in the form of both research and review papers.

Potential topics include but are not limited to the following:

- Complexity modelling and decision-making methods for complex Industry 4.0 systems
- Chaos theory, information theory, genetic and biologically inspired algorithms, cellular automata, neural networks, intelligent search algorithms, and evolutionary game theory in complex manufacturing applications
- Deterministic and nondeterministic approaches and algorithms
- Neural networks, Bayesian networks, and machine learning
- Manufacturing system complexity, methods, and measures
- Complexity management in supply chains and manufacturing networks
- Big data analytics for manufacturing and logistics applications
- Applications of complexity modelling and control in Industry 4.0 environments
- Internet of Things and complexity handling
- Complex robotic systems

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Papers are published upon acceptance, regardless of the Special Issue publication date.

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