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Editorial

Design and Management of Manufacturing Systems

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Although the design and management of manufacturing systems have been explored in the literature for many years now, they still remain topical problems in current scientific research. Changing market trends, globalization, the constant pressure to reduce production costs, and technical and technological progress make it necessary to search for new manufacturing methods and ways of organizing them, and to modify manufacturing-system design paradigms.

Even though the very concept of a manufacturing system emerged at the beginning of the 19th century, production continued to be an artisanal activity until the beginning of the 20th century. An important milestone (referred to today as the Second Industrial Revolution) was Henry Ford's introduction of the moving assembly line, which radically increased the efficiency of manufacturing processes. The following years, which, on the one hand, brought unprecedented progress in the development of manufacturing techniques, mechanization, and methods of controlling production devices, and, on the other hand, saw the evolution of customer expectations, necessitating the individualization of products, completely changed the paradigms of designing manufacturing systems at that time. To remain competitive, companies had to design manufacturing systems that not only produced high-quality products at low costs, but also allowed for producing a wide range of different products using the same system. As a consequence, research at the end of the 20th century was focused on the optimal design of flexible manufacturing systems (FMSs) capable of producing a variety of goods belonging to a defined family of a specific class of products. Unfortunately, FMSs turned out to be costly, most particularly because the equipment that possessed features enabling general flexibility was expensive to build and maintain. Those systems were also expensive because the machines that they used had more functionality than what they really needed, and this additional flexibility and functionality in many cases caused a waste of resources, since the added cost paid for this general functionality equalled unrealized capital investment until the extra functionality was actually used.

To eliminate the negative characteristics of both dedicated manufacturing lines (DMLs) and FMSs, and to combine the two opposing goals of reducing production costs and ensuring high system flexibility, new paradigms had to be defined, and new solutions for the design and management of manufacturing processes had to be found. The slogan "exactly the capacity and functionality needed, exactly when needed" became the keynote and main challenge of the process of designing manufacturing systems. Accordingly, in the past several years, research on the development of manufacturing systems has revolved around three main concepts that meet the assumptions of focused flexibility and the challenges of the Industry 4.0 philosophy: focused-flexibility manufacturing systems (FFMSs), reconfigurable manufacturing systems (RMSs), and smart manufacturing systems (SMSs).

Overall, designing manufacturing processes and systems is a complex multilevel procedure influenced by a large number of factors. Designing requires the indepth analysis of market targets, and possible ways of preparing and implementing usually automated and robotized manufacturing systems, assessing the impact of crucial factors, as well as integrating the knowledge of many branches of science and individual divisions. The target of each design is to optimally provide the design processes while maintaining the required quality and minimizing costs.

This Special Issue presents the current research in different areas connected with the design and management of manufacturing systems. In particular, papers published in this volume cover the following subject areas:

- methods supporting the design of manufacturing systems [1–6],
- methods of improving maintenance processes in companies [7–9],
- the design and improvement of manufacturing processes [10–14],
- the control of production processes in modern manufacturing systems [15,16],
- production methods and techniques used in modern manufacturing systems [17], and
- environmental aspects of production and their impact on the design and management of manufacturing systems [18–20].

The wide range of research findings reported in this Special Issue confirms that the design of manufacturing systems is a complex problem, and the achievement of goals set for modern manufacturing systems requires interdisciplinary knowledge and simultaneous design of product, process, and system, as well as the knowledge of modern manufacturing and organizational methods and techniques. The need for and ability to reduce the negative impact of manufacturing processes on the natural environment are also of importance, as signaled in this introductory article and this volume. I wish to thank all the authors for the effort that they expended in preparing their papers. I hope that this Special Issue will be of wide interest to readers and inspire further research, leading to the development of new effective solutions supporting the processes of designing and managing manufacturing systems.

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