

## **Production Engineering – a new approach to management or a new discipline?**

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**Abstract:** *Production Engineering – a new approach to management or a new discipline?* The paper discusses the origins and the evolution of *production engineering*, which, in 2010, became a separate discipline of technological sciences. It outlines the definition of *production engineering* as formulated by the American Institute of Industrial Engineers, in 1989. Based on that definition, the body of knowledge referring to the product lifecycle is described and, next, 10 areas – the building blocks of the *production engineering* discipline are delineated. All of them are based on IT technological developments.

*Keywords:* Production Engineering ,new discipline.

### INTRODUCTION –COMPETITIVENESS OF COMPANIES – ORIGINS AND FUTURE

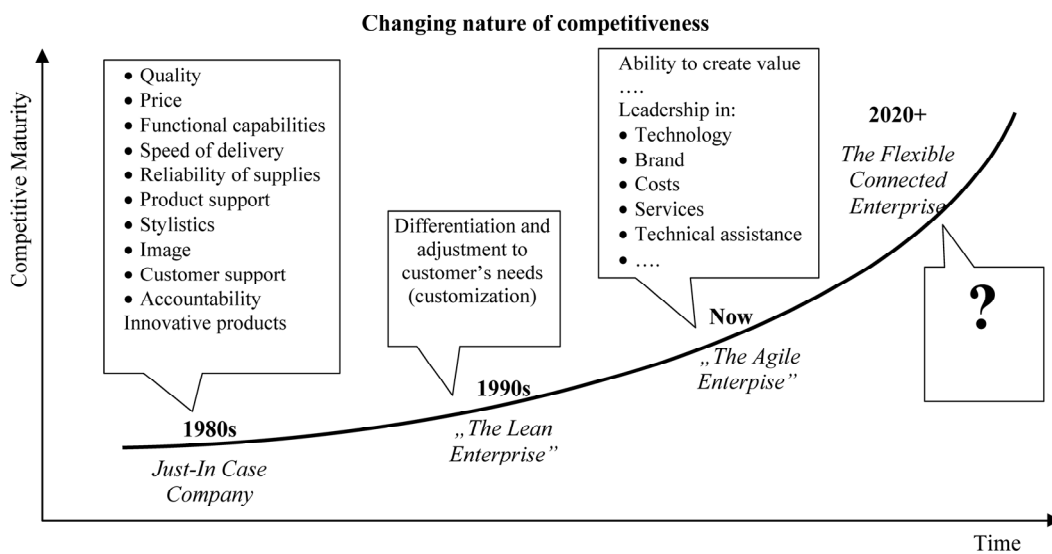
The *industrial civilization*, which Toffler (2006) called the second wave, took its shape at the end of the 18<sup>th</sup> century in England and in the second half of the 19<sup>th</sup> century in the United States. It was embodied by the *massive production* of material goods, which led to the separation of manufacturing and consumption stages. The production was based on *non-renewable energy sources* (fossil fuels such as coal, gas and petrol), and used steam and electrical energy. The mass production process followed *6 rules of bureaucracy: standardization and specialization, synchronization* (of human and machine work rhythms), *concentration* of people in urban centers, of the production and of capital, and *power centralization* (decision making based on the superior-executor-direct reportpattern), *maximization* of productions and profits.

In the second half of the 20<sup>th</sup> century, and namely in 1980s, the environment of companies underwent a substantial number of changes: it became *more and more turbulent*, marked with an increasing complexity and speed, the intensity of change and technological innovation. Companies thus faced *the challenge of responding to such changes* (Drucker 1995).

That evolution brought about ensuing developments in the corporate management process: companies needed to take into account the necessary conditions of the protection of the quality and safety of natural and social environment. This was achieved, among all, through the decentralization of decision-making processes in large companies, from both manufacturing and service sectors, at the end of 1980s. In 1990s, the pursuit of an increased effectiveness fostered the emergence of *re-engineering* and *outsourcing of manufacturing and auxiliary processes*, which, in turn, stimulated the introduction of *lean management*, and the rise on an unprecedented scale of innovation in *small and medium enterprises*, e.g. in the Silicon Valley. The *commercialization of Internet* (1994) paved the way for *the one-to-onere-orientation*, i.e. the focus on specific clients, which, in turn, led to the emergence of new individualized modalities of product and service provision: a standard and tailor-made approach called *customization (mass customization)*. As in the first decade of the 21<sup>st</sup> century, businesses have become more and more flexible, in the nearest future we should witness the *increase in networking*, with the *even more cohesive nodes*, among large and small companies as well. (see Fig. 1).

## NOTION OF PRODUCTION ENGINEERING AND AREAS OF ITS APPLICATION

The emergence of mass production based on steam, and next on electric energy, which, thanks to Ford, in 1909 took the orderly shape of the production line, required specific organization rules which would foster its effectiveness. Since the end of the 19<sup>th</sup> century, those rules had been presented at technological universities established in the most industrialized economies. In the USA, the first department which hosted lectures on those principles was Harold & Inge Arcus Department of Industrial & Manufacturing Engineering at the Pennsylvania State University, founded in 1908. In Poland, such research center was set up in 1919, at the Technological University of Warsaw, by Professor K. Adamiecki.



**Figure 1.** Specificity of competitiveness in the changing world, from 1980s to the first decade of the 21<sup>st</sup> century and on.

Source: Santarek K., *Stan i kierunki rozwoju inżynierii produkcji w USA i krajach Europy Zachodniej*, lecture for the meeting of the Production Engineering Committee of the Polish Academy of Science, Zakopane, 2010.

*Production engineering* combines several technological scientific disciplines which describe manufacturing and management processes, and integrates a wide range of research areas on technologies and organizations. In consequence, it requires a different approach to any problem-solving. In 1989, the American Institute of Industrial Engineers (IIE) established the definition of *production engineering*, which is still of value today.

***Production engineering* covers planning, design and management of production systems and logistics systems, and the assurance of their functioning. Such systems are understood as socio-technical systems integrating workers, information, energy, materials and work tools during the whole *product lifecycle*. In order to achieve a more effective operation of such system, production engineering focuses on technological, economic, human and social sciences, and uses telecommunication and information knowledge, knowledge on management, social communication and stimulation of worker's creativity. *Human orientation* is the key factor which differentiates *production engineering* from other technological sciences. The most performing systems are those which continuously strive to upgrade the working environment, and in which human efforts bring the most vital contribution to efficiency, costs and work quality (*Istota inżynierii produkcji*, 2012)**

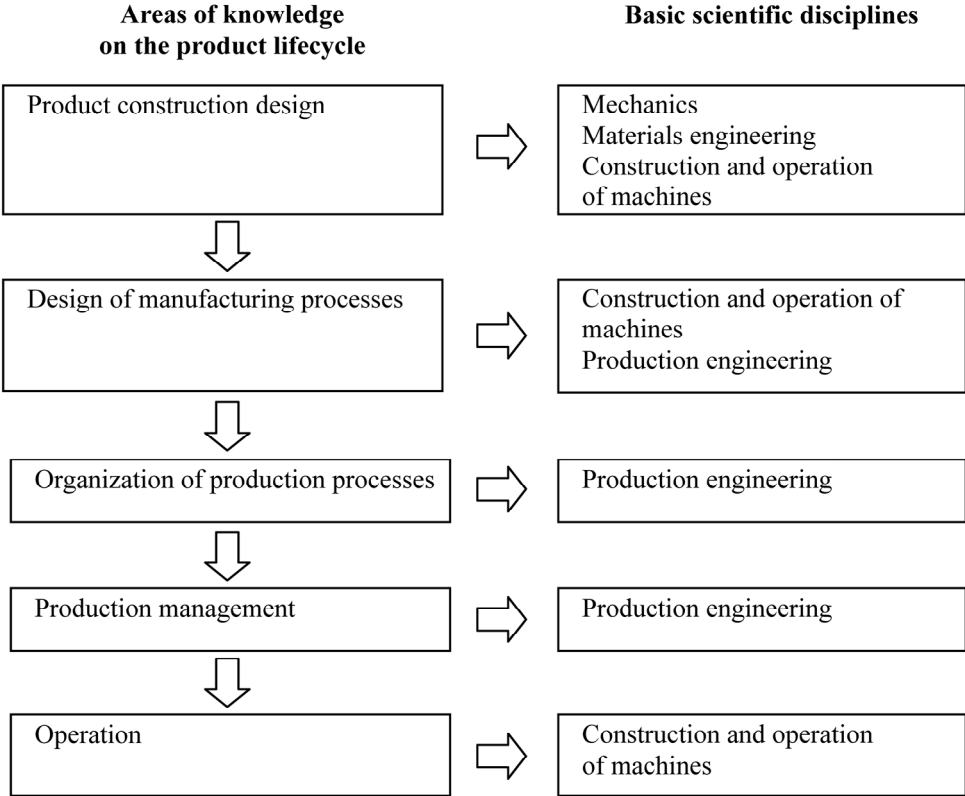
Understandably, each company would make all endeavors in order to increase its productivity, defined as the relation between the results and the expenditure made to achieve them. In practice, this means that research efforts should basically focus on three main areas:

- Analysis of the lifecycle of products and services;
- Study of manufacturing processes;
- Analysis of developments in the organization of the manufacturing system.

Considering the anticipated developments in the business environment and the evolution of manufacturing tendencies, as discussed above, product and service manufacturing processes and their delivery “just in time” should be analyzed in their specific variants. In fact, such transformations lead to increased spending on design and preparation, on the organization and on the management of manufacturing processes. These stages make all part of the product lifecycle, as detailed in Figure 2 below.

**PRODUCTION ENGINEERING RESEARCH AREAS**

The relations between the stages of the new product development and scientific disciplines which cover technological and social aspects of manufacturing activities, as outlined on Figure 2 .



**Figure 2.** Areas of knowledge on the product lifecycle versus basic scientific disciplines  
*Source: Istota inżynierii produkcji, Production Engineering Committee of the Polish Academy of Science, June 2012, p.5.*

**1. Organization and management of products and services**

The area covers such issues as the design and the organization of manufacturing processes, working time management, product cost streamlining, scheduling of production orders and the use of IT systems in corporate management.

## **2. Selected issues of production processes engineering**

The area covers the issues of management of resources processing into functional goods, namely the manufacturing of machine components, changes of their dimensions, modification of their surface structure, bonding of powders and molds, plastic working and plastics processing, coating, abrasive and erosive processing. Research should focus on problem-solving in the management of working time (workers and capital goods), as well as of materials and information flows.

## **3. Innovation management**

The area covers such topics as the creation and measurement of innovation processes and their management, and in particular methods and tools used for the development of innovative solutions, designing and development of innovations and transfer of technologies fostering the competitiveness of companies.

## **4. Production and service project management**

The area describes changing production conditions, technological progress as driven by the application of project management tools, reduced product market windows, the launch of new technologies and their timely implementations thanks to new methods applicable for scheduling, control and assessing the risk related to project execution deadlines.

## **5. Optimization of the supply chain and logistics**

The area covers such topics as the optimization of materials, information and financial flows across the organizational network oriented towards the production and delivery of products and services, while ensuring deadlines, quality, delivery costs and continuity.

## **6. Quality management**

Quality management allows for the improvement of company operations thanks to the application of standardized management support systems, and in particular the elimination of obstacles and difficulties in the implementation process. This may be achieved thanks to better management methods and techniques, as well as to better product safety standards and assurance of product liability.

## **7. Decision-making support systems. Production knowledge management.**

The area covers mathematical models, including decision-making models, and artificial intelligence instruments used to achieve financial and operational goals in production management.

## **8. Corporate forecasting. Modeling and computer simulation**

The area refers to forecasting of technological and economic processes and demand-side projections. Moreover, it includes the modeling and simulation of product design, the design of processes and tasks of production logistics and project management. The results of such modeling and simulation may be of use in designing new production systems or in reconstructing the existing ones.

## **9. Shaping the working environment. Work safety**

The area covers the bulk of analyses on factors which shape the safety in the working environment. Such analyses are performed with modeling and computer simulation methods used in production engineering, and thus pertain to such issues as early identification and prediction of technological risks and threats to health in the working environment, work

ergonomics, work valuation in production systems, application of RFID technology in the dissemination of best practices in occupational safety and health and reconstruction of incidents at work.

#### 10. Effectiveness, productivity and company organization

The area focuses on actions and decision taken by the management to apply new business models and new organizational solutions which will drive the effectiveness of the organization and lead to changes in its environment.

#### CONCLUSIONS

In the context of a more and more globalized corporate environment and of rapid changes in manufacturing processes, the body of knowledge needed for each engineer-manager should include both the current technological knowledge, and the business management know-how. This will necessarily entail the realization of 2 principles: [1 p.9-10]

**PRINCIPLE 1:** THERE IS NO MANUFACTURING WITHOUT MANAGEMENT, AND NO MANAGEMENT WITHOUT ANY SPECIFIC APPLICATION;

**PRINCIPLE 2:** THERE IS NO MANAGEMENT WITHOUT COMPUTER-AIDED METHODS.

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**Streszczenie:** W artykule przedstawiona zostanie geneza oraz rozwój *inżynierii produkcji*, która w 2010 stała się nową dyscypliną nauk technicznych. Podana zostanie definicja *inżynierii produkcji* sformułowana przez Amerykański Instytut Inżynierii Przemysłowej w 1989 r. Na podstawie tej definicji określone zostaną obszary wiedzy tworzące podstawowe dyscypliny naukowe związane z *cyklem życia wyrobu*, na podstawie których wyodrębnionych zostanie 10 kierunków tworzących dyscyplinę *inżynieria produkcji*. Wszystkie te *kierunki* oparte są na rozwoju technologii informacyjno-technologicznych.

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