

1

PRODUCTION ENGINEERING AS A DISCIPLINE AND THE POSSIBILITIES TO APPLY THE ORGANIZATION OF ITS ACHIEVEMENTS IN PRACTICE

1.1 INTRODUCTION

There has been over 110 years since the birth of science basis of organization and management. The list of founders of organization and management science basis is long and covers many names such as the most famous pioneers of this branch: F.W. Taylor, K. Adamiecki, H. Ford, H. Fayol. Nowadays organization and management science is an independent and mature science branch. Although, considering the subject of management, it is distinguished the main management and engineering management, so far the management in Poland is mainly associated with economics. In economics, which is the field of science, there is a branch called management science. Engineering management has occurred in many scientific branches so far but in Poland there has not been a clearly distinguished branch for it, in a technical science. In English literature we can find many equivalents of engineering management such as: industrial engineering, industrial management, engineering management. However, the exact meanings of those terms differ from one another. It may be assumed that the term „industrial engineering” is the historically oldest term, which was defined very similarly by various organizations such as Institute of Industrial Engineering (IIE), Verband für Arbeitsgestaltung, Betriebsorganisation und Unternehmensentwicklung (REFA), College International pour la Recherche et Productique (CIRP). In Poland the equivalent of this term is production engineering. Many scientists and representatives of economic practices has addressed the topic of industrial engineering [1, 2, 5, 6, 8, 9, 10, 11]. The specialists’ debate and the needs in this area has led to structural solutions. In April 2010 by the decision of Central Commission for Academic Title and Degrees in the branch of science it was created a new scientific branch – production engineering. Therefore, the individual scientific discipline has appeared in science: technical sciences, which concerns broadly defined engineering management.

The aim of this paper is to present a basic information about the new scientific discipline: production engineering, and to show exemplary possibilities of practical use of achievements in this discipline, in organizations of various sizes and profiles of activity.

1.2 BASIC INFORMATION ON PRODUCTION ENGINEERING AND EXAMPLES OF PRACTICAL APPLICATIONS OF ITS SOLUTIONS

In Poland term production engineering has been defined by The Committee on Production Engineering of Polish Academy of Sciences with the use of American Institute of Industrial Engineers (IIE): „Production engineering is a term containing issues of planning, designing, implementing and managing of production systems, logistic systems and securing their functioning. Those systems are understood as sociotechnical systems, integrating employees, information, energy, materials, working tools and processes within the whole life cycle of product. In order to achieve work efficiency of those systems, the production engineering is based on technical, economic, humanistic and social sciences, using data communication and management knowledge, social communication and stimulation of employees' creativity. The key element which differs production engineering from other technical disciplines is that it is people-oriented. The best systems are functioning in a constantly improved work environment in which human work is the most important factor influencing efficiency, costs and quality of work” [6].

In the field of technical sciences, in the discipline production engineering there has been distinguished 10 scientific and research fields:

1. Organization and managing of production and services – covering issues of designing the manufacturing processes, organization of production, managing work time resources, production costs optimization, scheduling the production orders and employing information technology management systems in company;
2. Selected issues of manufacturing process engineering – covering processes of managing the processing of materials for usable products such as manufacturing machinery elements by forming the shape, changing sizes, modification of surfaces and joining;
3. Innovations management – covering issues connected with creation and measurement of innovation processes and managing them;
4. Production and service projects management – covering especially subject of management of project's execution stage (managing the changes in range of work performed, updating tasks in project, defining deviations in relation to a basic schedule, controlling project costs), as well as risk management in execution stage;
5. Optimization of supply chain and logistics – covering issue of optimization of material, information and finance flow by the network of organizations, in order

- to produce and deliver product or service to consumer and to provide profitability and continuity of processes;
6. Quality management – covering issues, philosophy and essence of quality management targeted to improve the functioning of company;
 7. Decision support systems. Managing production knowledge – covering use of decision analysis method, mathematical models and artificial intelligence tools to implement financial and operational production management purposes;
 8. Forecasting in company. Modeling and computer simulation – covering issue of technological, economic and demand forecasting, as well as modeling and simulation of designing products, process designing, scheduling of production tasks, designing of production logistics and projects managing;
 9. Forming of work environment. Work safety – focusing on issue of shaping safe work environment with methods of computer modeling and simulation of anthropo-technical systems occurring in the field of production engineering;
 10. Efficiency, productivity and organization of companies – covering the issue of studies focusing on activities and decisions of managers, adoption of new business models and new systems and management methods which create new organizational solutions in a company [6].

The presented scientific-research fields clearly indicate that the production engineering is a discipline of a wide range, which contains: organization and management of production and services, chosen issues of manufacturing process engineering, innovation management, projects management, optimization of supply chain and logistics, quality management, forecasting in company, modeling and computer simulation, forming of work environment and work safety, efficiency, productivity and organization of companies. The fields focus on using not only engineering knowledge but also economic, social and humanistic. It causes the new discipline to be open for interdisciplinary research projects. The subject of production engineering studies is not only a production and service activity but also technical aspects of management: health protection, education system, national and government administration, cultural organizations etc. The production engineering discipline has been a potential field for searching for solutions to increase innovation in polish economy. According to Central Statistical Office of Poland in years 2013-2015 production and process innovations in the group of industrial companies have been introduced by 18,9% of all companies, whereas in the group of service companies only 10,6% [4]. In accordance with „The Global Innovation Index 2016” Poland is on 39th position in the world in terms of innovation, directly after Lithuania, Slovakia and Bulgaria, whereas in European Union Poland is on 25th position [3]. Considering the numbers mentioned, production engineering has got very crucial tasks to complete to increase innovation.

Analyzing the subject range of individual fields of production engineering, it can be noticed that it is the field of science especially predestined to a strict cooperation with various organizations. Connection of production engineering with

organization practice may be noticed in various fields and areas. The members of The Committee on Production Engineering of Polish Academy of Sciences are not only scientists but also representatives of economic practice – managers of companies. The Committee on Production Engineering of Polish Academy of Sciences has distinguished 4 sections within its activity:

1. Section of production and projects management
2. Section of innovation methodology and new technologies
3. Section of quality and work safety
4. Section of education and development of personnel.

This type of classification focuses on the main specializations in Committee's activity as well as on practical implications of the scientific discipline. Currently (March 2017) 14 organizational units – divisions in science and technology universities has got an authorization to grant a degree of PhD in science and technology in a discipline of production engineering, while 1 unit – Faculty of Mechanical Engineering of Cracow University of Technology has got authorization to grant a degree of habilitated doctor in this discipline [7]. There can be clearly noticed that discipline of production engineering has made a progress – more and more units of science and technology universities is trying to gain authority to grant degrees of PhD and habilitation in this discipline. Many universities offer first and second degree studies of management and production engineering. It proves that there is a great demand for specialists in various branches of production engineering.

Considering the presented scientific and research fields in a discipline production engineering we can indicate a very wide scope of practical application of solutions developed within this discipline. With a limitation to only 40 submitted papers from Poland and Czech Republic at the first conference within project Cross-border exchange of experiences in production engineering with the use of mathematical methods, we can perform various classifications of practical applications presented in those papers. Each author of the papers was asked to define a practical use of presented solutions and to indicate in which field the solution may be useful. Assuming the earlier presented classification for 10 scientific and research fields we can state that submitted papers can be assigned to the following fields:

1. Organization and management of production and service
2. Selected issues of manufacturing processes engineering
3. Innovations management
4. Projects management
5. Optimization of supply chain and logistics
6. Quality management
7. Decision support systems
8. Forecasting, modeling and computer simulation
9. Forming of work environment and work safety

10. Efficiency, productivity and organization of companies

Their subject contains all the fields defined in production engineering, where the amount of solutions in each field differs. We can indicate fields where several solutions were proposed, as well as fields where a single solution was proposed. The classification proposed by The Committee on Production Engineering can be applied in the papers prepared by authors. We can assign them to 4 particular groups, that is production and projects management, innovation methodology and new technologies methodology, quality and work safety, and education and development of personnel. The presented classifications confirm wide range of issues in production engineering and good division for fields and groups of this discipline.

Considering practical application of solutions presented in the papers we may adopt other classifications. In each paper there was indicated a field or fields where presented solution may be useful. The most frequently mentioned were production and service companies, subsequently production processes and production systems, several papers indicated mining industry, energetics, automotive industry, there were individual examples of research laboratory, power station, health resort, hospitals and hotels, units verifying technologies, materials engineering and biological processes. The presented fields indicate very wide scope of possibilities of solutions application within production engineering. We must also remember that those are only results of over 40 papers submitted by Polish and Czech scientists within one conference. Adopting another classification, therefore what a solution is regarding, we may indicate following examples: decision making tools, information technology systems supporting production and maintenance, modeling and computer simulations, co-relations between occurrences and recommendations connected with them, risk management and evaluation, quality management and methods, tools and quality techniques, danger analysis regarding safety, waste management, proper selection and reduction of fuel use, reduction of noise nuisance, indicatory evaluation, costs allocation problem, operational costs optimization, education and training recommendations. Mathematical methods are the most often presented – they offer a solution to particular issues. There are also information technology systems to support certain activities, computer software is analyzed for various usage, statistical methods are interpreted and used for various tasks. New solutions are proposed to improve currently exercised projects, also a use of methods, techniques, and tools is proposed, those which were never used before, and which are to optimize and improve particular processes. The presented examples pay attention to a wide range of solutions which are developed within production engineering. Considering their application value and large possibilities of use in various fields, they prove that production engineering is an important and necessary discipline in contemporary world.

1.3 CONCLUSION

Although engineering management has been present in many scientific disciplines of technical sciences, there was a lack of clearly and specifically classified discipline in Poland, which would take on this issue comprehensively. In 2010 there was classified a new discipline: production engineering in a field of technical sciences. In this discipline there has been separated 10 scientific and research fields which cover the whole range of projects executed in it. The paper presents a brief characteristics of all 10 fields with paying attention to its wide range of application. The subject of production engineering study was defined and it was pointed out that there is a need to connect technical knowledge with economic, social and humanistic. The paper defines the tasks for production engineering to increase innovation in Polish economy. It was pointed out that production engineering is strictly connected with economic practice and that there is a necessity to use its solutions in companies of various sizes and profiles of activity. Basing on information contained in over 40 papers submitted to the conference from Poland and Czech Republic there were presented examples of practical application of solutions elaborated within the discipline. Considering this issue there were presented various classifications of solutions e.g. depending on field in which they may be useful or depending what the solution refers to. Wide range of possible practical use was stated as well as their large application value. The presented solutions can be successfully employed in various organizations. Details of particular solutions and their practical application may be found in suitable papers prepared for the first conference within project Cross-border exchange of experiences in production engineering with the use of mathematical methods. Collective list of examples of practical application of solutions developed within the discipline of production engineering, prepared specially for the use of this paper indicates explicitly the wide range of solutions in the discipline and emphasizes its importance to development of Polish and Czech economy with a particular consideration for innovation field.

REFERENCES

1. I. Durlik, *Inżynieria zarządzania*, tom 1 i 2, Oficyna Wydawnicza Placet, Gdańsk, 1993.
2. I. Durlik, K. Santarek, *Inżynieria zarządzania III*, Wyd. C.H. Beck, Warszawa, 2015.
3. S. Dutta et al., The Global Innovation Index 2016. Winning with Global Innovation, <https://www.globalinnovationindex.org/gii-2016-report>. [Online] 15.03.2017.
4. Działalność innowacyjna przedsiębiorstw w Polsce w latach 2013-2015, Główny Urząd Statystyczny, <http://stat.gov.pl/obszary-tematyczne/nauka-i-technika-spoleczenstwo-informacyjne/nauka-i-technika/dzialalnosc-innowacyjna-przedsiębiorstw-w-polsce-w-latach-2013-2015,14,3.html>. [Online] 15.03.2017.
5. A. Gola, A. Świć, Współpraca nauka – biznes w inżynierii produkcji – problemy i

- wyzwania, w: *Innowacje w zarządzaniu i inżynierii produkcji*, red. R. Knosala, Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, Opole, 2013, s. 1277-1288.
6. *Istota inżynierii produkcji*, Komitet Inżynierii Produkcji Polska Akademia Nauk, Warszawa, 2012.
 7. Jednostki z prawem do nadawania stopnia naukowego, POL-on, <https://polon.nauka.gov.pl/opi/aa/ck/stnauk/upr?execution=e2s1> [Online] 15.03.2017.
 8. J. Kaźmierczak, Inżynieria produkcji: kilka refleksji, *Systemy Wspomagania w Inżynierii Produkcji*, 2012, z. 2, s. 7-15.
 9. R. Knosala i inni, *Zarządzanie innowacjami*, PWE, Warszawa, 2014.
 10. Praca zbiorowa pod red. J. Łunarskiego, *Zarządzanie innowacjami. Podstawy zarządzania innowacjami*, Wyd. Politechniki Rzeszowskiej, Rzeszów, 2007.
 11. *Stan i perspektywy badań naukowych w obszarze Inżynierii produkcji w Polsce*, Ekspertyza Komitetu Inżynierii Produkcji PAN, Warszawa 2010.

Date of submission of the article to the Editor: 04.2017

Date of acceptance of the article by the Editor: 05.2017

dr hab. inż. Mariusz J. Ligarski

Silesian University of Technology

Faculty of Organization and Management

Institute of Production Engineering

ul. Roosevelta 26-28, 41-800 Zabrze, Poland

tel.: +4832 277 73 48, e-mail: Mariusz.Ligarski@polsl.pl

PRODUCTION ENGINEERING AS A DISCIPLINE AND THE POSSIBILITIES TO APPLY THE ORGANIZATION OF ITS ACHIEVEMENTS IN PRACTICE

Abstract: *The paper presented basic information concerning a new scientific discipline in Poland: production engineering, which was created in 2010 within the field of technical sciences. Brief characteristics of 10 scientific – research fields was presented, separated within this discipline. There has been defined a subject of production engineering studies and tasks in the area of innovation. Basing on information included in over 40 papers within project Cross-border exchange of experiences in production engineering with the use of mathematical methods, it was presented examples of practical application of solutions developed within the discipline. The paper presented various classifications of developed solutions and pointed out their application value. It was confirmed that the elaborated solutions may have a wide range of application in various organizations. Summing up, the paper stated a large scope of solutions in production engineering and indicated its great value for development of Polish and Czech economy.*

Key words: *production engineering, scientific discipline, practical solution*

INŻYNIERIA PRODUKCJI JAKO DYSCYPLINA NAUKOWA I MOŻLIWOŚCI ZASTOSOWANIA W PRAKTYCE ORGANIZACJI JEJ OSIĄGNIĘĆ

Streszczenie: *W opracowaniu przedstawiono podstawowe informacje dotyczące nowej dyscypliny naukowej w Polsce: inżynierii produkcji, która została wydzielona w 2010 roku w ramach dziedziny nauk technicznych. Zaprezentowano krótką charakterystykę 10 obszarów naukowo-badawczych, wyodrębnionych w ramach tej dyscypliny. Określono podmiot badań inżynierii produkcji oraz wyartykułowano zadania, jakie stoją przed dyscypliną w obszarze innowacyjności. Opierając się na informacjach, zawartych w czterdziestu kilku referatach przygotowanych przez polskich i czeskich naukowców na konferencje w ramach projektu Transgraniczna wymiana doświadczeń w inżynierii produkcji z zastosowaniem metod matematycznych, zaprezentowano przykłady praktycznych zastosowań rozwiązań opracowanych w ramach dyscypliny. Przedstawiono różne podziały opracowanych rozwiązań i zwrócono uwagę na ich walory aplikacyjne. Potwierdzono, że opracowane rozwiązania mogą znaleźć szerokie zastosowanie w różnorodnych organizacjach. Podsumowując, stwierdzono szerokie spektrum rozwiązań w inżynierii produkcji oraz podkreślono jej wagę dla rozwoju gospodarki polskiej i czeskiej.*

Słowa kluczowe: *inżynieria produkcji, dyscyplina naukowa, rozwiązania praktyczne*