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**Editors: Dragan D. Milanović  
Vesna Spasojević-Brkić  
Mirjana Misita**

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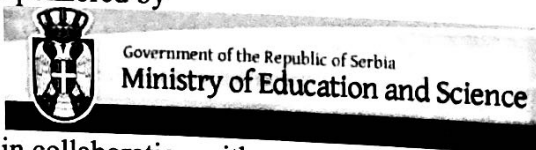
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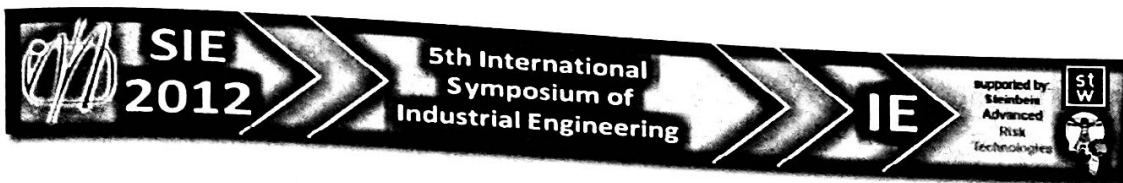
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## THE TWENTIETH ANNIVERSARY OF INDUSTRIAL ENGINEERING DEPARTMENT AT THE FACULTY OF MECHANICAL ENGINEERING UNIVERSITY OF BELGRADE

Dragan D. Milanović, Vesna Spasojević-Brkić, Mirjana Misita, Uglješa Bugarić  
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**Abstract.** *This paper presents formation and development of Industrial Engineering studies at the Faculty of Mechanical Engineering in Belgrade. It contains instructional plans and programs, and main work results of studies over the past 20 years.*  
**Keywords:** *Industrial engineering, plans, programs, students*

### FORMATION OF INDUSTRIAL ENGINEERING

Birth and development of industrial engineering is related to France at the time of Napoleon, when "Polytechnic School" (Ecole Polytechnique) was founded in 1794. In 1829, the school was renamed "Central School of Art and Industry" (Ecole Centrale des Arts et Manufactures) and this year can be taken as the year of appearance of industrial engineering studies [1]. The first department of Industrial Engineering was established in 1908 at the University of Pennsylvania in the USA [2]. In the first half of the 19th century, leading industrial countries such as Britain, Spain, Austria, Germany, Switzerland and the United States made a significant contribution to development of industrial engineering. Methods and techniques of industrial engineering development and their application in business, conditioned the appearance of university plans and programs in this field. Industrial engineering became well known and accepted by business people from the industry. Prior to mid 1950s IE was primarily concerned with human interactions in manufacturing systems, and after that period, with appearance of new mathematical/statistical methods IE shifts from qualitative to quantitative problem solving [6].

Industrial Engineering has been defined by the American Institute of Industrial Engineering, in 1955, and it states that [1]: Industrial Engineering deals with designing, specialization and installation of integrated systems of machines, materials and people. It uses scientific knowledge in mathematics,

natural and social sciences, linking them with the modern principles of engineering analysis, in order to determine predictions and assessments of results obtained from these systems [2].

Since 1950's, the scientific disciplines in the field of industrial engineering appear at the Faculty of Mechanical Engineering in Belgrade. During the school year of 1948/49, lectures on the subject "Scientific organization of labor" were held. In order to come closer to American plans and programs, which have been proven as very successful, the subject Scientific organization of labor has transformed into subjects Organization and economy of production, and the Organization of production 2, and afterwards, following subjects have been introduced: Organization of production, Organization and preparation of production, Organization operation A and B, Methods of quantitative analysis, Study and measurement of work, Engineering economy, Ergonomics, Maintenance of machinery and Organization of production problems. Back then, study direction name was the Organization of production. Industrial Engineering study, under current name was formed in 1991, at the Faculty of Mechanical Engineering, University of Belgrade.

It has been accepted with great interest and enthusiasm by the students of Faculty of Mechanical Engineering in Belgrade. It was established thanks to great persistence and work of professors who held lectures in this area. The survey was conducted in the economy and it showed that 70% of employed graduated mechanical engineers worked in the area of industrial engineering. Survey conducted in 26 companies of domestic industry showed that at that time there was a lack of 418 experts in the field of Industrial Engineering and predictions showed that in the next 10 years that number will be tripled.

Events in the period that followed have fully confirmed the validity of such predictions. Educational plans and programs of department of

Industrial Engineering at the University in Belgrade were created, as a result of extensive analysis of plans and programs of Mississippi State University (USA) and specially Purdue University Indiana, West Laffayette.

At the Faculty of Mechanical Engineering, the field of Industrial Engineering is perceived as the process of integration of technical -technological components of production and human factors in order to successfully manage production and business at companies. Preparing a graduate for a wide variety of jobs upon graduation is one of the unique aspects of IE program [8]. Complexity of problems to be solved requires a multidisciplinary and interdisciplinary approach.

Industrial Engineering as the department at the Faculty of Mechanical Engineering in Belgrade is very attractive and interesting for a number of students, as predicted by U.S. Department of Labor, Bureau of Labor Statistics, industrial engineers are expected to have employment growth of 20 percent over the projections decade, faster than the average for all occupations [4].

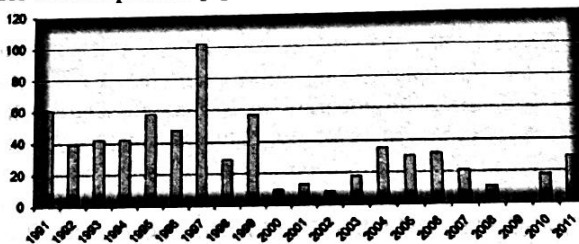


Table 1. Enrolled students at Industrial Eng. Dep.

Almost every year, due to the limited number of students registered at departments, it happens that the number of enrolled students is less than the number of interested persons. Tables 1 and 2 show

the number of enrolled students and number of graduates in the last 20 years.

During the last 20 years, total number of enrolled students was 705 or approximately 34 students per year, and the number of graduates was 545 or approximately 26 students.

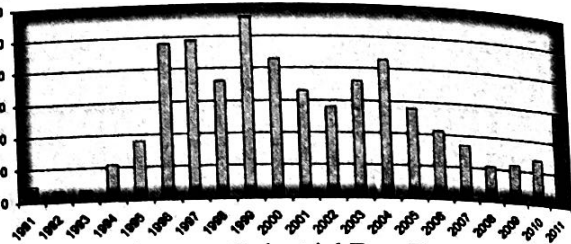


Table 2. Graduates at Industrial Eng. Dep.

These results, according to the number of enrolled students and graduates, distinguishes department of Industrial Engineering at third position in relation to other departments at the Faculty of Mechanical Engineering in Belgrade. Significant activities of department of Industrial Engineering are master and PhD studies, for which there is a great interest among students. In the same period of time, 41 master theses were defended, as well as 24 doctoral dissertations. The biggest contribution to the great success and popularity of department of Industrial Engineering at the Faculty of Mechanical Engineering in Belgrade is provided by members of department of Industrial Engineering by their high quality and professional work, and by giving great importance to the work with students in order to provide complete theoretical and practical knowledge.

Table 3 presents elective subjects belonging to the Industrial Engineering at the bachelor level and teacher's names.

### INDUSTRIAL ENGINEERING – Bachelor Studies

Hour weekly	1 <sup>st</sup> year		2 <sup>nd</sup> year		3 <sup>rd</sup> year		
	1	2	3	4	5	6	
1	Mathematics 1	Mathematics 2	Mathematics 3	Thermodynamics 1	Fluid mechanics B	Electrical and electronic engineering	
2	Mechanics 1	Basic of strength of constructions	Mechanics 2	Mechanics 3	Numerical methods	Control engineering	
3	Constructive geometry and graphics	Engineering graphics	Machine elements 1	Machine elements 2	Manufacturing technology	6.3.5 Business-production information systems Professor: Dragan D. Milanović	
4	Strength of materials						
5	Physics and measurements	Engineering materials 1	Engineering materials 2	6.4.0 Business management Professor: Stjepan Pabrić	6.4.5 Production management 1 Professor: Vesna Spasojević Brkić	6.4.5 Maintenance management Professor: Uglješa Bugarić	
6		Basic of sociology and economics.		Management of production processes Zorica Vagović Miljana Milić			
7		English 1		English 2	SKILL PRACTIS B-IE Professors: Vesna Spasojević Brkić Miljana Milić	5.8.5 Industrial ergonomics Professor: Aleksandar Žurjić	Final course with a report (B.Sc. work)
8		Programming		Computer tools			
9			Introduction to industrial engineering Professor: Dragan D. Milanović				
10			Engineering economy analysis Professor:				

Table 3. Basic academic studies (Bachelor)

Table 4 presents subject modules and elective subjects of the section of Industrial Engineering Master of academic studies as well as the names of the teachers.

INDUSTRIAL ENGINEERING – Master studies			
1 <sup>st</sup> year		2 <sup>nd</sup> year	
7	8	9	10
1.1.5 Production management 2 <i>Professor: Dragan D. Milanović</i>	2.1.5 Industrial logistics <i>Professor: Dušan Petrović</i>	3.1.5 Operations research <i>Professor: Uglješa Bugarić</i>	4.9 M.Sc. thesis (Diploma work)
1.2.5 Quantitative methods <i>Professor: Zorica Veljković</i>	2.2.5 Ergonomics design <i>Professor: Aleksandar Žunjić</i>	3.2.5 Database <i>Professor: Mirjana Misita</i>	
Mechanics M or Fluid mechanics M	2.3.5 Engineering economy <i>Professor: Dragan Lj. Milanović</i>	3.3.5 Industrial management <i>Professor: Slobodan Pokrajac</i>	
Thermodynamics M or Mechatronics	2.4.5 Terotechnology risk management <i>Professor: Vesna Spasojević Brkić</i>	3.4.5 Organizational design <i>Professor: Vesna Spasojević Brkić</i>	
1.5.5 Management information systems <i>Professor: Mirjana Misita</i>	2.5.5 Design of logistic and warehouse systems <i>Professors: Dušan Petrović Uglješa Bugarić</i>	3.5.5 System man-machine design <i>Professor: Aleksandar Žunjić</i>	

Table 4. Master academic studies

The most important resource of this section, are the employees at the Department of Industrial Engineering. Department consists of three organizational units: Department of Industrial Engineering consisting of nine graduate mechanical engineers, the Cabinet for social and economic sciences which consists of three graduate economists and Department of Foreign Languages, which has 2 English language lecturers.

Department of Industrial Engineering	<ol style="list-style-type: none"> <li>1. Prof. PhD Dragan D. Milanović</li> <li>2. Asoc.prof. PhD Uglješa Bugarić</li> <li>3. Asoc.prof. PhD Dragan Lj. Milanović</li> <li>4. Asoc.prof. PhD Vesna Spasojević-Brkić</li> <li>5. Asoc.prof. PhD Aleksandar Žunjić</li> <li>6. Asoc.prof. PhD Dušan Petrović</li> <li>7. Ass.prof. PhD Zorica Veljković</li> <li>8. Ass.prof. PhD Mirjana Misita</li> <li>9. MSc Tamara Sedmak, assistant</li> </ol>
The cabinet for social and economic sciences	<ol style="list-style-type: none"> <li>1. Prof.PhD Slobodan Pokrajac</li> <li>2. Asoc.prof. PhD Nikola Dondur</li> <li>3. MSc Sonja Josipović, assistant</li> </ol>
Department of foreign languages	<ol style="list-style-type: none"> <li>1. Mr Nada Krnjajić-Cekić</li> <li>2. Mr Tijana Vesić-Pavlović</li> </ol>

Table 5. Teaching staff and co-workers for the Industrial Engineering section

Table 5 shows personnel employed at the Department of Industrial Engineering. Along with the full commitment to teaching and working with students, teachers and staff also achieve significant results in scientific research in the field of industrial engineering. As a contribution to that statement there is a large number of papers published in international and national journals and at conferences. Books for almost all subjects and a number of monographs in the field of industrial engineering have been published as well. At the same time members of the Department participate in several national and international projects. Actual projects at this moment are:

1. Design and evaluation of user interface for remote collaborative management of production systems, bilateral cooperation - program of scientific and technological cooperation between Serbia and the Republic of Portugal for the period of 2011-2012.
2. Development of new generation of crane cabins as integrated visual systems for detection and interpretation of environment, Eureka project, E16761, 2011-2014.
3. TR 35017 - Development of a stochastic model of determining the elements of the cycle time of production and their optimization for series production in the metal industry and in the process of recycling, MPNRS, 2011-2014.
4. FP7 – iNTEgRisk, Early Recognition, Monitoring and Integrated, Management of Emerging, New Technology Related Risks, 2008-2013. Coordinator: EU-VRi European Virtual Institute for Integrated Risk.
5. Development and conquering of economic and special systems for the use and maintenance of fleets of vehicles and the development and implementation of an appropriate information system, Ministry of Science and Environmental Protection, the period of 2008-2011.

Department of Industrial Engineering has very good and successful cooperation with universities: Universidade do Minho, Braga/Guimaraes, PORTUGAL, University of Alberta Edmonton, Alberta CANADA and Universitat de Girona, Girona, SPAIN. This cooperation is significant in terms of internationalization of teaching processes and adjustment of plans and programs with the European and International university standards, to ensure mobility of students and professors.

## PERSPECTIVES OF INDUSTRIAL ENGINEERING

During the last few years, department has made effort to improve the laboratory work by purchasing new equipment. Providing funds for equipment and laboratory accreditation is one of the most important tasks in the near future.

Department of Industrial Engineering aims to follow the development of industrial engineering, which,

significantly differs from Industrial Engineering at its beginning. The scope of theoretical knowledge is getting wider, new methods and techniques are developing and perfecting, which is increasing the use of computers and other technical systems to solve problems in this area [7]. That is why the teachers and co-workers are being asked to continuously improve and coordinate teaching plans and study programs. Earlier studies presented in literature [5] and surveys with graduates, students and employers have revealed that IE education has problems such as theoretical approach to problem solving, insufficient understanding of real-life problems, and poor communication skills.

The last time that new teaching plans and programs were formed in accordance with the Bologna Declaration was in 2005. In 2010 their modification was carried out and since then they are under constant supervision and control of the teachers. It is required from students, in addition to current knowledge, to constantly improve knowledge and application of information technology in order to successfully manage and make decisions in companies. Large dynamic of events in the field of industrial engineering requires expertise and wisdom of teachers to maintain permanent knowledge and basis of industrial engineering as well as adaptability and flexibility, brought by the times in which we operate and live.

The labour market in the EU is evolving towards the service sector even if manufacturing still represents a significant share of both IE employment and gross domestic product. On average, IE in the EU is still within the framework of the 'market-driven' paradigm, which contrasts with the knowledge society aims pursued by the 'Bologna process'. R&D resources and human capital are identified as major success factors to overcome current limits for IE development in the EU [9].

Perhaps the most critical issue facing Industrial Engineering still is the need to increase the visibility of educational and career opportunities, going together with lack of knowledge about what Industrial Engineering Technology is since industrial engineers job titles differ from their profession's name [7].

To solve future challenges Quality Function Deployment framework usage is proposed. Good practice of QFD usage is seen in Sweden, where QFD process was used to develop a Mechanical Engineering Programme which was more responsive

to changes in industry [11] and to improve IE education quality at the Middle East Technical University in Turkey [12].

## LITERATURE

- [1] Ćosić I., Šešlija D., Ignjatovic J., "The development of industrial engineering education", Proceedings of the "Organizational Science - The Challenge for the 21st century", Belgrade, 2011, pp. 17-44. (in Serbian)
- [2] Maynard, HB, "Industrial Engineering", Economic Review, 1993. (in Serbian)
- [3] Bulat, V., "The mission of industrial engineering", Proceedings of the SIE '96, Belgrade, 1996, pp. 22-25. (in Serbian)
- [4] Daneshvar Rouyendegh B., Feryal Canb G., "Selection of working area for industrial engineering students", Procedia - Social and Behavioral Sciences 31, 2012, pp. 15-19.
- [5] Koksai G., Egitman A., "Planning and Design of Industrial Engineering Education Quality", Computers Ind. Engng Vol. 35, Nos 3-4, 1998, pp. 639-642
- [6] Salvendy G., "Handbook of Industrial Engineering", John Wiley and Sons, New York, 1982.
- [7] Mott, R., Neff, G., Stratton, M. Summers, D., "Future Directions For Mechanical, Manufacturing, And Industrial Engineering Technology Programs", Journal of Engineering Technology, 2002, vol. 91 2002, pp. 8-15,
- [8] Summers, D. "An Industrial Engineering Technology Curriculum for the Millennium", ASEE Annual Conference, Session 3248, 2000.
- [9] Mummolo G., The future for industrial engineers: education and research opportunities, European Journal of Engineering Education, Volume 32, Issue 5, 2007, pp. 587-598.
- [10] Benjamin C.O., Monplaisir L., Sankat C.K., Thompson D., "Industrial Engineering Education and Research: Current Issues and Future Directions for the Caribbean", The Journal of the Association of Professional Engineers of Trinidad and Tobago, Vol.37, No.1, October 2008, pp. 4-16.
- [11] Nilsson, P., Lofgren, B., and. Erixon, G., "QFD in the development of engineering studies", Transactions from the Seventh Symposium on Quality Function Deployment, Novi, Michigan, Ann Arbor, MI: QFD Institute, 1995, pp. 519-529.
- [12] Koksai, G. and Egitman, A., "Planning and design of industrial engineering education quality", Computers in Industrial Engineering, Vol. 35, No. 3, December, 1998, pp. 639-642.