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Message of Editor in Chief

Journal entries this year at 39 year of regular publication, ranking it among the magazines with the longest tradition of publishing in our country. Since the mid nineties, it began to publish their papers, scientists and experts from abroad, so that, after two thousand, as a rule, a number was in English. Since then (two thousand years), to date, came the forty numbers, published about 1500 papers (over 30% of the articles were in English), appeared around 3200 authors from over 60 countries.

Since 2004. years, we have officially promoted it as international, which are due Kobson and SCI (Serbian Citation Index), have become"visible"in the world you can check by searching Google Scholar. The last two years we have made further impruvements in the preparation and editing papers, bringing them in content and appearance to the level of papers from the most famous international journals with SCI index.

Our goal is to make the journal in the shortest possible time with the domestic, cross the International SCI lists.

In Belgrade, 30th March 2011.

Prof. Dr. Vidosav D. Majstorović

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The main objective of the Journal is to provide an *international forum for the exchange of knowledge, experience, research results and information* about various aspects of the state-of-the-art and the future development of total quality management and publishing only orginal articles.

The *scope* of the Journal covers *philosophical, scientific and practical concepts concerning research, development and application* of TQM-based advanced approaches.

Topics of interest include, but are not limited to:

- *Business excellence models (applications and development trends);*
- *TQM & manufacturing management;*
- *Quality Management and Integrated Management Systems*
- *World class performance;*
- *Attractive quality;*
- *Robust engineering;*
- *Six sigma model;*
- *Intelligent quality tools and methods;*
- *Virtual factory and virtual quality;*
- *Intelligent metrology in manufacturing;*
- *Intelligent and virtual CMM;*
- *Business process improvement;*
- *Breakthrough management;*
- *Organizational Excellence;*
- *Intelligem design for quality;*
- *Intelligent Business;*
- *Quality in Higher Education;*
- *Quality of the Public Services / health care;*
- *Advanced Quality approaches;*
- *Digital engineering/manufacturing;*
- Manu*future* initiative *and Micro-nano manufacturing / Metrology.*

Peer Review Policy

All articles in this journal have undergone rigorous peer review, based on initial editor screening and anonymous double-blind review.

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Manuscripts should be sent both as a Word and a PDF document to jusk@eunet.rs. The PDF document must be review friendly so all figures and tables must be included in the text. Please visit www.jusk.org for instructions for author or ask jusk@eunet.rs for template of paper.

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Appendix:

USING A PORTFOLIO OF BUSINESS GAMES IN THE HIGHER EDUCATION OF INDUSTRIAL AND MECHANICAL ENGINEERS – THEORETICAL AND PRACTICAL EXPERIENCES GAINED AT THE VIENNA UNIVERSITY OF TECHNOLOGY

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Abstract: *At the Department of Industrial and Systems Engineering at the Vienna University of Technology (VUT) a very differentiated teaching approach is used in the field of industrial engineering. Selecting the relevant knowledge domains for industrial engineers on the job in the German-speaking world, a comprehensive profile of requirements of operational competencies has been identified. Based on that and the state-of-the-art knowledge in the field of cognitive science, didactic ways and methodologies have been deducted to help the students develop the skills needed. This paper elaborates especially on activity-based learning in context of business games. The resulting insights can lead to broad usage of business games in the education of industrial and manufacturing engineers.*

Key Words: *Industrial Engineering Competencies, Industrial Engineering Education, Business Games.*

1. KNOWLEDGE DOMAINS OF FUTURE INDUSTRIAL ENGINEERS

The increasing complexity in our corporate world results in a steady demand for employees who are capable of keeping track of the business unit as a whole. To achieve this goal, both a diversified education and the ability to get familiar with complex subject areas and situations quickly and thoroughly are essential. To prepare industrial engineering students for this challenge and make all-rounder out of them, the two main pillars - industrial economics and engineering - are combined in an integrative approach, to give them the ability to independently deal with diverse tasks, and enable their so called operational competence [1]. Operational competence is defined as the interaction of professional, methodical, social [2] and personal competency [3].

1.1 Social and personal competency

These two levels of competence are sometimes referred to as soft skills in literature. Social competency describes different personality traits that influence the way people interact with one another [4] whereas personal competency is the ability to assess situations, to act systematically and to focus on goals. These competencies have evolved over time through interactions with the environment and can only be developed within certain bounds [5]. Because of that, imparting soft skills, especially in academic education, is by far more difficult than teaching technical or professional skills. Therefore, the key for teaching social and personal competency at university successfully, lies in the extensive use of team work, discussions and presentations in the courses.

Table 1 includes a list of skills in the field of social and personal competency, that are important to future industrial engineers. The primary source of these skills is a study, which deals with industrial engineering education in Germany [1].Therefore, to achieve environment adequate operational competence for all alumni, the university has to ensure that all parts of this model are equally well covered and coordinated during academic education. Based on the latest scientific and applied discourse in the German-speaking world, concrete knowledge domains and skills of future industrial engineers have been collected.

Table 1. Soft Skills

soft skills
social competency
capacity for teamwork, ability to cooperate, ability to manage conflict, communication skill, foreign languages, rhetorical skills, international/intercultural skills, ability to motivate others, sense of responsibility, assertiveness, decisiveness, leadership potential, appropriate behavior
personal competency
autonomy, reflexivity, assertiveness, creativity, ability to self-motivate, goal-oriented behavior, willingness to perform / ability to work under pressure, readiness to make decisions, flexibility, concentrativeness, willingness to familiarize oneself with new subject areas, integrity

1.2 Methodical and professional competency

Methodical competency is defined as the ability to effectively apply methodical procedures of problem-solving [1], therefore it includes the basic knowledge of working techniques and procedures. Professional competency ultimately describes knowledge of the occupational area itself, or, in other words, expertise [6].

Table 2 gives an overlook of the expertise and methodical skills, an industrial engineer in the field of

mechanical engineering should have from a Central European point of view. The results of an IfaA task force [7], consisting of members of several large German industrial enterprises, who discussed the future requirements of industrial engineers, serves as a basis for this enumeration. The results of this task force have been complemented with findings of Baumgartner et. al.[1], the MTM Basic - IE training course manual [8] and the IfaA trend indicator [9] as well as the curricula for industrial engineers in the field of mechanical engineering at the Universities of Technology Dortmund and Graz, the RWTH Aachen and the Karlsruhe Institute of Technology.

These are instructions for authors typesetting for the International Journal Total Quality Management & Excellence.

Table 2. Hard skills of future industrial engineers

hard skills – factor personnel
human resources management
capacity / staff planning, employee motivation, requirements analysis, performance assessment, compensation regulation, remuneration group definition, work time models / shift planning, management style, group and team work
Qualification
methodology competency, work instruction, employee training, information management, staff briefing
ergonomics & safety
motion studies, workplace design, work process planning, accident prevention / instructions, safety at work, workload and satisfaction analysis

hard skills – factor material
logistics, material management and internal transport
container management / load carrier, supply chain management, process organization, material flow optimization, logistics planning, supplier management, storage, JIT / JIS, milk runs, variant management, range of coverage, material requirements planning, bill of material usage, make-or-buy decision, material stock and material in circulation

hard skills - factor machinery
operating means planning, manufacturing facility design and plant layout
functional specifications, machine programming, tool management, machinery layout planning, jigs and fixtures design, toolingmachine design, operating means and installation optimization, equipment planning, procurement of spare parts and replacements
manufacture technique and planning
optimization of technology and processing operation, cost accounting technology and processing, selection of processing steps and sequence, selection of technology / new technologies

hard skills - factor processes
manufacturing systems
lean production implementation, design for manufacturing and assembly, CIP (continuous improvement process), standardized tasks, 5S, value stream analysis and mapping
improvements management
failure and quality measurements (DOE, FMEA, SPC etc.), design change, employee suggestion program, value analysis, improvement of methods, product and process quality improvement and assurance, project management, risk assessment, six sigma, total quality management
maintenance
TPM (total productive maintenance), maintenance and service, reliability testing
production planning and control
process organization, process flow optimization, batch sizing, work process analysis, definition of work operations and sequences, process inspection, production and schedule monitoring
work preparation and time management
throughput time measurement and optimization, phasing and sequencing, process planning, shift and capacity planning, work plan creation, work evaluation, allowed time calculation, performance degree evaluation, allowance time surcharge evaluation, work structurization, time studies, job description/description of activities, work instruction, work method standardization, work method analysis and optimization, automation / mechanization
layout planning
factory planning and design, indoor layout planning

hard skills – superordinate issues
business administration
accounting, calculation of cost, cost accounting, financial controlling, location decision-making, benchmarks (national/international), performance measuring / KPI, performance remuneration design
labor law
company agreements, communication with works council, occupational health and safety regulations

2. DIDACTIC CONCEPT OF THE DEPARTMENT OF INDUSTRIAL AND SYSTEMS

Based on this comprehensive profile of industrial engineering requirements and state-of-the-art knowledge in the field of cognitive science, the Department of Industrial and Systems Engineering at VUT established didactic and methodological ways to help the students develop the skills needed. Starting with traditional attendance courses via different eLearning approaches to physical business games and complex computer-based simulations, a great variety of different methodologies is used. All these methodologies can be assigned to three different teaching principles:

- . Auditory and visual learning – at attendance courses.
- . Autonomous learning, self-examination and repetition – with blended learning courses.
- . Activity- and problem-based learning – with business games.

Using these three methods, which meet the needs of all types of learners, the students get a holistic understanding of planning, managing, organizing, improving and simulating business processes. In this context, holistic understanding includes theoretical concepts and models as well as practical methods and their application plus all aspects in between.

2.1 Attendance courses with eLearning enrichment

All students at the Department of Industrial and Systems Engineering start their academic career with basic knowledge courses. Most of these courses are held as lectures, but also with these traditional lectures the full potential, which arises from the use of information technology, is taped out. Therefore in a strict sense, all courses use some kind of eLearning approach, for example tables, diagrams, animations or video sequences are presented in the lectures, as well as electronic scripts, lecture slides or further information material, which are made available for download.

2.2 Blended learning approach

The Internet provides alternative methods of communication and cooperation as well as new approaches to independently acquire knowledge in specified subject areas. Especially the autonomy in the learning process leads to a higher degree of self-organization of the students and promotes the development of media literacy [10].

Blended learning is an integrative approach, which includes attendance classes as well as autonomous online learning as equally important components. As to that, a combination of attendance classes, audio-visual online presentations, online multiple choice tests, a bulletin board and hard copy scripts give the students an understanding of the subject matter in a smart way. The basic idea behind this activity-based, hybrid approach is to give the students the opportunity of flexible and independent learning as well as to enable and ensure the sustainability of knowledge acquisition. The great advantage of this approach is that a by far larger number of students can be reached a lot more effectively, than without eLearning.

2.3 Activity- and problem-based learning

The main idea of activity-based learning is to let the students, in the true sense of the word, experience the so far learned theories, methods and tools. To accomplish that, acting, by itself, is used as a teaching method. Mostly through business games the students are brought into situations, where they have to participate actively in solving a problem or get a task done. Therefore the main goal of activity-based learning is to cultivate operational competence [3]. Another important objective is to generate transferable knowledge in order to close the gap between knowledge and action. Graduates often lack the skill to apply academic knowledge to occupational problems, in particular to assess, diagnose and manage authentic labor situations.

Problem-based learning extends this concept by putting an incompletely formulated problem description at the beginning of the learning process, so that the first step for the students in solving such a problem is to define, analyze and structure it. Hence these problems are not well-defined, like those being used to deepen or test the already present knowledge, but ill-defined. Ill-defined problems deal with realistic real-world topics, mostly in the form of a case study that allows different solution processes, and pushes the students to acquire new knowledge [11]. For this reason, the problem formulation should be chosen in a way, where the existing skills of the students are not sufficient to be able to define a solution, which motivates them to autonomously acquire the further knowledge needed. To sum up, problem oriented education helps the students to develop the power of judgement, and it trains them using social and informational resources to find practicable solutions to complex problems [11].

A big advantage of business games in activity oriented education is that students get immediate feedback on the effects of their actions for the sequel or outcome of the game situation. Thus they can test different decisions, actions and principles and therefore verify and consolidate theories they learned in previous lectures. Especially this practice-oriented, autonomous use of all their so far at university adopted knowledge leads to extremely motivated students [12]. Furthermore business games enable the students to trial and error on a wide variety of topics without the fear of any consequences whatsoever. This process of making mistakes explicitly is a fundamental part of the learning which helps the students develop a no blame culture and the need to sometimes think outside the box [11].

There are three categories of business or simulation games: those that primarily support tactical skills like pilot training in flight simulators, those that help the students create new knowledge and understanding like business simulations, and finally those that boost strategic acting [10]. To support industrial engineer education, the Department of Industrial and Systems Engineering uses the latter two categories of business games. As an example, the emergence of the Bullwhip Effect can be shown to students really strikingly by simulating a supply chain. By changing different system parameters, the students can identify coherences and structures of the simulated world. They can build up and verify their own cognitive model of that economic effect [13].

In addition to transfer of methodical and professional knowledge, or hard skills, business games are also a perfect match to promote autonomous, goal-oriented working in interdisciplinary and sometimes even international teams, which ultimately helps to develop soft skills. Due to the fact that especially social and personal competencies are emerging as major needs for future industrial engineers, the significant amount of additional time needed to coordinate the teamwork should be gladly accepted [2]. Experience has also shown, that all students are highly motivated when it comes to business games. This motivation can be explained through a realistic subject-specific task as well as through the opportunity to work in teams and make decisions under time pressure in a close to reality environment.

3. BUSINESS GAMES OFFERED AT THE DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

At Vienna University of Technology, the industrial engineering students can choose from a wide variety of different business games. All these games have in common that they are thematically settled in important operating areas of future industrial engineers.

The innovative concept of business game usage is based on a holistic view on the value-adding chain. The key element of all business games is a fictitious training factory. Inside this factory business games that, for example, deal with general management, digital factory planning or assembly optimization are established. At the edge of the training factory business games are situated that deal with logistics topics like supply chain management or milkruns. This approach helps to give the students an integrated understanding (theoretical concepts, methods, models) on planning, design, management, improvement and simulation of a manufacturing process and a supply chain as a whole.

The following paragraphs (3.1. – 3.7.) give an overview of all currently offered business games by the Institute of Management Sciences (Departement of Industrial Engineering) at Vienna University of Technology.

3.1. General Management business game

This computer based competitive business game simulates an oligopoly of several enterprises in the same industry. All of these companies are represented by a decision team of students who try to maximize their own company's profit. The effects of their management decisions (production planning, logistical decisions, human resource issues, financial aspects, risk decisions, etc.) are presented to the students as figures of the profit and loss statement and the balance sheet. This business game is designed to teach the students entrepreneurial and holistic thinking.

3.2. Supply Chain business game

Basically, this business game is an internet-based adaption of the 1960 at the Massachusetts Institute of Technology developed 'MIT Beer Distribution Game'. It's a simulation of a four-stage supply chain that illustrates the Bullwhip Effect by game theory. The students learn to know, in an impressive manner, the importance of an integrated information exchange along the supply chain.

3.3. Milkrun business game

Based on a variety of information the students have to develop optimized transport concepts for an entire supply chain. They have to define transport routes, include suppliers into these routes and ascertain delivery frequencies. With the help of this business game, students realize the potential of milkruns in supply logistics by an autonomously performed case study.

3.4. Production Planning business game

Production planning and control is the basis of every manufacturing company and should therefore be adequately trained by industrial engineering students. This business game simulates a manufacturing process with five different working stations (planning, picking/warehouse, preliminary assembly, final assembly, quality assurance, outbound logistics) and a customer. The students have to assembly different basic shapes out of magnetic rods and metal balls. At a later stage they have to put together these basic shapes to build a range of products that the customer can order. By using different production planning and control methods throughout the game, the students understand the benefits as well as the problems of the different approaches.

3.5. Lean-Assembly business game

In this business game the students learn, with the aid of Lego Technic wheel loaders, to implement and optimize a flow manufacturing approach step by step. They have to plan and realize the whole manufacturing process. While assembling the wheel loaders they have to measure the throughput of their assembly line.

With this business game, the students practice value stream mapping, time management methods, ergonomic workstation design, manufacturing control and logistical issues resulting in sustainable knowledge of these topics.

3.6. Lean Office business game

The participants of the Lean Office business game learn in teamwork to systematically identify weaknesses in administrative processes and take remedial action to optimize these processes. At the beginning of this case study is a company that faces a capacity bottleneck at the ordering process that leads to dissatisfied customers. Throughout a series of game-rounds, the students have to continuously analyze and optimize the ordering process.

3.7. Digital Factory Planning business game

Due to its intense nature, this business game is, in addition to the General Management business game, the top-of-the-range offer for the students. It covers all aspects of material flow planning, indoor layout design and (digital) factory planning. The game is characterized through very frequent use of IT technologies in the form of factory planning tools as well as web-based communication systems. Because this business game is played in cooperation with partner universities in Europe and the US, the students have to interact with their fellow team members over electronic communication channels, to work on the planning project.

4. BUSINESS GAMES EMBEDDED IN THE CURRICULUM

Table 3 establishes the connection between the business games and all for this paper relevant courses in the industrial engineering curriculum of Vienna University of Technology in its relevant version of October 2009. The table illustrates the coverage of all in the first part of this paper identified competency areas by the presented business games. It is completed by all those courses of the curriculum that try to establish the same skills in a traditional manner.

Table 3. Overview of competency areas covered by business games and traditional courses

			Soft Skills		Hard Skills															
			social competency	personal competency	human resources	qualification	ergonomics and safety	logistics, …	operating means planning, …	manufacture technique, …	manufacturing systems	improvements management	maintenance	production planning, …	work preparation, …	layout planning	business administration	labor law
business games		General Management	■	■	■			■	■				■	■			■	
		Supply Chain Management	■	■				■						■				
		Milk-Run	■	■	■	■		■			■			■	■	■		
		Production Planning and Control	■	■		■		■			■	■		■	■			
		Lean-Assembly / Training Factory	■	■	■	■	■	■			■	■		■	■	■		
		Lean-Office	■	■	■	■					■	■		■	■			
		Digital Factory Planning and Design	■	■				■	■		■	■		■		■		
industrial engineering courses at TU Vienna including ECTS (abridged version of the curriculum)	bachelor	Accounting	6														■	
		Basics of Cost Accounting	3														■	
		Basics of Finance	4														■	
		Corporate Planning and Control	3														■	
		Fundamentals about Engineering Design	3						■									
		Fundamentals about Transportation Systems	3					■										
		Fundamentals of Manufacturing Engineering	5							■								
		Industrial Law and Social Legislation	3															■
		Industrial Manufacturing Systems	4							■								
		Labor Science	4				■											
		Logistics	4					■								■		
		Machine Elements Design Practical	7						■									
		Machining and Forming	3							■								
		Methods in Product Development	4									■						
		Human Resource Management	4		■	■											■	
		Product Management	3							■								
		Production Management	4					■			■	■		■	■			
		Soft Skill Lectures	9	■	■													
		Stochastic	3														■	
		Systems Design and Project Management	3									■						
	master	Business Evaluation	5			■												
		Corporate Strategic Planning Simulation	3														■	
		Digital Factory Planning	2													■		
		Ergonomic Design and Occupational Safety	3				■									■		
		Factory Planning	5													■		
		Human Personnel Management	3		■	■												
		Industrial Psychology	3	■														
		Logistics in Automotive Industry	3					■								■		
		Maintenance and Reliability	3										■					
		Modern Methods in Production Management	3								■							
		NC Machine Tools	3							■								
		Occupational Health and Safety Act in Practice	3															■
		Process Management	6									■			■			
		Production Control (PROST)	3											■				
		Production Logistics	3					■						■				
		Production Planning and Control Systems	3											■				
		Project Management	4									■						
		Quality Management	3									■					■	
		Quality Management Tools	3									■						
		Selforganizing Production Systems	3								■							
		Soft Skill Lectures	4,5	■	■													
		Strategic Management	3														■	
		Supply Chain Management and Procurement	3					■										
		Work Planning and Control	5											■	■			

The relevance of business games in higher education of industrial engineers at Vienna University of Technology can be shown through interpretation of Table 3 on the basis of the European Credit Transfer and Accumulation System (ECTS). Bachelor students have the possibility to additionally enhance issue-areas of courses worth up to 64 credits (out of 180 credits required for a bachelor degree) through business games. The topics of master courses worth up to 76.5 ECTS (out of 120 ECTS required) are supported by business games meaning that, theoretically, industrial engineering students at TU Vienna can cover and deepen the topics of about 36% of bachelor-courses and up to 64% of master-courses by business games. This noticeable increase is explained by the fact that most of the business games are addressed by students in higher semesters already have gathered knowledge of the topics through classic courses and lectures.

Furthermore, the business games of the Department of Industrial and Systems Engineering

5. CONCLUSION

The offered business games support an optimal combination of methodical and professional competency as well as social and personal competency in higher education at Vienna University of Technology. As mentioned at the beginning, this ultimately leads to empowerment and operational competence of the alumni. By operating the business games, the future industrial and manufacturing engineers have the possibility to interdisciplinarily interconnect and consolidate with all of at the university adopted knowledge. This is especially important for employees in management positions, as many engineers will become sooner or later. They have to be capable of making decisions on the basis of comprehensive company information from different subject areas and implement them with determination.

Due to the fact that most of the business games are pretty new, there is as yet only qualitative feedback from the students themselves that unanimously confirms the benefits of the use of business games. Further qualitative research on the impacts of business games on higher education of industrial engineers is planned as soon as there is sufficient data available.

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