



M.S. Gusarova

UDC 378

## Developing Managerial Competencies of Master's Civil Engineering Students By Introducing Modern Teaching Techniques

M.S. Gusarova<sup>1</sup>

<sup>1</sup>Tyumen Industrial University, Tyumen, Russia

Received: 14.12.2016 / Accepted: 05.06.2017 / Published online: 31.12.2017

### Abstract

The article proposes the design of a unique course "Design HR engineering" for master's civil engineering students, which is aimed at shaping managerial competencies. The course is intended to develop managerial competencies by means of active teaching techniques: business games, project teams, case-studies, workshops. These teaching techniques contribute to developing leadership skills within the formats that are familiar to future engineers (engineering and project-based approach).

**Key words:** leadership, project team, managerial competencies, engineering education, managerial techniques and tools.

### Introduction

The modern economy of Russia has challenged the education system in terms of the need for revision of the programmes in order to train a highly-skilled leader who is able to make breakthroughs in technological fields.

According to the data presented in journal "Engineering Education", more than 60 % of students enrolled in various engineering programmes demonstrate low or middle level of leadership skills, which does not meet the Washington Accord (WA) requirements. This contradiction between the development level, requirements towards graduates' leadership skills and EQ structures allows drawing conclusion on the cause-effect relationship between improvement of professional and leadership skills of higher engineering universities' graduates and engineering education system itself [1, p. 121].

Introduction of competency-based approach into the system of higher engineering education, stated in the

Federal State Education Standard of Higher Education and professional standards, is one of the most important changes in recent years. E.V. Galanina noted: "the standards of engineering education in Russian is currently being revised, i.e. waiver of narrow focus of most engineering programmes and so-called "humanitarian, communicative-oriented shift" [2].

However, despite the positive trends, there are still certain traditional contradictions in engineering education. Precisely, interdisciplinary principle and project-oriented approach have not been sufficiently implemented. There is lack of management programmes.

### Implementing new approach to engineering training

In our opinion, traditional approaches to designing and implementing education programmes, as well as functional principle in defining the disciplines for students to attend, are the reasons for the above-mentioned contradictions. According to the learning outcomes of master's civil

engineering programmes, students should be trained not only within technical spheres, but also acquire knowledge of business communication with resource providers, personnel, and customers, work as a member of project teams, assume responsibility, in other words, they should be able to apply the required strategies and technologies in human resources management.

A young highly-skilled civil engineer may build his/her career within a short time and occupy senior position at the age of 25-30. Such managers often do not satisfy basic requirements, which leads to disappointment in the chosen profession and his/her competence. Technocracy is not always successful. To manage effectively, a young manager needs to shape basic skills of project management, management of human resources, situation-related leadership, and team work. Thus, the need to develop these skills as the result of engineering programme completion is obvious. The socio-humanitarian disciplines embedded into engineering programmes are usually taught in traditional manner. Such didactic approach to training engineers is insufficient as they need knowledge of real influence tactics upon their subordinates and interpersonal communication, ability to predict the consequences of their social activity. Therefore, it is urgent to search for new disciplines and training techniques.

Competency-based approach stated in the Federal State Education Standards of Higher Education (FSES HE) is an adequate training tool in modern knowledge-based economy. New version of the FSES HE includes cross-cultural and integrated professional competencies of an engineer-manager (CCC-2, IPC-2, IPC-3, PC-15, PC-17) which can be hardly developed within the traditional humanitarian disciplines, as well as some professional ones. There is a need to search for new training tools and formats.

The review of the recent education techniques, related to the same spectrum of problems and tasks within master's engineering programmes both in Russia and

abroad, has revealed the facts presented in table 1.

In Russia, engineering education is modernized on the basis of the CDIO concept [3] which is aimed at training graduates who are ready for complex engineering activity at all stages of the life cycle of products, processes and systems.

Overseas experience shows that most advanced and some developing countries have already created or have been creating conditions for implementing the CDIO initiative. The programmes include necessary disciplines and courses.

The analysis of more than 60 Russian master's programmes "Civil engineering" offered at 8 national research technical universities and 4 civil engineering universities has shown that the mentioned-above competencies are basically shaped within humanitarian disciplines, such as "Fundamentals of Pedagogy and Andragogy" (50 programmes), "Psychology and ethics of business communication", "Social, psychological, and legal communications", "Research fundamentals", "Fundamentals of professional activity" (these disciplines take the 2nd place), as well as final state certification and teaching practice. "Philosophical issues of science and engineering", "Planning and management in civil engineering", "Quality management", "Methods to solve research and engineering tasks in civil engineering" which are not necessary aimed at shaping the discussed competencies are less common. It is possible to state that trying to introduce modern teaching techniques universities follow the tradition and do not always incorporate more relevant disciplines and courses. There is only one programme "Value engineering", offered by Rostov University of Architecture and Civil Engineering, that includes the discipline "Management of human resources". This discipline is closest to the idea of shaping managerial competencies.

At Industrial University of Tyumen, due to the program of higher education "Personnel management" that has been successfully implemented for more than 10 years,

Table1. Education techniques analysis

University/education standard	Practice	Main trends
International experience		
International standards CDIO – (Conceive, Design, Implement, Operate), MIT (Massachusetts Institute of Technology)	According to the CDIO concept, engineering education revision is rooted in training graduates who are ready for complex engineering activity	The standards imply consistent training of engineers who are able to generate idea, design, to produce, operate and utilize the products of engineering activity – perform 4 basic engineering activities
RMUTT Rajamangala University of Technology Thanyaburi (RMUTT), Thailand	Industrial engineering programme/ Programme implementation – 2015	The focus is made on shaping and developing communication and interpersonal skills, as well as ability to work in a project team. The discipline “Management of Human Resources” is introduced in the second semester of the first year of education
Singapore Polytechnic, Сингапур	New adapted vocational programmes have been developed. They are based on the learning outcomes stated in the CDIO concept	In addition to fundamental competences, there are also the following competencies: ability to solve problems, ability to manage human resources, skills in team work and interpersonal communication
University of Debrecen	It is currently addressing the issue of “poor training of engineering graduates in terms of professional and universal skills and competencies”	Humanitarian sciences and economics account for 16% of work load; various interdisciplinary programmes are designed
National universities		
National Research Tomsk Polytechnic University	In 2012, new version of «Standards and guidance on ensuring quality of basic education programmes on priority directions of university development” was implemented	Additional education programme “Elite engineering education” implemented alongside basic programmes was developed. The programme includes module “Innovative leadership”
Siberian Federal University	Training techniques and professional competencies are developed within the programmes of the project “Special engineering education” at networking	The curriculum of discipline “Design fundamentals” includes the module “Company project management” which incorporates «Company and personnel management”, “Leadership programme” (Leader and team work – practical course)
Kazan National Research technological University	Training graduates for “the economy of new knowledge”	The focus is made on shaping leadership skills, individual intellectual resources within the module “Psychology”
Northern (Arctic) Federal University	Engineering education programmes are revised according to the CDIO concept	The programmes include: strategic planning, research practice, internship, management practice

University/education standard	Practice	Main trends
Gubkin Russian State University of Oil and Gas	Interdisciplinary approach is implemented into innovative projects of the university of the 21st century aimed at developing competencies of young specialists and engineers	“Virtual environment of professional activity as education environment” and “Joint virtual training for students of various programmes” are of particular interest. The disadvantage is complex methodology in development of cases
Peter the Great St. Petersburg Polytechnic University	Additional education programmes “Manager of a building company”, etc., aimed at shaping economy related and managerial competencies	Module 10 “Personnel management” Module 2. Management of project team in programme “Economy and organization of constructions” Module 9 “Business communication and personnel management” in the programme “Manager of a building company”
Universities of civil engineering (based on website monitoring)		
Moscow State University of Civil Engineering, Saint Petersburg State University of Architecture and Civil Engineering, Novosibirsk State University of Architecture and Civil Engineering, Rostov University of Architecture and Civil Engineering	Disciplines and practice courses: Philosophical issues in science and engineering; Social, psychological and legal communication; Planning and management of transport facilities construction; Mathematical modelling; Methods for problem solving in civil engineering; Quality management in road construction; New composite road-building materials; internship aimed at shaping basic professional competencies and teaching skills); State Final Certification	The programmes are mainly compiled on the basis of didactic approach, with certain disciplines (internship plans) including development of the required competencies. There is no complex system of shaping managerial competencies
Tyumen Industrial University		
Tyumen Industrial University	Disciplines and practice courses: Psychology and ethics of professional activity; Personnel management; Research practice; Internship aimed at shaping professional competencies and skills; State Final Examination	The programmes are mainly compiled on the basis of didactic approach, with certain disciplines (internship plans) including development of the required competencies. The managerial competence is shaped due to introduction of great number of courses on management of personnel, company, and projects into various programmes

the special training approach that helps educators shape the required competencies was developed. It implies introduction of discipline "Personnel management" as a basic subject of B1 cycle (the 2nd semester) into all master's programmes offered at the university. This discipline is an interdisciplinary course which is rather labor-intensive and characterized by the structure given in table 2 (by the example of master's programme "Management of building company", 08.04.01 "Civil engineering in terms of acquired competencies").

The discipline is delivered on the basis of the HR-engineering and project management principles.

HR-engineering is a systemic management of human resources which allows integrating an employee into corporate structure and information technologies. Methodology of HR-engineering is rooted in the systemic

approach (basic methodology), business engineering and socio-psychological approaches.

The methodology of the project-based approach which is initially an integrated component of civil engineering programmes is also proposed as a basic one in delivering "Personal Management". Upon this discipline completion, graduates acquire managerial competencies within the following domains:

- systemic knowledge of HR management;
- basis for globalization and localization of project management as a professional activity;
- mechanism to define functional structural tasks, formulate the tasks for a project team in various management systems including functional and cross-organizational systems;
- mechanism to build a project team;

Table 2. "Personnel Management" discipline structure

Competencies		Lecture topics
CCC-2 – readiness to act under non-standard conditions, assume social and ethic responsibility for taken decision		HR-engineering fundamentals
IPC-2 – readiness to manage people in the sphere of his/her professional activity, be tolerant to social, ethic, confessional, and cultural differences		Corporate culture as a managerial resource of a supervisor
		Fundamentals of team leadership
IPC-3 – ability to apply knowledge and skills in managing research and manufacturing activities, building teams, affecting team goals and socio-psychological climate in the required manner, as well as readiness for intensive social mobility		Forms and technologies of managerial activity. Motivation and performance evaluation
		Fundamentals of professional communication
		Design of professional teams
	Engineering of supervisor's personal work. Bases of time management	

- common language and terminology for project management specialists (civil engineers).

The novelty of the project is due to applying innovative teaching techniques in order to shape the required competencies. These innovative techniques aimed at training adult people include skills workshops, case-studies, business games, project teams. For example, skills workshop "Slalom", business game "Marafup" [4, P. 271], business game "Interview", practice course «Diagnostics of moral and psychological climate in a team by sociometry», case-study

"Conflict at Research and Design Institute", practice course "Analysis of cross-cultural interactions", etc.

**Conclusion**

The proposed course can be implemented as "Design HR-engineering". It is studied in the 2<sup>nd</sup> semester (17 lectures and 34 hours of practical classes) and it is an adequate response to employees' requirements. The course provides graduates with knowledge of HR management in civil engineering (design, manufacturing and other companies), equip them with team management skills by the example of real situations and case-studies.

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