Chapter 37
The Elite Engineering Education System:
Developing Professional Capabilities

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ABSTRACT

The chapter describes the experience of complex educational environment that is based on the concept of Elite Engineering Education Programme adopted by Tomsk Polytechnic University (TPU). The chapter focuses on the methods and tools that are used to improve personal, professional, and interpersonal capabilities which are considered to be necessary for modern engineers to adapt to the current volatile global technological environment. Also, it gives the statistics on the results of the students' training. The curriculum is presented in detail.

INTRODUCTION

The traditional system of higher education offers few opportunities to train the technical elite. The essence of the problem is an inadequate amount of attention placed on the development of personal and interpersonal competencies of future engineers. There is an isolation of theoretical knowledge from practical application, especially in the development and management of interdisciplinary projects. A flexible education system must be created to respond to the call of unprecedented technological development.

DOI: 10.4018/978-1-5225-3395-5.ch037

In 2004, an innovative system of elite technical education was created based on TPU. This system experimentally tested educational technologies designed to solve problems. EEEP was developed to train technical specialists (i.e., design engineers, product engineers, and process engineers) to generate new ideas, improve existing technological processes, and provide effective enterprise and business management (Soloviev & Zamyatina, 2013).

Currently, EEEP students acquire both technical and project management skills. "Taking this into account … education model of the future should resemble a Michelin restaurant, i.e., to be unique and produce the number of elite technical specialists that is small but capable of high impact engineering and entrepreneurial activities" (Chuchalin, Soloviev, Zamyatina, & Mozgaleva, p. 1004, 2013).

The existing list of necessary capabilities is based on experience and an adaptation of the conceive – design – implement – operate (CDIO) approach to an educational model (http://www.cdio.org/benefits-cdio/cdio-syllabus/cdio-syllabus-topical-form). CDIO standards can be applied to more than engineering education. They lead to the development of management capabilities, including team building knowledge, leadership skills, and communication strategies (Kondrat'ev & Chemezov, 2015). Engineering students should also be educated in project management. Regulations from the Massachusetts Institute of Technology (MIT) Engineering Leadership Program were considered (Ancona, Malone, Orlikowski, & Senge, 2007; Gordon, 2011). Thus, the authors studied the global educational environment for additional collaboration between world universities.

Uniting students of different specialties through the EEEP TPU system allows for the performance of interdisciplinary projects.

This study explains the structure of the current educational model, evaluates its effectiveness with a view to forming professional and personal competencies. Proposals for adjusting the curriculum are made based on the obtained data.

REQUIREMENTS OF EEEP GRADUATES

Many definitions of competency consider an individual's characteristics impacting effective and superior job performance (Whiddett & Hollyforde, 2003). It is possible to evaluate the development of student competency by studying the student's efficiency and end results during the creation and implementation of a client's project. EEEP TPU engineering leaders must have the following competencies (Chubik & Zamyatina, 2013):

1. Fundamentality based on profound knowledge of science, mathematics, economics, and foreign language
2. High level of professionalism, including active research work, student initiative, and inventive project activity
3. Innovation in the development of critical and creative thinking when analyzing modern problems
4. Entrepreneurship when the student organizes a simulated or actual process of manufacturing new engineering products
5. Leadership in designing innovative technological solutions

EEEP combines gifted students of different engineering departments. Therefore, an interdisciplinary program should promote leadership competencies for operating interindustry projects. The MIT