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Soft skills in engineering education. Practical approach of National Research University “Moscow Power Engineering Institute”

Abstract. Soft skills have become an essential attribute for a successful career in engineering in recent decades. The role of soft skills in engineering qualifications increases each year. It is observed that this European trend has been adopted by other countries and at present is inherent throughout the world. For an engineer today it is extremely important to focus not only on technical or technological issues while studying but to acquire a wider range of abilities and skills that are aimed at expanding professional and career opportunities.

A new course has been introduced into the Master's curriculum in National Research University “Moscow Power Engineering Institute” in 2020/2021 academic year to enhance soft-skills component in engineering training. Organizational Management is an interdisciplinary area of knowledge which is closely related to such fields as psychology, social sciences, management, economics, philosophy and history. As a part of curriculum this course is aimed at supplementing engineering qualifications with a whole range of skills and abilities of a social nature.

Introduction of this course into the curriculum of the last year of the Master's program of engineer training permits to supplement technical and technological qualifications with a number of soft skills necessary not only for future professional activities, but also for the performance of a Master's thesis.

Keywords: soft skills; organizational management; engineer training; master's curriculum; engineering qualifications; social skills; technical education; curriculum in Engineering

Introduction

Rapid development of technology and emergence of new aspects of bio-technological and socio-technological spheres radically changed the life of society and the engineering field. All areas of economics, manufacturing and business require the application of engineering knowledge today. That presents a lot of brilliant opportunities for young engineers. It appears that there has never been a better time to start a career in engineering. The variety of fields and the breadth of application of engineering knowledge have significantly expanded the very concept of the engineering in general.

Changes in technical and social reality entailed transformation of the professional duties of an engineer and, accordingly, a change in the competencies that an engineer should have. Besides, technical skills alone are no longer sufficient for a successful career in engineering. A significant increase of the importance of social, environmental, ethical and management issues nowadays demanded expanding the range of soft skills competencies for engineers. These circumstances forced to reconsider the whole concept of engineering education in order not only to modernize technical knowledge component, but also to find ways to include a soft skills unit in the engineering curriculum. This paper presents a practical approach of National Research University "Moscow Power Engineering Institute" in reaching this goal.

Literature review

To cope with the challenges of the 21st century, the younger generation needs a balanced set of cognitive, emotional, and social skills, including the ability to achieve goals, effectively collaborate with others and manage emotions. According to studies carried out by Harvard University, Carnegie Endowment and Stanford Research Institute, success in the professional sphere depends on the level of formation of "soft skills" by 75–85 % and only 15–25 % on hard skills [1; 2].

Scientists view soft skills in some scientific fields (e.g., in Engineering) and with the help of different approaches. Soft skills are "a set of non-specialized, career-critical over-professional skills that are responsible for successful participation in the work process, high productivity and are cross-cutting, that is, are not related to a specific subject area" [3]. Soft skills allow to find a common ground with other people, to establish and maintain contacts with them, to be able to convey their thoughts and emotions [4; 5]. Such socially oriented skills as "the ability to persuade, find an approach to people, lead, negotiate, work in a team, manage time, be erudite and creative", reflect the essence of soft skills [6].

Various aspects of the development of soft skills in education were considered by foreign scientists. In their work, they emphasize the importance of general skills in addition to technical ones. J. Scheerens, M. Werf, H. Boer conclude that soft skills are "unified skills and personal qualities that contribute to improving the efficiency of work and interaction with people around" [7]. Many scholars note that a person's performance in a profession is correlated with the level of development of soft skills [8–11].

Significant changes in the economy and the development of information technology force employers to consider not only the professional competencies but some additional knowledge and skills, such as the ability to solve complex problems, creativity, teamwork skills, critical thinking and emotional intelligence.

For our study, the opinion of the researchers is significant, who believe that the important soft skills of a specialist (engineer) can be considered the critical nature of thinking and activity; readiness to everything new and the ability to navigate in it; communication skills; the ability to find and process information; desire to constantly improve themselves [12–16].

So, soft skills are a social and labor characteristic of the totality of knowledge, abilities, skills and motivational characteristics of a person in various areas necessary for the successful performance of work. This is a characteristic of the readiness of a university graduate to work effectively in each situation at the workplace, individually or in a team.

Methodology

Introduction of a number of soft skills competencies in the new engineering educational standard set the task of making changes to the curriculum. The complexity of this task was to ensure the development of new knowledge and skills, but not to overload the curriculum. Also it was important to maintain a balance between fundamental and practical engineering training, on the one hand, and soft skills component, on the other.

The solution to this complex problem in National Research University “Moscow Power Engineering Institute” (“MPEI”) was the introduction of the discipline of Organizational Management into the curriculum of the Master's program in engineering in 2020/2021 academic year. Organizational Management is a traditional part of the Master of Business Administration (MBA) program curriculum. Study of this field of knowledge is an important component of the training of management personnel, heads of companies and organizations of different levels. Including this discipline in the Master's programs in engineering is aimed at expanding the competence field of the engineer in accordance with the new educational standard and the requirements of employers.

Table 1

**Number of 2nd year Master’s program students, who attended
the course of Organizational Management in National Research University “MPEI”**

№	Field of training (masters)	2020/2021	2021/2022
1	Institute of Power Machinery and Mechanics	54	39
2	Institute of Thermal and Nuclear Power Engineering	307	132
3	Institute of Energy Efficiency and Hydrogen Technologies	106	106
4	Institute of Electrical Engineering	185	148
5	Institute of Electrical Power Engineering	162	194
6	Institute of Information Technologies and Computer Science	201	125
7	Institute of Radio Engineering and Electronics	198	198
8	Engineering-Economic Institute	13	13
9	Institute of Hydropower and Renewable Energy	45	47
	In total	1,271	1,002

Compiled by the authors

The writing and implementation of the new course of Organizational Management was entrusted to the Department of Philosophy, Political Science, Sociology (Institute of the Humanities and Applied Sciences of National Research University ‘MPEI’) in the 2020/2021 academic year. This course was aimed at the second-year students of Master’s program in engineering. The course lasts one term (16 academic weeks), and its content is presented by 16 hours of lectures and 16 hours of tutorials, it also involves about 40 hours of self-study and preparation work. The course was

implemented for Master's programs in engineering at 9 Institutes of National Research University 'MPEI' (tab. 1) in 2020/2021 academic year, and reading the course has been continued in 2021/2022 academic year.

The total number of students that attended the Organization Management course in 2020/2021 and 2021/2022 academic years is 2,273 people. The decrease in the number of students in the 2021/22 academic year compared to the 2020/21 academic year reflects the decrease in enrollment for the Master's program associated with the Covid-19 pandemic.

The idea of introducing one complex academic discipline as a way of mastering necessary soft skills competencies for all fields of engineer training allowed to solve the pedagogical problem and at the same time to avoiding the overloading the curriculum with a number of separate disciplines.

Results

Reading the discipline of Organizational Management as part of Master's program training in engineering in accordance with the new educational standards for the last two academic years allows describing some results.

The educational standard for Master's program in engineering defines the following soft skills competencies that a student must master:

1. To be able to organize and manage the teamwork:
 - develop a team strategy for achieving a set goal;
 - lead teamwork.
2. To be aware of cultural diversity:
 - analyze and take into account the diversity of cultures;
 - be able to conduct multicultural interaction;
 - take into account the differences of religions and cultures in the social and professional interactions.
3. To be able to determine and implement the priorities of one's own activities:
 - assess one's own resources and their limits (personal, situational, time);
 - use resources optimally for the successful completion of the assigned task;
 - determine the priorities of personal growth and ways to improve them.

Studying Organizational Management as a complex academic discipline allows mastering abovementioned competencies and acquiring a number of social and managerial skills and abilities that are important for a successful professional activity of an engineer.

The discipline is eminently practice-oriented and aimed at raising professional and social awareness. Five different author's courses on Organizational Management were written and implemented at the Department of Philosophy, Political Science, Sociology (Institute of the Humanities and Applied Sciences of National Research University 'MPEI'). With all the difference in the author's approaches to the formation of the content of the courses, the goals and objectives of the courses coincide.

One of the approaches is based on the formidable work of Gareth Morgan which is widely known as a theory of "Organizational Metaphors" (Images of Organizations) [17]. Images of Organization is a very famous classical work in the field of management literature. It is based on an

idea of presenting organizational structures and processes through metaphors. Vivid images created by these metaphors stretch our imagination and lead to a significant breakthrough in understanding organizations and employee behavior. The book was reprinted many times since its first publication in 1986 and came out in Russian in the series of books of the Stockholm School of Economics in 2008 [18]. This fact made Gareth Morgan ideas wildly accessible for Russian-speaking students. Organizations presented through metaphors not only create memorable images, but also reveal hidden mechanisms that affect organizational processes. These ideas shed light on nature and various sources of power, features of leadership, the influence of the unconscious in organizational behavior and a number of other important aspects of management that usually are overlooked in the management literature.

Lectures of the new course have been devoted to theoretical material, including the unusual refraction of modern fundamental scientific theories in the field of management and social trends. Tutorials have focused on the peculiarities of teamwork, analysis of leadership strategies and management principles, cultural adversity and other important issues in the form of case studies and practical tasks. Also tutorials have been a platform for speeches, talks, workshops and discussions on studied topics. Independent student work apart from theoretical study has included writing essays on studied topics and presenting the results of study in oral and written speech using modern multimedia tools.

Through this course students learn to recognize the types of organization, institutions and societies, to define the strong and weak sides of different types of organizational structures. This knowledge helps to realize personal preferences and see the opportunities for building a successful career. Understanding the principles of teamwork and communication (the way of forming teams, developing a team strategy, performing different roles in a team, communicating within a team and with the outside world) is developed through practical tasks. Particular attention is paid to the cultural and social differences of people (including racial, national, religious, age, economic, linguistic, etc.) within the organization and in the external environment. The analysis of values and aims is aimed at building an ability to prevent and resolve conflicts. One of the most important points of the course is to learn how to acquire an ability to assess one's own resources and their limits (personal, situational, temporal, professional, emotional etc.) and to be able to assess other people's resources and competence.

In general, the theoretical basis and the practical components of the course are aimed at learning to identify and implement the priorities of one's own growth and to find ways of professional improvement.

Discussion

Changes in the technological environment and social processes have set new challenges for engineering education. Like any complex task, the review of the curriculum of the Master's program in engineering obliges to take into account a lot of factors, the key of which will be the peculiarities of technology and production, employer requests and social expectations. The Introduction of Organizational Management into the curriculum of Master's program in engineering training as a method of mastering requisite competencies is one of the possible ways to answer modern requests. Practice has shown that this path has a number of undeniable advantages.

Studying the course of Organizational Management allows developing communicational and organizational skills, adaptability, creativity and continuous improvement mindset. Acquiring teamwork skills, responsible leadership and problem-solving abilities through studying is seen as a multicomponent task aimed at expanding professional growth opportunities and developing an individual life strategy.

The complex nature of the Organizational Management as a field of study permits to form a large range of competencies. The complexity of the discipline is explained by the set of its main objects of study and a wide variety of approaches to them. Its main objects of study are a person (including psycho-physiological characteristics of a person and human behavior, professional competencies and responsibilities, attitude to work and motivation, decision making, problem solving), a group of people (including teamwork and communication, conflict and stress, interests and loyalty) and an organization (or institution) in general (including types of organizations, institutions and societies, the phenomenon of power and leadership).

The range of problems studied unambiguously emphasizes the complex nature of this field of research. Organizational Management as an area of knowledge is closely related to such fields as psychology, sociology, management, economics, philosophy and history. Besides it uses the achievements of such areas of research as political science, conflictology (or conflict management), cultural studies, anthropology and cognitive science. It is the complexity of this course that makes it possible to supplement engineering qualifications with a whole range of skills and abilities of a social nature.

Each of the areas of knowledge on which Organizational Management is based makes it possible to consider the objects of study from a specific point of view and see the obscure sides of the phenomenon. For instance:

- historical knowledge helps to see the patterns of the emergence of different types of institutions at different stages of human society, assess the stages of technical and legal development of societies;
- conflict management contributes to the understanding of the occurrence, development and settlement of various kinds of conflicts;
- achievements of political science help to study global corporations and peculiarities of management and business in certain countries;
- futurology contributes to the development of the ability to explore the future by extrapolating existing technological, economic, and social trends.

The importance of philosophical knowledge as the foundation of Organizational Management should be emphasized especially. Philosophy as the study of general principals and fundamental problems helps in realizing the manifestation of general laws in different areas of human life and natural processes (to see universal in individual or concrete). Besides philosophy develops ability of critical thinking, helps to logically organize data and teaches to admit the existence of different interpretations and opinions which formidably promotes reflection and argumentation skills.

Such a complex nature of Organizational Management as an area of knowledge contributes to the synergistic effect of its constituent parts. This feature of Organizational Management makes this area of research unique. It is this feature that allows solving the difficult task of acquisition and developing a whole range of soft skills competencies through introducing only one subject into the Master's program curriculum.

Conclusion

Soft skills have become an essential attribute for a successful career in engineering in recent decades. The role of soft skills in engineering qualifications increases each year. For an engineer today it is extremely important to focus not only on technical or technological issues while studying but to acquire a wider range of abilities and skills that are aimed at expanding professional and career opportunities.

A new course of Organizational Management that has been introduced into the Master's curriculum in National Research University "Moscow Power Engineering Institute" successfully reached the goal of providing soft skills competencies specified in the new educational standard in engineering for a high quality education.

The analysis of a new approach in engineering education applied at National Research University 'MPEI' as one of the leading technical universities in Russia is a useful methodological material, which can be helpful for other technical universities in curriculum development.

An indicator of the success of this approach in the short term is the positive feedback from students and the successful application of the acquired knowledge, skills and abilities in the performance of Master's thesis in 2020/2021 academic year.

In the long-term, the indicator of success will be an increase in the level of employment of graduates, their sustainable career growth, leadership positions, professional development and empowerment, scientific and professional achievements. Given this circumstance, the best way to get the most accurate estimate about the effectiveness of these changes in training is to get the feedback from the employers and graduates in the coming years. This information will be very valuable for making possible additions and changes to the curriculum and teaching methodology.

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Soft-skills компетенции в инженерном образовании. Практический подход Национального исследовательского университета “МЭИ”

Аннотация. В последние десятилетия soft-skills стали неотъемлемым атрибутом для успешной карьеры инженера. Роль этих компетенций в инженерном деле возрастает с каждым годом. Европейская тенденция на усиление роли soft-skills в инженерной сфере постепенно распространилась и на другие страны и в настоящее время распространилась по всему миру. Для инженера сегодня чрезвычайно важно обладать не только знаниями и умениями в технической и технологической отраслях, но и овладеть более широким спектром компетенций во время обучения, что позволит расширить профессиональные и карьерные возможности.

В 2020/2021 учебном году в программу магистратуры Национального исследовательского университета “Московского энергетического института” был введен новый курс, направленный на усиление компонента soft-skills в инженерной подготовке. Организационное поведение — это междисциплинарное знание, которое тесно связано с такими областями как психология, социология, менеджмент, экономика, философия и история. В рамках учебного плана этот курс направлен на дополнение инженерных квалификаций целым рядом навыков и умений социального характера.

Введение этого курса в учебный план последнего года магистерской подготовки инженеров позволяет дополнить техническую и технологическую квалификацию рядом необходимых и широко востребованных компетенций, которые важны не только для будущей профессиональной деятельности, но и для выполнения и защиты магистерской диссертации.

Ключевые слова: soft-skills; гибкие навыки; организационное поведение; подготовка инженеров; магистерская программа; инженерные компетенции; социальные навыки; техническое образование; учебная программа для инженеров