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Teaching Socio-Political Courses in the Framework of Modernization of Engineering Education

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Abstract: Relevance of the issue under consideration is due to the importance of the problem of modernization of engineering education. Socio-political subjects are play an important role in the development of a qualified engineer able to solve innovative creative tasks, since, they serve to form a systemic vision of the relationship between scientific and technological innovations and their consequences for the society to widen one's horizon and foster erudition in various areas of expertise, first of all in the history of scientific and technological activity. The study aims at studying place and role of the socio-political branches of knowledge in modernization of the future engineers training. The leading method in studying the problem was analysis of the teaching socio-political courses to students in engineering and technical fields of study and drawing lessons from it which would reveal the major cross-disciplinary issues of concern expected to be acquired by the students. Problematic issues in teaching socio-political courses have been analyzed with the aim of improving the future engineers training and development of the relevant knowledge, abilities and skills in them. Methodological approaches to teaching socio-political courses to students in engineering and technical fields of study have been developed. Recommendations on the improvement of teaching socio-political courses have been formulated. A place and role of the history of scientific and technological activity as an important cross-disciplinary field of knowledge and teaching it to the future engineers in the socio-political courses have been determined. Materials of the paper can be used by teaching stuff and higher school administration in improving the quality of education of the students in engineering and technical fields of study by the students in engineering and technical fields of study themselves (in Bachelor's, Master's and specialist's programs) as well as by all interested in problems of engineering education and the history of scientific and technological activity.

Key words: Engineers and technicians training, socio-political courses, history of scientific and technological activity, engineering, improving, education

INTRODUCTION

Modern high-technology economy sets rather high standards of an employee's professional competencies in general and engineering staff in particular. Meanwhile, there is a crisis of engineering and technical education in Russia and a degradation of the engineer's training in comparison with that of the Soviet period. That is why one of the relevant problems faced by the Russian educational system is a complex modernization of the engineering education and engineering staff training that would meet the modern demands of the economy. Efficient working in the present-day production with its ever-improving and complicating technologies, requires knowledge in various fields and ability to find optimal non-trivial solutions of the current tasks and emerging problems based on this knowledge (Zagvyazinsky, 2016). And modernization of the engineering education is impossible without the appropriate teaching of socio political courses (history, science and technology history, sociology, political studies, etc).

It is hard to imagine a highly qualified engineer capable of creative thinking and unconventional approach to the tasks who wouldn't understand the interrelation of the technological advance and different social and political processes or know various aspects of the history of scientific and technological activity.

Various issues of teaching humanities to future engineers and building competencies in humanties in them is addressed by Nokhrina (2004), Shevtsova (2010), Vasyukhin (2014), Fomina and Kuzmina (2011), Isamukhamedova (2014), Oreshnikov (2015), Shubkina (2015), Kazantsev (2014), Mikhaylova (2013), Mikhaylov (2014), Kopilov *et al*. (2016), Fedorova and Zavyalov (2015) as well as in many other researches. Special mention should be made of the works that regard in one

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way or other the history of science and technology and its role in future engineers training (Bordonskaya, 2016; Antifeeva and Petrova, 2009; Moskalenko, 2014) and many other researches.

These researcheres pay insufficient attention to a number of key problematic issues of the crucial importance for the engineers training, a complete explanation and acquirement by the students of which require a cross-disciplinary approach in the framework of socio-political courses.

First, these are the questions of studying forecasting the technology development; second, this is analysis of misconceptions and incorrect ideas of a specific area of scientific and technological development and discoveries dominating in collective consciousness and having a negative impact on the scientific culture of the whole society and of professionals in different fields of engineering in particular.

Third, it is specificities of the history of scientific and technological activity. Nowadays in Europe, pilot humanities programs are intensively introduced into the training process engineering education. Such programs are tailored to the requirements of an integrative and cross-disciplinary approaches in order to provide students with the comprehension of the extended limits of the modern engineering job, show cultural, philosophical, ethic, social, political, ecological, international, global contexts of the past and modern times, affecting engineering practice and applying science and technology, show the role of the humanities knowledge in a clear identifying, stating and solving technical problems, stimulate cognitive abilities of students, their interest in further exploring the problems if co-existence science, technics, society and individual (Shevtsova, 2010).

MATERIALS AND METHODS

The basis of the research were the following principles and methods: comparative pedagogical method which includes studying the main problematic questions a student in engineering can have when mastering the information during socio-political courses, analysis and synthesis serving the basis for revealing and discussing in detail the possibilities for the improvement of teaching socio-political courses to future engineers, method of consistency which allows revealing the key issues requiring a cross-disciplinary approach to be acquired by the students in socio-political courses.

Experimental basis of the research: Experimental base of the research includes: studying experience in teaching socio-political courses to students in engineering in the Russian State Vocational Pedagogical University and other Russian universities in Russia, analyzing scientific works on teaching socio-political courses to future engineers.

Stages of the study: There are three stages in the study:

- Revealing main problems a student in engineering can have when mastering the information during socio-political courses
- Analyzing the key issues to be acquired by the students in socio-political courses that require a cross-disciplinary approach
- Elaboration of methodological recommendations in mastering a number of topical issues by students during socio-political courses

RESULTS AND DISCUSSION

Nowadays the ongoing processes of scientific and technical revolution and technological advance define new standards in engineers training. The ability to calculate possible social consequences of both technologies and technological changes and implementation of various inventions and know-hows becomes necessary. A competent engineer must be familiar with the main tendencies of the scientific and technical revolution and technological advance, take into account historical experience of implementing upgrades both in Russia and abroad (first of all, to understand their technological aspects) have skills in a comparative-historical approach to analyzing modernization processes.

In the light of the above, it is clear that engineers training should be consistent and comprehensive that development of their all-around education and erudition in a wide range of subject areas and knowledge in the history of science and technical creativity is necessary. It is also necessary to adhere to humanistic value-driven ideas of the domestic education (Sergeeva and Voskrekasenko, 2016). And in this regard a major role is played by socio-political courses such as history, science and technology history, sociology, political studies, etc.

One of the shortcomings of the traditional structure of a specialist training in a technical university is a disconnection of specialized departments and departments in humanities themselves and the courses taught there which makes it impossible to form in students an idea of the unity of science and homogeneity of manifestations of the creativity principles. Nowadays, the issues of optimization of the content of the engineering education through mutual integration of technical and

humanitarian disciplines becomes relevant, since, only such an education can be an adequate response of the professional engineering to global challenges of the epoch, stimulating future engineers to solve creative tasks faced by the society (Shevtsova, 2010).

This makes it essential to systematize student courses, determine problematic issues whose understanding will allow students to elaborate a clear learning system, a kind of basis for further development of their competencies, skills and knowledge. Concerning socio-political courses, the following problem points requiring a cross-disciplinary approach can be distinguished.

First, student's introduction to the methods of technology forecasting acquires high relevance (Rudenko and Gorbachev, 2015) in view of it is evident that engineers in their future research will have to deal with analysis of technology forecasts and they should understand their specifics.

Significant time gap between a fundamental scientific discovery and its implementation in practice. For example, fundamental studies of the atom properties and began in the end of the 19th century but it is only a few decades later when their practical use was found: in 1945, a military use of the atom began in 1954, the first nuclear power plant was launched. Big fundamental discoveries do not necessarily bring an immediate applied and commercial effect. Thus, one of the major fundamental discoveries of the 20th century in physics, the general theory of relativity by Einstein (1916) still has a rather narrow area of application, mostly in astronomy. Such peculiarities explain why at the present stage not only commercial but governmental institutions as well sometimes do not want to spend financial means on fundamental scientific researches their practical orientation and applied effect are too questionable.

Non-linear development of engineering and technology. It can be clearly seen in cases of some inventions. For example, rocket engineering from the 1950's till 1980's developed by leaps and bounds rocket generations changed every few years, each subsequent model was vastly superior to the previous one in carrying capacity, flying range and accuracy and other technical features. And starting from the 1980's, a slower smooth development of the industry is observed. Another example is the development of shipbuilding in 19-20th centuries where a kind of cycles can also be found periods of a leap-ahead increasing shipping facilities, speed, power and durability of ships alternated with periods slowdown in growth of these characteristics. Such leaps and periods of the technological advance are very important for forecasting the results of engineering and understanding the laws of the development of technics.

Second, when teaching socio-political courses to the future engineers, a special attention must be paid to consider false stereotypes and erroneous notions on certain aspects of scientific and technical development and influence of technological advance on socio-political processes.

The first group of stereotypes is associated with ideas of Russia being below the world's leading states in a number of areas of science and technology. Together with peculiarities of the national state of mind and self-consciousness, these ideas often evolve into belief in historical inferiority of Russia its inadequacy as compared to the western states including in technological development. In Russian historico-philosophical tradition, this concept is associated, first of all with the name by Chaadayev (2001) and later it developed by radical liberals-Westernizers.

To be fair, one should note that during the last several centuries Russia had to catch-up other countries and the main aim of its scientific and technical development was the defensive one to keep pace with the West in military terms in order not to become an object of a colonial expansion. In general, this task was fulfilled by the state successfully, certainly to the detriment of the development of a civil sector and the overall living standards of people. The state didn't have the resources to develop all sectors of the economy to match with the leading states of the world (neither before the Revolution, nor in the Soviet period) which is explained by historical, climatic and geopolitical factors and peculiarities.

The second group of stereotypes is associated with time-honored wrong ideas on certain aspects of the history of engineering, deeply-rooted in mass consciousness due to the images presented in fiction and other works of art. Few of the general public study scientific literature and works of specialists. If an image is distorted, stereotypes and misconceptions far removed from reality can emerge. A classic example is the ideas on the small arms of the Great Patriotic War. In Soviet cinema German soldiers were depicted mostly armed with the ID 40 submachine gun. In fiction and journalism the belief in a superior firepower of the German infantry armed with automatic rifles began to circulate to the Soviet infantry mostly armed with Mosin-Nagant. Meanwhile, in the beginning of the war the vast majority of the German infantrymen were armed with Mauser 98 and Mauser Karabiner 98 k which didn't much differ from Mosin-Nagant (Isaev, 2004).

There are many other similar examples of not completely correct ideas and images from the history of engineering deeply-rooted in the modern mass consciousness. This has an adverse impact on the collective memory of the nation and the level of the science and technology culture of the society. The third group of stereotypes is associated with wrong ideas on the specifics of certain periods of human history rooted in the popular consciousness.

The third group of stereotypes and mistaken beliefs is due to a sharp decline in the scientific culture of the society in modern Russia as compared to the Soviet period. Today's media are often full of anti-scientific and pseudotechnological information such as astrological forecasts, various stories about sorcerers, psychics, prophecies, etc.

Craving for the supernatural and mysticism is growing, a large part of the population becomes keen on different cults and beliefs, mostly of the oriental origin, based on the ideas of the "reward" and "reincarnation". Of course such ideas contribute to the formation of a specific social atmosphere, reconciliation of the man with reality, stabilization of his mental condition in the unstable world. But most often they conflict with objective scientific cognition: scientific explanation of many phenomena is substituted with a mythologized one, using scientific terminology but lacking any rational scientific bases.

Crisis of scientism (belief in the science omnipotence which served the basis of the whole industrial civilization) and world ideologies (which provided a clear standard of the future, compartmentalized reality and gave answers to the question on the reason for the man's and nation's being) has restored a belief in the mysticism and supernatural, led to criticizing a possibility of a rational scientific explanation of reality.

Parascientific historic concepts have become more widespread such as belief in highly developed civilizations of the ancient Atlanteans, Lemurians, the Hyperboreans. Blatant bedtime stories are popularized, e.g., the one about secret underwater bases in the Antarctic created by the Hitlerite Germany in the end of the World War II and other stories. It leads to the formation of rather mosaic and syncretic world view of the modern man where science intersects with myths, so that, it becomes difficult to separate the two. All this cannot improve the scientific culture of the society. These problem areas as well as some others should be studied by students in socio-political courses.

A number of shortcomings of the traditional methods of teaching the humanities in engineering higher education institutes: student's indifference to the humanities, lack of a strategy for student's motivation and stimulation to intensively learn the humanities in the technical school because of the outdated methods of their teaching, disregarding the research teaching methods (analysis, synthesis, critical reasoning, a sketchy nature of the designed courses in humanities which leads to a lack of meaning in the understanding of their importance for an engineer and their relation to engineering issues (Shevtsova, 2010).

The role of socio-political courses in engineers training is manifold: the form the culture of scientific thinking, contribute to the formation of patriotic ideology and moral and ethic foundations in future specialists, improve the knowledge and elevate the mind, contribute to systemacity of thinking.

Such courses not only study the facts and regularities but based on them, also, form in a student an ideal of the citizen and civic awareness, give answers to the questions of the state's tasks and objectives, relationship between the authorities and society, shape in people national idea and image of a civilized state. It is especially relevant in engineering education, since, unlike humanitarians, engineers and technicians have much less time to master various socio-humanistic issues and carry out comparative analysis of different concepts in history, politics, sociology (which in fact serve the bases of the scientific thinking in the humanities). And the difference in worldviews of "techies" and humanities-minded people sometimes makes the former more susceptible to simplified and politicized concepts of socio-political processes.

When teaching socio-political courses to future engineers, a special attention should be paid to the history of scientific knowledge and technological inventions which forms important competencies of future professionals. This is a cross-disciplinary field of knowledge: in the history classes influence of inventions and scientific discoveries on political development of the society in the various periods can be studied, in the history of science and technology classes, the inventions and discoveries of different epochs can be studied, in political science and sociology courses, one can teach socio-political conditions necessary for scientific and technological advances of the society and influence of scientific and technical discoveries on political and social settings (Sergeeva and Voskrekasenko, 2016; Kopilov *et al*., 2016).

Central place of the history of scientific knowledge and technical advances is also determined by the applied significance of this intellectual field: first, historic experience of the development of political and social institutes and rise of conditions in different societies for the emergence and implementation of various inventions and know-hows can be important. Second, historic experience of different states in establishing

organizational structures dealing with the issues of know-hows implementation and staff training for the industry is relevant, since, activity of such organizations largely determined success or failure of certain aspects of commercial industrialization and modernization.

Third, historic experience of different states in creating an educational space favorable to the specialists, scientists and inventors training as well as to the modernization of engineering education is very interesting (though to a large extent it is a domain of the history of education and pedagogy).

Starting from the industrial era, studying the history of scientific knowledge and technological advances was given high importance. A pragmatic task of studying the experience of scientific inventions and discoveries was set in order to consider the mistakes of the past and to make scientific and technical creativity more effective. The attitude toward development of science was mostly based on enlightenment values: cult of the scientific knowledge ("scientism") and regarding the human history as an upward movement of the triumph of reason, science and progress over the ignorance and obscurantism. Values of the technological civilization and culture of rational reasoning were inculcated into the general public as it was proven admirably, for example, Weber and Foucault an unrestrained progressionism impelled people to the constructive and creative attitude to the future.

In the states of that epoch, inventions and discoveries of domestic scientists were popularized in every manner possible and if an authorship of one of them was disputable or if it was generated in some countries simultaneously (e.g., radio or combustion engine), a national scientist's priority was proclaimed. A violent manifestation of such situation can be found for example, in the USSR in the 1940-1960's when out of propagandist considerations, authorities tried to prove the state's superiority in all the spheres. Soviet intellectuals joked that X-rays were invented not by the German scientists in the end of the 19th century but much earlier by a Russian tzar Ivan the Terrible who used to tell the boyars, "I see right through you". Such approach can help to shape patriotism and national self-respect but sometimes in favor of propaganda, historic facts were evidently wangled.

At initial stages of industrialization one of the key tasks of the history of science and technology was to acquaint the public with the values of scientific and rational thinking and industrial civilization, so that the role of the technology was often romanticized and ideologized. Thus, in the USSR, a statement by I.V. Stalin was well known, according to which "engineering headed by people who mastered it can and must work wonders". For future engineers, knowing a wide variety of aspects of the history of scientific and technological activity promotes the development of creative thinking and unconventional approach to tasks. This increases motivation and preparedness to the research activity in students of technical universities as well as the level of their academic qualification (Fedorova and Zavyalov, 2015; Dorozhkin *et al*., 2016).

Moreover, history of scientific and technological activity should introduce students to different types of scientificity and rationality. For example, classical, non-classical and post-nonclassical science are characterized by rather different types of scientific rationality. In creation of a law-governed state and civil society, a principle of rationality is important, since, a man's civil culture depends to a large extent on a degree of easiness and deliberateness with which he makes a decision and his responsibility for his decisions (goal-instrumental behavior n terms by Weber. A precondition of this is to maintaining and development of the culture of rational thinking. Studying the history of science and technology plays a especial role in forming rational reasoning, since, it demonstrates interrelation between specific historic context of the development of different societies and civilizations on the one hand and development of science, engineering and technology there (historicist tradition), on the other hand and studies the process of the emergence of science, scientific rationality and criteria demarcating science from non science in their dynamics.

It is important to note that there are questions in the history of scientific and technological activity, studying which can help to elaborate a more effective strategy of reforming engineering education and contribute to the application of the historic experience in designing a framework of the policy of the state modernization at the present stage.

First: There is a range of issues associated with the problem of the rise and fall of scientific cultures. How does a scientific culture emerge and evolve? What factors contribute to its rise or fall? A comprehensive conceptual analysis of the question can contribute to the development of a strategy of science reformation in any country.

Second: Studying historic and cultural mechanisms of the society's ability to perceive and introduce know-hows as well as of the emergence and development of social institutes contributing to or impeding development of innovations and technologies is of the utmost interest. Thus, in medieval China a number of interesting technologies were invented earlier than in Europe (book-printing, vaccination, etc.) though later there was a significant development gap. Or, for example, in the late USSR, most industrial sectors (except for the defense

industry) couldn't acquire the majority of interesting inventions that produced by engineers. A comprehensive analysis of these mechanisms is necessary for a more efficient modernization strategy.

It should be noted that there were created institutes and organizations in the USSR designed to contribute to a practical implementation of inventions and know-hows into economy. The most famous of them was the all-union society of inventors and efficiency experts, in cities, meetings of the core groups of scientists, engineers and technologists-innovators were carried out systematically. The main objective of the meetings was to speed up scientific and technological progress in all the spheres of the national economy. Historic experience of these and many other establishment's activity can be relevant for creating mechanisms for introducing new technologies into economy and developing a system of the postgraduate lifelong training programs for engineers and technicians.

Third: The issues of adapting non-Western societies to the scientific and technical revolution and technological advance, closely associated with a complex problem of the "catch-up modernization" are still acute.

Fourth: The experience of reforming the structure of scientific and educational institutes, starting from the very first (medieval European universities, scientific societies and academies of the modern age, etc.) and its analysis in the context of interaction of authorities and science is very interesting.

Fifth: It is urgent for an engineer to know how science and culture developed at various points of the society's development, to know great personalities in science and culture, cultural heritage. These aspects form a historic and cultural base of physics (Bordonskaya, 2016) and some other sciences.

Sixth: Student should be able build a picture of development of any science from its beginning until our time in order to see interaction between the development of scientific knowledge in certain area and present level of scientific and technological advance (Antifeeva and Petrova, 2009).

CONCLUSION

Given the above, the following action aimed at improvement of teaching socio-political courses to students of technical universities can be proposed. Systematic study of the elements of scientific and engineering forecasting.

Analysis of the erroneous stereotypes and incorrect ideas about certain aspects of scientific and technological advance as well as the influence of the technologies development on socio-political processes.

At the same time, the following classification of the knowledge is completely applicable which is common for both engineering and humanities: theories (clearly demonstrated ideas), hypotheses (scientifically verified assumptions to be proved), deceptions and myths (irrational, non-scientific knowledge). Students should distinguish between these groups of knowledge and be familiar with their specificity.

It seems to be important to tell the students about leading scientists and inventors, their activity and major facts and tendencies of the development of scientific knowledge and technologies in different epochs.

Special attention should be paid to studying scientific revolutions, changes in scientific paradigms as well as different concepts of scientific and technical revolution, technological advance, technological development of the mankind, "knowledge society", comprehensive and systematic understanding of which serves the basis for the culture of an expert's scientific reasoning.

Students are to be taught skills in comparative-historic analysis of domestic and foreign scientific discoveries and achievements in order to form in them an adequate idea of the level of researches in a certain sphere of knowledge or branches of industry in different periods of time.

It is important to spend some time to regard actual problems of the modern science form an adequate idea of its achievements and prospects of further studies both in the whole and in each sphere of science and industry.

A comprehensive study of a range of fundamental problems in the history of the national science and industry is necessary: why the production sector often failed to implement the newest feats of engineering and know-hows into practice (this was the case of both tsarist Russia and Soviet Union) which socio-political institutes and organizations were created for this task, how their efficiency can be evaluated and whether it is possible to apply this experience in the actual situation and so on. Materials of the study can be used by teaching stuff in training the students in engineering by higher school administration and heads of the departments; potential employers of the students in engineering and technical fields of study the students themselves (in Bachelor's, Master's and specialist's programs) as well as by all interested in problems of engineering education and the history of scientific and technological activity.

RECOMMENDATIONS

During the study, new questions and problems arose which must be solved. Conceptual development of a mutual integration of engineering and humanities in

teaching is necessary in order to form competencies in solving innovative creative tasks in students. Improving approaches to the education, so that, they would help to develop a systemic vision of the interconnection between scientific and technological discoveries and their consequences for the society in future engineers. The issues of systematizing educational courses, revealing problem points and understanding them which will help students to form a clear system of acquiring learning material, this basis for the development of their competencies, knowledge and skills are also relevant.

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