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TEACHING HISTORY OF SCIENCE AND TECHNOLOGY IN TRAINING OF ENGINEERING PERSONNEL

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Abstract

The timeliness of the investigated problem is stipulated by the great importance of the whole complex of questions on improving the quality of engineering personnel training in Russia. In the modern economy, engineering and technical workers, their professionalism and competence are the most important factors for the successful modernization of both the country's economic system in whole and competitiveness of an individual enterprise. The questions of place and role of the history of science and technics in qualitative training of modern engineering and technical personnel are studied in the article and the main points of the history of scientific and technical creativity are revealed, which, in the authors opinion, should be given attention in training of future engineers. It is shown that the history of scientific and technical knowledge is a promising area of scientific research covering study of a wide range of factors contributing to acceleration of the industrial modernization and formation of the sociocultural prerequisites for scientific and technical development in a society, which, of course, is essential for the training of future engineers, production managers, business. The article materials can be useful: to the faculties and heads of universities improving the quality of students' training of engineering and technical majors; to the students of engineering and technical majors (bachelors, specialists, masters), as well as to all those interested in the issues of engineering education and the history of scientific and technical creativity.

Keywords: The history of science and technology, training of engineers and technicians.

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1. Introduction

The history of science and technology is rather specific and interesting field of knowledge, where achievements of both humanitarian and technical sciences are integrated, examined problematic issues, study of which requires an interdisciplinary approach. The need for modernization of the engineering education, without which Russia is threatened by loss of competitiveness and de-industrialization, makes urgent the study of historical experience of scientific achievements, technical discoveries, scientific and technological breakthroughs and revolutions. Effective work in the modern production with constantly improving and complicated technologies, requires knowledge in many areas and ability to find optimal non-trivial solutions to current tasks and emerging problems (Zagvyazinsky, 2016), which graduates need for professional implementation (Zinnatova, Konovalova, & Makarova, 2016).

In this context, historical disciplines acquire special significance, and this relates to "The History of Science and Technology" course, which is given in some universities of the Russian Federation. In RSVPU this discipline is currently given by the Department of Documentation, History and Legal Support.

It must be said that applicability of teaching the history of science and technology for future engineers is realized in Russian higher schools and has been reflected in a number of works (Bordonskaya, 2016; Antifeeva & Petrova, 2009; Rudenko & Gorbachev, 2015; Gordeeva, 2015; Isamukhamedova, 2014; Shubkina, 2015; Kazantsev, 2014; Fomina & Kuzmina, 2011; Mikhaylova, 2014; Moskalenko, Dorozhkin, Ozhiganova, Ryzhkova, & Samoylova, 2018), as well as in numerous other studies.

At the same time, it should be noted, that a number of problematic, key issues concerning teaching of the history of science and technology to future engineers, application of various aspects of scientific and technical creativity history in their scientific and practical activities have not been adequately studied in these works.

It should be mentioned, that in Europe experimental humanitarian programs are actively introduced in the educational process of engineers and developed in a way of integrative and interdisciplinary approaches in order to: 1) give students an awareness of the extended range of the modern engineering profession; 2) demonstrate cultural, philosophical, ethical, social, political, environmental, international, global contexts of the past and the present that affect engineering practice and application of science and technology; 3) show the role of humanitarian knowledge in clear identification, formulation and solution of technical problems; 4) stimulate students' cognitive abilities, their interest in further study of problems of the interconnected existence of science, technology, society, and an individual (Shevtsova, 2010). In European countries the system of vocational education pays much attention to integration of natural and humanitarian knowledge (Fominykh, Uskova, Lukinykh, Chapaev, Shreyner, & Smolin, 2018).

2. Problem Statement

Proceeding from the foregoing, the main tasks of this work will be:

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- Identification of the key problems that students of engineering and technical majors have when studying the history of science and technology and the specifics of scientific and technical creativity at various stages of its development.
- Analysis of the main issues and problem aspects of the history of scientific and technical creativity, which will be useful for future engineers and production managers in their successful professional work.

Development of the methodical and methodological recommendations for teaching the history of science and technology.

3. Research Questions

1. The first group of questions is dedicated to the evaluation of various inventions in different epochs and to the problems of their implementation which is important in studying of problematic aspects of the history of scientific and technical creativity. The ongoing processes of the scientific and technological revolution (nauchno-tekhnicheskaia revoliusiia; NTR) and the scientific and technological progress (nauchno-tekhnicheskii progress; NTP) set new requirements for both engineers and managers and managers of almost all levels. For the smart strategies' development for both state and region, as well as for an individual enterprise, manager should understand the main trends of the NTR and the NTP, consider historical experience of modernizations, and have skills of the comparative-historical approach to the analysis of modernization processes (Moskalenko, 2014). Engineers of different areas of expertise should have the same skills, so that managers in their decisions could rely on their expert opinion. Insufficient competence in these matters is fraught with such events as, for example, "Lysenkoism", when the USSR leadership erroneously supported some social climbers from science, which led to the serious lag in some branches of biology.

2. This leads to the second group of questions: how to evaluate prospects of one or another design studies? In history there are many examples of both successful and unsuccessful assessments of certain projects prospects. One of the striking examples is the project of so-called "Tsar Tank" (a combat vehicle on 10-meter-wide wheels), during the First World War it was proposed by engineer N.N. Lebedenko. The heavy spending for building this machine did not pay off at all, is was unable to move. A question arises: weather it was possible to assess the impracticability of this project before its construction? After all, it was required only to conduct its qualitative engineering expertise. Or another example: projects of creating the Soviet linear fleet after the Great Patriotic War, when large battle ships with powerful artillery armament were designed and started to be built – the Stalingrad-class battlecruisers. Meanwhile, experience of naval battles of the Second World War showed that the most promising type of large warships are the aircraft carriers (they were not built in the USSR until the 1970s), and the battleships with powerful artillery are quite vulnerable against modern weapons, their combat value is doubtful. The military sailors headed by People's Commissar of the Navy N.G. Kuznetsov also didn't approve the construction of these ships. Nevertheless, the construction of these expensive ships began and was stopped only in 1953; the ships didn't come into operation.

Naturally, much depends on the level of the technological culture of high-level managers, who make decisions on the implementation of a particular expensive project, their erudition, their outlook, and

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an ability to assess opinions of expert engineers (sometimes contradictory). There are cases when these decisions were made under the influence of the demonstration effect after presentation by enterprising designers of their models (as it was with the Tsar-tank in the above-mentioned case: Nicholas II was delighted with showing of its scaled-down model), and then, in practice, showed their complete failure. But there were also positive examples in history: for example, Churchill, as First Lord of the Admiralty before the First World War, decided to begin building of the Queen Elizabeth-class battleships, for which large-caliber cannons that were fundamentally new for those years were not yet assembled; their development began with the beginning of the construction of these ships. The decision of Winston Churchill was successful: British engineers successfully developed the largest at that time sea guns after the ship's construction, and the battleships of this series proved to be reliable and powerful warships, served both in the First and Second World Wars and actively participated in fighting.

Naturally, this problem is closely related to the features of structure responsibility of managers and subordinates (Mukhlynina, Zhdanova, Kondyurina, Bastrakova, Kovaleva, & Mirzabalaeva, 2016; Davydova, Dorozhkin, & Fedorov, 2016, 2018), but this is already a matter of the organizational psychology.

These facts show that study of the history of science and technology is extremely relevant for both engineers and managers and can improve the effectiveness of their professional training (Fedulova, Fedulova, Kirillova, Vagina, & Kuznetsov, 2017). And naturally, all these factors should be taken into account by a teacher in the system of vocational training (Fedulova, Fedulova, Kirillova, Vagina, & Kuznetsov, 2017).

Therefore, for students it is necessary to conduct the systematic analysis of discoveries and inventions: what social conditions contributed to their emergence and implementation? What social institutions influenced a certain know-how?

3. The third group of questions: how societies of the non-Western type, which Russia belongs to, should create effective mechanisms for technical modernization of industry? Modernization as a phenomenon that arose in the countries of Western Europe, and most other countries of the world had to artificially, through active intervention in the economy of a state, stimulate the modernization processes, primarily to keep up with the West in the military-technological aspect. Several states (the USSR in the 1930s, Japan in the 1960s-1970s, China in the 2000s, etc.) managed to successfully implement the large-scale modernization policy, which resulted in creation of the modern competitive industries.

This range of issues is of interest both for students of engineering and economic specialties, since the historical experience of organizing the industrial production and creating the organizational mechanisms for the implementation of technical inventions is very valuable in modern conditions.

As the teaching experience of the authors of this work shows, the students of engineering and technical majors often have trouble picturing the specifics of modernization in Russia, which was primarily conditioned by the mobilization type of the society development. The most vivid expression of this mobilization type of development was received in the USSR. It should be noted that in times of the Russian Empire the militarized, mobilization type of the society had developed, in which the state power played a decisive, determining role in development of the country, integration of the society and the mobilization of resources to achieve political, military and economic goals. In the Soviet period,

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"mechanization" of all aspects of life, inherent in the industrialism (according to Michel Foucault's concept), was a part of this specific aspect of the society, and the new large-scale mechanisms (which, more often were forced) appeared to concentrate resources (financial, material, human) to solve the state problems. This led to such important results as the industrialization and creation of a powerful military-industrial complex, the victory in the Great Patriotic War, strengthening in the geopolitical positions and in the position of a superpower. Liberal historiography notes such negative features of the Soviet mobilization model as enormous victims among the population; formation of the authoritarian-totalitarian model of governance based on the fear of repressions; lack of democratic freedoms. The liberal assessment (approach), as a rule, is more political and ideological, opportunistic, and violates one of the postulates of liberalism itself - totally does not accept any "different" in culture, endowing it with demonic features. But even such an ardent opponent of Bolshevism and the Soviet system, like Churchill, recognized the effectiveness of the Soviet mobilization model. His words are quite widely known: "No government could resist such terrible severe wounds that Hitler inflicted on Russia." In the most dramatic moments of the Great Patriotic War, the effectiveness of the resources mobilization, together with heroism and dedication of soldiers, officers and workers in many ways was able to reverse the course of military operations on the Soviet-German front.

In this context the following questions are of interest for future engineers:

a) Process of occurrence of the new equipment samples, direction of the design ideas. Many decisions of Soviet engineers during creation of the most diverse models of both military and civilian equipment were non-standard and were implemented in the country that had recently embarked on the path of forced industrialization and in circumstances of huge shortage of skilled workers and production experience (recall that in the 1930s, some of the high-tech industries at that time in the USSR were created "from scratch");

b) Organizational structures and institutions that were created to introduce developed technology. It is known that in the 1930s and 40s many inventions and know-how were introduced in the Soviet industry in record time. And why then, in the 1960-70s their introduction in the Soviet industry (its civil sector) stalled? After all, it would seem, it should accelerate: the number of engineers and highly qualified industrial workers has increased several times; rather sufficiently effective system of education and training was created; among young people engineering and technical professions were popular, and there were many talented young people; in the country the structures, involved in implementation of inventions, for example, the All-Union Society of Inventors and Rationalizers (Vsesoiuznoe Obschestvo Izobretatelei i Ratsionalizatorov, VOIR), continued to function, their main task was to promote further progress in technology, and in large cities the meetings of scientists, engineers and technicians, innovators of production sphere were periodically held. Why, under such seemingly favorable conditions, the so-called "stagnation" arose in the economy and industry, and the introduction of know-how in comparison with the developed countries was low?

4. The fourth group of questions that must be revealed in teaching of the history of science and technology: how, considering the previous world and Russian experience, to directly organize scientific and technical creativity at the present stage in the most effective way? What mechanisms of a labor organization of engineers and implementation of their inventions were applied, for example, by G. Ford

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in the USA, or in Japan in the middle of the 20th century, during their "economic miracle" in the creation of the high-tech industry, and in other states? To what extent can this experience be applied in Russia at the present stage? What, based on historical experience, can there be methods for assessing and stimulating the work of inventors?

4. Purpose of the Study

The article is aimed at studying the place and role of the history of science and technology in improving the quality of professional training of future engineers, production managers, and business leaders.

For future engineers, knowledge of the most diverse aspects of the history of scientific and technical creativity contributes to the development of creative thinking and non-standard approach to tasks. This increases motivation and readiness of the technical university students for research activities and the level of their academic training (Fedorova & Zavyalov, 2014). All this increases competitiveness of future engineers and technicians (Dorozhkin, Tarasyuk, Sinkina, Deryabina, & Sisimbaeva, 2016).

5. Research Methods

As the basis of the study the following principles and methods were used:

- comparative-pedagogical method, including study of the main problematic questions that have students of engineering and technical majors while studying various aspects of the history of science and technology;
- analysis and synthesis, based on which the ways of improving teaching of the history of science and technology, understanding of certain aspects of the history of scientific and technical creativity by future engineers are emphasized and considered in detail;
- systematic principle, which allows you to identify the key issues in teaching students the history of science and technology.

6. Findings

1. At present, the ongoing processes of the scientific and technological revolution and the scientific and technological progress set new requirements for the training of engineers. It becomes necessary to calculate the social consequences of both the development of engineering and technology, and the introduction of a wide variety of inventions and know-how. A competent engineer must understand the main trends in the development of the scientific and technological revolution and the scientific and technological progress, consider the historical experience of modernization in Russia and abroad (first of all, technological aspects), and have skills of comparative historical approach to the analysis of modernization processes. For engineering education, the problem of optimizing its content is being actualized through the mutual integration of technical and humanitarian disciplines, since only such training can become the answer of professional engineering to global epoch-making challenges and orient future engineers to tackle creative tasks, which society is facing (Shevtsova, 2010).

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This highlights the problem of systematization of training courses, finding of the problematic issues, understanding of which will allow students to make a clear system of learning, a sort of foundation for the development of their competences, knowledge, skills, possessions. All this is a necessary condition for creating an effective scientific and educational network (Davydova, Dorozhkin, Polyanskova, & Nuykina, 2016; Davydova, Dorozhkin, & Fedorov, 2018).

2. In order to increase the practical applied value of teaching the history of science and technology, the issues of familiarizing students with the methodology of scientific and technical forecasting (Rudenko & Gorbachev, 2015) are very urgent because of the extremely rapid pace of the scientific and technological progress development in modern civilization. Engineers and production managers in their future profession will have to deal with the analysis of scientific and technical forecasts. Meanwhile, in history there are several examples where certain technological innovations were not appreciated. In this respect, an illustrative example is the steam engine of I.I. Polzunov, which was quite profitable, but after the death of the inventor was disassembled, work on it was stopped, and after decades, Russia started buying the steam engines in England. Or scientific and technical forecasts of the 1960s: it was predicted that at the beginning of the XXI century mankind will be able to purposefully manage climate of the Earth and make interplanetary flights on spacecrafts (which was not realized), and practically no one foresaw the rapid, abrupt development of cellular communications and personal computers.

3. Study of the history of scientific and technical creativity is closely connected with its development at the present stage. It is difficult to imagine that student's study the issues of the artificial intelligence modern development (Chubarkova, Sadchikov, Suslova, Tsaregorodtsev, & Milova, 2016) without knowledge of the background of its creation.

It should be noted that for implementation of these provisions, an important factor is also the training of a teacher, his ability to represent material with some degree of artistry (Zhdanova et al., 2017), since the specifics of teaching the history of scientific and technical creativity leave a lot of space for creative improvisation in the process of conducting classes with students.

Implementation of these provisions will allow to improve the quality of graduates' training and will give an educational organization advantages in competition in the market of educational services (Ivinskaya et al., 2016) and improve the quality of the educational organization (Tkacheva, Simonova, & Matveev, 2016).

7. Conclusion

Proceeding from the above, students should be trained in skills of the comparative historical analysis of domestic and foreign scientific discoveries and achievements to adequately picture the level of research in particular field of knowledge or industry in different periods.

It is important to familiarize students with the great scientists and inventors, the process of their creativity, as well as the basic facts and trends in the development of scientific knowledge and technology in time. World and Soviet (Russian) historical science can offer student a wide range of works of such a genre as a historical portrait, including those dedicated to describing the work of outstanding inventors of the past (first of all, the legendary series "The Life of Remarkable People" ("Zhizn zamechatelnikh liudei", ZhZL). In many of them there is a complex analysis of the scientist's activity in correlation with

historical conditions and an interesting description of his research activity is given, etc. Special attention should be given to the study of the scientific revolutions, scientific paradigms change, as well as to the various concepts of the scientific and technological revolution, the scientific and technological progress, technological development of mankind and the "information society", integral and systematic interpretation of which forms the culture of scientific thinking of a professional.

The materials of this article can be useful: to the faculties of universities, who are engaged in training of engineering personnel; to the heads of universities and university departments; to the potential employers for engineering and technical training students; to the students of engineering and technical areas of training (bachelors, specialists, masters) as well as all those interested in the issues of engineering education and the history of scientific and technical creativity.

In process of the research, the new questions and problems that should be solved have appeared. Continuity between the study of the history of scientific and technological discoveries and the modern approaches to the scientific and technical creativity and solution of the inventive problems is necessary. It is important to improve the approaches to studying, which would create in minds of future engineers the systematic vision of the relationship between scientific and technological discoveries and their consequences for a society.

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