The European Proceedings of
Social & Behavioural Sciences
EpSBS

Future Academy

ISSN: 2357-1330

https://dx.doi.org/10.15405/epsbs.2018.12.133

RPTSS 2018
International Conference on Research Paradigms Transformation in Social Sciences

HUMANITIES EDUCATION AS WAY OF FORMING SOCIAL RESPONSIBILITY OF ENGINEER

A.V Shutaleva (a)*, A.A. Kartasheva (b)
*Corresponding author

(a) Ural Federal University, Ekaterinburg, Russian Federation, E-mail: a.v.shutaleva@urfu.ru
(b) Ural Federal University, Ekaterinburg, Russian Federation, E-mail: anna.kartasheva@gmail.com

Abstract

The article is devoted to the study of modern requirements for the engineering profession. The topic of the humanitarian component of engineering education is relevant for modern investigation, because the object of modern engineering activity is a complex object, work with which requires the inclusion of social aspects, which seemed previously secondary. The purpose of the article is to study the problem area of the humanitarian component in engineering education. This article reveals the main humanitarian factors in engineering education, which play a significant role in the formation of the ethical responsibility of the engineer. The worldview level of the engineer and the ways of its formation becomes a topic for research, as modern engineering activity includes social and technical design, where the social and psychological aspects of the professional activity of an engineer are of great importance. The socio-technical design is a design without prototypes; modern engineers do not have ready-made intellectual solutions for solving complex scientific and technical problems. The modern engineer becomes a methodologist in the design of individual industrial products and systems design. A significant part of humanitarian problems of an engineering activity is the implementation of practical engineering activities in the context of its comprehension through the prism of an interdisciplinary and moral assessment of using engineering products and consequences of their use.

Keywords: Engineering education, engineering thinking, engineer ethics, responsible research and innovation, humanities, social responsibility.

https://dx.doi.org/10.15405/epsbs.2018.12.133
Corresponding Author: A.V Shutaleva
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

1. Introduction

Modern engineering activity demonstrates the complexity, the involvement of modern high-tech tools, as well as the need to solve non-traditional tasks for it, requiring a new type of engineering thinking. An important problem, which actualizes the modern understanding of the requirements for the education of engineers, is that the universities are guided mainly by the image of the engineer of the second half of the XIX, first half of the XX century. The modern structure of the responsibility of the engineer is polycentric, not monocentric, which was true for the engineer of the late XIX - early XX century. The achievements of modern engineering thought very quickly penetrate into the sociocultural reality, and the basic norm of responsibility, previously understood as "right work", today includes the requirement of social responsibility. The problem of the humanitarian context of engineering thinking is most often posed through the prism of humanitarian education for engineering specialties. The need to move from the extensive information system of education to the problem-analytical system poses a special task for humanitarian knowledge, namely, humanitarian knowledge must acquire the features of technology in order to be really in demand among engineers. But it remains unclear what technologies should be used, how it is necessary to teach humanities engineers. In this article, we are trying to show the ways in which humanitarian education affects the formation of the world outlook and the ethical responsibility of the engineer.

2. Problem Statement

Engineering activity is inherent in the historicity of development and, therefore, its understanding and explanation. The works written by J. Beckmann are among those that investigate the phenomenon of engineering activity of the classical period (Beckmann, 1806). Several investigators embody the technique as cultures (Dessauer, 1908; Mayer, 1906; Shroeter, 1933; Wendt, 1906; Zschimmer, 1937). Problems of classical philosophy of technology are examined in the works of many scientists (Engelmeyer, 1968; Kapp, 1978; Rapp, 1978; Weihe, 1935). Researchers working in the paradigm of a non-classical philosophy of technology transfer the idea of A. Bergson's life impulse to the creative evolution of technology. Technicality is understood as a "mediator" between the man and the world, as a technical object is grasped not through work, but through the concept of operator functioning. The phase that balances technicality is the religious mode of existence (Simondon, 1958). The non-classical philosophy of technology notes that technical objects are not fundamentally reduced to physics and biology (Stigler, 2015), and technological constitution (Stigler, 1998).

One of the main aspects of modern engineers training is related to social-time problems of society because it is the engineer who takes responsibility in solving such issues in his professional practice and decision-making system (Harris, Pritchard, Rabins, James, & Englehardt, 2013; Balakrishnan & Visvanathan, 2013; Zandvoort, 2008; Newberry, 2004). One problem raised by Boonsong, Siharak, Srikanok dedicated to the development of learning management that enhances the development of the moral ethics and Code of students' ethics at the University of technology (Boonsong et al., 2018). Several investigators consider theoretical and practical approaches and ethical aspects of modern medical practical activity (Bruynseels, de Sio & van den Hoven, 2018). A number of studies are devoted to the use of the constructivist approach in the teaching of engineering ethics Larochelle, Bednarz & Garrison, 1998;

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Jonassen, 1999; Martin, Conlon, & Bowe, 2018). Alkhatib and Abdou devote their research to the problem of ethical dilemmas and conflicts that arise due to unresolved technical and ethical problems. To address these challenges and avoid the expected ethical dilemmas, the authors propose the development of standards and professional frameworks that are designed to ensure the implementation of effective decision-making models and robust compliance plans with practices with ethical rules and professional regulations in the engineering industry (Alkhatib & Abdou 2018). The integration of humanitarian and technical components of the educational process is possible on the basis of additions the humanitarian topics in educational programs of technical specialties (Yegorov, Portnov, & Ogoltsova 2016). A number of researchers apply for integrative educational and research programs (Lozano et al, 2018; Shipkova, Vdovenko, Kukushkin, & Lukyanova, 2016).

Modern normative documents that regulate engineering activities and engineering education include the description of engineer's competences, the ability to holistically approach the solution of professional problems. These normative documents are the CDIO standards as the Standard of Conceive Design Implement Operate, ABET as the Accreditation Board for Engineering and Technology, professional standards, the Federal State Educational Standard.

3. Research Questions

The modern aspects of engineering activity relate to the question of specific engineering education to content modern requirements to the engineering profession, and to content character and tendencies of modern engineering activity. The humanitarian component of engineering education should change in order to correspond the modern engineer's goals and tasks. Changes in the content of engineering activities require effective changes in its teaching methods. Therefore this article devoted to the question how exactly the methods of humanitarian education for engineers should change and why it is necessary.

4. Purpose of the Study

The aim of our study is to investigate a problem field of the humanitarian component in engineering education. The value of humanitarian education should be clearly understood by future engineers. However, new methods of transferring humanitarian knowledge, including value-based and project-based approaches, need to be developed for. Humanitarian knowledge should not be perceived as "optional", otherwise, it always needs to be in the focus of any pathway of engineering education. At the same time, the engineering activity itself in the modern world acquires the character of technology; therefore, humanitarian disciplines should also become technological.

5. Research Methods

The methodological basis of this study is an approach to understanding engineering activities, which include the value component. Modern engineering is a socio-technical activity because it includes not only the solution of a professional problem, but also a vision of how its activities are consistent with the natural environment, society, human life. Today, the engineer carries out sociotechnical activities, because the technique in modern social alterations has changed itself so much that the technique in the form of new technologies is increasingly developing in the direction of social, environmental, structural and ethical-joint

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technology. Sociotechnical work of the engineer connected with its humanitarization. Turn to the concept of moral and social responsibility of the engineer is due as problems in terms of new technological opportunities arise and further lead to large-scale consequences for the whole nature, and these problems cannot be predicted. These are the problems of proliferation of nuclear weapons, the use of nuclear energy, environmental pollution, and other problems. Technical actions related to such problems imply a special level of responsibility for them.

6. Findings

6.1. The humanitarian context in the engineering thinking

There are three levels of "penetration" humanitarian knowledge into engineering thinking. First, knowledge of the human's biopsychic properties being is inherently humanitarian. The technique of the conveyor solved the problem of human involvement in the technological process, mechanically combining the mechanism and the physical characteristics of the person. Further problems of human involvement in monotonous machine technological processes began to be solved at the level of mental processes. Ergonomics, engineering psychology, safety have appeared. This is an applied aspect of humanitarian knowledge for engineering thinking. Secondly, social, economic and environmental knowledge of how to integrate technical projects into the social community is a humanitarian one. This aspect is connected with the humanitarian examination or social assessment of technology. Thirdly, the knowledge linked with worldview is humanitarian. At the same time, we are not talking about intelligence as a concept that incorporates the idea of spirituality, morality, culture, education, but it is about the worldview as a set of ideas about the world and its place in it.

Two sides of the humanitarian knowledge connect with worldview. On the one hand, humanitarian knowledge is necessary for understanding the world around us, people around us and ourselves, and on the other hand, the humanitarian contributes to the development of independent thinking, worldview and, of course, responsibility. These two sides of human knowledge can also be linked to humanitarian education. On the one hand, it is about extensive-information training and orientation "outside", on the other – about analytic-problem training and orientation "inside". It is possible to distinguish two types of engineer's professional competence, which are formed precisely in the study of humanities. Thus, the first group of competencies or qualities can be distinguished, otherwise called "soft skills" and marking the readiness of the engineer to work in their profession. Among the competencies of this type can be called scientific and technical, economic, creative and environmental thinking, as well as entrepreneurial skills, ability to work with people, initiative, a culture of thinking, the ability to manage their emotions and actions. These qualities are formed in the future engineer through extensive-information training in the humanitarian component. But it is possible to allocate also the second group of the competencies or qualities marking the engineer's relation to his work. Among the competencies of this type can be called responsibility, discipline, integrity. At the same time, the issue of responsibility can be raised at the level of personal responsibility, as well as at the level of collective responsibility.

The engineer of the second half of the XIX – the first half of the XX centuries understood the responsibility as "correct work". It is important to assign a task at any cost that can neglect a responsibility to other people. Social progress is due to the efforts of technicians (Veblen, 1919). Since engineers

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represent the interests of the technology development itself, and also the interests of society as a whole. Based on this point of view, a chemical engineer, to whom the superiors instructed to invent a new type of poison, will be considered competent if the case is brought to an end. So understandable responsibility is monocentric since it is based only on the awareness of the engineer of his work duties. Job duties of the engineer related to how well the engineer is familiar with his major disciplines' material and with the latest developments in the field of science and technology. But not only that. In the early twentieth century, German engineer Riddler noted that engineering is not only the art of scientific and economic leadership but at the same time, the cultural task (Riedler, 1900). Today the engineer acts not only in the system man-nature or man-technology but also in the system of man-society. The modern structure of the engineer's responsibility is polycentric. The responsibility for direct work added the responsibility for the engineer's awareness of his role in society and his dependence on society – social responsibility (Morton, 1971). Hereby, there are two cores in the structure of engineering responsibility – technical and humanitarian. That is why it is important to humanize engineering education. The normative requirement of parallelism between disciplinary (technical) and humanitarian expertise forms the strategy of "humanization of technology" (Weinstein, 2010) and "system rationality open type" (Bühl, 1997).

The problem of modification of humanitarian education for engineering specialties and ask questions consider the question – how exactly to teach the second type of competences? Is it possible to "instill" responsibility? Is it possible to "teach free thinking"? As one of the possible approaches can be called the project activity, understood as the acquisition of skills by students while working in conditions close to reality. Modeling the negative effects of the new technology helps to develop the skill of critical technology assessment. Project activities are always fundamentally interdisciplinary. In this regard, it is impossible not to mention such a paradigm of engineering education as the STEM as constituted from Science, Technology, Engineering and Mathematics. The project approach becomes particularly important with the advent of system engineering. Its main features are the interdisciplinary language, which allows participants to agree during the project, as well as the idea of the life cycle, according to which it becomes possible to correct errors at the earliest possible stage: the global initiative for the development of engineering education Standard of Conceive, Design, Implement, Operate. The abbreviation is formed from the terms defining all stages of the life cycle: conceive, design, implement, operate. Thus, system engineering is an interdisciplinary approach and means to ensure the full life cycle of a successful system, including problem formulation, solution development and operational support and use according to Guide to the Systems Engineering Body of Knowledge – SEBoK.

System engineers ensure the integrity of the engineering project. For example, they design an oil platform, distributing parts of the work to an engineer by profession and collecting the results, gathering to a reliable engineering system. It is for system engineers need an in-depth study of humanities. Science does not automatically control itself, even being able to provide tools for such control (Agazzi, 2009). The humanitarian component in engineering education should take into consideration the simultaneous presence in engineering activity and engineering education as a methodology of responsible research and innovation as the initial design models of the technological future, and the methodology of "disruptive innovation", which set the task of destroying entire industries, the wreckage of which is only possible engineering creativity. The humanitarian context must accompany engineering activities constantly. Higher education

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institutions working on training programs for future engineers will have to actively participate in the development of systems and institutions that support such an educational strategy as life-long learning. The goal of social development is self-development and self-improvement of each individual and because technique from the threat to humanity becomes a vehicle for the implementation of humanistic values (Adorno, 1953). Creation of oneself is an indispensable condition of moral activity. Self-regulation is an essential feature of the engineering profession, as well as the result of the understanding of responsibility to society (Brownlee, 2015). Social responsibility can be adaptive, as the need to "adjust", "react" and non-adaptive (outstripping action). A professional voluntarily takes responsibility; he wants to change not only the world, but also himself.

6.2. The humanitarian component of the education of an engineer as a condition for success in his socio-technical activities

Engineering ethics regulates a set of rules that regulate the behavior of an engineer, such as responsibility for the results of their professional activities, the relationship of the engineer with other participants in the process of creating and practicing the product of engineering activities. And this area of engineering activity is not fixed in legal norms and is based on norms, customs, moral, cultural and philosophical level of the participants themselves. Moreover, the society forms the social order to the engineer, the fulfillment of which requires the engineer to follow the worldview of the era in his activity. A practical design installation in the field of architectural construction at the beginning of the twentieth century can be considered as an example of following an engineer's world outlook. The activity of engineers was connected with the design and construction of buildings, which were designed to promote the formation of a new collective life, the consolidation of the proletarian community, the broad communication of workers, their upbringing and cultural development. House-communes, clubs, Palaces of work and recreation served as a dream for the creation of a new man. After the Second World War in Russia, the micro-district concept and a step-by-step public service system are being implemented. In the 1960s, design methodology and design methodology were being developed. In the 1970s, a social design was singled out as an independent activity, which required the synthesis of a project approach with a sociological approach within the framework of the development of social management, social planning, design and design of organizational and social processes and structures, design and urban planning.

Social design is a kind of social engineering activity; hence, prediction determines its many characteristics. For example, forecasting should show the reality of the implementation of projects, provide information on possible and achievable goals, and provide a basis for decision-making, revealing the possible consequences of social design. At the beginning of the twentieth century, design appeared as a special kind of engineering activity, since engineering betrayed a whole direction and complexity to the whole cycle of engineering activities. Designing in this period is connected both with the activity of the draftsmen and the need for a specialized, faithful graphic representation that allows engineers to convey the intent of the engineers. Gradually, the implementation of the project activity shifted towards merging it with scientific and technical calculations, and on the draft, the main parameters of the future technical system and its preliminary research were reflected. Since the middle of the XX century, the object of engineering activity is changing and becomes a complex object, the consideration of which requires the

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inclusion of such aspects as environmental and social, previously considered secondary. For example, the construction of power plants and other complex technical systems does not imply that the environmental situation is “external” for design. Environmental requirements are the starting point for the design of complex technical systems. Engineering activity becomes complex, including socio-technical design, in which the main role is played not by machine components, but by human activity, its social and psychological aspects. One of the features of the socio-technical design is that it is a design without prototypes. This stipulates that socio-technical design is oriented towards the realization of socio-cultural ideals, rather than ready-made stamps and templates. Socio-technical design includes such types of activities as production, social functioning, operational, traditional design and other activities.

Modern urban planners face situations when they do not have ready-made intellectual developments to solve specific scientific and technical problems. This situation brings the modern engineer to the need to become a methodologist in the design of individual industrial products and systems design. The peculiarity of the design of systems is that the engineer in search of images and conceptual schemes refer to the cultural heritage of humanity. The modern social design is social because it must have its leading position and project ontology. Socio-humanitarian courses are included in engineering education, which allows, first, to give presentations and knowledge characterizing the main features of the subject of engineering disciplines, including knowledge of the history of their formation, and secondly, to form the systemic thinking that is necessary for engineering work.

Humanitarian knowledge is essential in a number of areas. For example, in the system of national economic management, in which expertise of scientific and technical projects, consulting, forecasting require the involvement of knowledge of system analysis, the philosophy of science and technology. Reflections on the technical and technological aspects of the processes suggest that the engineer has a high culture of thinking (Harris, Pritchard, Rabins, & James, & Englehardt, 2013; Balakrishnan & Visvanathan, 2013; Zandvoort, 2008). The engineer must take into account the influence of technology on the fate of civilization and some humanitarian ideals in their own work. The intellectual situation for the basic unit of educational material, then the engineer must solve a certain research program to overcome difficulties and problems, implement it, reveal its heuristic value, advantages over other areas. The activity of the engineer realizes in practice a special methodological reconstruction, which is feasible on the basis of the theory of activity, system analysis, sociology, culturology and a number of other disciplines. In this regard, one of the aspects of engineering education is the teaching in technical colleges of philosophy, sociology, theory and history of culture, psychology and other disciplines of the humanities cycle. It should be noted that the humanitarian component consists not so much in the study of humanitarian disciplines as in the formation of a special approach to reality, a special way of thinking and worldview. Teaching humanitarian disciplines will help the engineer to form a holistic vision of the object within its own socio-technical activities.

The identification of the humanitarian component is possible in modern technical culture. This is due to the fact that a modern scientist and engineer discover that their activities are not impersonal. The activity of the engineer affects society, nature, man (Rapp, 1978; Alkhatib & Abdou, 2018). Engineering activity creates benefits, but it can also destroy nature, and the mechanization of society can pervert the spirit of man. Therefore, engineering education assumes that the analysis of current and crisis-created engineering situations should include an analysis of values, world paintings. Negative consequences of

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engineering activities for nature, society or man should be understood both at the level of scientific study and the practical level of industrial production, on which the errors of a scientist, engineer, designer or technologist are explicitly revealed. Consequently, the appeal to humanitarian disciplines must occur in the context of engineer's understanding the positive and negative consequences of his activity for man or nature. Humanitarization of technical presupposes a certain system of content. In the process of the engineer's formation, the basic attitudes are related both to the subject, methodological and historical areas, and must include the humanitarian component. If the demand for the development of a substantive, methodological and historical component of the content component of an engineer's education is feasible, then the presence of a humanitarian component requires justification and increase in its specific weight in educational programs. In accordance with the humanitarian attitude, ethical and axiological problems are of great importance. For example, the problems of cultural-semiotic and communication aspects of engineering activities; the problem of analyzing and assessing the socio-cultural meaning of the development of modern technology and technology.

Engineering education at the level of the subject professional component should include knowledge of organizational and managerial professions. This need is conditioned by the tasks of engineering management and organization. The level of the subject professional component involves studying the features of design and engineering thinking, as well as their boundaries of expedient use. Therefore, it is necessary humanitarian and methodological introduction to engineering and design, as well as art, which will allow understanding the feature of the activity, which, in general, is referred to as “techne”. Engineering education should include social and philosophical-methodological disciplines since the engineer in his practical activity faces situations of making complex decisions in the field of enterprise management, requiring knowledge of the theory of conflicts, economic regulation, and the theory of reflexive processes, economic legislation, and ethical issues.

7. Conclusion

For modern engineering activity and thinking, a number of features that require access to the humanitarian component in the education of the engineer can be identified. We can distinguish five ways of influence on the liberal education of engineers. Firstly, the sociotechnical nature of engineering thinking assumes a high general culture of the engineer's personality to be capable of reflecting on his own activities, using the modern methodology and applied humanities. Secondly, engineering activity today is connected with principle interdisciplinary, as well as social, economic and environmental aspects of engineering activity. The engineer often designs and manufactures technical products, which are complex systems, including both technical and non-technical subsystems, the development of which assumes that the modern engineer must be a specialist in the fields of psychology, design, applied ecology, sociology, economics. Thirdly, the engineer should carry out modeling and calculations of not only the main processes of the designed object, but also the possible consequences of its functioning. The consequences can be considered as changes in the environment and nature, changes in the ways of activity and infrastructure and human changes, i.e. the impact of the invention on human beings, which can be implemented as a change in human needs, living conditions. Fourthly, the engineer is responsible to the society for the possible unpredictable negative results of his developments, even calculating all possible consequences. Understood in this way,

social responsibility can affect the motivation for engineering creativity. Therefore, it is important for the engineer to understand how to intensify his creative work, as well as independently to build the structure of his own social responsibility. For this reason, the engineer needs knowledge not only from the fields of law and economics but also from the fields of ethics and philosophy. The development of a holistic view of professional opportunities and social responsibility contributes to the method of project training. Fifthly, a modern engineer cannot take part in the educational process only once in his life. It is necessary to constantly improve skills, learn new knowledge, as each technological innovation entails a huge sufficient number of changes in society. Therefore, it is necessary to use the concept of life-long learning. Consequently, the humanitarian component in education works for all five above-mentioned features of engineering thinking.

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