- a unified programme of internal audits and social surveys;
- an annual QMS analysis is carried out with regard to TC activity assessment according to the process "Compliance assessment".

IMS implementation optimizes functions and flow of documents, thus breaking down the barriers and saving IMS costs. We keep to the following principles: not to destroy the existing QMS of TC, to minimize all possible accreditation risks, and to ensure the possibility of increasing the volume and quality of the services provided as well as its work efficiency. Positive results from IMS implementation can only be obtained on condition that the TC management team and all the staff are involved in the process.

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Socially Oriented Approach: Professional and Personal Competencies of Engineering Graduates

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The paper addresses development of engineering graduates' competencies in terms of social position rather than economic, traditional, viewpoint. It emphasizes the importance to develop internal University culture that brings up engineers' responsible attitude to their professional activity. The authors provide some survey data related to TPU students' internal culture research.

Key words: university graduate's competencies, responsibility, university internal culture, engineering education, engineer.

"The first duty of the university is to teach wisdom, not a trade; character, not technicalities".
W. Churchill

Today, the concept "engineer" implies three categories of people [1].

The first category embraces people who occupy engineering positions. They should meet the requirements set both by the government regulations and industry-specific regulatory documents.

For example:

- Third grade engineer: higher professional (technical) education, work experience is not required; or vocational (technical) education, not less than three-year work experience in a position of the first grade technician or other positions (not less than five-year work experience for vocational degree holders).
- Second grade engineer: higher professional (technical) education, three-year work experience in a position of an engineer or other engineering positions.
- First grade engineer: higher professional (technical) education, not less than three-year work experience in a position of a second grade engineer.

The position of an engineer is gradually vanishing in Russia. It is replaced by such posts as "specialists", "expert", etc.

The second category involves people who graduated from the university with a degree in engineering or were accredited by a professional-public accreditation agency after submission of all required documents or passing corresponding exams.

The first group of people within this category embraces those who had graduated from university before Russia adopted a two-tier (Bachelor, Master) degree system. In reality, the two-tier degree structure of education system was adopted by some Russian universities in 1993, though Russia signed the Bologna Declaration in 2003. In 2011, Russian universities eventually moved to the two-tier bologna system of education. This group comprises the working age population.

The second group is a relatively new phenomenon. In Russia, it appeared approximately in 2011. It is worth noting that the degree of engineer has been awarded in the western countries (with exception of Germany) by definite professional-public accreditation agencies for a long period of time. Western universities have never awarded their students such a degree. In

Russia, the lack of the engineering legislation impedes the sharp increase in the number of people awarded the degree of engineer by the professional-public accreditation agencies.

Finally, the third category is comprised of people who are directly involved in engineering activity. They may hold corresponding degrees and occupy engineering positions. However, it is not obligatory for this category.

Engineering is termed as an activity aimed at practical application of scientific, economic, and social knowledge in order to secure efficient use of natural resources with benefits for people [2]. The main objectives of engineering are to invent, innovate, design, build, maintain or improve structures, machines, materials, and processes. Engineering is closely interwoven with science. It rests on the postulates of the fundamental science and findings of practice-oriented research.

A vision for the engineer of the future is being intensively discussed [3-6]. Without going into detail of various engineering degree training, it is possible to outline a number of general considerations.

Speculating on the vision for the engineer of the future, first of all, one should bear in mind a wide range of engineering tasks an engineer should be able to tackle even within the scope of one engineering discipline. From the above-mentioned objectives of the engineering activity, it is obvious that an engineer may either be involved in absolutely creative work (invention, design, implementation) or perform routine engineering tasks (maintenance, repair, improvement). To effectively manage all these activities, an engineer should acquire a set of professional and personal competencies. In addition, unequal distribution of creative and routine work, also within the process of technological innovation, should be considered. Thus, a designer may need dozens, perhaps thousands (depending on the complexity of the designed products) of detail draftsmen whose work requires less or even no creativity.

Relating to the professional competencies, an engineer involved in creative work must demonstrate a deep insight into various branches of both fundamental and applied science (for aircraft designers it is essential to know how birds really fly), while an implementation engineer or machine engineer who is in charge of maintenance, repair, and improvement of machine, processes, and materials should have knowledge of the regulatory documents, standards, definite properties and specifications of the machines and equipment he/she works with.

The personal competencies can vary. An engineer-designer who, indeed, creates the future is a leader both at rational and intuitive levels (suffice it recall the story about S.P. Korolev, a designer of space aircrafts, who wrote the following in response to the demand to prove that the lunar surface vehicle would not drown in lunar dust "The moon is hard!" and signed the document). Such talented people are not often open to communication, do not wish to subject, like to take risks, etc. and, as a rule, it is useless to reeducate them.

An implementation engineer or machine engineer, vise verse, should be sociable, ready to subject and avoid risky actions.

Hence, the wrong conclusion can be made that universities should take into account the difference in characteristics of various types of engineers and correspondingly correct the number of graduates trained within this or that engineering specialization. It is this conclusion that forces Russian universities to increase the number of various engineering degree programmes, introduce new disciplines into the curricula and carry out a great number of tests to divide students into the groups according to their abilities.

Also, when developing the requirements to the engineer of the future, the opinion of an employer should be treated with caution.

The timeframe that the modern business plan covers seldom exceeds a year, especially in the context of crisis. The business owners are not capable of defining what type of machinery and equipment they will use in 3-5, all the more 10 years. At the same time, the timeframe of university plans varies from 4 to 6 years (curriculum is usually developed for the entire study period). In addition, university is a cradle for science, it means that new machinery and technologies are conceived at universities on the basis of up-to-date scientific achievements. This fact is seldom considered by employers when formulating the requirements to engineering graduates. Evidence of this phenomenon can be found in the results of the practical course carried out several years ago at National Research Tomsk Polytechnic University (TPU) [7]. The training course was designed for TPU faculty, business owners and specialists of a number of Tomsk enterprises. They were asked to formulate the requirements to TPU graduates. It was revealed the university faculty made up a list of certain requirements, while potential employers restricted themselves to general phrases and memories of the "kind" past.

Another important factor to be considered in formulating requirements to the engineer of the future is elimination of the imbalance between professional and personal competencies.

More attention is now paid to the development of professional competencies. It is enough to look through the list of competencies for a graduate to achieve upon any programme completion in order to notice this imbalance.

As a rule, the list of competencies always contains such a competency as "responsibility", however, it is usually understood as responsibility for the entrusted work that should be done at any cost, rather than responsibility for what you do. From this perspective, a chemical engineer who invented new poisonous gas upon instructions from the authorities is a rather competent engineer.

Besides, the present education degree programmes do not clarify when and how such a competency as "responsibility" is developed.

Nowadays, as machinery and technologies intensively develop, responsibility of engineers becomes more important. The lack of responsibility could result in severe technogenic disasters. It is enough to recall the 1986 disaster at the Chernobyl Nuclear Power Plant, failure at Sayano-Shushenskaya hydroelectric dam, accident at the Fukushima Daiichi nuclear power plant… The responsibility of an engineer will become more and more important. Hence, this competency should be particularly emphasized within the scheduled engineering curricula.

The issue of training engineers of the future is closely interwoven with the changes in social structure and organization of the society.

The modern Government and, to some extent, the society itself are trying to impose constraints on the universities so that they "produce screws" for the economic machine. In order to guarantee that this "screw" fits for its purpose (make profit), it should be properly designed (initial parameters should be correctly set), properly produced (abundant characteristics and possibilities should be eliminated), properly used (place it where it is designed to work). Hence, a lot of attempts are made to identify students' unique strengths at the stage of entrance exams in order to build appropriate study paths that would ensure so-called "screw production". Fortunately, all these attempts regularly fail, however, persistence in this issue gives reasons for concern.

The question is how to evaluate the scope of engineering activity in engineering training?

Today, this scope is defined by the life itself. A graduate found him/herself at a real workplace can try any activities within his/her position or occupation and, as a result, choose those which suit him/her better. Despite some obvious efforts, this way is proved to be the best one.

Due to the above-mentioned inertia, higher education would never meet up-to-the-minute requirements of the economy. Therefore, universities should equip their graduates with some crucial fundamental and practical competencies, personal attributes, willingness and capability of pursuing further education within the chosen domain. A graduate should not only display a deep knowledge of his/her profession (it would never be possible to know everything), but, first of all, demonstrate ability to think. This is, actually, in consistent with the employers' requirements. The workplace needs analysis has revealed that emphasizing the need for highly-qualified workers, employers usually expect their workers to demonstrate not specific knowledge and competencies, but definite level of thinking, experience, and responsibility.

It is reasonable to introduce such an education system so that each person would have a possibility to attain required knowledge and skills precisely at the moment he/she needs them (lifelong learning), but not in advance. Therefore, the emphasis should be made on the retraining courses which are currently regarded as a non-core activity that brings profit both to university and faculty members. However, it should become the basic activity of the universities along with teaching within the core degree programmes. This approach will be in consistent with the above-mentioned education system when the degree "engineer" is awarded by professional-public accreditation agencies.

It is required to clarify terminology in the system of retraining education, which would eliminate the existing confusion. For example, it is absolutely unclear what level of knowledge the Diploma of Professional Retraining and Advanced Training Certificate imply. What is more important is that how these levels of knowledge relate to that gained upon completion of bachelor's and master's degree programmes.

Such approach to basic and additional education stipulates the changes in planning, organization, and implementation of the training process itself, as well as fosters the understanding that faculty members involved in basic and retraining programmes should meet different requirements.

Hence, the employers should be engaged in formulating the requirements to the competencies of retraining programme graduates, but not to the graduates of the core degree programmes. Within the retraining education, the opinion of employers is of particular importance.

However, first of all, it is required to initiate three key changes in the society, which would contribute to training the engineer of the future:

1. To develop and approve the Doctrine of Engineering Education in the Russian Federation (RF), or, perhaps, the Doctrine of Education of the RF.

2. To develop and approve the Law of the RF "On Engineering Activity".

3. To develop and implement a set of actions aimed at enhancing the image of an engineer.

When it comes to personal competencies (the term itself is rather improper), i.e., first of all, responsibility, it is worth noting that it is quite a complicated task to develop it. To resolve the task, it is important to create a certain environment at the university – organizational culture – which would both directly and indirectly influence personality of a graduate.

The university community is comprised of two groups of people: constant group – faculty members, and inconstant group – students. Based on this statement, it is possible to assume that the organizational culture of university involves two subcultures.

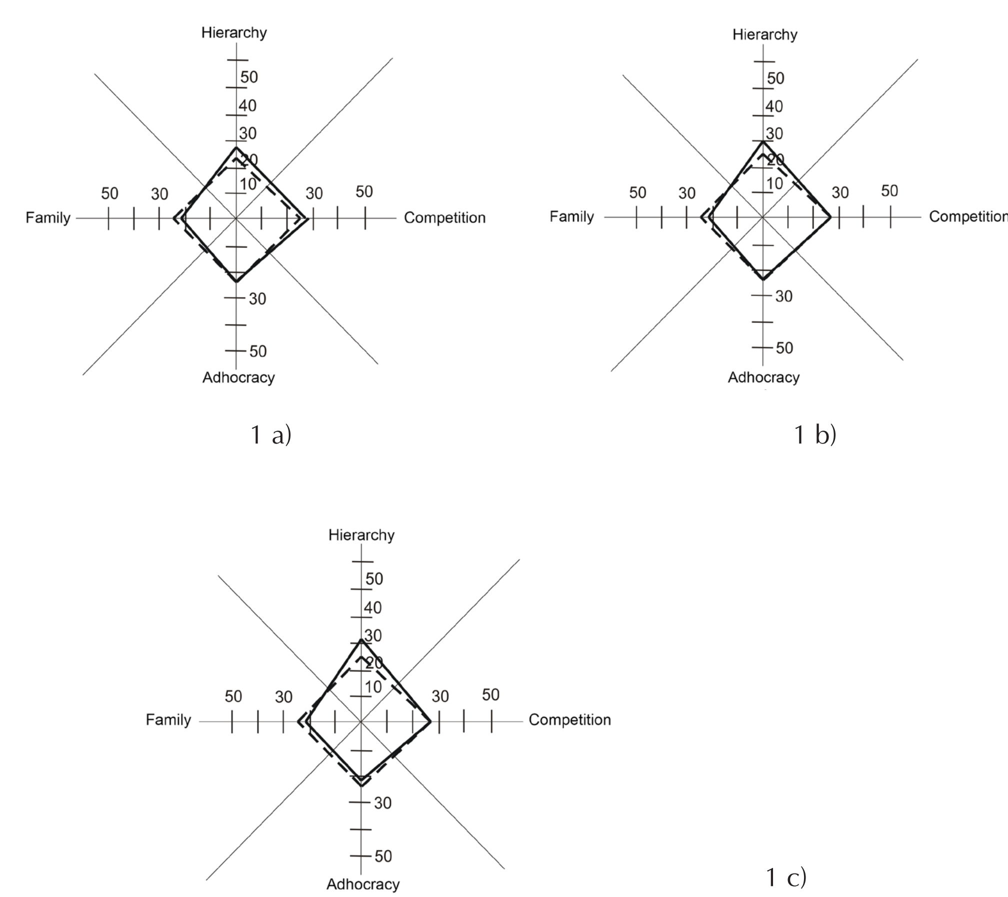
The organizational culture of the faculty members is currently being intensively discussed. The quite interesting findings are presented in [17-22].

The student organizational culture usually implies sport, amateur performances, volunteer work and other similar student activities [8-16]. However, despite the obvious importance of the above-mentioned activities, it is essential to remember that personal competencies are basically shaped in the process of training and research. It is this close interaction with a supervisor, a teacher that shapes the world view and values of a future graduate during training and research process. Scientific schools which are comprised of professors and students who share the same views, ethics, and values are the best examples. Therefore, of particular interest is to analyze the student organizational culture by means of the methods and perspectives applied in the analysis of the faculty organizational culture. In addition, the two cultures can be compared.

To address this task, the organizational culture of TPU students was analyzed via the Organizational Culture Assessment Instrument (OCAI) [20]. The typical questionnaire of this instrument was adapted to the level of students' reception of the organizational culture. This modification of the instrument was agreed with the developers of OCAI. In addition, in order to be sure that students understand the questions correctly, a number of seminars were conducted involving various year students. These seminars enabled students to discuss the organizational culture both in a free format and via the questionnaire. It helped students adequately understand the principles of the questionnaire. 2000 questionnaires were distributed among the bachelor's students of the 1st and 4^{th} year of education and master's students of TPU (the total number of full-time students at TPU was 9944 in 2016). Once students completed the questionnaires and the spoilt questionnaires were separated, 1762 questionnaires were accepted for further analysis.

Fig. 1 a) and 1 b) show the organizational profiles of bachelor's students of the 1^{st} and 4^{th} year of education, while fig. 1 c) shows the organizational profile of master's students (full lines – "now" culture,

Fig. 1. Organizational profiles of TPU students



dashed lines – "preferred" culture).

As shown in fig. 1, the current organizational profile is approximately uniform for all students of TPU (the 1st, 4th year students and master's students). It means that almost all subcultures are presented in all quadrants. There is slight emphasis on the hierarchy quadrant (about 30 points), which is considered normal for such a huge organization as TPU. The "Preferred" profile is absolutely uniform. The discrepancy between "Now" and "Preferred" organizational profiles is insignificant, which means that students do not wish to change anything at the university.

The organizational profiles of definite degree programmes and institutes show the similar trends, which proves the uniform character of TPU structure. It means that there are no specific subcultures in various institutes of TPU.

Fig. 2 shows the organizational profiles of TPU faculty members [19].

It is obvious that the organizational profiles presented in fig. 1 and 2 are almost the same. The close examinations of the organizational profiles of students and faculty members of certain TPU institutes has revealed that the faculty organizational profile deviates from the average value of TPU at the same way the student organizational profile does. It is shown in fig. 3 which presents the organizational profiles of faculty members and master's students of Institute of Humanities and Social Technologies, TPU.

The findings of the current research prove that the organizational culture of the university is powerful enough to swallow up new-comers who, as a result, have to accept this culture being unable to resist. The deviations from this culture are severely punished. As the main contributors to the organizational culture of the university are faculty members and authorities, they have a possibility to impose their vision of the organizational culture on students, which is actually obvious from the analyzed profiles.

Such situation requires from the university authorities and faculty members to pay serious attention to formulating their own organizational culture, as this culture is further transmitted through students into the society and state. Upon university completion, students display the values which they have taken over in the course of education. Since the organizational cultures of most Russian technical universities are similar [18], this type of culture could easily dominate in our society and state.

As it was mentioned above, responsibility for what one does is one of the most crucial

Fig. 2. Organizational profiles of TPU faculty members

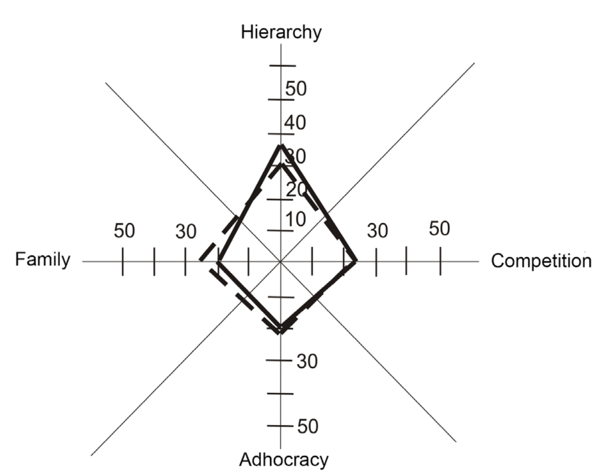
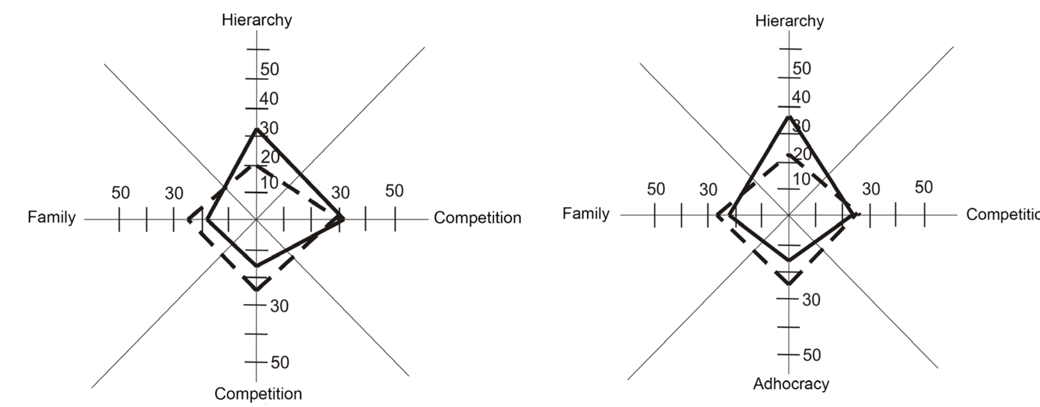


Fig. 3. Organizational profiles of faculty members and master's students of Institute of Humanities and Social Technologies, TPU.



faculty *master's students*

personal competencies of an engineering graduate. Therefore, the organizational culture of the university should become the best example of such responsibility. The faculty members should illustrate what such responsibility means by all of their activities. In this regard, an educator who gives classes half-assedly (students are usually attuned to such cases) because he/she is currently preparing the article for submitting into the scientific journal with high impact-factor, completely destroys the image of a responsible person so that no conversations and seminars could compensate for it. Thus, the systems of faculty motivation should, at least, equally stimulate efficient scientific research and qualitative class delivery.

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