Training system for professionally competent personnel of student construction brigades' main office in NRU MGSU (2011-2019)

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Abstract. The rapid development of engineering and technologies determines the urgent need to train professionally competent personnel for all areas of the national economy. The construction industry, which serve as one of the national economy's drivers, is no exception. Improvement of young professionals' training processes in engineering specialties is possible using institution of the student construction brigades, which turns into an effective tool for students to develop both hard and soft skills, when implemented at the proper level. Achieving the stated effect becomes possible providing timely decision of a number of organizational and managerial tasks. Such as the formation of a clear goals hierarchy of the movement, the selection and systematic transformation of the most effective organizational structure type of student construction brigades in an educational organization, as well as the development and implementation of a training system that provides for both consolidation of students professional skills and their personal qualities development. In 2011-2020, authors of the study developed, implemented and constantly improved the system for training professionally competent personnel of NRU MGSU student construction brigades. Implementation results of three events cycles interconnected in time, goals and resources in 2014 - 2019 was an achievement of significant success in training young specialists for the construction industry by NRU MGSU SCB.

1. Introduction

The construction industry is one of the national economy growth drivers. According to a number of experts, weight of construction in GDP exceeds 6%, and the number of employees in the construction industry is 8.8% of the total manpower in the country [1]. Meanwhile, the construction industry itself needs systemic investment and training for its current and future needs of professionally competent personnel.

Within the framework of this and subsequent studies, by professionally competent personnel we mean specialists trained in strict accordance with the current qualification requirements, capable of effectively carrying out professional activities based on practical knowledge, experience and skills.
University students training in such programs as 08.03.01 "Construction" (bachelor's degree) and 08.05.01 "Construction of unique buildings and structures" (specialist program) in modern conditions should provide not only an increase in technical competence (hard skills) [2], but assume development of “soft skills” among young specialists [3].

This circumstance is becoming more and more relevant in the context of science, technology, information and communication technologies' rapid development [4]. Civil engineering graduate's ability to use modern technical solutions in their professional activities, for example, tools for multidimensional, statistical or neural network modeling [5], should be reinforced by the specialist's capability to work in team and build strong and effective communication channels with other project participants.

In recent years, in construction industry there has been an acute shortage of qualified personnel, who are able to solve not only applied problems that fall within the competence of a particular department, but also issues of related areas, disciplines, and technologies.

Participation in the implementation of large-scale investment and construction projects (ICP) [6,7], simultaneous involvement in a variety of long-term projects has aggravated the need for most design and construction organizations to create production coordination departments within their organizational and staff structure. The establishment of coordinators and project managers positions, whose tasks include not only technical support of project implementation, but also solving a large number of organizational and managerial tasks [8], creates an urgent need for competent personnel, who equally have both applicative knowledge and a high degree of socialization as well as communication and organizational skills.

Thus, at this point, there has been a trend in construction industry to increase the importance and role of employees "soft skills" while maintaining the previous level of development of their hard skills. According to the authors of the study, ensuring the students' of technical universities overall development, construction specialization in particular, can be achieved by full-scale use in the learning process of a tool of professional training and socialization of the student such as the movement of student construction brigade (SCB) [9].

However, it should be noted that the activities of the SCB should be organized in such a way as to create the most favorable conditions for the students to consolidate on practice theoretical knowledge, development of professional competence, teamwork skills and the construction of strong communication channels with other participants in the interaction. At the same time, a simple foundation of the SCB's main office or another similar unit in the educational organization is not enough. It is necessary to meet regulatory requirements of SCB’s activities that are based on the latest organizational and methodological developments and experience of the leading participants of the SCB movement, as well as construction and following improvement of its own training system for professionally competent personnel.

2. Materials and methods

The study of the formation and development of human capital in the modern realities of socio-economic development [10] has been extensively developed in the last 10-15 years. A decrease in share of manual work, which accelerate automation and mechanization of technological processes, makes it possible to free labor resources and direct them to solving unique problems and implementing innovative projects [11].

It should also be noted that digitalization of the information space significantly reduces barriers to interaction between specialists in various industries, promotes technology transfer [12,13] and integration of market participants through the association or collaboration of production, research, engineering, educational and other agents [14]. Under these conditions, it becomes possible to implement the most ambitious plans and revolutionary ideas.

Numerous studies of domestic and foreign scientists in recent years clearly demonstrate the existence of a close relationship between individual personal qualities of a specialist, such as labor motivation and social competence, and economic indicators of the employer organization [15].
The previous desire to search the labor market for a specialist with a set of necessary theoretical knowledge, practical experience, and skills is gradually giving way to the interest of employers in recruiting certain candidates. Those who, in addition to all the above, have the necessary set of personal qualities and are able to quickly integrate into the work team, develop and implement creative ideas, and comply with the ethical standards of conduct and company corporate ethics.

However, these "soft skills" cannot be fully developed by a university student only within the framework of their academic theoretical training. The solution to this contradiction can be the involvement of students in interaction with each other by organizing various events, projects, creating sports, creative, scientific student societies, as well as organizing joint professional and labor activities of students. Since the mid-50s of the XX century, the SCB institution has been actively developing in the USSR, which has become a real forge of personnel for various sectors of the national economy.

In 2011, the SCB's main office was re-established in the FSBEI of Higher Education "NRU MGSU" (NRU MGSU). The updated structure incorporated the long-term history and traditions of the nationwide SCB movement, and also used the experience of previous years in organizing the work experience internship for students of the heat power facilities construction faculty.

The most valuable organizational and managerial experience of employees and students of the NRU MGSU's department "Construction of thermal and nuclear power facilities" was obtained in 2010 during the first after a long break internship for third-year students at the construction of Novovoronezh NPP-2 (NV NPP-2). This practice made it possible to integrate a group of 6 students, who were training in specialized field, into the production construction process of the second power unit of NV NPP-2.

Along with the performance of professional duties, students were expected to perform within 30 calendar days subsequent tasks:

- organize the process of collecting information in accordance with the received assignment for practice by establishing communication channels with various project participants;
- develop and effectively implement a collective plan for non-professional activities in your free time, including organizing and participating in sports, career guidance, and cultural events.

This pilot project demonstrated the sufficient relevance of such formats for students to undergo work experience internship, and the gained experience was used in the revival in 2011 of the student construction brigades' main office at NRU MGSU.

In 2011, the accumulated experience of 2010 was used in organizing the labor semester that was first in history of renewed SCB NRU MGSU main office [16], which took place at the construction of Olympic facilities in Sochi. Three formed linear student construction brigades of NRU MGSU with a total number of 68 people took part in this project.

In the following years, the University has implemented dozens of similar projects, which allowed students to take part in the construction of thermal and nuclear power facilities in Russia and abroad, as well as hydro-power facilities, aerospace complex, projects in the far North and Renovation of Moscow. Along with the expansion of the geography and work specifics, a training system for professionally competent personnel within the framework of student construction brigades was created and developed. By 2020, its final formation took place, which made it possible to qualitatively increase the competitiveness in the labor market of NRU MGSU students, that were participants of the SCB movement. The training system for professionally competent personnel developed by the SCB's main office of the NRU MGSU in 2011-2019, that had been implementing and improving until 2020 is shown in figure 1.
Figure 1. The training system for professionally competent personnel within the framework of student construction brigades.

This system includes three interrelated cycles of activities. The first professional training cycle was focused on the acquisition and consolidation of professional skills (hard skills) and consisted of:

1. ACHIEVEMENT OF TRADESMAN QUALIFICATION WITH FOLLOWING PROFESSIONAL QUALIFICATIONS ASSIGNMENT OF THE APPROPRIATE LABOR GRADE.
2. VISITING UNIQUE ENGINEERING STRUCTURES AND LARGE-SCALE INVESTMENT AND CONSTRUCTION PROJECTS AS PART OF PROFESSIONAL STUDY TOURS.
3. TRAINING IN SAFE METHODS AND TECHNIQUES FOR PERFORMING WORK WITH A PERMIT-TO-WORK AT A HEIGHT OF 1.1 M OR MORE WITH THE USE OF SCAFFOLDING.
4. PREPARATION AND PARTICIPATION IN THE ANNUAL COMPETITION PROFESSIONAL SKILLS OF "THE BEST IN PROFESSION IN THE CONSTRUCTION OF THE NUCLEAR INDUSTRY".
5. PREPARATION AND PARTICIPATION IN THE ALL-RUSSIAN COMPETITION OF PROFESSIONAL SKILLS AMONG STUDENT BRIGADES "TRUDKRUT".
6. LECTURES AND PRACTICUMS COURSE OF THE SPRING CYCLE OF NRU MGSU SCB'S SCHOOL.
7. PARTICIPATION IN THE SPRING FIELD SCHOOL BY NRU MGSU SCB'S MAIN OFFICE.
8. ORGANIZATION AND PARTICIPATION IN FINAL REPORTING EVENTS OF NRU MGSU SCB (MEETING NRU MGSU SCB), AND STARTING AN AGITATION COMPANY OF THE NEW SEASON.
9. ORGANIZATION AND PARTICIPATION IN THE FALL CLASSES CYCLE OF SCB SCHOOL.
10. PARTICIPATION IN THE FALL FIELD SCHOOL BY NRU MGSU SCB'S MAIN OFFICE.
11. ORGANIZATION AND HOLDING OF THE NEW YEAR FESTIVAL OF THE NRU MGSU SCB.
12. PARTICIPATION IN THE ALL-RUSSIAN PATRIOTIC CAMPAIGN "SNEZHNYJ DESANT RSO".
13. PARTICIPATION IN SCHOOLS FOR SCB"S SENIOR MEMBERS, WHICH IS HELD BY THE MOSCOW REGIONAL BRANCH OF MOOO "ROSSIJSKIE STUDENChESKIE OTRYADY".
14. PARTICIPATION IN THE OPENING EVENTS OF THE SCB'S THIRD LABOR SEMESTER.
15. PREPARATION AND PARTICIPATION IN THE ANNUAL MEETING OF STUDENT BRIGADES OF MOSCOW.
16. PARTICIPATION IN THE STRATEGIC SESSION OF THE MOSCOW REGIONAL BRANCH OF MOOO "ROSSIJSKIE STUDENChESKIE OTRYADY".
17. PARTICIPATION IN THE BRIGADES' FORUM "SNEZHNYJ DESANT RSO" OF MOOO "RSO".
• University students gained tradesman qualification (f. i. concrete worker, reinforcement worker, bricklayer, plasterer, manual arc welder, welding controller) with the following professional qualifications assignment of the appropriate labor grade.

• Visitation of unique engineering structures and large-scale investment and construction projects as part of professional study tours.

• Training in safe methods and techniques for performing work with a permit-to-work at a height of 1.1 m or more with the use of scaffolding.

• Preparation and participation in the annual competition professional skills of "The best in profession in the construction of the nuclear industry”.

• Preparation and participation in the All-Russian competition of professional skills among student brigades "#TRUDKRUT".

Training for construction workers and obtaining admission to work at height was implemented jointly by NRU MGSU and the Non-state educational Institution "Uchebnyj centr professionalnoj podgotovki rabochih stroitelno-montazhnogo kompleksa atomnoj otrasli" (NOU DPO "UCPR") later it was merged into the "Working profession to an engineer" program.

As part of the study tours students of NRU MGSU regularly visited: the enterprise for the extraction and processing of gypsum raw materials OOO «Knauf Gips Novomoskovsk», Ryazanskaya State District Power Plant, a buildings and engineering structures complex of the Institute of High Energy Physics, an manufacturer of nuclear fuel production for Russian and foreign nuclear power plants - PAO «Mashinostroitelnyy zavod», Rostokino facility of reinforced concrete complex «DSK-1», housing facilities under construction upon the Moscow Renovation project.

A wide list of trade jobs obtained in framework of professional training, and, as a result, highly effective labor activity during the third labor semester of the SCB allowed students of NRU MGSU in 2015-2018 to systematically participate in professional skill competitions [17]. Forming basis of the Central Federal District team, the members of NRU MGSU SCB twice became winners of the All-Russian professional skill competitions among student brigades "#TRUDKRUT" (2016, 2017).

As the second component of the training system functioning in the student construction brigades of NRU MGSU, a series of events that focused on personal qualities development of the SCB members was used. Along with the third cycle - adaptation and socialization - the two listed components of the training system provided students with the development of "soft skills" (social intelligence).

The development of students personal qualities was carried out in the framework of:

• SCB schools, decomposed into spring and autumn cycles of lectures, practical and group classes.
• Traveling 3-day schools of the NRU MGSU SCB senior members.
• Reporting events of the NRU MGSU SCB, summing up the work semester.
• New year's multi-format festival of NRU MGSU SCB.

These activities involved individual and group work of SCB members, as well as joint execution of creative, sports, volunteer, professionally oriented projects, and also a participation in the organizational activity of the SCB's main office. All this made it possible both to implement educational programs, and to identify and develop abilities and talents of students, encouraging them to show initiative, leadership qualities, and form a sense of corporate responsibility and team spirit.

Development cycle of personal qualities is systemically interconnected with the events organized by the Youth all-Russian public organization "Russian student brigades" [18]. These events form the third element of the NRU MGSU's SCB training system - adaptation and socialization cycle of SCB members.

The events of this cycle unite students from many educational organizations and provide opportunities for common members and the movement as a whole to import and export experience, knowledge and traditions, as well as ensure transfer of technologies, and best management practices.
They also build communication channels between university students and the SCB's main offices of various constituent entities of the Russian Federation.

The special role of events in this cycle is to maintain the spirit of socialist competition [19] between the SCB's main office, educational organizations and common participants of the movement. For that purpose, numerous seminars, meetings, and strategic sessions of city, district, and Federal levels are held that actively use competitive mechanisms to evaluate the performance of movement participants.

All three presented cycles of the training system for professionally competent personnel developed and implemented by the SCB's main office were linked to each other in terms of time, goals, and resources. The necessary "rest" intervals were provided for students to fully concentrate on passing term exams (June and January) and recuperate after the end of the labor semester in SCB.

3. Results

Evolution of NRU MGSU construction brigades movement in recent history, the systematic work of the SCB's main office authorities from 2011 to 2020, as well as approbation and implementation of new training tools, innovative ideas and projects allowed to:

- Import the history, traditions, and experience of student brigades that have been preserved in individual educational organizations since the Soviet era;
- Borrow and adapt the most modern methods and forms of interaction with students used by the country's leading student brigades;
- Establish communication channels with key organizers of regional and Federal events, programs and projects in the field of vocational employment of students;
- Develop and systematically implement the program "Working profession to an engineer" together with the NOU DPO "UCPR" - the leader of professional training and retraining of nuclear industry construction complex employees.
- Build interaction with leading enterprises in construction industry, what ensured attraction of students from NRU MGSU to participate in the largest investment and construction projects of our time, including international ones;
- Create conditions for professional, creative, and sports realization of university students through organization, execution, and participation in a significant number of events at the city, regional, and Federal levels.

Basis formation of development system for students professional and personal qualities was completed by 2017, which allowed NRU MGSU SCB's main office in 2016-2019 achieving significant success in training professionally competent personnel. In the following years, the system was updated and corrected, increasing the efficiency of SCB movement at the University and opening up new opportunities for students.

Victory in "#TRUDKRUT" an all-Russian competition of professional skills among student brigades in 2016 and 2017, the recognition of the NRU MGSU SCB's main office as the best one of the student brigades among Moscow educational organizations in 2014, 2017, 2018, the constant presence of NRU MGSU students as part of international student construction brigades of the State Atomic Energy Corporation "Rosatom" is a clear demonstration of the relevance and efficiency of the training system for professionally competent personnel, which was developed by SCB's main office.

4. Conclusions

Improvement of the higher professional education system can be considered as a process of students simultaneously and consistently developing higher level and quality of mastering both professional knowledge and skills, as well as their non-professional ones. The personal harmonious, balanced...
competence formation of a future specialist can create conditions for his further successful fulfilment in dynamically changing conditions of social and professional life spheres.

Communication skills, aptitude to organize teamwork, creativity, ability to effectively organize work processes and allocate time, along with professional qualifications, become clear competitive advantages of future specialists. According to the authors of the study, it is possible to form and consolidate the listed hard and soft skills among students of technical universities, construction in particular, using the student brigades institution in the educational process, which should be implemented in accordance with the most modern and effective forms and methods of work.

Organization experience of a training system for professionally competent personnel in 2011-2019 within the framework of student construction brigades of NRU MGSU can be used and adapted in the future by other educational organizations to improve the training quality of students. However, the import of methods and practices should be carried out consistently, gradually, taking into account regional, social and time features as well as available resources.

Along with the construction of its own system for training SCB members, the administrative and managerial staff of educational organization should pay sufficient attention to several fundamental aspects. Firstly, the formation of a clear and achievable goals hierarchy of forming (restoring) SCB movement. Then the selection of SCB's organizational structure [20], which has the greatest potential for development, and lastly its evolutionary transformation in the development process of the construction brigade movement.

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