

# Continuing engineering education: background and development vectors

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**Abstract**—The authors consider the challenge of improving continuous engineering education in current conditions. The paper shows the role of students' professional identities in the field of engineering professions, reveals the continuity of general and professional education in training future engineers, and highlights how the Centers for Technological Support of Education help to integrate diverse aspects of the professional development of future engineers. It also discusses the problem of promoting the professional identities of young people in the field of engineering professions and reveals the results of research addressing this problem conducted at the Center for Technological Support of Education at the Russian State Agrarian University – Moscow Timiryazev Agricultural Academy. In particular, the authors outline the experience of "City of the Future" design and research engineering school, part of the "Engineering Vacations" project. The school was organized in 2018 by engineering universities in Moscow for senior pupils of secondary schools.

**Keywords**—*continuing education; professional identity; engineering education; Center for Technological Support of Education.*

## I. INTRODUCTION

The only possible way of achieving sustainable high rates of economic growth in the country is to foster the development of high-tech industries, the establishment of knowledge-intensive industries, and the transition to the use of high technologies, in which intellectual components make up more than half of their cost. At the turn of 2025–2035, a number of technological breakthroughs are sure to be made:

- massive transition to the use of digital sensors, detectors, actuators and control systems;
- management of all technological objects and processes on the basis of mathematical models and digital data;
- wide use of robotic and automated systems;
- use of nature-like technologies (bio-engineering), etc.

This will lead to significant changes in the labor market: the 25–30% robotization of industrial jobs by 2035; the end in life-long employment; the establishment of a system of

advanced training and retraining of personnel for new labor markets, etc.

The quality of engineering personnel is a key factor in successfully solving technological breakthrough problems to ensure the state's competitiveness and its technological and economic independence.

However, analysis of the current state of engineering education in Russia shows that it still fails to satisfy modern technological requirements. Engineering education is still isolated from real production conditions, advanced scientific research and applied research projects [1]. One of the reasons for this is the inert nature of both the content and forms of mass engineering education.

The modern technologized world does not encourage young people (especially those who have not yet chosen their career path) to master key professional skills (why should we learn if search engines know everything?!). However, in these new conditions, the core of education still lies in the development of thinking skills, the ability to communicate and cooperate, to understand and utilize the capacity of new technologies, as well as in the personal qualities that serve, for many people, as a basis for self-actualization.

However, in a situation where 50% of the scientific knowledge accumulated by mankind has been generated during the lifetime of a single generation, qualitatively different approaches to the content of education are also required [2].

In modern conditions of the "compression of knowledge", it is necessary to find invariants that permeate a compressed knowledge package. Fundamental science provides these invariants. It is precisely the fundamental laws of nature that do not become obsolete and form the basis of any technologies of the present and the future. However, actual current practice of general school education features defundamentalization and simplification of the basic foundations of engineering education. So, a school course of physics (aimed at laying the foundations for an engineering education) has ceased to be a compulsory subject in the Unified State Exam. The same tendency is beginning to be seen in relation to mathematics.

In this respect, the problem of improving the system of continuing engineering education is becoming particularly pressing and requires – amongst other things – studying the professional identity formation of young people in the field of engineering.

## II. CURRENT STATE OF AND PREREQUISITES FOR THE DEVELOPMENT OF CONTINUOUS ENGINEERING EDUCATION IN RUSSIA

In the system of continuous education, two main approaches are currently being implemented: “superstructure” (an approach to adult education) and “coupling” (an approach to ensuring curricula continuity in the professional education system). Both approaches describe only the visible organizational aspect, based on an idea of the social nature of education and its role in human life. The development of lifelong education today therefore requires rethinking and restructuring the entire paradigm of the education content and its organizational foundations.

The relatively slow evolution of society and production in the past determined the corresponding constancy of educational content, in which the knowledge and skills obtained during specialist training retained their value throughout one’s whole life – it was “education for life”.

At the present stage of high-tech development, a new approach to the distinction between initial and continuous education has taken shape. Continuing education cannot be associated only with a certain period of a person’s life and cannot be limited to one goal only – preparation for professional activity. “Lifelong learning” is necessary for personal and professional development. This concerns training objectives, access to education, curricula content, the structure of educational organizations, various fields of activity, curricula pace and duration, organizational forms of the education process, the methods used, the qualifications of teaching staff, the overall adaptability of educational institutions to new and anticipated needs; establishing flexible and change-sensitive structures that provide access to education [3; 4].

In the middle of the last century, the problems of lifelong learning were considered problems of adult education, necessary to compensate for shortcomings and to replenish knowledge to meet life’s demands. Continuing education was understood as advanced training in relation to a specialist field of activity.

However, by the mid-1970s in developed countries, the goal of lifelong learning was declared as obtaining a lifelong qualification providing the ability to adapt to life in a modern developed society. Thus, in the mid-1970s, continuing education becomes socially orientated in general and is regarded as a means of increasing the social adaptability of adults [5].

The concept of continuing education, reflecting global changes in the economy, production, technology and various spheres of life, was launched by UNESCO in 1972. It is the development of market economy and an increase in the mobility of its conjuncture that make it necessary to constantly learn and relearn. And this applies not only to those cases where a person changes his/her job or profession, but also when people continue to work in one place for a

long time. This is forced by the constant search for new production technologies, high-tech goods and services, and the improvement of technologies in a competitive environment.

In connection with these processes, the following prerequisites for the development of continuing education can be identified.

1. Further scientific and technological progress accompanied by the inflation of knowledge and information. The pace of these changes is becoming so rapid that they come ahead of the education development. Therefore, the initial vocational education becomes insufficient for a successful professional activity during the whole working life. There is a need to harmonize the process of education with the pace and directions of scientific and technical changes.

2. Economic evolution. The economic system of society is complicated to such an extent that it is difficult for a person lacking appropriate economic knowledge to navigate not only in professional activities. Individuals are required to have broader economic competence [6], which allows them to make the right financial decisions relating to work and home issues to meet their needs and develop abilities, improve professional level, preserve their workplace, ensure career growth, and increase earnings.

3. Discrepancy between the educational system and the economic needs of society. If education develops contrary to the economic needs of society, as is the case today, for example, in Russia (overproduction of specialists in some professions and qualification levels and shortage of others), this may lead to hardly avoidable social contradictions.

4. Trends in the demographic situation development. An increased share of the advanced age in the population composition due to the fall in the birth rate creates a situation of not only relative, but also an absolute increase in the obsolescence rate of knowledge and skills.

Society can continue to move along the path of progress and prosperity, if the entire population is sufficiently educated and everyone has an opportunity for self-development, which, in turn, is possible if only a broad approach to continuing education as a social process that requires restructuring of all education system links is implemented.

Today, dozens of countries around the world are looking for and implementing their models of continuing education. In many developed countries, the network of educational institutions of all types has sharply increased, and the number of adults studying in various forms has exceeded the number of schoolchildren and students.

Over the past 15–20 years, educational institutions in Russia have gained ample opportunities for flexible adaptation to modern conditions of life.

The formation of the autonomy of educational institutions is accompanied by the development of their variability.

Opportunities for students to choose the level and type of education have fundamentally changed due to the provision of educational services on a paid basis. In general, a multi-

channel education financing system, including extra-budgetary funds of manufacturing enterprises, companies and organizations, is being currently established.

Vocational schools are becoming more accessible to residents of remote areas due to the development of modern distance learning technologies. All this has led to significant changes in the structure of training for individual professions, areas, and specialties.

Public institutions of education management are being formed: teaching and methodological associations, scientific and methodological councils, associations of educational institutions, etc. Thus, the system of social partnership in the field of education is being developed. The recognized practices of combining training with industrial work – dual training – are being restored. Future technicians and engineers get familiarized with their professional activity in the process of industrial internships by performing real professional functions directly in enterprises [7]. Employer-sponsored training becomes relevant again, ensuring the integration of the interests of all stakeholders of the educational process, including employers.

A special role is given to scientific and production consortia – associations of enterprises of the real sector of economy, scientific organizations and higher educational institutions that carry out a joint production and scientific and technological program aimed at the implementation of priority scientific and technological projects and creating basic platform technology solutions and supply chains that perform operating-and-tactical tasks of replacing high-tech imports. The integration of educational and scientific institutions, industrial enterprises allows to systematically solve the problems of curricula succession at different levels, strengthen the relationship of education, science and production, use the material base, financial resources and teaching staff more efficiently [8].

Issues of continuity in engineering education in modern conditions are particularly relevant. Continuity is understood as the relationship between various development stages, the essence of which is to preserve certain elements of the whole system and its individual characteristics during the transition to a new state. Continuity determines pedagogical conditions for the implementation of the integrative nature of training, reflects the patterns of changes in the structure, goals, content, combination of methods, coordination of pedagogical actions and cooperation of all participants in the pedagogical process. The principle of continuity is aimed at overcoming linear-discrete tendencies of education.

The main legal provisions for the development of the education system and its modern strategy are stated in the Education Act of the Russian Federation. However, the system of continuing engineering education still needs to be improved. The problem under discussion has another important aspect. A specialist is not born with a university (college) degree. A specialist begins his/her way still in school. The peculiarity of modern education (both in a secondary comprehensive school and in the system of professional education) is associated with an extremely rapid, or exponential development of science. Therefore, the most important task is to reduce the time lag between the emergence of technical and technological innovations in

science and production and their introduction into the educational process.

### III. PROMOTION OF PROFESSIONAL SELF-DETERMINATION OF THE YOUNGER GENERATION IN THE FIELD OF ENGINEERING PROFESSIONS

The Strategy of the Scientific and Technological Development of Russia states the need to form an interest in technical creativity starting from school, which can be achieved in two ways:

- expansion of the network of specialized educational institutions of general education with in-depth scientific and physical-and-mathematical training, or the establishment of similar structural units in large educational parks;
- providing a system of extracurricular activities oriented towards the development of technical creativity of schoolchildren.

Indeed, improving the quality of engineering education is not possible without raising the level of school education, in which there is an urgent need to apply fundamentally new learning technologies that are focused on developing future technicians and engineers with the most important soft skills: creativity, readiness for changes, teamwork skills, digital competence, critical thinking, etc., as well as technical creative abilities.

Of particular importance are the issues of vocational guidance of young people towards the acquisition of engineering professions.

The main task of career guidance is to help the young people in forming professional identity, which is the process by which an individual forms his/her attitude towards professional activity and its conscious choice. Assistance in forming professional identity of young people implies the development of personal qualities necessary for a person for self-orientation and the choice of profession. The most effective forms of career guidance are those that familiarize the younger generation with the professional environment and its successful representatives. A possibility of obtaining primary practical professional experience allows young men and women to implement their abilities and dispositions, as well as to help them make the right professional choice.

Positive experience in finding effective ways to solve the problems of young people's awareness of engineering education has been accumulated by the Moscow Department of Education, including:

- the project "Engineering class in Moscow school", implementing the strategy of engineering classes based on the Global Engineering Education Standard – CDIO, creating an environment in which novice engineers should be able to "Envision-Design-Implement-Control" [9]. About 100 schools, more than 100 high-tech enterprises and 20 leading technical universities of the capital participate in the project. The project stimulates the technical creativity of schoolchildren, providing them with additional opportunities to participate in various competitions and scientific conferences, provides students with the real production environment, specific enterprises and

engineering specialties. School teachers, university lecturers and production experts are giving engineering classes. Special workshops and training seminars on the use of innovative educational technologies are offered for teachers involved in the project implementation [10], on the implementation of interdisciplinary pre-vocational education engineering;

- a program for the development of a material base of educational organizations on a new technological basis (3D modeling, robotics, machine tools with numerical program control, etc.);
- the establishment of a system of institutions of further education of a new type: quantoria (children's technoparks); engineering competence resource centers; STEM centers, STEM laboratories; Youth Innovation Creativity Centers, etc.

#### IV. CENTERS OF TECHNOLOGICAL SUPPORT FOR EDUCATION AND THEIR INTEGRATING FUNCTION IN THE PROFESSIONAL IDENTITY DEVELOPMENT OF FUTURE ENGINEERS

Considering the development of technical thinking skills systemically, it is important to distinguish a key component of this system that allows streamlining the interaction of the other components and their integration into a coherent whole. Particularly noteworthy is the large-scale project of the Center for Technological Support of Education (CTSE) established in 2012, which is aimed at providing and using the infrastructure of technological support for education in Moscow with the goal of developing scientific and technical creativity, design and research activities of students.

The establishment of a network of CTSEs contributes to the implementation of a number of urgent tasks:

- integration of science, education and business to create an environment that provides the industries of high priority for the modernization of the country's economy with a new generation of specialists who are capable of active innovation activity using modern technologies and equipment;
- establishing a resource base for the implementation of a program aimed at improving the technological literacy of students;
- integrated technological support for engineering and technological education;
- establishing a system for training teachers to organize study programs for general, further and professional education in engineering and technology;
- popularization of the achievements of modern science and high technologies, innovation, research and engineering-and-technological activities;
- forming an integrated engineering education space and scientific and technical creative activities of the younger generation;
- establishing a system of professional selection and support of gifted children and talented young people in engineering and technical areas;

- forming a model of expert and consulting support for youth-focused engineering-and-technological projects.

The composition of study and laboratory equipment of the CTSE reflecting the trends and forecasts of the development of modern technologies and digital production, the involvement of qualified scientific and teaching staff of higher education allows conducting training, vocational guidance and educational programs in priority areas of science, engineering and technology.

Each CTSE is an open platform at the university, which, taking into account its specific features and sectoral focus, organizes activities to solve the problems of resource support for continuing education. Educational, consulting and expert services provide technical training for students, teaching staff and specialists, forming innovative educational clusters in the integrated system with general and further education.

All CTSEs work in the mode of collective access to high-tech equipment and modern digital technologies based on a network partnership of universities, schools, lyceums and colleges. More than 100 Moscow schools have signed contracts with the CTSEs and are implementing programs with a sectoral focus of universities. According to the information portal of the Moscow CTSE Network, over 20,000 students annually take part in various forms of the activities of the CTSE Network, and about 150–170 supplementary education programs are implemented. Each center runs at least 30 projects. About 200 of the best projects of pupils from vocational schools from 40 city schools take part in the annual Forum “Engineering Start”. As a rule, 60–70 projects reach the final stage of the competition. Winners of Competitions are awarded additional points when entering higher education institutions. Up to 70% of graduates of some of the most successful CTSEs are enrolled in specialized engineering universities.

The CTSE at Russian State Agrarian University – Moscow Timiryazev Agricultural Academy (hereinafter referred to as the Center) operates at the Pedagogy and Psychology of Vocational Education Department due to grant funding from the Department of Education of Moscow. The purpose of the Center is to develop the infrastructure of technological support for education.

The main tasks of the Center are to create an open information and technological platform as an object of additional education infrastructure; development of a modern system of professional identification of students, career guidance in the field of science, machinery and technology use; ensuring the conditions of professional communication and development of teaching staff in the field of modern educational technologies.

The Center implements career-oriented training programs (“3D-modeling and prototyping”, “Space technologies in agriculture”, “Robotics”, “Greenhouse plant growing in the urban environment”), organizes circle activities, as well as design and R&D activities of schoolchildren and students. The Center runs professional development programs of teaching staff in the use of innovative technologies in career guidance work with students.

The material and technical base of the Center includes a laboratory of electronic educational resources; hardware-

software packages for technical tests; laboratory of 3D-modeling and prototyping; robotics laboratory; laser technology; unmanned aerial vehicles.

As part of the Center's activities, research is being conducted in the field of developing technologies for vocational guidance and further education, searching for effective methods for developing technical abilities, and addressing informatization problems in engineering education.

Every year, about 1,200 schoolchildren, students of higher educational institutions and colleges, teachers of general educational organizations in Moscow take part in the events and career guidance programs of the Center. The Center cooperates with 11 educational organizations of general and secondary professional education.

The experience of organizing vocational guidance for schoolchildren in relation to engineering professions has shown that the implementation of programs based on the principle of integration, involving both consideration of modern trans-professional tendencies (going beyond the same profession) [11] as well as the need to unite the efforts of all stakeholders in the 'school' – 'university' – 'enterprise' system. The Center promotes the development of technical thinking skills and modern professional competencies of future engineers by involving industry representatives and students in working with schoolchildren. The representatives of the professional community can clearly demonstrate successful experience in mastering engineering professions. Students engaged in working with schoolchildren as part of circle-based group work and project activities can demonstrate and put into practice their knowledge and skills, as well as reflect on their experience, realize their capabilities and the level of development as future engineers. The relatively small age difference between students and schoolchildren allows them to better communicate and increases their mutual interest in the activities they perform.

#### V. "ENGINEERING VACATIONS" AS AN INNOVATIVE EDUCATIONAL AND DEVELOPING ENVIRONMENT

In 2018, Russian State Agrarian University – Moscow Timiryazev Agricultural Academy together with five Moscow universities (National University of Science and Technology "MISiS", Moscow State University of Civil Engineering (National Research University), Kosygin State University of Russia, Moscow State University of Food Production, Moscow State University of Technology "STANKIN") organized a design and research engineering school "City of the Future" within the framework of the "Engineering Vacations" project. Russian State Agrarian University – Moscow Timiryazev Agricultural Academy implemented the program "Designing Urban Agrarian Ecosystems".

Schoolchildren from five secondary schools in Moscow who passed the qualifying stage took part in the project session. They were offered theoretical classes, workshops, excursions, and also they carried out project activities in three areas: home city farm, school city farm, production of useful plants in the urban environment.

Pupils received knowledge in the field of designing and modeling closed ecosystems, automating plant life support,

as well as getting acquainted with the basics of plant growing. The participants of the project activities were divided into teams in accordance with the school represented. The goal of the project activity was to develop a greenhouse model (in accordance with the chosen direction) with automated control of life support systems for the plants grown in it, creating a working prototype for a greenhouse, and proving the economic feasibility of growing certain crops in it. The work results were evaluated during the public defense of the projects.

In the framework of the implementation of the "Engineering vacations" project, a study was conducted aimed at identifying the dynamics of personal traits of schoolchildren immersed in the project activity.

The study involved 46 schoolchildren aged 15–17 years (35 boys and 11 girls), as well as volunteers (students of Russian State Agrarian University – Moscow Timiryazev Agricultural Academy) and teaching staff – 12 people.

Prior to the commencement of project activities, schoolchildren were asked to fill out a questionnaire, in which besides questions regarding the goals of their participation in the event and expected results, they were asked to assess the development degree of skills required in project activities (dealing with information, organizing their activities, analyzing their results, working in a team, creativity), as well as motivational attitudes to future activities (focus on results, team work, recognition, status enhancement, creation and maintenance of comfortable work conditions). At the end of the project session, schoolchildren also rated themselves according to these parameters.

As a result, the following outcomes were obtained, reflecting the dynamics of changes that occur with schoolchildren during their immersion into active engineering and design activities.

Thus, as to the purpose of participation in this event, schoolchildren mostly indicated: obtaining new knowledge – 21 people; getting experience in project activities – 17 people. Also, schoolchildren expected that the ongoing activities will contribute to their personal development (7 people), they will be able to try themselves for engineering jobs (4 people); gain teamwork experience (5 people).

Many students answered the question "What would you like to learn?" saying that they would like to learn how to work in a team (23 people) as well as acquire mastery in projecting, designing and modeling (10 people). To a lesser extent, such skills were indicated as how to set goals correctly and achieve them (5 people), get new experience (5 people), learn something new (4 people). Summing it all up, we can say that schoolchildren were clearly aware of the content of the upcoming activities and were ready to learn and participate in project activities. In addition, there was a need for practical work experience, including team work experience.

When assessing the skills required for a project activity (five skill groups), the following dynamics was identified at the beginning of the event and at the end of it (Fig. 1).

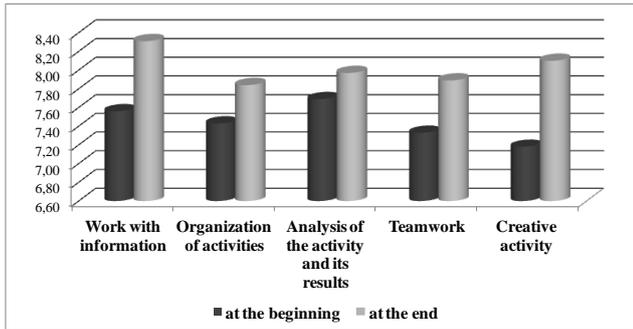


Fig. 1. Evaluation of the skills of project work before and after the activity of schoolchildren (group averages)

In general, the project session participants noted that they had positive changes in the development of project work skills. To the greatest extent it concerns the skills of dealing with information (7.56 before, 8.31 after) and creative activity (7.18 and 8.01, respectively). There was also an increase in the other groups of skills. A more detailed analysis of the results showed that estimates of the dynamics of skills in a group are not uniform. 21 schoolchildren (a little less than half) demonstrated a certain decrease in the marks of skills before and after participation in the project session. When analyzing the dynamics of skills in this part of schoolchildren, a decline in indicators was revealed in several parameters (Fig. 2).

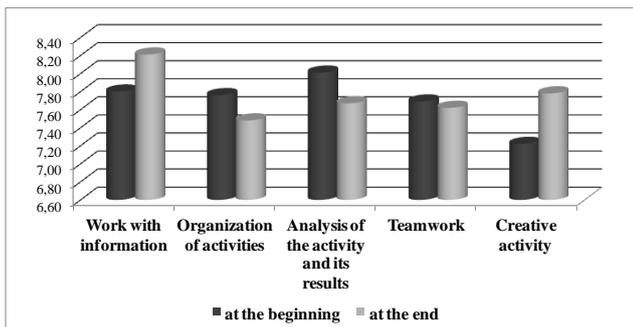


Fig. 2. Assessment of skills of project work before and after the end of the activity of groups of schoolchildren showing a decrease in grades for two or more indicators (group averages)

They, like the whole group, noted an increase in skills of dealing with information and creative activity. At the same time, the assessment grades of the skills of organizing activity and analyzing its results, as well as teamwork, decreased. These results can be explained by the fact that the analyzed group of schoolchildren initially overestimated their ideas about the level of development of their skills. Immersion in the real project activity allowed them to correct their ideas and more adequately assess themselves, which, in turn, does not contradict the overall positive dynamics of the project work skills, since the correction of assessing their skills is part of their development. In addition, teachers and volunteers noted an increase in skills in project work among schoolchildren.

An analysis of the prevailing motivational attitudes before the start of the project activity showed that the schoolchildren were least likely to be inclined to increase their status, prestige, and recognition (3.5 points out of 5). These indicators correlate with the priority goals and

expectations of schoolchildren – to get new experience and knowledge. At the same time, none of the participants indicated a victory in the project activity as a final goal. When analyzing the priority motivational attitudes, their redistribution was revealed in the assessment of schoolchildren at the beginning and at the end of the event (Fig. 3).

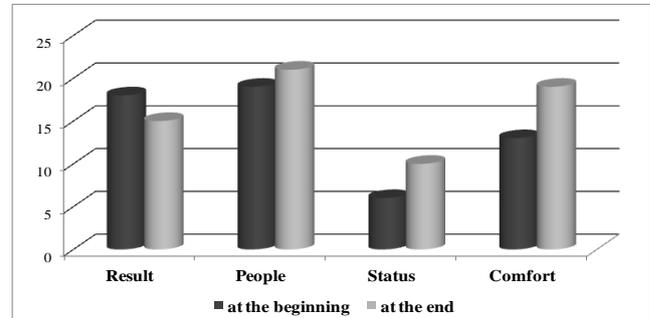


Fig. 3. Prevailing motivational attitudes before and after the completion of the project activity of schoolchildren (the number of people)

Schoolchildren at the end of the project activity indicated that obtaining a specific result, achievement, or development was less important for them. At the same time, the importance of comfortable working conditions, clear organization and distribution of responsibilities, joint activities, obtaining a collective result and its recognition increased. This can be explained by the fact that the design tasks set for schoolchildren were impossible to solve singlehandedly, and well-organized teamwork became more important than personal achievements. The increased importance of the status also indicates the desire to be useful and accepted in the team. Thus, immersion in collective project activities allowed schoolchildren to form a more adequate understanding of the work of an engineer in modern conditions, when it is necessary to integrate the efforts of various specialists, and also to be able to work effectively at all stages of modern engineering activity ('Envision' – 'Design' – 'Implement' – 'Control').

At the end of the event, all the teams of schoolchildren successfully carried out the project activity, presenting and defending their engineering solutions. Accordingly, they were able to successfully solve a number of technical problems, gain experience in design and engineering. According to schoolchildren's assessments of useful knowledge and experience they gained, the following results were revealed. The students noted that they had acquired knowledge mainly in the field of agroengineering and biology (18 people), they also gained experience in teamwork (15 people), experience in projecting and designing, working with equipment (16 people). Schoolchildren noted that during the project shift they learned how to work with real equipment, use various technical devices, perform assembly and programming activities. Especially important was the experience of public speaking, time management planning and interacting with team members.

Thus, the organization of engineering design activity of schoolchildren allowed them not only to get an idea of the modern technologies of designing agricultural systems, but also to acquire skills in plant growing, assembling and

installation of plant life support systems. The working out of a complete functioning prototype of a city farm for students was a certain professional breakdown in the field of agricultural production. Conducting such project sessions ensures that students obtain a kind of career awareness towards engineering professions. The organization of such events by combining the efforts of the university (its scientific and educational capacities) and the school allows to ensure the continuity of engineering education at its various levels.

## VI. CONCLUSION

Successful professional identification in the field of engineering professions can be considered as the most important motivational factor contributing to the development of the system of continuing engineering education. The global strategic goal of this system is to provide the conditions for a technological breakthrough.

The main conditions for the dynamic development of continuous engineering education are:

- ensuring continuity between all levels of general and professional education of engineering and technical profile, as well as supplementary education of children and adults and further professional education;
- goal-oriented work to improve the prestige of engineering professions in society, establishing a system of dual education based on social partnership of engineering education with science, industry and business;
- regular updating of the material and technical base of engineering and technical education;
- development of international cooperation with advanced foreign educational organizations of engineering profile.

The CTSE network, being an open information and technological platform, provides conditions for professional communication and teaching staff competence growth in the field of modern educational technologies, for developing a system of career guidance for young people to choose a profession in science, engineering and technology, contributes to the formation of a single educational space of technological creativity and continuous engineering and

technological education, provides resource and study-and-methodological support of space elements, thereby making a significant contribution to the provision of new opportunities for future technological breakthroughs.

## REFERENCES

- [1] M.A. Loshchilova, V.G. Lizunkov, and A.V. Zavjalova, "Professional Training of Bachelors in Mechanical Engineering, Based on Networking Resources", in *Procedia – Social and Behavioral Sciences*, vol. 206, pp. 399-405, 2015.
- [2] V.E. Fortov, "Innovation, Science and Engineering Education", *New Economy. Innovative Portrait of Russia*, Moscow, pp. 73-77, 2014. (in Russian).
- [3] P. Kubrushko, E. Kozlenkova, O. Mikhailenko, and L. Nazarova, "Facilitation of Innovative Pedagogical Activity of University Teachers", in *Advances in Social Science, Education and Humanities Research: International Conference on the Theory and Practice of Personality Formation in Modern Society (ICTPPFMS-18)*, Atlantis Press, vol. 198, pp. 266-269, 2018.
- [4] N.I. Zyryanova, V.A. Fedorov, E.V. Zaitseva, I.S. Tolkacheva, and P.S. Glushchenko, "Modern Requirements to Preparation of Professional and Pedagogical Personnel", in *International Journal of Environmental and Science Education*, vol. 11, No. 16, pp. 8800-8810, 2016.
- [5] J. Branch, S. Hayes, A. Horsted, and C. Nygaard, "New Innovations in Teaching and Learning in Higher Education", in *The Learning in Higher Education Series*, 2018.
- [6] V.G. Lizunkov, O.T. Ergunova, and E.Y. Malushko, "Forming System of Strategic Innovation Management at High-tech Engineering Enterprises", in *IOP Conference Series: Materials Science and Engineering*, vol. 177, No. 1, Article number 012046, pp. 1-7, 2017.
- [7] Z.S. Sazonova, and N.Yu. Sidiyakina, "New Forms of Professional Practice Organization for Students", in *Joint International IGIP-SEFI Annual Conference*, 2010.
- [8] T. Tkacheva, and Z. Sazonova, "Creativity Development as Indisputable Component of Long-Life Education", in *Proceedings of 2014 International Conference on Interactive Collaborative Learning, ICL 2014*, pp. 1026-1032, 2014.
- [9] M. Minin, A. Kriushova, and E. Muratova, "Assessment of the CDIO Syllabus Learning Outcomes: from Theory to Practice", in *Proceedings of 2015 International Conference on Interactive Collaborative Learning, ICL 2015*, pp. 689-694, 2015.
- [10] P.F. Kubrushko, and L.I. Nazarova, "Professional Development of Technical University Lecturers in Field of Innovation Teaching", in *2013 International Conference on Interactive Collaborative Learning, ICL 2013*, pp. 467-469, 2013.
- [11] E.F. Zeer, M.V. Zinnatova, and T.D. Bukovei, "Transprofessionalism of the Subjects of Professional Activity: Prolegomena, Platform, Formation", in *Journal of Engineering and Applied Sciences*, vol. 12, No. S11, pp. 9137-9143, 2017.