

# Improvement of Quality of Training of Students of Engineering Specialties with Use of New Technologies

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**Abstract**—This paper is dedicated to the education process for engineers at Nizhny Novgorod State Technical University n.a. R.E. Alekseev based on market oriented and industry demand of the particular specialists as well as the University facility infrastructure upgrade.

The infrastructure upgrade aims to provide equal opportunities to the students in access to modern knowledge, technologies, recent achievements in science and engineering and helps graduates with a career choice.

We present the key points of our strategical project "Regional Platform "Engineering Elevator" that includes preliminary career choice at the school level, promotion of engineering jobs and professions etc. An integrated approach to the education process involving modern technologies and equipment allows to facilitate a new-comer probation period for the post-graduates in industry.

Practical implementation examples are presented.

**Keywords**—student, training, higher education, Regional Platform «Engineering Elevator».

## I. INTRODUCTION

The growth of high-intelligent industrial production, research and development has revealed an extremely severe shortage of highly qualified specialists who have a command of modern technologies, capable of developing and implementing competitive equipment and technologies, oriented to innovative work in the market economy. The lack of qualified personnel today is one of the main obstacles in the development of priority industries. In the modern high-tech production environment, requirements to the level of professional training of engineering and technical personnel are rising every year.

Therefore, modern engineering education should be predictively advancing in relation to dynamically changing technologies in the field. The need to improve the professional training of specialists is caused by objective trends in the accelerating technological progress, which requires fundamentally new technical and technological approaches that can be developed by specialists capable of integrating ideas from different domains of science, handling interdisciplinary categories, and perceiving the innovation process comprehensively.

Today, the main contradiction of higher engineering education is a mismatch of professional competencies acquired by graduates of technical universities during their training and the increased requirements of high-tech enterprises, design and scientific organizations. Taking this into account, the term "advanced technologies" becomes topical, which means fundamentally new technologies that provide leadership in the world market and new engineering education should outrun the "advanced technologies".

In addition, at the moment, an issue of life cycle management of complex engineering facilities becomes extremely topical. A major contribution to this field was made by the military, who in the 1980s formulated the concept of Continuous Acquisition and Life Cycle Support (CALS) – continuous information product life cycle support. The reason for the development of the CALS technology was that developers of modern automation facilities created their own models, which often were incompatible with those of their partners in the equipment production and operation. In the civilian environment, the concept of Product Life Management (PLM) or life-cycle management became widespread. PLM is a strategic business approach and an integrated solution for the cooperative development, management, dissemination and use of information within the enterprise and between its partners from the moment of concept formation until the withdrawal of products from the market, processes, business systems and intellectual assets that unite people [1-5].

Five years ago, more than 90% of the today's professions required by the digital economy did not even exist. The educational system with typical diplomas just cannot keep up with the demands of the labor market. Therefore, it is necessary to train specialists in professions, for which there are no formal rules, professional and educational standards, in a very short time. But at the same time it appears that there are no grounds for awarding a diploma, as these professions are not specified in the state regulatory framework. At the same time, it does not make much sense to include them there, since the professions will have become obsolete, before all bureaucratic procedures for developing and approving the standards are completed.

For example, at the present time, there is a demand for specialists in the introduction of artificial intelligence systems, but there is no relevant educational standard. And there is no university that would train people to be qualified as “Artificial Intelligence Specialist”.

The practical implementation of a practice-oriented approach to the training of engineering specialists demanded by the industry requires a certain upgrade of the educational infrastructure. So, in their term papers or graduate projects, students create an end-to-end design according to the “idea - 3D-model - calculation - prototype - finished product” scheme. In addition, a comprehensive approach to the organization of the educational space of the region, the creation of a system of continuous training, development and support of personnel, and the development of youth initiatives in the scientific and technical creativity of youth is being implemented. The approach is based on a multi-level system for identifying and developing the student’s scientific and technical potential, starting with the primary school level and ending with the implementation of practice-oriented knowledge and skills within the real sectors of the economy, in particular, the high-tech, knowledge-intensive and innovative sector [5-8].

This is a way the comprehensive approach to the organization of the educational space of the region, the creation of a system of continuous training, development and support of personnel, and the development of youth initiatives in the scientific and technical creativity of youth is implemented. The approach is based on a multi-level system for identifying and developing the student’s scientific and technical potential, starting with the primary school level and ending with the implementation of practice-oriented knowledge and skills within the real sectors of the economy, in particular, the high-tech, knowledge-intensive and innovative sector.

The analysis of the situation in the sphere of occupational guidance for students at schools in the Nizhny Novgorod region demonstrates the need to create a structured system for supporting the processes of involving students in scientific and technical creativity, creating the environment for their intellectual growth to meet the needs of the region in professionally oriented engineering personnel.

This work is implemented with in the strategic project of the Nizhny Novgorod State Technical University n.a. R.E. Alekseev – “Regional Platform “Engineering Elevator”” [9]. The tasks of this project include:

- development of a structured methodology for occupational guidance of school students corresponding to the level of personal development;
- establishment of a free access center for scientific and technical creativity in various engineering fields for school students;
- creation of remote and field services to promote engineering education and improve the level of training in individual disciplines;
- formation of a community of mentors from among students and teaching staff of the universities in the region to

comply with demand of students in schools for engineering skills;

- creation of a database of motivated applicants for targeted training at the requests of industrial enterprises in the region

In this regard, it is proposed to create a regional platform that allows to solve the specified range of tasks in several stages.

The first stage is the creation of a structured methodology for occupational guidance of school students corresponding to the level of personal development, which involves division into age groups, organization of multi-level involvement in scientific and technical creativity, launching a free-access center and opening of children’s specialized laboratories.

At the second stage, it is planned to elaborate the created methodology and increase the coverage of the school audience by engaging the municipalities of the region and scaling up the developed programs and methods through remote and field services, increasing the number of student projects being implemented, involving students and teaching staff of universities in the region in work at the free-access center.

The final stage envisages creation of a system of mentoring, a regularly updated electronic database of applicants who completed the occupational guidance program, and generation of requests from industrial enterprises for targeted training.

Furthermore, a specialist engaged in the development of flow processes by computer modeling, should be a process engineer. Since it is easier to train an engineer in working with software than to teach a programmer the basics of a particular technology. Not only the efficiency of the production planning system, but also the advisability of using computer technology, depends on the ability of a specialist to correctly evaluate the results of modeling and find the optimal engineering solutions. A fundamentally important formidable problem of computer modeling is the reliability of the database used, since the forecasting accuracy depends entirely on behavior models of the materials as included in the calculation. The engineering practice provides for the calculation of strength assuming uniform mechanical properties and zero initial residual stress in the loaded structure. At the same time, any manufacturing techniques introduces its own specificity to the structure and properties of the part. It is important to specify correctly mechanical, thermal and physical properties of the materials used.

The following projects can be mentioned as the examples of practical implementation.



Fig. 1. 3D-model of a Formula Student sports car.



Fig. 2. Model of a steering knuckle of a sports car.



Fig. 3. Formula Student car by Nizhny Novgorod State Technical University n.a. R.E. Alekseev.

Participation in the international technical project “Formula SAE”, engineering competitions for the creation of sports cars held by the Institution of Mechanical Engineers (ImechE), the Society of Automotive Engineers (SAE) and the Engineering and Technology Association (I&T), a part of the SAECollegiate Design Series.

Designing and evaluation of strength and safety of components of a Formula Student car by the Nizhny Novgorod State Technical University n.a. R.E. Alekseev (Figures 1 - 3) were based on using computational methods and software packages for finite element modeling. The results obtained served as the basis for implementing the subsequent stages of end-to-end digital designing and embodiment of the components of a sports car.



Fig.4. 3D model of bone tissue of the knee joint obtained using a tomograph.

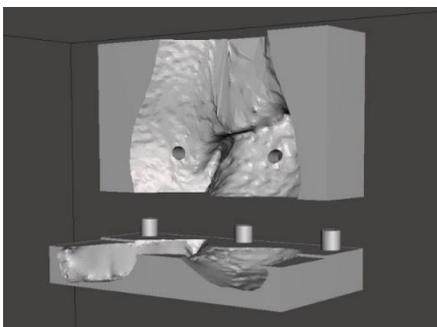


Fig.5. 3D model of an individual pin guide for resection blocks.



Fig.6. Intraoperative photos of the surgery stage.

Figures 4-6 show the stages of creation and practical implementation of the technology for production of individual pin guides of a resection block designed with the participation of the graduate of the NNSTU Metallurgical Department. Furthermore, the key feature of the project was work in the interdisciplinary field “medicine – 3D modeling – materials science”.

## II. CONCLUSION

The successful implementation of the project demonstrates that end-to-end digital designing can be adopted today even by youth at a higher educational institution within a relatively short period of time. At the same time, an integrated approach with the use of modern equipment makes it possible to train qualified specialists for the industry who, in practice, master the full cycle of manufacturing complex products, are capable of starting work with modern science-intensive equipment and advanced technologies just after graduation.

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