# The organization of students' research and know-how activity in a regional engineering higher school

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Abstract. The analysis of various peculiarities of the organization of research and know-how activity in foreign and Russian higher schools is given in the article. The authors highlight the main advantages and disadvantages in the organization of students' research activity. The peculiarities of the organization of students' research and know-how activity in Penza State Technological University on the interaction basis between the university, enterprises, business and authorities is under consideration in the article. The authors show the results of the organization of students' research and know-how activity in Penza State Technological University.

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# Introduction

Organization and management issues of students' research activity (SRA) in higher schools are considered both in the works of some Russian scientists in the sphere of education, economy, higher school organization, such as V.V. Balashov [1], A.A. Glushenko [2], G.S. Kochetkova [3], and foreign researchers in the field of higher education – X. Hummel [4], R. Dave [5], P. Legrand [6].

Foreign experience in the organization of SRA is of great interest under present-day conditions of Russia's entering global education space and the admission of Russian higher schools into the Bologna process.

The analysis of approaches to the SRA organization in England, Germany, the USA, France, and Japan shows that versatile forms of the organization of SRA are traditionally developed and widely used there: scientific introductory courses and proseminars in Japan; research programs in Germany, the USA, Japan; problem-oriented courses in Germany, England, France; project technologies in small research groups in the USA, Japan.

The foreign system of higher education has accumulated large experience in organizing SRA as learning-teaching process being combined with students' research work is more and more transforming into the real professional activity. A university becomes not only a place for studies, but also a center of research work. As a result this university is both a "personnel's forge" and an "art school" for SRA.

The analysis of the peculiarities of the SRA organization in Russian higher schools (Tomsk State University of Control Systems and Radio electronics, Tomsk Polytechnic University, Moscow State Technical University named after N.E. Bauman, Moscow Institute of Physics and Technology, Moscow Power Engineering Institute, National Research Nuclear University "MEPHI") allows coming to the conclusion that higher schools do a lot in establishing special students' research and know-how subdivisions, holding conferences, fairs and contests to attract younger generation to SRA, and involving students in scientific project activity in labs and centers.

Organizing SRA Russian engineering higher schools make an emphasis on students' orientation to ideas generation and realization in scientific research programs. This is rather positive in developing SRA in Russia.

However the analysis of the SRA organization in engineering higher schools in Russia allows underlining the following lacks:

- the SRA organization on the voluntary principles leading to only "top class" students' participation in it and to the absence of motivation of other students;

- a gap between SRA and learning-teaching process;

- the absence of a step-by-step mechanism of students' involving into SRA.

Thus, we have defined the peculiarities of the SRA organization in Russian and foreign higher schools which positive elements have been borrowed as a basis for the SRA system in Penza State Technological University (PenzSTU).

# The body

PenzSTU is the only multilevel educational complex in the Penza region embracing all levels of professional education: from primary to postgraduate. Training is carried out in engineering, biotechnological, economic and pedagogical areas [7].

Since 2011 the PenzSTU administration has been adopting a policy of know-how development with the function of an entrepreneurial higher school. This was contributed by the adoption of the Federal Law  $(02.08.09, N \ge 217$ -F3) "About Changes Application in Some Legislative Acts of the Russian Federation on Issues of Establishing Business Entities for Implementing Results of Intellectual Activities by Budget Scientific and Educational Institutions"; by the development of a unique regional system of supporting and promoting innovations by the Penza region Administration; by grants and subsidies provision from the Federal and regional budgets for the commercial realization of the results of higher schools research activity.

The educational process in PenzSTU is based on the Triple Helix model, the concept developed by G. Itskovich and L. Leydesdorff [8]. It presupposes the interaction of the university, authorities, and business. More over in reference to the state and business universities play a leading role in the society based on knowledge because of the existence of the knowledge production system in the form of researches, and concentration of majority of young people [9].

In this connection in October, 2011 the knowhow infrastructure "Start-Park Penza" project started working on the basis of PenzSTU with the participation of the Penza region Administration, the Northwestern Centre of VC investments and business communities of Penza.

"Start-Park" is a "factory" for know-how undertakings production based on the commercialization technology of research and knowhow activity results including the best international experience and many years of hard work in adapting it to our Russian reality.

The main objective of the project is the realization of the know-how potential of students, postgraduates, and scientists of PenzSTU via scientific project activity.

The "Start-Park Penza" project includes the following mechanisms: the project Campus, ideas search and generation, the business school, the entrepreneurial university. Let's consider each mechanism in details.

The project Campus is a virtual and real site uniting PenzSTU active young people of various branches of science, engineering and technology. Different events take regularly place within the Campus framework pointing at the attraction of young people to research activity (lectures, master-classes of businessmen, managers and scientists; discussions, presentations, projects discussions, projects auctions; startup-weekends – a day-off-the-week event where all ideas are improved up to the prototype level) and their further monitoring.

Ideas search and generation mean to hold contests of research and know-how ideas for future small-scale know-how enterprises, to stimulate financially the authors of the best ideas and their scientific supervisors; to organize discussion sites for analyzing modern technologies and products.

The PenzSTU business school is the most important mechanism of the development of young people know-how potential. Its audience consists of students, postgraduates, and higher schools staff having passed preliminary selection and tests. The representatives of both regional and country business play the role of trainers. They have classes weekly in the form of trainings, master-classes, Round Tables etc. Such teaching techniques as brain storm, casestudy, project and others are used.

Studying in this business school allows people to get initial skills in starting and running their own business, testing their ideas, and taking part in the development and realization of research and knowhow projects.

The entrepreneurial university is a mechanism offering term papers writing by the students in economic and engineering subjects in the form of real research and know-how projects products.

The research and know-how infrastructure has been developed for providing the efficient work of all mechanisms of the "Start-Park Penza" project in PenzSTU. It is made up of the Youth Know-How and Technological Center (YKTC) including the Students' Scientific Society "Idea" (SSS "Idea") and Students' Research and Project Campus; the Scientists' Training Department with a training and scientific lab for students' research work [10].

PenzSTU research and know-how subdivisions provide: the organization and holding of scientific events for the university students (conferences, fairs, and contests); the realization of students' potential in scientific project activity; the formation of creative teams being engaged into scientific project activity; the interaction with enterprises, business of educational institutions and others structures.

Summarizing all mentioned above we can conclude that the PenzSTU students have all the opportunities for carrying out research and know-how activity at different levels and in different forms.

Thus, we have developed the step-by-step structure of organizing research and know-how activity in an engineering higher school being realized in PenzSTU for students' potential realization in the field of science and innovations.

The first step is called a motivational and special-purpose one (the 3d term).

The given step includes:

- the introduction to scientific supervisors, chairs products and research and know-how subdivisions of the university ("Meeting with Science" event); - meetings with enterprises and business community representatives ("Youth Fair of Vacancies", excursions to enterprise-partners, the talkshow "100 Questions to "Penztyazhpromarmatura" Ltd., master-class "Career is a step to Success");

- the introduction to the regional know-how infrastructure (Round Table with the representatives from the Department of Know-How Policy and Special Projects of the Penza Region Administration, excursions to industrial parks and businessincubators);

- the monitoring of students' interests to SRA (a students' questionnaire survey in order to find out challenging scientific fields and the necessity to introduce some elective courses covering the peculiarities of the participation in the extracurricular research activity, the theory and methodology of scientific research; a survey on project activity fundamentals);

- participations in the events of Students' Scientific Society (the "IQ-sprint" contest)

- the attendance of the university scientific conference "Urgent Problems of Science and Education" for students, postgraduates and young scientists and the fair of scientific and engineering creative work of young people;

- the preparation of their own career promotion plan.

At the end of the first step the students know about research and know-how and staff potential both of the university and region. They also know what specialists are in demand, what projects our authorities' representatives are ready to promote and business ones are ready to implement, and how scientific events – conferences, fairs and contests - are held. The students are divided according to the fields of the extracurricular research activity and choose scientific supervisors.

The second step is called a scientific and theoretical one (the 4th term).

This step aims at acquiring theoretical knowledge and practical skills by the students which are necessary for the successful research activity organization and holding. Firstly, the students are taking the elective course "Extracurricular Research Activity of Engineering Students". This course includes: information about the project idea and structure. project management peculiarities: information about the idea, categories and structure of the research; data about the content and types of the extracurricular research activity of engineering students; features of the solution theory of inventive tasks; aspects connected with the approbation of results (writing scientific research papers. participations in scientific and practical conferences, fairs, forums); information about supportive measures

of students' research activity (scientific scholarships, contests, grants); the main aspects connected with rights protection on intellectual property; data about the varieties of students' scientific organizations (students' scientific societies, students' design engineering bureau etc.).

During and after this elective course the students are to formulate and generate ideas for the project (via the "Ideas Generator" event). In the result of ideas accumulation and analysis some elaborations take place for further realization as a project (ideas discussions in the YKTC with the representatives from science, enterprises and business). Taking into account the data received scientific project teams are formed (students, scientific supervisors, representatives from enterprises and business communities). Finishing the second step the students make corrections in the plans of their own career promotion as they have clearer ideas concerning their would-be professional activity.

The third step is called a scientific project one (the 5th - 7th terms).

The students acquire practical skills in developing and presenting projects, in applying the necessary methods and means to carry out researches, in presenting results of researches as patents, certificates, articles and reports etc.

This step starts with the project development by the students and their supervisors. The representatives from enterprises and business are both trainers and consultants. Students should defend their projects in public. The Vice-rector for Research, representatives from enterprises and business, deans, representatives from research and know - how subdivisions of the university, chairs heads, students and scientific supervisors are invited.

Judging by the results of the defense there may appear some remarks. Students should make corrections in order to take part in grants contests ("A Participant of Youth International Research and Know-How Contest" ("UMNIK") held by the Fund for the Promotion of the Development of Small Businesses in the Sphere of Science and Technology and others), in research work contests (the university contest "Science Is a Step to the Future" and others) for searching finances to carry out the project research and its further development.

During their practical training the students are sent to various enterprises to develop a project laboratory pattern for testing. The scientific experiment and empiric data gaining are carried out by means of this developed laboratory pattern. The students can start the execution of patents and certificates. They can also take part in conferences, fairs, forums and publish articles.

At the end of the third step and after the successful completion of all activities a student or a

project team can start their practical realization of the developed project at the enterprise or start searching for investors, partners to do their own business.

All the time the students have an opportunity to participate in competitions for special purposes, in scientific and practical conferences and scientific contests of different levels, in events held by the YKTC, the SSS "Idea", students' scientific and project Campus. The participation in such contests allows results testing of the research.

### Conclusions

As a result of the structure realization of students' research and know-how activity in PenzSTU our students have achieved the following outcomes for the last 3 years:

- the triumph in the "UMNIK" program;

- scientific scholarships within the framework of the project "Lift to the Future" in searching for, supporting and promoting talented young people;

- the triumph in the contest of experimental research projects of professional education institutions held by Ministry of Education of the Penza region;

- the establishment of a small innovative enterprise called "Know-How Technologies in Power Engineering" Ltd. (the output – mass production of solar collectors on the basis of "Nizhnelomovskiy Electromechanical Plant" JSC);

- 7 patents on inventions, 16 patents on utility models, 1 certificate on the program for computers;

- the participation in All-Russian and International forums ("Seliger", "Engineers of the Future", Economic Forum in Krasnoyarsk);

- the participation and triumph in All-Russian fair of scientific and engineering creative work of students "HTTM-2011" and "HTTM-2012";

- the participation in university, interregional, All-Russian and International scientific and practical conferences;

- publications in various journals including "Young Scientist", "Defense Complex to Scientific Engineering Progress of Russia", "XXI Century: Resumes of the Past and Challenges of the Present plus", "Transport and Telecommunication", "Assembly in Engineering and Computer Industry" etc. editing by the Higher Attestation Commission;

- the triumph in the All-Russian contest of talented young people's achievements "National Heritage of Russia";

- scholarships and prizes from the President of the RF and Government of the RF;

- the scholarship from the President of the RF for studying abroad in the National Engineering

School in St-Étienne (France), in the laboratory on know-how adaptive technologies and in the university in Jyvaskyla (Finland) in the sphere of "Introduction to Nanotechnology and Nanoelectronics".

The system of SRA organization in PenzSTU was awarded by a laureate title of the All-Russian contest in the field of the development of student government bodies "Student Activists" in the category "The Best Project in the Sphere of the Development of Students' Research Activity" (2012). It was also awarded by the diploma of the third degree in the category "The Best Project in the Sphere of Promotion and Popularization of Research Activity" in the All-Russian contest of the best organization of student government bodies activity in educational institutions of vocational and professional education held by Rosmolodyozs and Ministry of Education and Science of the Russian Federation.

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