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Nanotechnology Research and Education Centers as an Intellectual Basis of Nanotechnology in Russia

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Abstract: Today one of the top priorities of the state policy of the Russian Federation is transfer of the economy to the innovation way of development. This transition requires a favorable environment for forming an effective production and using knowledge, development and introduction of new technologies. The intellectual core of the development of innovative trends and training of highly qualified scientific personnel in the field of nanotechnology is science education centers. The interest in such organizations is huge, because of that today the value of research and inventions is determined by their practical utility. Besides, these organizations not only develop and expand the scope of nanotechnology application, but also form the basis of commercial interaction. Huge role in forming the knowledge economy is played by universities. University and research centers are important for the organization of research in different spheres.

Key words: Innovation · Knowledge · University science · Nanotechnology · Personnel · Nanotech centers · High-tech industries · Research and educational centers (RECs) · Motivation · Productivity · Self-education · Scientific work

INTRODUCTION

The innovation process is the preparation and implementation of innovative changes; it consists of interrelated functions that form a comprehensive whole. New technologies have resulted from the development and merge of a number of scientific fields and the development and practical application of many fundamental achievements obtained for a long time and only now becoming the basis for new technologies. Analysis of the demand for the results of scientific research in priority areas of science and technology allowed identifying the most popular and needed research areas.

As it is apparent from Fig. 1, "Power engineering and energy efficiency", "Information systems" and "Nanosystems and materials" are the most in demand in Russia.

It is necessary to implement a model of innovative development strategy, where all the resource capacity (human, financial, material and technical) should be focused on the innovative development structure.

At that, there should be no doubt that the basic condition for innovative development of the country is an intellectual resource. The contribution of knowledge to economic growth and competitiveness is a priority throughout the world [1, 2].

In the new economy, creative ideas and new technologies are the key to growth, new jobs and higher living standards. The ideas are not born in a vacuum, or divided, they need to be shared and developed.

Therefore, the role of science, creativity and innovation has not only increased, but has become qualitatively different. Science itself as a form of activity, institution and system of knowledge is undergoing profound qualitative changes.

The processes of differentiation and integration of the gained knowledge proceed with great intensity.

Thus, the most important functions of education in an innovative partnership are:

- Integration of Science and higher education, development of a network of research and education universities, centers of alliances for the implementation of national programs and projects;
- Training, retraining and advanced training of researchers, designers, engineers and skilled workers to perform basic innovations;

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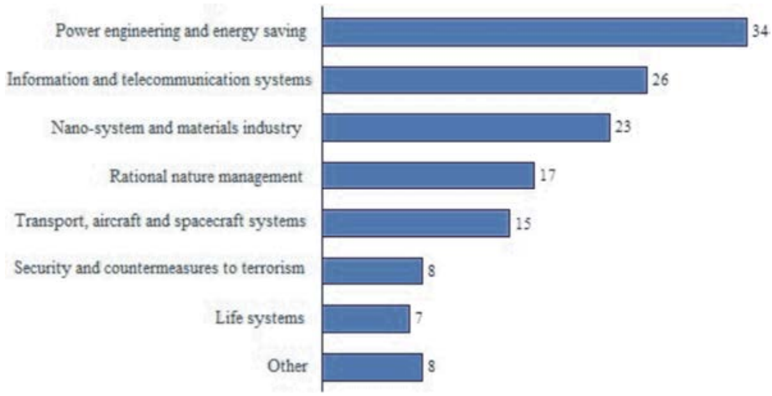

Fig. 1: The demand for scientific advances in the priority areas of science, technology and engineering

- Education of the new generation in an innovative and pioneering spirit of creativity romance; overcoming unreasonable market success, the pursuit of profit; transfer of the entire amount of knowledge on the laws and prospects of social development and Russia's development strategy to the younger generation.

Nanotechnology evolved from the merge of fundamental research into various sciences (chemistry, physics, biology, mathematics, materials processing, etc.).

The development of nanotechnology will lead to significant changes both in the organization of research and in the system for education and training of scientific personnel. A huge role in the development and implementation of nanotechnologies is played by the system of researchers training.

During personnel recruitment it is very important to decide, what incentives the employees of modern research and design organizations, dealing with scientific developments, have, what conditions are needed for a new research and how we can teach the educated, enthusiastic professionals to accept and pass on knowledge. To date, the value of research and inventions is determined by their practical utility. Therefore, we believe that the task of evaluating the productivity of scientific staff can be solved by identifying the indicators of creativity. The study [3] highlights the inclination of scientists to self-motivation.

We have studied the criteria for assessing the productivity of the scientist. To determine the criteria of scientific labor productivity, we applied an expert method; therefore some parameters of scientific productivity were based on the judgments about the work of each scientist expressed by the employees. Our study was conducted in the leading innovative organizations, where the management of scientific staff productivity is highly relevant due to the fact that the specificity of scientific work is difficult to reconcile with the organized activity of economic entities.

We have four main criteria for assessing the productivity of a researcher and divided them into two groups:

- The productivity of labor that characterizes the quantitative results and their utility for practice;
- The potential of the researcher measured by the qualitative evaluation of the scientific contributions and the number of published results (regardless of whether they were implemented or not).

Productivity of Scientist	
Performance (in the evaluation period)	Potential (for the future)
Number of reports	Scientific contribution (estimated from outside)
Number of published papers and patents	Usefulness

Data, obtained in the study, are divided into two groups:

- Information about the scientist and the conditions prevailing in the laboratory, where he works;
- Information about the productivity of the scientist.

Then we moved on to the study of the effect of creative freedom on the productivity of scientific activity and used the method of the anonymous survey. Productive activity is to get a new result and any research activities should be directed to obtain such result.

Scientists say they need freedom as an opportunity to direct their own activities is critical to the high scientific productivity. It was found that, in general, scientists do better when they make important decisions together with several other officers in different posts. The greater was the number of parties who took part in determining the theme of the scientist's work and made at least a small contribution, the higher his colleagues evaluated his scientific contribution and value to the organization. In addition, this researcher writes more articles and reports.

Scientific productivity increases depending on the extent of the employees' influence on the choice of their research subjects [4]. Our data clearly indicate the need for the management of scientific research and design organizations not only to take into account a number of features of scientific personnel management, when choosing the forms of interference in the creative process, but also to understand that freedom and independence are not an absolute dominant in achieving high scientific productivity [5]. It is therefore necessary to find methods for solving problems of information exchange between scientists from different disciplines. Thus, the very important are personal contacts, close relationship in the research teams and scientific works.

Efficiency (commercial or innovative) of a particular scientific result is also an important criterion for evaluation of scientific organization. It is therefore necessary to create not a scientific organization, but the organizations involved in research and development. The researchers, including in scientific work must be clear about what science is, how it is organized, know the laws of its development and the structure of scientific knowledge. Scientist should not do science in general; he should know a clear direction for the work, put a specific goal and consistently achieve it.

As such, modern RECs rightfully claim to be the prototype of an innovative organization in the field of education. Scientific and Educational Center (SEC) is now becoming one of the most effective forms of training and post-graduate training of scientific personnel.

The concept of SEC was supported within the frameworks of the Federal Program "Scientific and scientific-pedagogical personnel of innovative Russia" for 2009-2013. It is thanks to the REC that the continuous system of highly qualified personnel training in a single research, education and innovation process can be provided [6].

The basis of SEC is to be the leading educational institution and the research center conducting basic and applied research in priority areas of science and technology, including the interdisciplinary areas.

The authors of [8] consider the foreign experience of creation and functioning of REC in nanotechnology. Comparison between Malaysian universities and other higher education institutions in the U.S., UK, Singapore and Australia shows that the competitiveness of foreign REC is provided by a wide variety of educational programs for different levels of knowledge and expertise in the field of nanotechnology (individual approach, distant learning programs, a training system for preschool and school age students, masters).

Having considered educational technologies for the system generalization of nano-education activities in nanotechnology [9], we can say that there must be scientific organizations, specialized in the development of a specific priority field and they should be fully liable for its implementation, for realization of science and technology policy to the government and the state.

All variety of features of scientific and educational development in the field of nanotechnology abroad can be summarized in five structural models, differing in scale and nature (Fig. 2).

Multilevel system of training allows for a more focused orientation of the educational process in the specialized disciplines considering the problems in the training areas, as reflected in the master's program. Clusters are particularly relevant in research institutes, where a multilevel system of personnel training is introduced. "Cluster" model relies on basic major universities and regional localization of research and educational projects with a focus on one or more areas of nanotechnology. The specific feature of this model is vertical integration of scientific research and education, covering the major areas of complex research, involving a large group of scientists and developers.

Ural Federal District has the experience in developing the nanotechnology clusters in the field of composite materials, construction materials and nano-biotechnology [10].

In August 2009, a law, authorizing the budgetary research organizations to create innovative small enterprises (SIE), entered into force. As a result, Perm National Research Polytechnic University has the right to independently create the institutes for introducing the results of intellectual activity and the rights to these

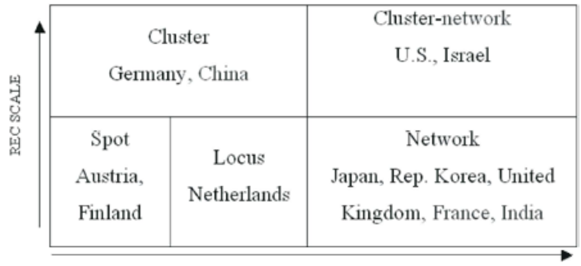

Fig. 2: Models of scientific and educational development in the field of nanotechnology abroad

results belong to this university. This Law allowed universities to legitimize commercial use of the results of their innovation activities. Besides, it contributed to resolving of the personnel issues. Young people can proceed not interrupting their educational and scientific activity, but at the same time, they should understand that it is not easy to connect their lives to science and innovation. Therefore, training for innovative Russia must be added with internships in a good innovation team.

The basis of modern training system that meets the innovative economic model can be scientific and educational centers (RECs), that brings together under one "roof" a research institute, the department, laboratories of RAS, small innovative structures, etc. The concept of REC was supported within the Federal Program "Scientific and scientific-pedagogical personnel of innovative Russia" for 2009-2013. It is REC that can provide the continuous system of highly qualified personnel training in a single research, education and innovation process.

Research and Education Center "Nanotechnologies and Nanomaterials" was created as a subdivision of the Perm National Research Polytechnic University (PNIPU).

In PNIPU, REC is an organizational form of integration and coordination of educational, research, innovation and implementation potential of subdivisions. In addition, REC provides training of highly qualified specialists.

In Scientific Centre of Powder Materials of Perm National Research Polytechnic University (PNIPU) there is a specialty "Powder Materials and Nanomaterials". This allows ensuring interaction of fundamental and applied research with the educational process at all stages, including the use of the results of joint research projects in lecture courses, experimental facilities for research and training, laboratory and term papers, industrial and pre-diploma practice [11].

The Center prepares specialists in the field of nanotechnologies who can solve the personnel problem for the analytical and certifying centers and access centers, using modern complex and expensive equipment in their work.

The implemented program includes a continuous system of interdisciplinary education, covering secondary education, higher education, postgraduate and doctoral programs, as well as training of the available scientific and engineering personnel [12].

CONCLUSIONS

Thus, the development of the educational component of nanotechnology is intended to generate the sustainable positive public opinion on nanomaterials and nanotechnology. In turn, the positive public opinion motivates new young researchers to choose a career and carry out active research and development.

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