CONTROL OVER RESEARCH OF CREATING NANOPRODUCTS AND NANOTECHNOLOGY FOR TEXTILE INDUSTRY

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Abstract
The paper looks into principles of control over research within realization of research programs and strategic work plans of an educational establishment, based on the example of Moscow State Textile University "A.N. Kosygin". Features of controlling research in creating innovative materials and nanotechnology for textile industry are analyzed. The role of controlling R&D subsystem in innovative activity of textile enterprises in correlation with the educational establishment is demonstrated.
Key words: Nanotechnology, R&D, innovations, educational establishment, enterprise.

1. Introduction

Transition of textile industry enterprises to the innovative path of development is a feature of the modern economy. This leads to the fact that forming competitiveness of a modern enterprise is measured according to the part of the output which production is based on knowledge. This concept of functioning of textile industry enterprises can exist only on condition of collaborating with educational establishments. As part of such collaboration universities and enterprises carry out realization of the system of steps of development, implementation, adoption, spreading, and commercialization of innovation. A particular emphasis is placed among the steps of the formed system of complex actions on development of innovative and scientific activity in solving the tasks of textile industry.

Increasing efficiency of innovative and scientific activity is in development and adoption of progressive technology – nanotechnology. Creating nanoproducts and nanotechnology is a vital factor of innovative development of the industry. Results of fundamental and research work carried out in this field are already rather high in Russia.

For example, merchandise with anti-bacterial properties developed by sectoral research institutes is successfully promoted on the domestic market. Pilot studies on creating bioactive nanostructured polymer-textile materials are carried out. Among the elements of these materials are breathable and watertight cover made on the basis of modern polymers with a full-blown nanostructure. Nanostructured polymer-textile materials with set functional and protective properties are mastered. Such innovative products are intended for various activities: cloth and sportswear, tourism, etc. Nanotechnology development and creating nanoproducts on the basis of it will enable to set up production of new generation goods, for instance, masking materials with electrophysical properties on the basis of using nanostructured ferromagnetic microwire. Industrial application of these materials will enable to create computers and monitor screens with minimal thickness.

2. Control over the R&D system in collaboration of the educational establishment and enterprise

Cooperation of educational establishment and sectoral enterprise is one of the core elements of the national innovation system in the knowledge economy. Such enterprise focuses its activities on creating, mastering and practical application of the whole set of innovations. An educational establishment and enterprise need significant material, financial and intellectual resources in order for the innovative activity to be efficient. The problem of attracting investment resources for such cooperation is of utmost importance at the initial stage of the innovation lifecycle – creating novelty. During the process of creating innovation Research

and Development (R&D) are carried out and production-organizing structures are formed. At the investment stage of the innovation lifecycle the results of R&D are brought to production of scientific and technical output.

R&D that are executed during the creation of innovation include, firstly, research that may be fundamental, pilot or experimental, and secondly, carrying out development work and technological design. As a result of fundamental and pilot studies, new knowledge is created. Application and experimental studies enable to make conclusions about possibilities of creating new products of practical importance (product innovation) and new technology for making these products (process innovation). Development work is the final stage of research that includes implementing the results of application studies in order to create (upgrade or perfect) new models of produce, equipment, materials and technology.

Proper conditions are necessary so that R&D system functions effectively. These conditions lie in correspondence of choice of external and internal capital formation sources with needs of educational establishment for material, financial, intellectual and other resources. Resource influence must ensure the required novelty level of conducted R&D and achievement of standards, form conditions for transfer of created innovations.

Complexity of the R&D system is defined by heterogeneity of current tasks, elements of the R&D system and correlation between these elements, and also by uncertainty of innovative activity results and high rate of its risk. As a result, complexity of the system determines necessity of using methods of probabilistic scenario planning of R&D conducted by the enterprise. Within the bounds of development and realization of the strategy of managing innovative activities the problem of controlling R&D arises, including planning and control of planned steps. Methods of graph theory and scheduling theory may serve as effective tools to solve this task. Combining these methods within the single R&D control system enables to allocate limited resources of the enterprise in the optimal way in time and to ensure effective execution of different R&D.

Management efficiency of the R&D system depends largely on the extent of rational usage of different types of resources – both admitting accumulation in time, and not admitting, e.g., task time. In practice, resources used to conduct R&D are usually limited. Thus, the R&D control system faces the problem of allocating limited resources among separate tasks. This coordination requires from the educational establishment and enterprise hierarchical system of strategic goals. This system is a prerequisite requirement for forming heuristic preference rules. These rules enable to solve clashes between tasks that claim simultaneous inclusion into schedule which characterizes sequence of the R&D business processes performance in the best way in conditions of limited resources.

Strategic goals of the collaboration, including goals realized by the R&D system, must be linked together. For instance, from the view of increasing research effectiveness it is necessary to maximize the number of patents and other protection documents. However, if the educational establishment and enterprise do not have efficacious innovation transfer system, disproportions in efficiency of collaboration between the R&D system and the number of innovations accepted for production may emerge. Such situation will lead to ineffective use of resources and increasing probability of investment risks emergence in conditions of uncertainty of the lifecycle of creating and producing innovative product. Thus, within the bounds of realizing the general strategy goals of the educational establishment and enterprise are coordinated with the required quantity of resources that must be allocated in the optimal way not only in time, but also to current innovative development and structural divisions that take part in this development.

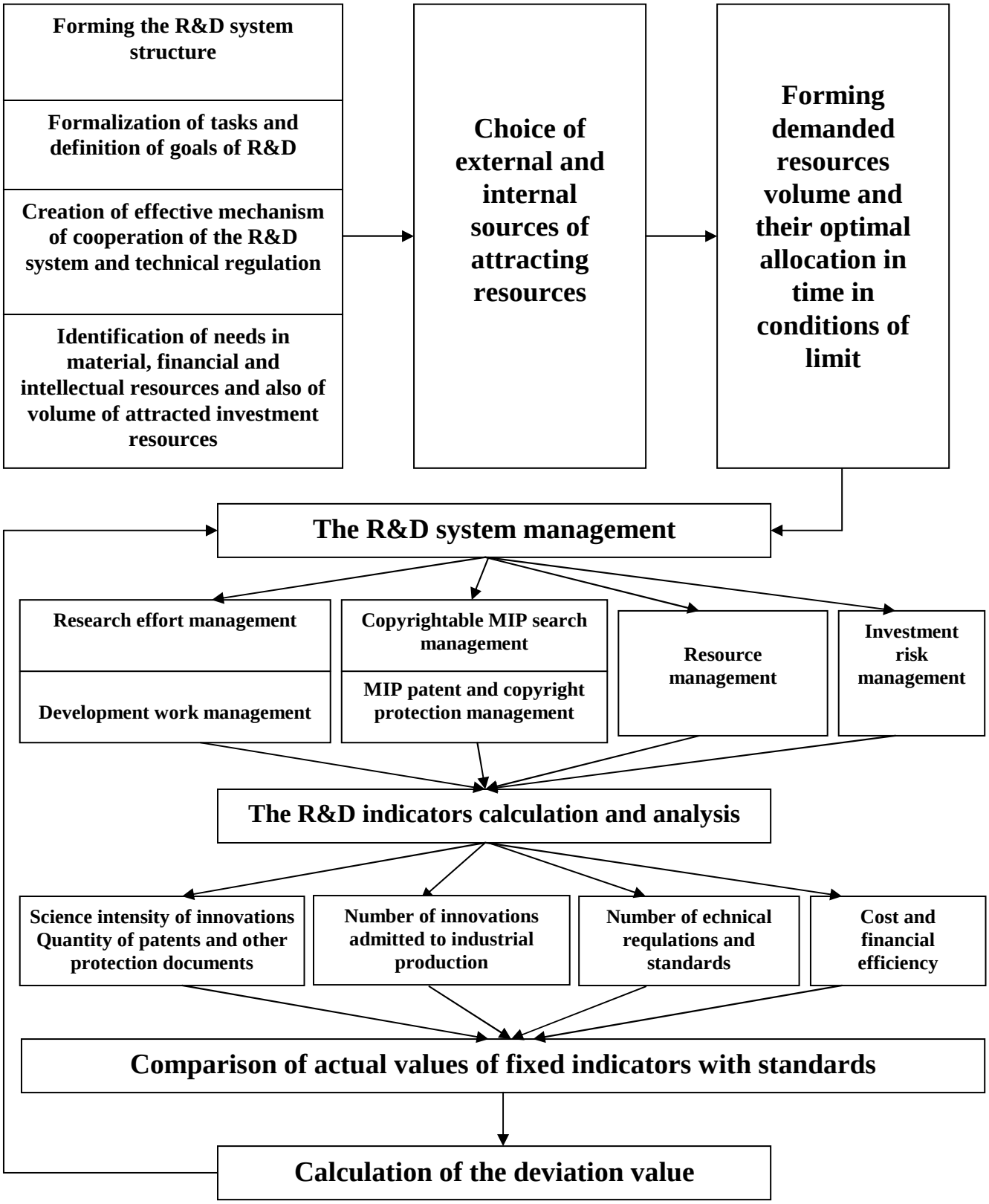

Fig. 1. The process of managing the R&D system

In the process of R&D management not only systems approach is used, but also process approach. Usage of these approaches presupposes that the R&D system realizes the whole set

of interconnected processes. Thus, the R&D system may be divided into separate parts (local subsystems and elements). For example, subsystems of managing search for copyrightable matters of intellectual property (MIP), patent and copyright protection management and etc. act as elements of the R&D system. Within the bounds of managing patent and copyright protection of MIP subsystems of intangible assets control are singled out. A part that cannot be further differentiated within the bounds this system is regarded as an element. For example, know-how of research methods, scientific and technical information, and developed R&D regulations are elements of the R&D system. Each element of the R&D system performs certain function that is typical only for it. Figure 1 demonstrates scheme of the process of managing the R&D system.

The R&D system is a dynamic control system. This is conditioned by the fact that influence of quick-changing external factors determines high rate of dynamics of innovative changes, i.e. requirements for innovative activity of both an educational establishment and an enterprise are constantly changing [3]. This leads to the fact that when choosing external and internal funding sources it is necessary to procure both traditional sources and those that ensure effective activity of R&D in conditions of high risks. It can be venture and planning funding, financial leasing, franchising, license agreements, etc.

Collaboration of an educational establishment with an enterprise is a process of continuous adaptation to changing external and internal factors. Their influence forces to compare actual values of indicators with standards within bounds of managing the R&D system. In this case it is possible to use internal reserves and attract extra resources from external environment, to perfect R&D and improve production processes, etc. The above mentioned is necessary in order to ensure performance efficiency of the enterprise in coordination with the educational establishment in the best way.

3. Forming areas of R&D in creating innovative materials and nanotechnology in textile industry

At the moment requirements for textile materials are rapidly changing. Modern environmental conditions, increase of anthropogenic situations, environmental and biological catastrophes, and allergic diseases growth have called forth the necessity of creating new generation textile goods. One of the ways to give textile materials multifunctional set properties is use of nanotechnology. Textile which is based on nanotechnology acquires unique bioactive, watertight, stain-repellant, heat-conducting, electroconductive and other characteristics. Russian scientists are actively carrying our research in the field of using nanotechnology for creating new set of consumer properties of textile industry goods.

Range of R&D in MSTU “A.N. Kosygin” is rather wide and covers fields of creating new textile materials and technology of their manufacturing, development of new chemical, physical and other methods of textile materials modification. Scientific effort of university staff is focused on development of fundamental and pilot studies, increase of research effectiveness rate, development of innovative forms of organizing scientific effort, tightening bonds with industrial sectors, practical application of R&D results in the national economy and syllabus. In research studies take part: faculty – 548 people, R&D management workers – 10 people, doctoral candidates and postgraduate students – 189 people, students – more than 3600 people.

According to the R&D development plan, following sciences have been further developed in the university.

- *In the field of developing theory of textile industry workflow:*

- theoretical dependence of physical and mechanical characteristics of mixed and cotton yard from characteristics of componentry mix are acquired (head researcher professor A.N. Chernikov);
- mathematical formulation of destruction of textile-metal thread used to make reflecting surface is acquired; a plant for determination of thread durability is created (head researcher professor V.P. Shcherbakov);
- geometrical models of triaxial fabrics texture under different parameters is created; a method of designing triaxial fabrics under predetermined parameters and characteristics is suggested (head researcher professor S.D. Nikolaev);
- conditions for stability and composition elements for acquiring nonwoven composition materials with special characteristics (protective, filtering, sorption) are defined (head researcher professor V.M. Gorchakova);
- pilot research of two-dimensional deformation of metal knitted material with different structures is carried out (head researcher professor L.A. Kudryavin);
- mathematical models of formal description of warp-knitted textures on microlevel are developed (head researcher professor I.G. Tsitovich).

❖ *In the field of creating theory of workflow of polymer and polymer materials modification, including nanostructures use:*

- regularities of processes of filling polymers with nano-sized additions are established; methods of acquiring nano-dispersed systems and regularities of processes of filling polymers with nano-sized medicinal agents are developed; conditions of intensification of inoculative polymerization by adding nano-sized metal-containing components of initiating systems and conditions of emulsive polymerization of fluorinealkylacrylate and ultrasonic impact ensuring acquiring nano-dispersed latex for giving textile materials anti-adhesion characteristics are defined; method of acquiring fire retarding system containing nano-dispersed components is suggested (head researcher professor L.S. Galbraih);
- hydrogel surface specifically modified by intruding carbonyl group generated on surface of a chitosan membrane in the process of glutaric aldehyde oligomerization was used for acquiring nanoparticles of silver. The acquired results will serve as the basis for creating textile medical materials that combine biocompatibility and bioactivity (head researcher professor B.A. Izmaylov).

❖ *In the field of creating ecologically pure technology of finishing production:*

- methods of synthesis of several bisazo dyes that can be used as dyes and pigments for coloring different textile materials are developed (head researcher professor K.I. Kobrakov);
- methods of intensification processes of dyeing textile materials with using cyclodextrins are developed (head researcher professor V.V. Safonov).

Nowadays MSTU “A.N. Kosygin” carries out intensive projects on creating nanotextile, research on forming nano-sized elements and intrusion of nanoparticles into structures of polymers in order to create high-performance functionally-active materials for different purposes. For instance, after research on thermolysis processes with different additives scientists ascertained that intrusion of nano-sized metal-containing compounds into polymers significantly reduces combustibility of materials and volume of toxic carbon monoxides

emitted during combustion. As a result, so-called fire retarding systems have been developed that are now used for creating flameproof materials. Such materials have lower electrization, do not irritate human skin, and maintain flameproof characteristics after washing and dry-cleaning; durability and other physical and mechanical characteristics decrease no more than by 10-15% compared to other existing materials. Technology of creating flameproof carpeting surfaces on the basis of polypropylene with low smoke generation and toxicity of combustion products with use of Russian halogen containing combustion retarder has been developed. Based on the latest R&D results, products with water- and oil-repellent characteristics (cloaks, tents, awnings, and overalls for workers of chemical, oil and gas, pulp and paper and other industries) are manufactured.

University scientists have developed technology for creating new chemisorption fibrous materials by the method of chemical modifying viscose and polycaproamide fibers. These materials can be used for discharged waters purification, personal protective equipment for respiratory apparatus, as filters for industrial air-gas mixture purification, for trapping ions of rare and nonferrous metals from spent electrolytes and scourage. Areas of new medical materials research play an important role in developing university R&D. One of the latest projects of department of chemical fibers technology is creation of modified retention sutures covered by biocompatible and biodegradable polymer. Derived retention sutures excel existing analogs on a number of points. The same department has developed a film dressing with a synergistic and prolonging biological effect.

4. Conclusion. Perspective development of innovations, nanoproducts and nanotechnology in textile industry of Russia by 2020

Adoption of innovative development model by textile industry enterprises is focused on increasing output of new generation quality goods. To achieve the set tasks modern production of an innovative product requires professional capacity and high intellectual potential from educational establishments and enterprises of the industry. During joint innovative activities realization of purposeful system of measures on development, implementation, mastering, spreading and commercialization of novelties is carried out. It is necessary to intensively upgrade production, renew and implement new technology, restructure systems of business and research management in order to increase competitiveness of new textile industry products.

The innovative model of textile industry appointed by the Government of the Russian Federation contributes to creating favorable economic conditions and realization of innovative scenario of industry development. This intends to ensure amount of competitive products growth 3.1 times as for the rate of 2008 and to increase export 4.0 times that will be roughly 3.0 billion US dollars. Implementation into industry of more than 50 new techniques, including world-class, and issue of more than 70 patents, proving novelty of technological solutions, is expected from 2009 to 2020 due to stimulating innovations. Share of domestics on the Russian market must be not less than 50%, innovative goods and goods with patent protection (trademark, utility model) – not less than 46% of production volume of textile and light industries [1].

Forming industrial clusters, qualitative modernization, stimulating innovations, “breakthrough” innovations, including nanotechnology, are becoming strategic priorities of sector development. Achieving high results of enterprise activity requires not only significant investments and financial resources, but also increasing textile industry scientific and innovative potential, forming manpower resources with high intellectual level at enterprises. In order to maintain and develop intellectual potential of the sector, acceleration of nanodevelopment on creating highly needed nanostructured materials on the textile basis and their adoption into production structural reorganization of sectoral science is stipulated. In order to achieve this goal creation of a state

research center of innovative technology and a single methodological instrument basis for objective appraisal of raw material, semi-finished products and finished goods are planned. To solve the above mentioned tasks creating a center for shared use of developed nanotechnology and range of nanoproducts in academic and scientific institutes is proposed. Realization of sector's innovative policy steps must contribute to consolidation of scientific development in the single state center of innovative technology, increase significance of domestic science. As a result, this will ensure acquiring expected profit of 1.6 billion US dollars at developing innovation-oriented enterprises and assignments from profit to budget – 0.4 billion US dollars in 2020 [1].

While improving efficiency of innovative activities textile industry enterprises will seek to increase intellectual potential of their personnel in order to create and service creation of innovations. Economic growth will be more and more defined by fraction of output and availability of technology based on progressive knowledge at enterprises. In post-industrial economy production and sales of products now largely depend not only on material and financial resources but also on economically significant intellectual resources. The national concept of transition of economy to innovative factors of development will reach the set goals only with the direct participation of educational establishments in creating quality intellectual resources for an enterprise.

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