Socio-Economic Aspects of Integration in Science, Education and Manufacturing

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Abstract*: *The article is devoted to the substantiation of socio-economic aspects of integration in science, education and manufacturing. It has been established that integration refreshed educational institutions' needs for managerial innovation and changes in the organizational structure, for stricter control over the quality of education on the part of employers, for cooperation with the parties interested in quality assurance of education. It has been determined that a certain synthesizing idea for the unification of various forms of integration is the idea of a research university that can become a center of innovation technological development of the industrial and social sectors, an important facility to be managed on a regional and sometimes national level. It has been proved that a university can become a coordinating center of power, a laboratory for the transformation of scientific ideas into a valuable product, a foothold for international forums and conferences.

***Index Terms*: *education, science, manufacturing, society, technologies, management, integration, system, economy*.**

I. INTRODUCTION

At the modern stage, science and education in most countries are considered as the biggest priorities of their national strategies for survival and development. One of the generally accepted global priorities in the formation of the post-industrial society is the development of a system designed to train professionals, which is based on the principle of equality between education and science, which provides a combination of values of fundamental education and possibilities of flexible reaction to the needs for human resources for the development of topical scientific areas and knowledge-intensive technologies.

A main feature of the knowledge-based society is the ability to create and make efficient use of scientific knowledge, to turn it into sources of profit, which plays a decisive role for sustainable economic development and higher living standards of a country's population. At the same time, to build an innovation economy, it is necessary to achieve close interaction and cooperation between education, science and manufacturing, to ensure they are integrated into a unified system that will organically connect in the socio-economic environment each of these human activities, and this will eventually improve the lives of people, and will prompt the society to develop at a steady pace.

The integration of science and education aims to overcome a gap between scientific and educational institutions when executing publicly important functions of manufacturing, transfer and distribution of knowledge. This implies the accumulation of resources to ensure sustainable development of the country's research educational system, the establishment of research educational facilities that can operate efficiently and successfully solve both research and educational problems.

Studies related to the integration of science, education and manufacturing were reflected in the papers by S.D. Bodrunov [1], R.M. Magomedova [2], A.M. Sagdatullin [3], E.M. Sokolov [4], I.V. Sycheva [5], V.A. Yakushev [6] and others. The analysis of articles devoted to the topic under research allows us to highlight contradictions, which prove that it is necessary to generalize socio-economic aspects of integration in science, education and manufacturing.

II. METHODS

The study's theoretical and methodological basis is the abstract logical method, techniques of induction, deduction, analysis, synthesis and systematization used to substantiate socio-economic aspects of integration in science, education and manufacturing, graphical methods used to study the level and trends in the development of science, education and manufacturing, and the weighing method used to define ratings of educational institutions.

The article's information base consists of statistical data from public authorities, legislative and statutory documents, which regulate socio-economic aspects of integration in science, education and manufacturing [7-9].

In the course of the study, we plan to enhance approaches to the integration in science, education and manufacturing, to elaborate measures to coordinate activities carried out by main participants of the generation and promotion of knowledge, to substantiate provisions on the formation of an integration system that provides coordination among science, education and manufacturing.

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III. RESULTS

The integration of business and education reflects modern trends in the development of companies that relate to the

practical implementation of ideas, which arise during life-long learning. This process implies a distribution of responsibility for the development of a system designed for professional training and re-training between educational institutions and businesses and means the establishment of training manufacturing facilities that can satisfy employers' needs for highly qualified workers.

At the same time, the tripartite integration of science, education and business reflects a key vector of development of the knowledge economy because this makes it possible to efficiently resolve problems related to the integrated support of innovation. Traditional areas of material manufacturing tend to transform into the knowledge economy, and their technology base changes radically. Such qualitative changes in the material base are possible only when scientific developments outrun market needs and when real mechanisms for their introduction are created.

Thus, only close integration between science and manufacturing makes it possible to achieve an innovation effect, but this is not enough. The experience of industrially developed countries showed that the focus only on incentives for innovation by funneling financial and information flows into separate research centers is limited. The important factor of the establishment of the modern economy is the active perception of new ideas, systems and technologies, readiness to bring them to fruition, which requires a constant upgrade of the material base of manufacturing and constant life-long self-education of an employee.

As a rule, universities constitute a center of such integration. Of the three components of the so-called triada "education – science – manufacturing", education itself is viewed as a key link, which influences integration at the national level. At the same time, as an institution of socialization, education is very significant socially and has substantial material, technical and human resources.

An innovation triad with educational, research and manufacturing components is implemented based on a university. In this case, each party benefits as the university obtains a guaranteed paid order for the training of professionals, the possibility to develop its experimental and research base, to increase financial support of academic teachers and encourage them to grow professionally; scientific organizations get the possibility to expand their material and technical bases and accelerate commercialization of research developments; a corporate client gets the possibility of training in a university qualified professionals who meet its requirements; graduates are provided with guaranteed jobs in line with their qualification with earlier described career prospects; and the state gets the possibility of distributing limited resources more efficiently and boosting economic growth (Figure 1).

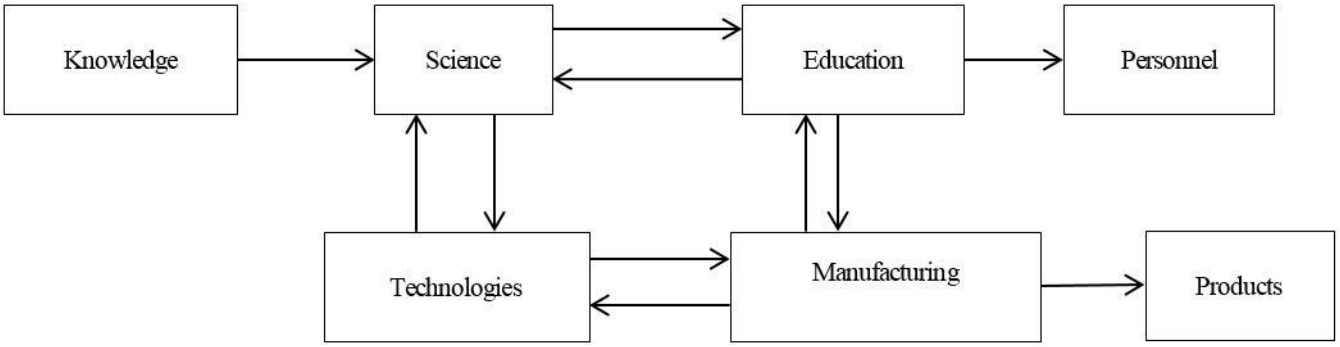

Fig. 1. Areas of interaction among science, education and manufacturing

The peculiarity of integration in science, education and manufacturing is their interrelated activities for attaining a single final goal. For more complete satisfaction of the society's needs, new targets are set for the manufacturing sector, the achievement of which creates incentives for the development of science. Science, in turn, is a means of enhancement of machinery, technologies of production, methods and methodology of education. However, the main task of education is to distribute scientific, technical and technological knowledge, transfer it to the next generation and to develop people's abilities to use their knowledge in work and life.

Moreover, economic globalization, the democratization of the society, and tougher competition in the educational services market are big hurdles for higher education and science in the market conditions. Nowadays, main problems are insufficient integration between science and training in most educational institutions, which restrains proper training of highly qualified professionals; low socio-economic attractiveness of work performed by research workers and scientists, a high educational workload of academic teachers, the practice of combining core professional activities with other areas of business; weak demand for research results, especially with regard to higher education institutions; limited financial support of education and science, physical and moral deterioration of the material-technical base; the breach of partnership relations among educational institutions and regional employers, institutions and organizations; a gap between demand for highly qualified professionals in the labor market and the quality of training of these professionals in higher education institutions.

The resolution of these problems requires coordinated actions on the part of legislative, executive and local self-government bodies and a number of organizational managerial decisions to be made. Main objectives in the field of integration of science and higher education are, therefore, the establishment of integrated research firms, universities and inter-university complexes and support of their activities, research, training and production centers to consolidate efforts and resources, the deepening of international coordination and international cooperation in order to train qualified professionals in scientific, technical and innovation fields; the development of advanced ICT and other knowledge-intensive technologies and their implementation in scientific and technical activities and the educational process; the joint use of scientific, experimental base of acamedic, higher education and sectoral sectors of science in research and educational processes.

The practice has shown that research segments of higher education institutions in developed countries of the world and Eastern Europe have been expanding in line with several diverse organizational legal models of cooperation between research institutions and higher education institutions. Research facilities in a higher education institution were quite spacious in the world and the Russian Federation in particular, but later government spending on research trended down substantially. However, currently, there is a slow revival of research divisions in higher education institutions.

A key issue in this respect is the improvement of research infrastructure, as all-out research growth cannot be achieved without developed infrastructure. Experience shows that when students are specially trained in close cooperation with scientific organizations, the nature of knowledge acquired by students changes immediately.

At the same time, modern forms of joint investment in a higher education institution's scientific and technical activities, participation in grants and scientific programs assume substantiated organizational technical and information support of research infrastructure. Higher education institutions need this assistance for academic teachers, post-graduates and students to take a valuable part in research taking into account diversified topics of their scientific interests.In the conditions of limited resources, scheduled integration of science and education should lead to better coordination of work performed in higher education institutions and academic research institutions, the elimination of superfluous redundancy, and the concentration of financial resources on priority areas of research and personnel training. However, there are examples in global practice when universities organized a base for the training of professionals at all educational levels, and conducted fundamental and applied research in nearly all industrial sectors, economy and the social sector. Such a system of education exists in the United States and other highly developed countries.International integration within the system of science, education and manufacturing deserves attention. The conduct of joint research with partner higher education institutions aims, first and foremost, to form multinational research teams. A specific feature of scientific cooperation is not the study of general scientific topics, but the conduct of independent research in joint scientific areas.

All thi makes it possible to deal with a wider range of scientific problems and to create favorable conditions for the exchange of scientific research, and promotes the exchange of scientific ideas about further development of research in a specific sector. The most important thing is that such an approach provides the formation of an efficient international research team that aims to solve economic and scientific problems given the experience of a scientific partner.

Problems related to the integration of science, educa ion and manufacturing could be solved by uniting educational institutions at a various level (from schools, professional retraining institutions and research firms) into a single complex. Such integration will make it possible to use financial and human resources more efficiently, to provide faster and more flexible adaptation of the professional education system to labor market changes, the execution of major scientific and technical projects and programs at a regional and federal level.At the same time, inter-sectoral integration implies the cooperation of scientific organizations and higher education institutions that are governed by various ministries and agencies. Forms of inter-sectoral integration in scientific and educational activities are joint activities conducted by higher education and scientific institutions (the conduct of joint research, the preparation of academic methodical literature); research workers' participation in pedagogical activities; the involvement of students and post-graduates in research activities of scientific institutions; the joint use of information and experimental bases of research organizations.An important organizational and legal form of inter-sectoral integration is the establishment of inter-departmental scientific and educational institutions (training scientific complexes, and research educational centers), and joint centers for the collective use of information, material and technical resources. Inter-sectorial integration implies an interaction between scientific and educational activities within an institution, organization or the conduct of joint activities by scientific and educational institutions that belong to the same sector (both education and science). The implementation of such forms of cooperation will encourage young professionals to take part in scientific activities, improve the level of education and science, and, consequently, their competitiveness in the international market.The integration of science, education and manufacturing looks appropriate in the following conditions: integration is productive if there are quality interrelations of educational, research institutions and manufacturing; integration becomes more efficient provided that its structural and isomorphic components grow; the high quality of training of professionals is achieved provided that the requirements imposed by subjects of interactive cooperation in education,

science and manufacturing are met; competitiveness of future professionals and their focus on employment in the relevant sector are ensured provided that the integration of education, science and manufacturing is built into the content of training.

IV. RESULTS

The reliability of the proposed approaches is confirmed by the fact that the experience of integrated development of academic and university sciences implies various options of the organizational economic mechanism of establishment and operation of integrated structures [10-12]. The practice showed that the establishment of university-based integrated complexes constitutes an organizational and pedagogical system, in which students master programs of professional education of various levels and areas, and organically combine theoretical education and practical activities in a selected professional area.

It is important that integrated university complexes do not limit themselves to educational tasks only; they also organize innovation technology centers, above all technology parks that provide graduates with jobs and accumulate their scientific initiatives. For the effective execution of the tasks set joint structural divisions can be formed within partnership interaction among participants of an integrated university complex.

At the same time, the establishment of training-research-production complexes can be initiated in a main higher education institution that has its own tradition in the area of applied research and related introduction, including cooperation with applied research firms and partner enterprises. In this regard of priority are technical universities that are capable of providing several sectors of the regional economy with human resources, and keep stable ties with the regional elite. This provides favorable conditions for the establishment of such complexes in which legally independent organizations or their divisions are combined on a contractual basis.

Such a form of integration helps achieve a synergetic effect from the use of possibilities offered by industrial equipment in the educational process and the exchange of knowledge among scientists, academic teachers and manufacturers. At the same time, experience amassed by various universities show multi-pronged integrated cooperation: the integration of faculties with core enterprises in both educational and research areas; the establishment of a special division in a higher education institution whose tasks, for instance, are to assist chairs and faculties in the search of strategic production partners, the elaboration of targeted programs and an organizational economic mechanism of their implementation, information analytical support of these programs.

V. CONCLUSION

Summing up main forms and areas for the integration of education, business and science on the basis of higher education institutions, a hypothesis can be announced that integration processes actualize educational institutions' needs for managerial innovations and changes in organizational structures, tighter control over the quality of education on the part of employers, cooperation with interested parties for quality assurance in education.

A certain synthesizing idea for the amalgamation of diverse forms of integration is the idea of a research university that can become a center of innovation technological development of the industrial and social sectors, an important facility to be managed at a regional and sometimes national level. Nowadays, a university can get new colors, i.e. to become a coordinative center of power, a laboratory for the transformation of scientific ideas into valuable products, a foothold for international forums.

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