## UNIVERSITY RESOURCES IN INNOVATION CYCLE

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***ABSTRACT***

*The author assesses a current state of Russian transport education system, touches upon the history (genesis) of domestic higher school of railway engineers, formulates the essence of the integrated mission of transport universities at the stage of market reforms. Particular attention is paid to the quality of the training of students, formation of professional competences of future specialists, the role of transport university complexes in the innovation cycle, total research and educational activities of university researchers and lecturers.*

**ENGLISH SUMMARY**

**Background.** *The features of the Russian transport education are: system relationship with the development of the transport sector, a very clear focus on the interests of employers, anticipatory formation of educational infrastructure and provision of continuing education at all levels. This is true for any mode of transport – road, air, water (river and sea), rail. However, in terms of chronology of events and relevant tasks each of them and its staffing have own dates and key points.*

**Objective.** *The objective of the author is to assess a current state of Russian transport education system with account of genesis of transport education, and to submit for discussion vital topics determining further vector of its development.*

**Methods.** *The author uses evaluation method, description, historical and comparison method, forecasting, contextual analysis.*

**Results.**

***Genesis of transport higher education institutions***

*Foundation and development of a training system for railways anticipated their construction, as evidenced by time and geography of universities' creation. The first higher education institution, which initiated specialized training for railways, opened in 1809, before the construction of the first railway in St. Petersburg, and for quite a long period satisfied the demand of the entire country. With the development of railways in the European part and primarily for staffing of Trans-Siberian main line high school of railway engineers (now – MIIT University) was established in Moscow; Tomsk technological institute began to train rail engineers. Expansion of the network of railways required training of specialists for the South of Russia (Rostov-on-Don), Far East (Khabarovsk), as well as the emergence of universities in Siberia, in Tomsk (later transferred to Omsk) and in Novosibirsk.*

*Later additional educational centers, reinforcing that network, were opened (Yekaterinburg, Samara, Irkutsk). Inauguration of Irkutsk State University of Railway Engineering in 1975, in fact marked the last stage of shaping of the network of rail universities, which lasted almost 170 years. Training of rail engineers has always been key element of rail transport educational system.*

*In this period repeated merging of departments and higher schools (including those working in the field of water, motor, electric transport) occurred, while inverse processes led to the emergence of institutions, focused on their own mode of transport.*

*Sectoral specialization of higher education institutions prevailed in the railway industry. And this situation to some extent, continues to this day. Incrementally universities of railway transport turned from solving problems of industrialization and mass training of engineers to complex tasks of fundamental engineering education, training of engineers for new areas of engineering and technology (information, construction, communications, environment, safety). During rather long period university organizations existed within the Ministry of Railways.*

*In 2003 following the reform of railway sector, the Ministry of Railways was deprived of the right to conduct economic and business acitvities (later dismantled), JSC Russian Railways was established, rail high and higher educational complex was maintained as public owned but subordinated to Federal Railway Agency. Nevertheless, see the similar reforms regarding other modes of transportation, it is now possible to speak about sectoral transport education in the broad sense (as training of specialists for all modes of transport in any training and educational institution never mind its (their) nature and subordination) and in the narrow sense (as the activities of Universities subordinated to appropriate federal agency – Federal Railway Agency, Federal Air Transport Agency, Federal Marine and River Transport agency and corporate educational institutions).*

*By 2009, in order to maintain the required volume and improve the quality of training of technicians with secondary education former technical (vocational) high schools were incorporated into higher education institutions as branches, and thus higher educational institutions were transformed into vertically integrated university complexes. These aggregated structures could provide training in secondary vocational, higher and advanced professional training, as well as workforce training, school education and pre-university training [e.g. 5].*

*Within the framework of horizontal integration MIIT integrated institute of enterpreneurship protection (law) and Russian open railway academy. At the same time universities implemented the principles of the Bologna process and began organizing bachelor's and master's programs. But taking into account preferences of employers for engineering 5-year long studies, the Universities maintained to almost previously existent extent the relevant engineer courses (e. g., four enlarged groups of railway specialties).*

*On the eve of 2020s external conditions are changing and new challenges emerging for staff training, so transport education system should anticipate the responses and learn to be procative.*

*The mission is very responsible one and implies implementing of series of fundamental and applied researches, encouraging the development and implementation of innovative programs. During recently held Second forum on transport education this mission was unambiguously defined by Russian minister of transport and other participants. Transport educational system based on engineering training should focus on main modern task of developing breakthrough technology and consolidate the efforts with research centers and relevant organizations.*

*Transport Universities should work at:*

*– Continuous generation of new knowledge and their integration in the educational process;*

*– Implementation of all stages of lifelong education, including training, retraining and further training of transport employees development of new promising competencies in a wide range of qualifications required by business and society;*

*– System integration of achievements of the transport industry and sectoral education in the CIS and in the course of cooperation with world leading universities, companies and organizations of transport.*

*Mission of transport universities cannot be implemented in isolation from continuous interaction with employers, verification of quantitative and qualification needs. This is a kind of point of entry into the system of transport education, providing its subsequent quality. The key point at the output of the process, in our opinion, is also an opinion of employers. Most important evaluation is an assessment by practices related to how a graduate is in-demand, how his knowledge and competence are to date and what «safety margin» he has, how knowledge acquired in higher education institution influences capacity and outlook for his professional growth in foreseeable future.*

*In this regard, an independent evaluation of the quality of training seems to be more related to the correlation of motivated expectations of employers towards graduates than results of some average tests or measurements. One can witness further evolution of the forms of employer focused assessments (participation of representatives of employers in the public commissions of final attestation of graduates, public attestation of educational programs by professional community and employers' associations). Then comes the construction of an integrated system to assess competence throughout the working career of an engineer from the date of entering the university.*

*Higher education institutions have systems of an intermediate knowledge assessment, some companies keep a kind of «portfolio» of students who study on the basis of contracts with employers, called targeted education (special forms of contracts which guarantee corporate support during the studies, supplementary free minor courses, renumerated internship, employment after graduation in exchange for sucess in studies and employment directly with the contracted company. If students fail to get employed by relevant company after graduation due to their own fault or unwilligness they have to reimburse all the related expenses to the company – ed.note). Education development plans, developed by ministry of education, provide for the establishment of qualification assessment centers. Number of business corporations have systems for assessing competence of recruited graduates and extensive system of evaluation of professional and corporate competencies during professional career. This problem is not new, especially for enterprise systems of studying abroad [see, e. g., 2]. Its aim is to develop an integrated system, adapted to the specific Russian conditions, which allows combining all links of yet fragmented chains, providing constant feedback. The goal of assessing the quality of education is not to state on its current state, but to constantly improve personal competence of a student or an employee, as well as teaching methodologies.*

*But if the statement of the problems at the input defines the strategy of development of engineering education, and evaluation at the output determines the end result in terms of quality, the formation of quality occurs mostly directly within the educational process.*

*Principal requirements for the quality of training of engineers of the transport industry are justified by technological conditions of transportation process as a complex of systemically interrelated technologies. They are:*

*– Combination of fundamental engineering training with practical skills (from mastering a blue-collar job to technologies actually applied in transport) that dictates the need to maintain a 5-year training program for engineers within the specialist's education program;*

*– Inter-level coordination of the curriculum of secondary vocational and higher education, justified by integrated technologies;*

*– The need for concentration of narrowly specialized faculty members at Universities;*

*– Use of expensive laboratory equipment, operating models, specific for very narrow range of transport departments and sectors;*

*– Setting of training centers closer to business locations to provide practical training, to apply actually used equipment, technologies, to extend in training of existing professionals of the industry;*

*– Retention of graduates at linear enterprises;*

*– Maintaining special requirements for students due to safety conditions of the transportation process, occupational safety and health.*

*Approach to training of economists, lawyers, managers with transport profile is still among most disputable questions and it was confirmed during the above mentioned Forum on transport education. Form the very first view there is a simple dilemma: or it is better to give additional training at job to a certain «universal» economist or lawyer graduated from not-a-transport University, either to train him form the very start in transport higher school.*

*Employers prefer in most of the cases to hire those young candidates who have received initial transport focused education. They study in transport environment, get comprehensive view of transportation process seen from all its engineering and organization aspects, and, last but not the least, get acquainted with professional culture of transport community and additionally with corporate values and competences if they are contracted by enterprises. But nevertheless there is no dilemma here. The response to the question should not be regarded as permission or refusal to train so called not basically transport specialists in transport higher schools, but should have regard to the quality of training, outlook for employment, their assessment from behalf of professional community. The choice should belong to employer but the right of transport higher schools to conduct the courses of that kind should not be apriori artificially denied or limited.*

*Whether we follow here world trends? As far as training of air personnel (except for pilots) and crews of sea and river ships is concerned, it is based on international conventions and has no distinctive national features. But as far as road, rail, multimode transport and operation of transport networks are concerned, practices differ considerably from country to country. Specially profiled transport education is traditional for Asian countries with large transportation systems (PRC, Vietnam, Republic of Korea, Kazakhstan, India). In many EU countries distinct transport profiles exist for master courses.*

*Recently we have noticed a trend to extend or to come back to specialized transport engineering training in Universities and to vocational training in high schools (Germany, Spain, France, Nederland, Austria, Czech Republic, Poland, Romania, Bulgaria and other countries). Newly emerged rail faculties can prove that along with increasing interest to develop joint programs with MIIT University.*

*This is due to relatively stable comparison of the results of more efficient training of engineers with initial rail profile and less efficient more-than-a year adaptation of a graduate with general engineering knowledge to rail job.*

*Outperformance formation of competencies of students is dictated by the forecast of the railway industry development. To achieve the goals, it is necessary to solve a number of interrelated tasks in the field of training.*

*It is required to make a transition from training of specialists, knowing technologies of today (which leads to the actual lag effect of competences due to a gap between the time of training and employment), to create a generation of specialists who can quickly adapt to new technologies, and then to improve them due to their own self-development capacity.*

*In fact, a transition is required from improving innovations to breakthrough technology that under the conditions of railway transport is nothing else but a return to traditions of engineering of the beginning of the era of railways, when engineers were primarily designers and creators of technology and infrastructure, and only then became their operators. This task is the maximum that will be implemented in respect to the most successful graduates. A minimum goal is creation of self-sufficient capacity based on University acquired knowledge, which would allow all graduates faster and better adapt to modern technology.*

*Vector of development of engineering education with transport specificity largely coincides with overall strategic objectives of the national higher education. And these matching projections should be considered as undoubted equal priorities:*

*– Improving the approaches to the implementation of educational programs (achieving an optimal development balance of new levels and areas of training from the point of view of traditional partners and market conditions, shaping out of modular and additional courses, creation of local laboratories and centers, network forms of learning, training of students for blue-collar jobs; introduction of interactive, digital learning methods; individualization of curricula for the student and according to demand of his potential employers, etc.);*

*– Increasing practical skills of the students (participation together with future employers in the development of professional standards, implementation and adjustment (actualization) of curricula and programs, taking into account views of employers; professional and public certification of universities and programs; qualification assessment centers; network forms; creation of industry based leading departments; development of industrial laboratories, research and education centers, innovative business entities; building practical competencies of graduates using special forms of training, etc.);*

*– Optimizing legal form of universities and improvement of management (development of the institution of trustees (supervisory) boards, endowments and associated organizational structures; measures for reproduction of teaching staff, elimination of age disparities; improvement of management structure; monitoring and execution of tasks to maintain a competitive level of wages);*

*– academic and international cooperation (network communication, implementation of joint educational programs with leading Russian and foreign universities, educational institutions of the sector; the growth in the number and proportion of foreign students and guest lecturers, engaging leading foreign scientists to perform scientific work; intensification of programs of academic mobility of teachers and students; adherence to the activities of international academic and professional associations; participation in international sectoral organizations (increasing the role of teachers and university scientists as experts);*

*– promotion of employment (the establishment of centers of employment in higher education institutions and practical training of all undergraduates and graduates; professional testing and certification; development of reliable forms of employment monitoring, in general as well as employment in conformity with graduates' profiles).*

***Role in innovation cycle***

*Research activity is particularly noteworthy. The reason for it is not only an objective necessity of a combination of scientific and educational activities for the development and translation of research results into the educational process, but also the specific conditions of the transport industry. For example, in view of the current situation in our country rail transport universities are the only structural basis on which scientific and educational centers can be formed to solve both complex and applied transportation problems. Large industrial research institutes are absent, corporate research centers deal with narrowly applied technological tasks.*

*Since its introduction in the early XIX century the Russian system of transport education has always solved dual task of conducting educational and research activities. Immediately appeared the understanding that the participation of teachers in research is a key to successful learning, and accumulation of creative skills, new industry knowledge through conducting applied research provides generation of knowledge and competence transmitted to students. It is not a coincidence that among university teachers there have always been prominent scientists representing various fields and areas of science.*

*If we talk about modern universities of railway transport, they successfully integrate the educational process and scientific research, carrying out a large amount of research on the basis of contracts with companies of the industry, and are entitled to be considered as innovative research and education complexes. There are nearly 200 scientific schools at railway Universities. The process of developing innovative business entities within the railway Unveirsities is underway. Three universities of railway transport in 2009–2010, became winners of the contest for state support of innovative educational programs.*

*Now the focus should be put just on the role of transport universities in the innovative development. Foreign practices of recent decades (and even earlier in the USA) have witnessed growing participation of universities in the innovation process, which is understood as a complete innovation cycle from the birth of a scientific idea to its realization in the final product or technology. This made it possible for H. Etzkowitz to introduce a notion of «triple helix». According to him, universities, companies and the government, regardless of their declared priorities and goals constantly perform functions of each other: «The university, for example, acts as an industry, stimulating research and development of new firms, putting the «capitalization of knowledge» as an academic goal. In turn, companies encourage staff development and sharing of knowledge in order to create joint ventures, doing so in part the role of universities. The government, exercising a regulatory function, often acts as a venture capitalist. This approach is directly opposed to the theories that place the initiative of innovation's generation on authorities or business. The triple helix model suggests that universities may be centers of generating technologies and new forms of business, keeping their right to a critical assessment of a project» [3, p. 27–28, retranslation].*

*A notable feature of the landscape of contemporary research activity abroad was the formation of innovation infrastructure around universities: industrial parks, science parks, technopolis, cluster structures. This is due to largely new relationship developing in the economic sphere. Interaction with universities is profitable for business. According to K. K. Prahalad and M. S. Krishnan «to remain competitive and stay ahead of competitors, it*

*is important to have a flair for innovation, emerging in laboratories at world-class universities and small «smart» startups, and then skillfully use them» [4, p.47, retranslation].*

*The essential role is played by the factor of globalization, which in the innovation context, the same authors presented as a formula R = G, where R means resources, derived from numerous suppliers, often from around the globe [4, p. 27]. Thus, in describing the change processes of innovation vector, they resort to examples from the transport industry «The source of knowledge is shifting from physical products (e. g., tires) to the solution (for example, to specific applications required for managers of large vehicle fleets) and individual experience (such as the driver of the tractor-trailer) [4, p. 53].*

*Focus of Russian universities on innovation and tools that encourage them to do so, is at the center of efforts to modernize the education system. However, there is a problem of transition from research phase of the innovation cycle to actually innovative, and this problem can not be regarded as a purely Russian. Previously quoted H. Etzkowitz notes (making, however, focus on the entrepreneurial nature of university activities) that «many scientists believe that their main task is research and educational activities, so they should refrain from participating in the economic and social development. According to this view universities do an excellent job with the third goal through the implementation of the first two. However, even among such conservative scholars, who comment on the capitalization of knowledge rather skeptically, there is a growing desire to find a practical application for their scientific research ... Gradually the understanding is coming to realize that, in contrast to a society based on the production of material goods, a society based on production and consumption of knowledge is subject to a completely different logic and has a different dynamics. Knowledge economy has a more intimate contact with the sources of knowledge, which in turn are subject to change» [3, p. 32–33].*

*Not detailing matters of public support for the innovative development of transport higher education institutions, which they will certainly need, it must be stated that Russian transport universities, in particular rail Univerisities, possess characteristics, defining a special relationship with the government and business, historical traditions of close cooperation with the institutions of industrial science.*

*Foundational principles of innovation activities of railway universities with account of mentioned specifics is the expansion of a range of potential users of developments and innovative products of the sector, as well as a range of partners to implement it due to:*

*– A significant development capacity of cooperation with JSC «VNIIZhT», JSC «NIIAS» and other research subsidiaries of JSC «Russian Railways», independent manufacturers of transport equipment and vehicles' operators;*

*– Russian and foreign partners in need for technical certification of technology and equipment for transport, their promotion to the market;*

*– Enhanced cooperation with foreign manufacturers of transport equipment in order to adapt their products to Russian conditions;*

*– Establishment of joint centers, laboratories or industrial parks with Russian manufacturers of transport vehicles and equipment (for example, there is the chair, organized with the assistance of «Yamaltransstroy»);*

*– Opening of research and education centers with the participation of Russian and foreign transport companies (there are letters of intent with «Siemens», German and French railways, in both last cases with the participation of JSC «Russian Railways»);*

*– Participation in scientific programs through international transport organizations;*

*– Attraction of potential partners from number of transport departments of regional and city authorities.*

**Conclusion.** *Thus, the development of transport education in order to improve its quality will be carried out using a system approach. It will focus on the use of those tools which are equally important for all Russian Universities but duly adapted to the features of transport sector. In addition, the field of engineering education will see a number of features dictated by industry requirements (a high share of specialist's programs and students contracted by companies, providing a unified educational trajectory from secondary vocational to higher education, further developing forms of interaction with employers, a large share of applied research on the basis of contracts with transport companies). All those factors taken into account, transport Universities' resources will effectively serve to enhance the quality of transport education and training.*

*Keywords: system of higher education, university, transport, development strategy, quality of engineering education, competence, innovation cycle, international cooperation, integration of resources.*

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