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Project of an Educational Program for Synchronised Training in the Specialty «Roads and Aerodromes»

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ABSTRACT

Within the task to open a separate enlarged group of specialties and degrees in the field of transport education, the authors, based on many years of pedagogical and industrial experience, developed an exclusive project of a synchronised training program in the specialty «Roads and Aerodromes» to be included into the above-mentioned enlarged group.

The article presents, also for the purpose of discussion by the professional community, a modular scheme of the synchronised main professional educational program «Roads and Aerodromes» and examines the specifics of structuring each module and filling it with disciplines.

Particular attention is paid to the well-known problem of the relationship between the number of humanitarian and technical disciplines in the educational process. Upon showing main reasons for inclusion of an increased number of humanitarian disciplines into engineering-focused general professional educational programs, proposals have been made on mechanisms for eliminating existing imbalances.

The article highlights main problems in the system of training in engineering specialties in terms of programs' funding, of covering the programs of the developed enlarged group of specialties «Road Sector» with requirements of professional standards, of providing the educational process and research work of departments responsible for graduation with research / laboratory equipment and road machines.

Suggesting one of the possible ways of introducing the «Roads and Aerodromes» program into the practice of professional training of the system of higher educational institutions of the Russian Federation, the authors substantiate the opinion that the most promising solution would be creation of Interdepartmental Scientific and Educational Centres of regional significance (ISECR), assigned to specific road and climatic zones.

Keywords: roads, education, personnel training, educational program, organisation of professional training, scientific and educational centres, cryolithozone.

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INTRODUCTION

The training of engineering and technical personnel is one of the fundamental factors in intensification of economic development and strengthening of the national sovereignty of the Russian Federation in the field of technology and industrial production. The general theory of training engineering and technical personnel and organisation of educational process attires attention at various levels[1,2,3]; a significant number of scientific works have been devoted to this problem, namely, [1–8]. Issues of training engineering personnel for the transport industry are considered, for example, in [9–12]. At the same time, there are very few publications in scientific periodicals concerning the real problems of training personnel for the road construction industry (they include, for example, [13]).

The development of higher education in the field of road sector received additional impetus following the meeting of the Presidium of the Government Commission on Transport on April 10, 2023. It approved the proposal of the Ministry of Transport of Russia on formation of a federal project «Development of human resources in the transport industry» for the period 2026–2035[4]. As stated, «its purpose is to provide the necessary funding, implement educational programs and train the required number of specialists, including for new distinct directions of studies.., which the Ministry of Transport proposes to introduce through formation of a separate enlarged group of «Road Sector» specialties and directions of studies for training in the field of education «Transport»[4]. Two specialties, which are inseparable, in our opinion, namely, «Roads and Aerodromes», «Bridges and Transport Tunnels» were highlighted within this enlarged group.

Currently, in accordance with the Russian Classifier [Classification] of Specialties in Education OK 009–2016 (OKSO)[5], training of personnel for the road construction industry in the sections III, IV, V of the directions of studies in higher education, referring, respectively, to training bachelors, masters, and specialists (via specialties of higher education), is now classified within field of education «Engineering, technology and technical science», within the enlarged group of specialties 08 (EGS) «2.08.00.00 Engineering and construction technologies.» Within the framework of this EGS, training of bachelors (08.03) and masters (08.04) for the road construction industry is implemented within the same direction of studies 2.08.03(04).01 «Construction», and training of specialists via specialties of higher education (08.05) is implemented within specialty 08.05.02 «Construction, operation, renovation and technical protection of roads, bridges and tunnels».

The current situation creates many problems for educational institutions of higher education regarding organisation, implementation and synchronisation of the educational process at different levels of education (bachelor's, master's, specialist's training). Training of specialists within the program 08.05.02 «Construction, operation, renovation and technical protection of roads, bridges and tunnels» does not fit with the with the direction of bachelor's and master's studies. The title of the specialty program includes the phrase «renovation and technical protection», borrowed from military terminology, but there is no mention of activity regarding survey, design, construction, operations, maintenance and repair, which are significant for modern road construction sector from technological, industrial, organisational and managerial point of view. In general, there is an almost insoluble problem of synchronising training programs for specialists, on the one hand, and bachelors and masters, on the other. This uncertainty regarding the distribution of professional competencies and their level in the educational process affects even the employment of graduates at enterprises and organisations in the road construction industry.

At the same time, another problem is associated with the OKSO code for bachelor's and master's studies 08.03(04).01, and that problem is faced by absolutely all universities and higher education institutions that have

[1] Podtserob, M. In Russia, there are constantly talking about the shortage of engineering personnel // Vedomosti, 25 July2023 [In Russian]. [Electronic resource]: https://www.vedomosti.ru/management/articles/2023/07/25/986739-v-rossii-postoyanno-govoryat-o-defitsite-inzhenernih-kadrov. Last accessed 15.11.2023.

[2] Indicators of education 2023. Statistical collection. [In Russian]. National Research University Higher School of Economics, 433 p., P. 36. ISBN 978-5-7598-2746-7.

3 Data of the Ministry of Science and Higher Education of the Russian Federation. [Electronic resource]: https://publications.hse.ru/pubs/share/direct/269677991.pdf. Last accessed 27.12.2023.

[4] Andrey Belousov held a meeting of the Government Commission on Transport. [In Russian]. [Electronic resource]: http://government.ru/news/48205/. Last accessed 27.12.2023.

5 [Electronic resource]: https://www.consultant.ru/document/cons_doc_LAW_212200/.

several structurally separated educational units at the level of faculties or institutes providing training using this code. This problem is related to the peculiarities of allocating places for enrolment subsidised from the federal budget [further on referred to as «budgeted places»]. The Ministry of Science and Higher Education of the Russian Federation allocates budgeted places dedicated for studies within an enlarged group of specialties (08.00.00) for different levels of education (08.03 or 08.04) and for a specific specialty. The current OKSO codes provide for only one specialty – 08.03(04).01 «Construction». Accordingly, when distributing admission quotas even between two structurally separated educational units, in charge, at the same higher education institution, e. g., for studies, respectively, in industrial and civil engineering, and in road construction, problems arise that can lead to closure of certain areas of training in one of those educational units. For example, at Northern-Eastern Federal University in Yakutsk, such a situation arises annually when distributing budgeted places between the Engineering and Technical Institute, focused on industrial and civil engineering, and the Road Transport Faculty, which trains personnel for the road construction industry, and it is not always resolved in favour of the Road Transport Faculty. This problem can be traced also in developing/financing laboratory and empirical bases of structurally separated educational units.

OBJECTIVE OF THE RESEARCH

To prepare implementation of the decisions of the Government Commission on Transport dated April 10, 2023, and considering the provisions of the Decree of the President of the Russian Federation «On some issues of improving the higher education system», dated May 12, 2023, No. 343[6], the authors submit some proposals to be discussed by the professional community on organising synchronised education and training of specialists for the road construction industry regarding the direction of studies «Roads and Aerodromes». The proposals have been prepared based on many years of teaching experience within bachelor's, master's and specialty directions of studies at the Department of Roads and Aerodromes of the Road Transport Faculty of Northern-Eastern Federal University in Yakutsk.

6 [Electronic resource]: http://www.kremlin.ru/acts/news/71118.

RESULTS AND DISCUSSION

Synchronised Education Scheme

To solve the problem of choosing a specific specialty/direction of studies by students within the framework of the planned EGS «Road Sector» and to synchronise various levels of higher education within the specialist training program «Roads and Aerodromes», the authors have developed an enlarged scheme of the main professional educational program (Pic. 1).

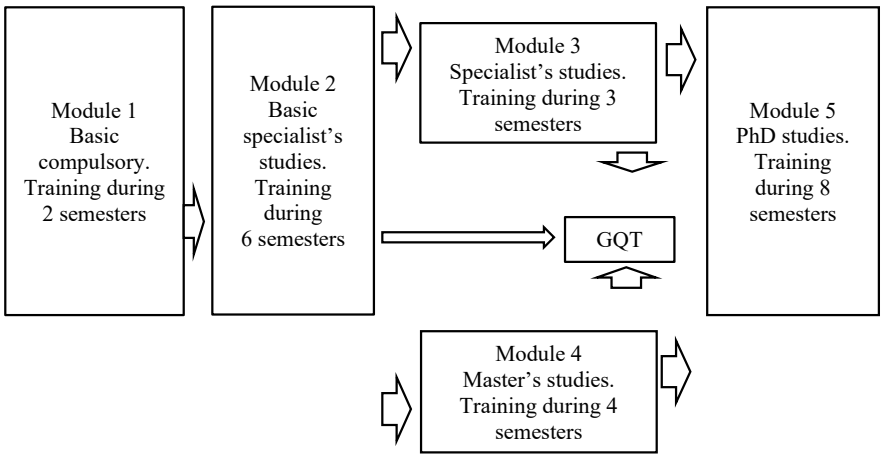
It should be noted that Module 5 «Ph.D. studies» is not organisationally included in the «Roads and Aerodromes» program. Ph.D. studies are carried out based on an independent accredited general professional educational program (GPEP). A separate article should be devoted to problems associated with training of highly qualified research personnel.

In general, the proposed scheme of synchronised training within the direction of studies «Roads and Aerodromes» has several advantages compared to the existing system, enlisted below.

1. It is amenable to regulation and control by the state and educational organisation in terms of the number of required/trained personnel of a certain qualification, even at the level of individual regions/universities. At the state level, the Ministry of Science and Higher Education of the Russian Federation, together with the Ministry of Transport of the Russian Federation, annually forms quota for admission of specialists of various levels in the form of allocation of budgeted places distributed among specific universities. The educational organisation fulfils this state commission guarantying quality of knowledge and the scope of competencies for each level of education: basic specialist's, master's, specialist's studies.

2. There emerges an unambiguous division according to the level of knowledge, practical skills and competencies between basic specialist's, master's and specialist's studies.

3. *Module 1 («Basic compulsory»)* (Pic. 1) is identical for all specialties and directions of training of the EGS «Road Sector» being formed. The only exceptions are the extended course «Introduction to the Specialty» and disciplines for which the curriculum provides for summer internships after the first year of studies. The structure of the module harmonises as much as possible the training of first-year students within all directions of training. It allows students to timely decide on the choice of specialty and, in case of dissatisfaction, without numerous retakes, switch to another specialty, including other educational institutions, within the



Pic. 1. Scheme of the synchronised main professional educational program «Roads and Aerodromes» [performed by the authors].

framework of the EGS «Road Sector». As a result, the most motivated students are retained at each direction of training after the first year of studies.

4. *Module 2 («Basic specialist's studies»)*. All disciplines of the module are of general professional nature, related exclusively to survey, design, construction, operation and maintenance of roads. The fundamental feature of this module is integration into it of educational courses for obtaining professions at the level of secondary vocational education (driver of licensed categories A, B, C, D; tractor driver; grader operator; asphalt paver operator; road roller operator; asphalt distributor operator; front-end loader driver; geodesist, etc. Obtaining additional professions is carried out based on the «Elective disciplines» set. As a result, upon completion of three years of study, students will have additional professions (from three to six, depending on duration of the training course).

5. *Module 3 («Specialist's studies»)*. The core focus of the module is development of skills, including practical ones, in engineering creativity, carrying out experimental design, design and construction based on acquired knowledge and scientific training, as week as organisation and management of processes in the road construction industry. It allows to implement individual trends in training with expanded knowledge and practical skills in certain areas of professional activity. Individual educational trajectories are formed based on the modules of elective disciplines provided for in the Federal State Educational Standards, optional classes, research activities of students at departmental/institute laboratories, as well as by involving students in carrying out research and experimental design under government contracts and business contracts. Individual trends in student education are implemented to train selected specialists for whom there is an urgent current need at the regional level.

6. *Module 4 («Master's studies»)*. The master's studies are included in the specialist's studies program as a separate level of education. Currently, program accreditation and training are carried out independently of the «Roads and Aerodromes» direction of studies. At the same time, the master's studies constitute the most important component of the proposed synchronised training system and should be included in the single federal state standard along with modules 1–3. Its presence in the educational process makes it possible for graduates of the basic specialist's studies, after gaining some experience of practical work at manufacturing enterprises, to continue their education at a higher level. On the other hand, specialists who have received education within other enlarged groups of specialties, for example, economists, managers, specialists in transport systems, materials science specialists, etc., can enrol in master's programs as well. The principles of training organisation are identical to those of module 3 «Specialist's studies». The specifics of the master's studies are research and development activities, development of new technologies and materials, training of specialists with expanded competencies in monitoring, expert and rule-making areas.

7. Depending on the current needs for personnel of a certain qualification both in the entire industry and in regional / municipal enterprises and organisations, the proposed education system

makes it possible to quickly train the required number of highly specialised personnel through organisation of courses of additional professional education (APE) at the levels of basic specialist's, specialist's and master's studies.

As emphasised in paragraph 12 of Section II «Current state of staffing and education for the road sector» of the «Concept for development of road education until 2035»[7], approved by the Minister of Transport of the Russian Federation V. G. Savelyev on February 15, 2023, educational programs for training of road builders are overloaded with «… humanitarian disciplines that are not related to formation of development of professional competencies». This well-known problem in the engineering education system is associated with the peculiarities of staffing of the educational and methodological units of universities. Having a predominantly humanitarian educational background, employees of educational and methodological departments, when developing basic (BC) and detailed («working», DWC) curricula for engineering specialties, because of their background competencies, are not able to create balanced curricula. As a result, during the first four semesters (two study years) students study disciplines that are mostly not related to the problems of survey, design, construction, operation and maintenance of roads and aerodromes. During senior study years, the same humanities disciplines almost completely fill the modules of elective disciplines and are also present in the modules of general professional and professional disciplines.

From a formal point of view, the proposed synchronised training scheme can eliminate an unreasonably large number of humanities disciplines in the educational programs of engineering GPEPs. However, the fundamental solution lies in the organisational plane.

First, in accordance with the Federal Law of December 29, 2012, No. 273-FZ «On Education in the Russian Federation»[8] and regulatory documents of educational institutions (charter, regulations for educational units), organisation and implementation of educational processes within the directions of studies is entrusted to educational units and departments of the corresponding profile. Consequently, the decision on the disciplines taught within the framework of GPEP, necessary for training of qualified personnel, should be made by the departments responsible for graduation. Educational and methodological units should not interfere in formation of the list of taught disciplines due to their lack of the required competencies. Their main role is methodological and technical support for departments responsible for graduation in preparation of BC and DWC, primarily through distribution of disciplines/hours per semester and shaping electronic document formats.

Second, the federal state educational standards of the third generation (Federal State Educational Standards 3, 3+, 3++), as well as the layout of the fourth generation[9] Federal State Educational Standard, clearly prescribe the number and scope of compulsory humanities disciplines. All recent generations of standards indicated no more than five disciplines in humanities, including physical education and sports. Clause 2.5 of the draft layout of the fourth generation Federal State Educational Standard also contains the following disciplines: philosophy, foreign language, life safety, history of Russia (at least 4 credits or, respectively, 144 hours), physical education and sports, with a volume of at least 328 academic hours.

Based on basic legal documents, we can draw a fairly clear conclusion: the oversaturation of GPEP of engineering disciplines with humanities is associated with the peculiarities of the internal organisational structure of higher educational institutions, when the filling of BC and DWC with disciplines is carried out not by departments responsible for graduation, development and implementation of GPEP, the quality of training specialists, but by educational and methodological units of universities that do not have sometimes the required qualifications and knowledge in the field of engineering sciences.

We can quote the example of «Life safety» discipline. From the standpoint of natural science and humanities the problem is relevant for technogenic safety, environmental protection, resource use, social and economic relations, interethnic, cultural, linguistic, religious interactions, pedagogy and andragogy. In the engineering sciences and, in particular, within the GPEP «Roads and Aerodromes», the relevance of the discipline is shifting to specific areas of human interaction with technical means, processes and technologies (production base, road machines and mechanisms, structural materials, safety

7 [Electronic resource]: https://dor-obr.ru/files/007/601/233/7601233/original/Концепция_развития_дорожного_образования_до_2035_года.pdf.

8 [Electronic resource]: https://www.consultant.ru/ document/cons_doc_LAW_140174/.

9 [Electronic resource]: https://fgosvo.ru/uploadfiles/fgos4/Maket_FGOSVO_4.pdf?ysclid=lhevl8fg6p700616569.

precautions) considering implementation of environmental protection against factors of production activity of both society and nature.

Accordingly, the problem is solved by bringing the organisational structure of educational institutions and of the procedure for formation of BC and DWC into compliance with the requirements of basic regulatory documents.

A significant number of disciplines in humanities are included in the BC and DWC due to the presence of regulatory requirements for inclusion in the educational process of mandatory blocks/modules/disciplines that reflect regional specifics: the so-called «regional component». Based on the authors' many years of experience, we can propose a solution to the problem – to add a clause to the Federal State Educational Standard requiring that the regional component be formed exclusively by general professional and professional disciplines. For example, for the direction «Roads and Aerodromes» of the department of the same name at the Road Transport Faculty of Northern-Eastern Federal University in Yakutsk, the regional component should be aimed at solving a number of problems in the road construction industry: construction technologies on permafrost soils, land winter roads, ice roads and crossings, stability of road construction equipment, materials and structures at extremely low temperatures, logistics problems of the permafrost zone, etc.

Basic problems and risks of implementing a synchronised training program

The synchronised system of training specialists in survey, design, construction, operation and maintenance of roads and road infrastructure proposed for discussion by the professional community can be implemented when authorised bodies carry out several organisational, legal, financial and economic actions. The main ones are:

1. Funding should be focused on the training program.

Currently, funding of the activities of departments is carried out on a «per capita» basis: departments responsible for graduation receive allocated funds to form a full-time teaching staff at the rate of 1 full-time teacher per 12 students studying at the department. This approach is justified by «economic feasibility». On the one hand, in practice, such an approach leads to a significant decrease in quality of education, because with emergence of low-budget/incomplete groups a number of measures are being taken to reduce budget expenses (e.g., at NEFU in 2022–2023 academic group was considered as a less complete group with fewer than 20 students in the specialist's academic group, less than 22 students in the bachelor's group, less than 12 students in the master's group). It may result in the transfer of teaching staff to extra-budgetary rates, the transfer of students to study on a paid basis, the transfer of a significant part of classroom hours (lectures, laboratory and practical classes) to the column of DWC «Individual work of students» (IWS). These are natural consequences of the «per capita» principle of financing. In accordance with the current Federal State Educational Standards and DWC, the volume of teaching hours in five specialty courses is about 10800 hours (300 credit units or 60 credit units per course). At NEFU, with a standard annual teaching load of 900 hours for assistant lecturers, senior lecturers and associate professors, 12 staff positions are required to implement the curriculum. Accordingly, the number of students should be at least 144 people or, on average, 29 students in each course. As practical experience shows, for example, if 26 students are enrolled the first year, by the fifth year there are 15–16 people left in the group, i.e. about 61,5 % of the contingent remains. Consequently, to retain full-time teaching staff, educational departments are forced to transfer about 40 % of classroom hours (lectures, laboratory, practical) to student's individual work or extra-budgetary rates. On the other hand, the concept of «economic feasibility» is incompatible both with social phenomena in general and with educational processes in particular. If the need for personnel of a certain qualification by issuing licensing and accreditation documents is confirmed and the required number of these specialists (allocated budgeted places) is determined, then the question of the «economic feasibility» of fulfilling the state commission should not arise. The educational organisation represented by the department responsible for graduation should prepare the required number of personnel with the required specialisation for the road construction industry.

The amount of funding for an entire synchronised program is determined quite simply. Let's consider this using the example of the proposed education scheme, considering the standard annual teaching load of teaching staff adopted at NEFU – 900 hours/year (this load varies in universities) and the volume of the annual program of 60 credit units (2160 hours).

The total hourly load of teaching staff is:

• At the basic specialist's studies level (modules 1, 2, Pic. 1) – 2640 hours.

• At the specialist's studies level (module 3, Pic. 1) – 3240 hours.

• At the master's studies level (module 4, Pic. 1) – 4320 hours.

The total number of hours required for quality training of students within a synchronised program is 10200 hours. To implement the program, 10200/900~11,4 teaching staff rates are required. Considering the presence of professors on the staff of any department, who often have a smaller annual hourly load, to implement the in-class program, the department must have about 12 staff positions of assistant lecturers, lecturers, associate professors and professors. In addition to these rates, the department should be allocated staff positions for engineering and technical workers (depending on the availability of specific laboratories), as well as rates for industrial training trainers to conduct classes within the vocational training system (VTS) integrated into the basic specialist's training program.

2. At the level of professional standards, unambiguous labour functions should be formed for each level of education – basic specialist's, specialist's and master's studies.

To date, only one professional standard[10] has been approved for road industry specialists with higher education. Despite the date of its publication, its structure cannot in any way contribute to development of GPEP and Federal State Educational Standard, adequate to modern requirements and challenges. First, it describes the labour functions of bachelors as a basic element of the educational structure. Second, section III «Characteristics of generalised labour functions» lists positions/professions/specialties and labour functions related exclusively to road construction, organisation and management of road construction processes and monitoring the quality of their implementation. Entire sets of operations and responsibilities have been removed from the labour functions of a road employee, in particular:

– Road surveys. For example, on the territory of the permafrost zone they should include about two dozen surveys. In accordance with the requirements of regulatory documents, mandatory surveys include: climatic characteristics of the operation area; geomorphological characteristics and relief; geobotanical characteristics; hydrological conditions; geological structure, lithological composition of soils, their age and genetic characteristics; tectonic conditions; hydrogeological conditions; areal distribution of permafrost and thawed soils; thickness and vertical structure of the permafrost; depths of seasonal thawing and freezing of soils; temperature regime of soils; temperature-strength state of soils (hard-frozen, plastic-frozen, loose-frozen, frosty); characteristics of soil heaving; cryogenic soil textures; permafrost physical and geological processes and phenomena; physical, thermophysical and mechanical characteristics of soils; soil salinity; characteristics of seismicity of the operation area and recurrence of seismic impacts in it, as well as the increment of seismicity (positive and negative) of construction sites (in seismic areas).

– Design of roads considering data from the set of surveys.

– Operation/maintenance of roads considering transport and logistics, natural-climatic and engineering-geological characteristics of specific regions. For the permafrost zone, for example, there is the need for specialists in land winter roads, ice roads and crossings.

– Control, maintenance and repair of road construction machines operating in specific natural and climatic conditions.

– Operation and maintenance of road construction industrial bases (quarries for extraction of road construction materials; asphalt concrete, cement concrete, crushing plants, monitoring sites, repair bases, etc.).

– Laboratory/scientific support of road construction (road laboratories, incoming inspection laboratories, expert laboratories, etc.).

– Research work on development of new construction technologies and road-building materials; examination of ongoing work and analysis of the condition of roads, systems for organising scientific research and reporting; organisation and conduct of research work at experimental and production sites, etc.

– Construction and operation of the road infrastructure, which includes culverts and drainage structures, lighting, traffic lights, video cameras, energy supply, signs, horizontal markings, noise protection, pedestrian crossings, sidewalks, etc.

– Monitoring of the condition and inspection of roads.

The paradox is that in the absence of professional standards, in training programs for specialists within the direction of studies 08.05.02 «Construction, operation, renovation and technical protection of roads, bridges and tunnels», all the

10 Order of the Ministry of Labour and Social Protection «On approval of the professional standard «Specialist in organising construction of road facilities», dated March 20, 2023, No. 182n. [Electronic resource]: http://publication.pravo.gov.ru/Document/View/0001202304190017. Last accessed 15.11.2023.

above tasks/specialisations/qualifications are present in the form of separate disciplines.

The need for professional standards is dictated by the requirements of the Federal State Educational Standards and GPEP and DWC developed on their basis, in accordance with which, in turn, the educational process is organised. The Federal State Educational Standard also presents three types of competencies: universal (UC), general professional (GPC) and professional (PC) competencies. The content of the UC is stipulated in the Federal State Educational Standard, and they are the same for all disciplines, all levels of higher education and all enlarged groups of specialties. This is one of the main factors of disproportionately large number of humanities disciplines within engineering directions of studies, because the educational and methodological units of universities believe that general professional and professional engineering disciplines do not contain these educational disciplines. As a rule, in DWC, universal competencies are tied exclusively to the humanities.

General professional and professional competencies must be developed in accordance with professional standards, which have not been developed for the road construction industry. For such a case, the Federal State Educational Standard contains an explanation: «(if available)». What to do if there are no professional standards, no explanation is given. In this regard, when preparing documentation that contains formulations of these competencies (GPEP, BC, DWC, detailed work programs in specific disciplines), definitions of general professional and professional competencies for bachelor's, master's and specialist's degrees are developed indeed by the faculty of the department based on the existing pedagogical expertise, production experience and as agreed with employers. The current situation indicates, if not the complete formality of the concept of «competence,» then the pointlessness of linking educational «competencies» to professional standards, at least for road specialists, for the coming decades. Since it is impossible to abolish professional standards, there is only one way out: exclusion of the concept of «competence» from the Federal State Educational Standard.

As many years of teaching experience show, within the educational process, the lack of professional standards is mitigated solely by professionalism of the teaching staff of educational organisations in close cooperation with regional production enterprises and organisations. However, at the level of state planning of the occupational structure and determining the capacity of the road construction industry, reflected, in particular, in allocation of budgeted places for educational institutions, the problem of the lack of professional standards is of paramount importance. The regulator of professional road construction activities is the Ministry of Transport of the Russian Federation represented by the Federal Road Agency (Rosavtodor). Only these institutions have the rights and competence to draw up long-term plans for staffing in the industry and to develop requirements at the state level for quality and quantity of required specialists with various competencies. Requirements for quality of specialists of various levels of training and a set of their competencies are formalised at the level of professional standards. Educational institutions, in accordance with the requirements of the Federal State Educational Standard, train personnel that meet the needs of the industry as set out in professional standards. With the advent of the Association of Road Education and its proposal to create an educational and methodological centre [13], there is hope that in the near future the regulator in the field of road infrastructure will develop professional standards at various levels that are so necessary for educational processes.

3. The problem of providing the educational process and research of departments responsible for graduation with research/laboratory equipment and road machines.

The scheme of synchronised training in the specialty «Roads and Aerodromes» proposed for consideration by the professional community is aimed at training professional personnel for the road construction industry at all levels of education. A high degree of professionalism presupposes not only that students have in-depth knowledge of the subjects taught and interdisciplinary relationships, but also the consolidation of this knowledge in laboratory and practical classes. An important aspect of the educational process is acquisition by students of practical skills in surveying, design, construction, operation and maintenance of roads.

Students can obtain practical skills either during training sessions (practical and laboratory work), or during educational and industrial internships conducted at production enterprises.

Industrial internships are the most effective mechanism for consolidating the knowledge acquired during study and gaining real practical experience. However, they are subject to strict restraints related both to the specifics of the mandatory time for in-class training, determined by the Federal State Educational Standard, and to

the peculiarities of organisation of work in the industry. In the Republic of Sakha (Yakutia), for example, the active phase of road construction works begins in May and continues until the end of September. In general, the road construction season lasts about five months. The educational process at the department of «Roads and Aerodromes» of Road Transport Faculty of NEFU, in accordance with the requirements of the Federal State Educational Standard, begins on September 1 and ends, depending on the level of education, within the period from June 10 through June 30. Even if the department has agreements on organising practical training with almost all road construction enterprises of the Republic of Sakha (Yakutia), due to formal reasons, students can actually start working only in the last ten days of June. By this time, only positions of road workers remain vacant at production enterprises, and trainees are hired for these job positions. The possibility of trainees' participation in the production process is limited to two months (July–August). With a very busy schedule of construction work, students, especially after the second year of study, do not have time to obtain higher qualifications, and the employer has neither the opportunity nor the right (no license for educational activities) to train trainees. Accordingly, the knowledge acquired by students during industrial internship is consolidated only at the level of qualification of a road worker.

On the other hand, students cannot, in principle, acquire practical skills in construction, maintenance and operation of land winter roads, ice roads and crossings.

The problem is solved within the framework of the proposed synchronised training system. The acquisition of additional specialties and the acquisition of practical skills in them for all types of practical activities of students is carried out during the educational process, starting from the first year when mastering elective disciplines, disciplines related to the regional component, elective classes, research activities and specialised club-like classes. Moreover, the additional specialties and qualifications of various levels obtained must be confirmed by documents issued in conformity with state-approved format (driver license of a specified category, licenses, certificates, diplomas, letters of confirmation, etc.).

In the future, it is possible to adopt a system of personnel retraining, which has been practiced for a long time in educational institutions and industrial enterprises of water transport. Upon completion of training at the vocational training level, graduates are issued, in addition to a diploma of completion, a working seafarer's diploma, which is the basis for admission to work. The validity period of a working diploma is five years. Managers also undergo specialised retraining courses once every five years with the issuance of a state-approved certificate.

The main principle of transferring practically significant skills to students in working with modern equipment should be systematic reorganisation of educational laboratories of universities into real research laboratories, organisationally structured by analogy with laboratories of academic institutes and manufacturing enterprises. The organisation of the proposed principle of training in the specialty «Roads and Aerodromes» involves formation and acquisition for the educational institution:

– Several accredited research stationary laboratories and offices, provided with a full set of modern equipment and full-time staff (the priority list should include laboratories in: soil science, road materials science, testing of asphalt concrete and road bitumen, geodesy/geoinformation systems/ digital technologies).

– A fully equipped road laboratory.

– A laboratory for road inspection/monitoring equipped with a full set of equipment.

– Road construction equipment for training and practice of students within the framework of the second module «Basic specialist's studies» (Pic. 1).

– Construction of a race track, experimental and industrial field sites for research and testing of materials, technologies and road construction equipment, which is especially important for natural and climatic conditions of the permafrost zone.

– Providing tools and equipment with premises and repair facilities.

Replacing the very limited teaching and laboratory base of educational institutions with industrial research facilities is an extremely expensive undertaking. Unmanned aerial vehicle (UAV) of a professional type can be called one of the most «budget» devices, necessary for students to learn digital technologies and to acquire practical skills in remote sensing and digitisation of roads, creating digital terrain models, condition monitoring, building 3D models, creating databases of automated traffic control and computer-aided design. The cost of the UAV itself ranges from 2–3 million rubles, not considering software and computer support. The cost of a fully equipped mobile laboratory for examining the condition of roads according to 2022 data is 27 million rubles. A laboratory for testing asphalt concrete, equipped in accordance with new regulatory requirements,

costs about 16–18 million rubles. Even for these three positions, the total amount of funding exceeds the allocated annual budget funds per a department of a federal university.

Proposals for an organisational scheme for synchronised learning

Based on the analysis, it becomes obvious that there is a certain, and not entirely natural contradiction. Educational institutions, even at the federal level, having a license to conduct training and human resources, cannot ensure system scientific research and high-quality training of personnel with practical skills and road specialties, due to the lack of necessary equipment, which is due, first, to the lack of financial resources. Manufacturing enterprises, having both equipment and financial resources at their disposal, have neither the right nor the time opportunity to improve the qualifications of student trainees above the level of a road worker.

Consolidation of opportunities and capacity of educational institutions and enterprises of road construction industry (taking in mind Ministry of Science and Higher Education and Ministry of Transport of the Russian Federation and its regional institutions) is possible through creation of already known entities: scientific and educational centres (SEC).

One of the possible comprehensive solutions to a significant part of the existing problems could be creation of several (in accordance with the existing road and climate zoning of the Russian Federation) Interdepartmental Scientific and Educational Centres of Regional Importance (ISECR).

The Road Transport Faculty of the North-Eastern Federal University in Yakutsk is a unique ground for creating an ISECR for the first road-climatic zone. This conclusion is based on the following features of the educational unit:

• Localisation of an educational unit of road construction in the territory of permafrost (in terms of uniqueness of localisation, it is the only one in Russia).

• Availability of a license for educational activities, accreditation of currently existing bachelor's, specialist's and master's programs in road construction.

• Availability of teaching staff who not only have unique knowledge and experience in teaching disciplines considering the extreme conditions of the Far North, but also have practical job experience and experience in organising technological processes in cryolithozone conditions.

• The faculty has infrastructure facilities and a laboratory base, including two racing tracks, a full-scale test site with an area of 72 hectares, a variety of simulators, a fleet of passenger cars, a bus, road construction equipment (asphalt paver, grader, tractor, front-end loader, mini-loader, trucks), geodesy, materials science and soil science laboratory, as well as a complete set of equipment for a laboratory for testing asphalt concrete (the laboratory plans to receive accreditation in 2024).

• The Department «Roads and Aerodromes» of the NEFU Road Transport Faculty is in close cooperation, including contractual obligations, with majority of organisations and enterprises in the road construction industry of the Republic of Sakha (Yakutia). Scientific cooperation has been established with the Institute of Permafrost Science named after P. I. Melnikov of the Siberian Branch of the Russian Academy of Sciences.

Creation of the Interdepartmental Scientific and Educational Centre (ISECR) for the first road-climatic zone based at the grounds of the Road Transport Faculty of the North-Eastern Federal University in Yakutsk will significantly speed up both creation of such a structure and optimise costs.

CONCLUSION

The scheme of synchronised training in the specialty «Roads and Aerodromes» presented for discussion by the professional community, despite the apparent difficulty of implementation in existing higher educational institutions, is in fact already working, at least in educational departments focused on road construction. The proposed scheme is fundamentally different from the current teaching structure by:

– The second module, which is a bachelor's program with a system of qualifications/working specialties of secondary vocational training integrated into it.

– System of organisation and integration of different levels of education into a single synchronised program.

– A relatively clearer division of areas of professional activity according to the amount of knowledge acquired at each stage of training.

The presence of a basic scheme of the educational process provides the basis for development of the Federal State Educational Standard for the specialty «Roads and Aerodromes» and the subsequent formation of GPEP.

The fundamental positions of the presented training scheme, considering the specifics, can be applied to development of main professional

educational training programs for any engineering specialty.

The proposed organisational structure of training which is Interdepartmental Scientific and Educational Centres of Regional Importance (ISECR) can be formed, depending on the tasks assigned to them and the problems of specific territories, at the level of governments of the constituent entities of the Russian Federation or, what seems more reasonable, offices of plenipotentiary representatives in Federal Districts.

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From the editors. *It is possible that some of the authors' proposals and judgments may seem quite radical and at least highly debatable, but they are certainly aimed at improving the quality of training specialists, dictated by the established experience of implementing programs for training road specialists, and are reasoned and structured. Along with this, and in addition to assessing the main content of the proposals, in the editors' opinion, it is necessary to discuss and validate the authors' opinion on the ubiquity and predominantly internal organisational reasons for oversaturation of GPEP of engineering disciplines with humanities ones, given that it is important and especially relevant to search for a balanced approach to the role of humanities, their selectivity, both considering adaptation to the tasks of training highly qualified specialists, and necessarily taking into account the growth of their relevance in solving educative tasks in relation to students. It seems that some conclusions, including those regarding the role of educational and methodological units, are dictated by local conditions and are far from those inherent, for example, for transport universities. It also seems overly pessimistic to conclude that it is inappropriate to use a competency-based approach in the context of highlighted need for professional standards in the road industry and given the broad opportunities for any interested organisations to develop them.*

At the same time, the authors themselves repeatedly indicate in the article that the purpose of the work is to submit the proposals for discussion, which is what this publication serves. In this regard, the editors count on the professional opinion of road industry employees and higher education experts.