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AN EFFECTIVE MODEL FOR TRAINING SPECIALISTS IN TRANSPORT CONSTRUCTION: A CASE STUDY ON THE BASE DEPARTMENT OF JSC "MOSTOSTROY-11"

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Abstract. This article addresses the problem of training managerial and engineering personnel for the transport construction industry in Russia. It highlights a systemic personnel crisis, the aging of academic staff, and the lack of interest among young people in academic careers. The classical higher education system, for all its merits, often fails to keep pace with the dynamics of business, creating a painful gap between the theory taught in classrooms and the practice prevailing at construction sites and design institutes. A university graduate joining an enterprise faces the need for lengthy and costly adaptation: they must relearn, master current software, immerse themselves in the company's internal standards, and understand the logic of real-world, rather than academic, construction and business processes. The article describes the successful experience of cooperation between a higher education institution and the transport construction industry, implemented at the Tyumen Industrial University, where an effective model for training specialists in transport construction, focused on the real needs of the industry, has been created. This is a full-fledged public-private partnership, where the company acts as a co-author and active participant in training its future employees at all stages. The universality of the principles embedded in this model—continuity of the educational path (from schools to university), practice-oriented approach, direct employer involvement in the educational process, and the use of real cases and technologies—makes it an effective template for replication in other sectors of the economy: oil and gas, mechanical engineering, energy, and the IT sector.

Keywords: personnel training, transport construction, specialist training model, base department, industry-university partnership, practical training, JSC "Mostostroy-11".

1.Introduction. The primary mission of an engineer in transport construction in our material world is to ensure the reliability of constructed facilities and their sufficient resilience to numerous natural and artificial factors. However, this must be achieved with minimal expenditure of time, labor, materials, and energy in short, with maximum cost savings. It is not so difficult to build one small structure so that it does not collapse; the challenge is to build many such structures. Any over expenditure of materials, any excessive safety margins or inefficiencies, which might sometimes be acceptable for unique structures, are detrimental in the context of mass construction, as they can negate its entire purpose. In other words, economical, rational, and comprehensively justified solutions allow for the accumulation of sufficient capital to invest in mass construction. And it is the engineer who plays the leading role here. Only they can prove that a given structure possesses the necessary reliability at a specific level of economy, that precisely this amount of material is required, and that these specific methods should be used to erect the structure to protect this creation of human hands from various real or potential dangers.

Yet, despite its importance and necessity, mass construction cannot be the true field of activity for an engineer. The true field for an engineer, the area where their talent is manifested, where they can

apply all their knowledge and imagination, is unique structures. These are bridges spanning hundreds of meters, even several kilometers, without intermediate supports. The invisible conflict between the forces of gravity and the structure, which is less acute in conventional construction, reaches its climax here. Internal forces strive to break the connections within the structure, to destroy the material from which it is made. And only a skilled engineer can correctly proportion the quantity, form, and structure of the material so that the structure ultimately emerges victorious from any confrontation with the blind forces of nature and remains victorious throughout its entire service life.

Natural disasters and various emergency situations rarely occur in properly designed, constructed, and maintained structures; in some fortunate cases, they may not occur at all during the structure's existence. But this does not mean the structure is at rest under these conditions. On the contrary! Every structure is subjected daily, hourly, throughout its life, to "service" loads, which are inevitable for it. These loads acting on the structure have a natural tendency to move downwards along the most direct path vertically, which in ordinary language means collapse, catastrophe. Only a rational and expedient structure restrains this catastrophic downward tendency, and this struggle between the structure and the loads continues tirelessly for days, years, and, if fortunate, centuries. One could say that the structure is a perpetually tensed muscle that must be indefatigable. It is easy to imagine what would happen if this muscle, holding thousands of tons, were to tire and relax. Of course, under normal conditions, this muscle the structure is not maximally stressed. This is logical, as it must conserve strength for emergency, particularly severe conditions. Under normal operational conditions, the primary acting force is the mass of the structure itself and the useful load for which it was built (in the case of a bridge, this is the live load: cars, trains). Stresses in this case are significantly lower than the ultimate strength capabilities of the material. The load-bearing system of the structure responds to the increase and decrease of loads with peculiar ebbs and flows of stresses in its elements. At a certain moment, all loads may act on the structure simultaneously, causing stresses to rise sharply, and the structural muscle finds itself in a dangerously stressed state. It is strained to the extreme, with the material working at the limit of its capabilities. Will the engineer be able to foresee such a severe, yet quite realistic situation, which could be critical for a given element or node of the structure? They must. They must foresee everything. They must foresee not only all possible impacts on the future bridge structure but also all possible combinations of individual impacts. And not only foresee them but also provide as accurate a quantitative assessment as possible.

Now, let us turn to the problem of training the qualified engineers the country needs. Unfortunately, the modern transport construction industry in Russia is facing a systemic personnel crisis, manifested both in an acute shortage of qualified bridge engineers and a deficit of academic staff capable of training such specialists [1-7]. This problem is one of the most acute and systemic for the country's infrastructure development, as it directly threatens the implementation of large-scale national projects related to the expansion and modernization of the transport network. An analysis of the state of higher education shows that personnel training for bridge construction is concentrated in a limited number of universities, with many regions of the country lacking specialized graduating departments. The situation is exacerbated by the absence of a coordinated state policy in road and bridge education, weak funding for research and teaching activities, low salary levels for faculty, and high teaching loads that leave no time for scientific work [4,6]. As a result, university graduating departments are aging, young people are not striving for academic careers, and employers face difficulties in attracting competent specialists. Thus, the gap between the needs of a dynamically developing industry and the capabilities of the education system is becoming critical, which determines the high relevance of finding effective solutions.

In these conditions, the experience of successful cooperation between universities and the transport construction industry, implemented at the base department of JSC "Mostostroy-11" at the Tyumen Industrial University, where an effective model for training specialists in transport construction, focused on the real needs of the industry, has been created, is of particular relevance.

2.The problem: systemic personnel crisis and the gap between education and practice.

Modern transport infrastructure (multi-kilometer bridges, complex interchanges, high-speed highways) is not only a symbol of a state's technological progress but also its strategic economic asset. Behind

every created object lies the colossal work of engineers, designers, technologists, and managers. It is human capital, not just concrete and metal, that becomes the key resource in global competition. And here, the transport construction industry faces a systemic challenge: an acute shortage of personnel ready to work in the realities of complex, high-tech projects. The classical higher education system, for all its merits, often fails to keep pace with the dynamics of business, creating a painful gap between the theory taught in classrooms and the practice prevailing at construction sites and design institutes [3,5,7,9].

A university graduate joining an enterprise faces the need for lengthy and costly adaptation. They must relearn: master current software, immerse themselves in the company's internal standards, and understand the logic of real-world, rather than academic, construction and business processes. For the enterprise, these are direct economic costs: the time of experienced mentors, slowdown of work processes, and the risk of errors. For the young specialist, it is stress, loss of motivation, and, often, disillusionment with the chosen profession. This problem is systemic and requires a systemic, strategic approach to solve it.

The problem is further intensified by the widespread digital transformation, where project efficiency directly depends on proficiency with advanced digital tools and neural network technologies, requiring graduates to possess competencies that meet the level of modern technological challenges.

3. The solution: an integrated base department model as a bridge between university and industry. One effective response to this problem can be a model of deep integration of large business into the educational process. An example of the successful implementation of such a strategy is the experience of one of Russia's leading infrastructure companies, JSC "Mostostroy-11" (part of the infrastructure holding JSC "Group of Companies 'Natsproektstroy'"), in creating, supporting, and developing a base department at the Tyumen Industrial University (TIU). This is not sponsorship or one-off master classes, but a full-fledged public-private partnership, where the company acts as a co-author and active participant in training its future employees at all stages.

3.1. A continuous path from the school classroom to the engineering workshop. The general concept of the project is based on the principle of educational continuity. It is obvious that fostering a loyal and motivated specialist should begin long before they become an applicant. The work starts with career guidance in target schools. In our case, the partnership includes specialized classes at the MBOU OO "Isilkul Lyceum" (annual graduation of 25-30 people), MAOU Secondary School No. 88 in Tyumen (annual graduation of 30-35 people), and a networked "Mostostroy-Class" at TIU (annual graduation - in-person: 35 people, online: 140-150 people). In the 2024-2025 academic year, career guidance events were held in 19 schools in the region, reaching about 1200 students in grades 8-11. This work is complemented by technical excursions for schoolchildren to the production base (up to 10 excursions annually), organization of preparatory courses for the Unified State Exam (up to 200 listeners), and support for applicant enrollment in universities.

An important link in this chain is interaction with secondary vocational education (SVE) institutions. JSC "Mostostroy-11" is a key employer of the Interregional Sectoral Educational and Methodological Center for SVE in the transport sector and a core employer of the "Transport and Road Construction" cluster within the "Professionalitet" Federal Project in the Tyumen Region, the core of which is the GA POU TO "Tyumen College of Production and Social Technologies". The company's contribution includes not only updating the material and technical base (supply of a truck crane, sets of components) but also adapting curricula, internships for teachers, student internships, including as part of Russian Student Teams (RSO), and concluding targeted training agreements (11 agreements in 2024). In 2025, the employment of 41 SVE graduates is planned.

The next stage is the Bachelor's degree in "Construction". At this stage, students involved in the orbit of the base department begin to immerse themselves in the corporate environment. The final link in this trajectory is the Master's degree in highly specialized and highly demanded programs, such as "Digital Construction" and "Management of Bridge and Overpass Construction Projects on Highways". Thus, by the time of graduation, the university releases not just a person with a diploma,

but a comprehensively trained engineer who has undergone years of targeted training and is well-acquainted with the philosophy, values, and specifics of their future employer's work.

Starting next year, a new educational trajectory will open at the base department - a Specialist degree in the bridge direction: "Construction (Reconstruction), Operation, and Technical Cover of Bridges and Tunnels" with five years of full-time study. In developing the curriculum and syllabi for disciplines, the main emphasis was placed precisely on engineering disciplines, and the content of the syllabi corresponds to modern requirements and the needs of practice.

3.2. The core of training: practice as the main educational module. The fundamental difference of the base department model is the flipped learning paradigm. While in the traditional format, theory is supplemented by episodic practice (which, unfortunately, is quite rare), here the entire educational process is built around the real tasks and cases of JSC "Mostostroy-11". Lectures and seminars are saturated with examples from ongoing projects, analysis of real design documentation, and work with current estimates and technological charts. Students deal not with outdated textbooks but with live materials that are used here and now. It should also be added that the department staff (both faculty and invited specialists from JSC "Mostostroy-11") have jointly written and published more than ten new textbooks and monographs to ensure the quality of the educational process [8].

But the true "gold asset" of the program is the unique internship system called "Vertushka" (Rotation). Its essence is the sequential passage of students through all key departments and production units of the company: Production and Technical Department, Project Management Department, Executive Documentation Department, Pricing Department, Planning and Economic Department, Artificial Structures Design Department, construction and installation sites, and production workshops.

This approach solves several critical tasks. First, it erases the student's stereotypical view of a construction company as a monolith. They see from their own experience how different services interact, how a project is born, how its cost is determined, how structures are manufactured, and how all this is brought together at the site. They begin to understand not only their future function but the entire product creation cycle. Secondly, the "Vertushka" is a powerful tool for career guidance both for the students themselves and for the company. The young person can determine in practice what they are more inclined towards: meticulous calculation work, managing people on a construction site, or technological processes in production. For HR specialists and managers, this is an invaluable opportunity to assess the potential, soft skills and professional inclinations of each intern, in order to subsequently offer them a position where they can fully realize themselves.

3.3. The power of knowledge: practitioner lecturers, relevant courses and digital technologies. The composition of the teaching staff is equally important. At the base department, lectures and practical classes are conducted not only by academic scholars but also by current managers and leading specialists of JSC "Mostostroy-11" and LLC "MStroy": chief project engineers, heads of production departments, leading technologists, and economists. They bring to the classroom not only up-to-date knowledge but also that very context, market understanding, logic of managerial decision-making, and experience in solving non-standard tasks that cannot be found in textbooks. This ensures an unprecedented transfer of knowledge "first-hand".

Simultaneously, leading scientists from the Russian bridge industry are involved in the educational process, guaranteeing the fundamental nature of the training and connection with cutting-edge science. The synthesis of practical business experience and academic depth creates a unique educational environment.

The content of the curricula has also been radically revised. Together with the university, the company developed and implemented a number of unique proprietary courses directly responding to the demands of the modern construction industry. Among them are "Project Management", where students master not only classical project management but also agile methodologies; "Digital Construction", dedicated to working with Building Information Modeling (BIM) technologies; "Pricing and Estimate Preparation", providing an understanding of project economics; and "Lean Manufacturing", aimed at optimizing all processes.

A distinctive feature is the use of modern software in training, including the company's own development, the "MStroy" software package. This is a comprehensive digital construction management system created by leading experts based on the management technologies of JSC "Mostostroy-11". The platform is integrated with the ISUP of the Russian Ministry of Construction and includes modules: "Manager's Office" (dashboards, photo/video reports), "Construction" (work production schedules), "Labor Resource Management", "Machine and Mechanism Management", "Material Management", "Construction Control", "Executive Documentation", "Cost Management" (KS-2, KS-3 forms), and "BI Analytics". The platform is used by over 4500 users from more than 250 organizations, managing over 500 active projects with a total value exceeding 200 billion rubles. Using MStroy in the educational process allows for the training of specialists who are already proficient with corporate tools and ready for effective work in the context of active industry digitalization at the forefront of modern technologies: digital technologies and neural networks.

4. Conclusions: measurable success and a replicable model for Russia's future. The effectiveness of any model is proven by results, and here the base department's indicators speak for themselves. The success is most evident in employment figures. Out of more than 100 department graduates who completed the full cycle of training and the "Vertushka" internship, 60 people were employed by JSC "Mostostroy-11" and its structural divisions. Importantly, this is not just employment but effective adaptation. Moreover, 33 graduates from among those hired or already working in the organization received career promotions in a short time, indicating their high level of training and quick integration. Many undergraduate students combine their studies with part-time work at the company, allowing them to accumulate practical experience while still at the university. Furthermore, a number of department graduates have enrolled in postgraduate studies and, while engaged in research, also teach students, thus preparing the future faculty corps.

The main business result for the company is a radical reduction in the costs of adapting a new employee. A graduate of the base department does not come to the workplace as a "blank slate". They are already familiar with the corporate culture, internal regulations, software, key processes, and, no less important, with the team. Their period of "re-learning" and onboarding is reduced from the traditional 6-12 months to one or two. This is a direct saving of mentors' time, monetary resources for training, and minimization of the risk of errors due to inexperience.

The university also benefits. Constant exchange with production allows the faculty to update their knowledge, stay abreast of the latest technological trends, and obtain material for scientific research from the real sector of the economy. This improves the overall level of teaching across all relevant departments of the university. Furthermore, JSC "Mostostroy-11" provides material support to the base department, equipping it with necessary computer technology, instruments and equipment, and organizing trips for students and faculty to conferences and seminars of various levels.

The experience of the JSC "Mostostroy-11" base department at TIU is more than a successful local project. It is a proven, practice-tested model of public-private partnership in education that demonstrates high efficiency in solving personnel issues. It allows for the training of not just graduates, but motivated, highly qualified practitioner-specialists proficient in both fundamental engineering knowledge and the most modern digital and managerial competencies.

The universality of the principles embedded in this model: continuity of the trajectory (from schools and SVE to university), practice-oriented approach, direct employer participation in the educational process, and the use of real cases and technologies, makes it an effective template for replication in other sectors of the economy: oil and gas, mechanical engineering, energy, and the IT sector. For Russia, whose economic development and technological sovereignty directly depend on the quality of human capital, scaling such experience is not just an option but a strategic necessity. Investments in integrating business and education are investments in the future, in building a solid "bridge" to the next generation of Russian engineers capable of bringing the country's most ambitious infrastructure projects to life.

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