Aircraft Industry Staff Retraining as a Part of Vocational Education in the Russian Federation

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Abstract **– The article includes items related to the military-industrial complex (MIC) staffing shortages. It is considered that there is a possibility for learning the missing professional capacities using vocational education programs. There is a comparison of the professional capacities and duration of the high education program and vocational education program.**

Keywords **– Military-industrial complex, staff shortage, professional capacities, vocational education, education program.**

1. Introduction

During the recent years, the attention of the country's leadership has been drawn to the development of the defence industry. Large-scale modernization and technical re-equipment have put forward new requirements to the personnel composition of the industry [11]. The Russian defence industry includes more than 1.700 enterprises and organizations employing more than 2.5 million people, which is about 5 % of those employed in the country's economy and about 17 % of those employed in industrial corporations [12]. The share of science-intensive high-tech products manufactured by defence industry enterprises in a number of industries (aviation, space, optics, radio electronics) is 90-100 % [14].

In the aviation industry, the share of managers in the total number of employees is about 13 %; specialists, 23 %; and workers, 61 %. At the same time, there is a steady tendency in order to increase the number of employees with higher (23.33 %) and specialized secondary education (61.85 %) [21].

2. Methodology

Within the framework of growing competition in the market of defence industry products, defence industry enterprises are forced to staff their design, technological and production subdivisions with personnel capable of modernizing the existing ones and creating new models of military equipment [10].

The existing shortage of qualified personnel (especially in the regional markets) forces employers to hire graduates from non-specialized technical universities to the aerospace industry and to organize their professional retraining in order to obtain the necessary competences.

Educational process of master's degree programs is connected with the study of general education and also technical and special disciplines. At the same time, the system of professional retraining which includes the programs of further education (FE) is significantly connected with qualification requirements, specific employer and production [22].

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A systematic approach to FE requires the provision of quality assurance for additional professional education, the formation of a regulatory framework of methodological materials, certifications based on qualification frameworks, professional standards and other requirements. At the same time, it is desirable to organize a system of professional development and retraining of engineers and technicians in a specialized educational institution without their separation from the production [4]. The use of distance learning technologies within the framework of the educational process makes it possible to conduct retraining of personnel in the most sparing form for production. At the same time, elements of the teacher's contact work with the listener are a mandatory component of the learning process [13].

Let's consider the peculiarities of training under professional retraining programs. The concept of "professional standard" was introduced by the Federal Law of 03.12.2012 № 236-FL into the Labour Code of the Russian Federation (LC RF) in the article 195.1 [8]. It should be noted that in accordance with article 195.3 of the LC RF, the application of professional standards by employers as a general rule is voluntary: the characteristics of qualification, which are contained in the professional standards, are used by employers as a basis for determining the requirements for the qualification of employees, taking into account the specifics of the labour functions performed by employees [20]. The application of professional standards is mandatory only in those cases when the Labour Code of the Russian Federation and other regulatory legal acts establish specific requirements to the employee in order to perform a certain job function [4]. At the same time, when submitting requirements to employees, employers have the right to choose: to be guided by the qualification reference book or by the professional standard. However, the mandatory introduction of professional standards in the state or municipal unitary enterprises, state corporations and companies (which are those whose capital is at least 50 % owned by public entities) is established by the Government Resolution No. 584 of June 27, 2016 [16]. Taking into account that enterprises of the aviation and space-rocket industry belong to the above-mentioned organizations, their personnel services face the problem of workers' compliance with the requirements of professional standards, in particular the level of qualification, knowledge and skills corresponding to the performed labour function (in learning standards terminology — "to be professionally competent") [2].

Some employers solve this problem when an employee reaches one of the stages of higher education in the required direction and profile. In this case, a sufficiently large part of the time is spent on mastering the general cultural competences by the listener, which he has already acquired within the framework of the existing secondary vocational or higher education [3]. Obviously, the most rational option in this situation is training under the program of professional retraining, which is focused on the formation of the employee lacking professional competencies [15]. This option has the following advantages:

- during the training, most of the time is devoted to the acquisition and improvement of professional competencies, due to the fact that the disciplines that form general cultural competences are represented in the minimum level or are absent in professional retraining programs;
- if necessary, it is created an individual plan for the student, in which the disciplines studied before can be recounted;
- in corporate training, the content of the program adapts to the needs of the employer (the employer has the right to choose the type and complexity of the additional professional retraining program, taking into account the readiness, experience and other characteristics of the workers) [9].

MAI successfully implements such professional retraining programs (Table 1) for defence enterprises.

Table 1. Professional retraining programs implemented for the aviation and rocket and space industry

№	Name of the professional retraining program	Assigned qualification
1	Design, manufacture, testing and operation of helicopters	Specialist in helicopter construction
2	New materials for special vehicles, radio navigation systems and unmanned aerial vehicles	Specialist in materials and radio electronics for navigation equipment and unmanned aerial vehicles
3	Thermal and gas dynamics and heat exchange of aircraft power plants	Specialist in the field of thermal and gas dynamics and heat exchange of aircraft power plants
4	Electrotechnical systems and complexes of onboard electric equipment of aircraft	Specialist in the development of electrical systems and complexes of onboard electrical equipment for aircrafts
5	Physical fundamentals of the device and operation of aerospace equipment	Specialist in the field of physical processes modeling
6	Radio-technical support and design-ballistic analysis of rocket-space equipment	Specialist in the field of radio engineering and design and ballistic analysis of rocket and space technology.

The content of professional retraining programs is focused on the requirements of professional standards: “Specialist in the design and engineering of aircraft” (approved by the order of the Ministry of Labor and Social Protection of the Russian Federation of December 8, 2014 № 985n), “Specialist in design and construction of spacecraft and systems" (approved by the order of the Ministry of Labor and Social Protection of the Russian Federation dated November 28, 2013 № 702n), “Specialist in the development of airborne systems equipment of aviation aircraft” (approved by the order of the Ministry of Labor and Social Protection of the Russian Federation dated December 15, 2014 № 1042n), “Specialist in research and development engineering” (approved by the order of the Ministry of Labor and Social Protection of the Russian Federation of March 4, 2014 № 121n) [5].

As an example, we can take into consideration the content of the professional retraining program for helicopter construction. Additionally, it is also important to compare the content of the main educational program (MEP) in the specialty "Aircraft and helicopter building", the specialization "Helicopter building" and the professional retraining program (PRP) "Design, production, testing and operation of helicopters".

The specialization “Helicopter construction” was developed with the requirements of the Federal State Standards Service of the Russian Federation (specialty 24.05.07 "Aircraft and Helicopter Industry") [7]. The PRP "Design, Production, Testing and Operation of Helicopters" was developed on the basis of the requirements of professional standard 32.002 "Specialist in the design and construction of aircraft" (approved by the Order of the Ministry of Labor of Russia № 678n, November 28, 2016). The PRP is aimed at mastering the following generalized labor function from the above professional standard: "Carrying out design and engineering and settlement works on development of aviation equipment" (code B, qualification level 6).

The PRP is aimed at developing professional competencies among the students. It is assumed that the trainees should already possess general cultural competences, since the program of professional retraining is accepted by persons who either already have or are receiving secondary professional or higher education [16]. Table 2 shows the correspondence of professional competences acquired by students studying in the major "Helicopter construction”. Professional competences acquired by the students of PRP "Helicopter design, production, testing and operation" and the result of their development are showed in Table 3[19].

Table 2. Correspondence of MEP professional competences by specialization "Helicopter building" and "Design, production, testing and operation of helicopters"

MEP specialization "Helicopter construction"	**PRP "Design, manufacture, testing and operation of helicopters"**
Readiness to participate in the development of projects of helicopters for various purposes	Willingness to participate in the development of helicopter projects for various purposes
Ability to develop structural power circuits for helicopter units and their units	Willingness to participate in the development of structural and power schemes of helicopter units and their components
Ability to develop technologies for manufacturing helicopter parts, assemblies and units	Willingness to participate in the development of technology for manufacturing parts, units and units of helicopters
Skills in aerodynamic design, flight dynamics, strength and economics of the helicopter under design	Ability to perform design calculations of aerodynamics, flight dynamics and strength of the helicopter under design

Table 3. Correspondence of the results of MEP development in the specialization "Helicopter construction" (for the disciplines of professional cycle) and PRP "Design, production, testing and operation of helicopters"

MEP specialization "Helicopter construction"	**PRP "Design, manufacture, testing and operation of helicopters"**
Ability to develop projects of helicopters for various purposes	Know how to design helicopters
Ability to develop structural and power schemes of helicopter units and their components	
Knowledge of methods for selecting parameters and calculating helicopter components and systems	
Knowledge about the technology of helicopter parts, assemblies and units manufacturing	Knowledge of aircraft and helicopter technology Knowledge of construction materials Knowledge of structural materials processing technology Knowledge of metrology, standardization and certification of aeronautical equipment
Knowledge of the methods of aerodynamic design calculations, flight dynamics, strength and economics of the designed helicopter	Knowing the dynamics of the helicopter
Knowledge of the theory and methods for determining the aerodynamic characteristics of helicopter propellers.	

MEP specialization "Helicopter construction"	PRP "Design, manufacture, testing and operation of helicopters"
Knowledge methods of calculation of aerodynamic and flight-technical characteristics of the helicopter.	Ability to perform aerodynamic calculations of a helicopter
Knowledge of the methods of selecting parameters and calculating the main flight characteristics of the helicopter	
Knowledge of the methods of designing main helicopter units and systems	Knowledge of general electrical engineering and electronics
Ability to design helicopter units and systems	Ability to design helicopter units
Know the basics of helicopter design	Knowledge of structural strength and aircraft construction mechanics
Knowledge of design solutions that increase the operational efficiency of the helicopter	Know the history and design of rotary-wing aircraft
Knowledge of technical solutions to ensure reliability and safety of helicopter operation	Knowledge of processability and reliability

Table 4 shows the compliance of the disciplines of professional orientation included in the curricula of the MEP for the specialization "Helicopter construction" and PRP "Design, production, testing and operation of helicopters". The analysis has shown that the list of disciplines comprising the professional retraining program includes almost all disciplines of the professional cycle of the MEP.

At the same time, the comparison of MEP labor intensity in the specialization "Helicopter building" and PRP "Helicopter design, production, testing and operation" (Table 5) showed that the development of the professional retraining program takes much less time due to the lack of disciplines of humanitarian, social, economic, mathematical and natural science cycle [18].

Table 4. Compliance with the disciplines of professional orientation for the PLO for the specialization "Helicopter" and PRP "Design, production, testing and operation of helicopters."

№	MEP specialization "Helicopter construction"	PRP "Design, manufacture, testing and operation of helicopters"
1	Introduction to the specialty	Introduction to the specialty
		Analysis of the state and prospects of rotary-wing aircraft development
2	Aerodynamic helicopter design	Dynamics of helicopter flight
	Dynamics of helicopter flight	
	Aerodynamics of aircraft parts	
3	Helicopter structure	Helicopter design
		Design features of the Ka-32 helicopter
		Design features of the Ka-226 helicopter
4	Helicopter design	Basics of helicopter design
5	Construction of helicopter units	Design of helicopter parts and assemblies
6	Structural strength	Durability of helicopter structures
	Strength of materials	Calculation of the strength of helicopter components by methods of finite element analysis
7	Mechanical equipment systems	Helicopter mechanical equipment systems
8	Construction materials	Design features of composite aggregates
9	Technology of processing structural materials	Structural materials
10	Helicopter Production Technology	Helicopter production technology
11	Aircraft Certification	Aircraft Certification
12	Instrumentation Systems	Instrumentation Systems
13	Power unit	Power unit
14	Modelling of engineering tasks	Automation of design and development works
15	Operating technology and reliability	Operating technology and reliability
16	Information support for product life cycle	Helicopter life cycle stages and related documentation

Table 5. Comparison of the laboriousness of the MEP and the PRT

MEP specialization "Helicopter construction"		PRP "Design, manufacture, testing and operation of helicopters"	
	Labor intensity, academic hours.		Labor intensity, academic hours.
Total	12 208		982
Humanitarian, social and economic cycle	1 624	-	-
Mathematical and science cycle	2 736	-	-
Professional cycle	5 688	Professional disciplines	922
Practical works	1 836	-	-
Final State certification	324	Final certification work	60

The analysis of the compliance of the results of the development of the PRP "Design, production, testing and operation of helicopters" with the requirements of the professional standard necessary for the performance of labor functions is given in Table 6 [17].

Table 6. Analysis of the compliance of the PRP development results with the requirements of the professional standard (PS) 32.002 "Specialist in the design and engineering of aircraft equipment"

PRP "Design, manufacture, testing and operation of helicopters"	**PS 32.002 "Specialist in the design and engineering of aircraft", a generalized labor function (code B, skill level 6)**
Development results	**Required knowledge / skills**
Ability to design helicopters	Ability to use the methodical apparatus for the design of aircraft
Ability to design helicopter units	Ability to apply methods of kinematic calculations of nodes
Knowledge of the metrology, standardization and certification of aviation equipment	Ability to apply recommended reference materials and restrictive assortments on construction materials, standardized products, lubricants, fuels, working fluids and systems of maximum deviations of sizes and shapes
Knowledge of the requirements of State standards and other regulatory documents for the design of text and graphic materials.	Ability to use standard software for documentation
Knowledge of the automation of design work	Ability to use standard application packages when performing the graphic design of the project
Knowledge of modeling engineering tasks	
Knowledge of the strength of structures and structural mechanics of the aircraft	Knowledge of technical mechanics
	Knowledge of strength and stiffness calculation
Knowledge of the metrology, standardization and certification of aviation equipment	Knowledge of the basics of metrology, standardization and certification
Knowledge of construction materials	Knowledge of the basic information about the properties of structural materials
	Knowledge of the technology of construction materials
Ability to carry out aerodynamic calculations of the helicopter	Knowledge of the aerodynamics
	Knowledge of flight dynamics, stability and controllability of the aircraft
Knowledge of the systems of instrumentation equipment	Knowledge of aircraft equipment
Knowledge of the power units of aircraft	Knowledge of the power units of aircraft
Knowledge of the history of the creation and design of rotary-wing aircrafts	Knowledge of the construction and structure of aircraft: the main stages of the design of aircraft and a list of works performed at each stage
Knowledge of the technology of processing construction materials	Knowledge of the basics of aviation technology
Knowledge of operational manufacturability and reliability	Know the basics of operating aircraft

3. Conclusion

Considering the above, in order to eliminate the personnel shortage and fulfill the requirements of PS, defense enterprises should focus on measures that provide a satisfactory result as soon as possible. The main mechanism for meeting the current needs of enterprises and organizations of the MIC in personnel in the short term are additional vocational education programs [22]. The indisputable advantage of additional professional education over the second higher education is the possibility for an employee to obtain the missing set of professional competencies in a reduced amount of time time. The acquired competencies and results of development will allow them to perform labor functions corresponding to its type of activity [6].

It is also necessary to note the following tendency regarding the elimination of the personnel deficit in the MIC. The MIC corporations have already created several corporate universities and some more are expected to be created in the future. Personnel services of enterprises of corporations are trying to solve the problems of shortage of personnel of appropriate qualifications on their own with the help of such a resource. However, the experience of training specialists in the interests of defense enterprises, accumulated by higher education in Soviet times, suggests that without the involvement of universities that have the necessary educational and methodological base, and thar can provide systematic training of students [1], it is almost impossible for defense enterprises to fulfill the tasks of developing human resources that have the necessary theoretical preparation.

References

[1] Agrawal T., & Agrawal A. (2017). Vocational education and training in India: a labor market perspective. *Journal of Education and Training, 69*(2), 246–265.

[2] Agrawal T. (2014). Skill development in India: an examination. *Journal of Education and Training, 27*(6), 629–650.

[3] Andersson, P., & Köpsén, S. (2015). Continuing professional development of vocational teachers: participation in a Swedish national initiative. *Empirical Research in Vocational Education and Training*, *7*(1), 7.

[4] Balantsev E.V. (2017). Issues of using professional standards in vocational education organizations. *Dopolnitel'noe professional'noe obrazovanie v strane i mire [Further education in Russia and in the world]*, *6*(36), 7. (in Russian).

[5] Banerjee T. (2016). Impacts of vocational education and training on employment and wages in Indian manufacturing industries: variation across social groups—empirical evidences from the 68th round NSSO data. *Indian Journal of Labour Econonomics*, *59*(4), 489–509.

[6] Cedefop (2016). Leaving education early: putting vocational education and training centre stage. Volume II: evaluating policy impact, vol II. *Publications Office of the European Union*, Luxembourg. DOI: 10.2801/967263.

[7] Csíkos, C., Kovács, Z., & Kereszty, O. (2018). Hungarian vocational education teachers' views on their pedagogical knowledge and the information sources suitable for their professional development. *Empirical Research in Vocational Education and Training*, *10*(1), 2.

[8] Decree of the Russian Federation government "Issues of using professional standards" of June 27, 2016 № 584. (in Russian.). Retrieved from: http://www.garant.ru/products/ipo/prime/doc/71331038/#ixzz5VFhDMx2I [accessed: 07 February 2019].

[9] Dmitriev O.N., & Novikov S.V. (2018). Economic Assessment of Federal Scientific Programs. *Russian Engineering Research*, *38*(4), 326-329.

[10] Eegdeman, I., Meeter, M., & Van Klaveren, C. (2018). Cognitive skills, personality traits and dropout in Dutch vocational education. *Empirical Research in Vocational Education and Training*, *10*(1), 11.

[11] Eichhorst W., Rodríguez-Planas N., Schmidl R., & Zimmermann K.F. (2015). A road map to vocational education and training in industrialized countries. *ILR Review*, *68*(2), 314–337.

[12] Fedorov I.B., Baltyan V.K., Krutko P.D., Matveev V.I., & Savelʹev A.YA. (2018). About modern trends in evolution of human resources of a Russian Federation military-industrial complex. Proc. of the 14th scientific conf. *"Education and young people issues in aircraft industry*". Moscow: 304-311.

[13] Fritsch, S., Berger, S., Seifried, J., Bouley, F., Wuttke, E., Schnick-Vollmer, K., & Schmitz, B. (2015). The impact of university teacher training on prospective teachers' CK and PCK–a comparison between Austria and Germany. *Empirical Research in Vocational Education and Training*, *7*(1), 4.

[14] Grigorev S.N., & Eleneva Y.Y. (2013). Training for Russian military-industrial complex: problems and solutions // *Vysshee obrazovanie v Rossii* [*Higher Education in Russia*], 6, 3-11 (In Russian).

[15] Hof, S., & Leiser, M. S. (2014). Teaching in vocational education as a second career. *Empirical research in vocational education and training*, *6*(1), 8.

[16] Kumar, R., Mandava, S., & Gopanapalli, V. S. (2019). Vocational training in India: determinants of participation and effect on wages. *Empirical Research in Vocational Education and Training*, *11*(1), 3.

[17] Mitrofana, N., & Iona, A. (2013). Predictors of academic performance. The relation between the big five factors and academic performance. *Procedia-Social and Behavioral Sciences*, *78*, 125-129.

[18] Novikov S.V., & Dmitriev O.N. (2018). Vision of Genesis of Presentation of Hi-Tech Project during Competitive Selection. *Russian Engineering Research*, *38*(4), 320-322.

[19] Beverborg, A. O. G., Sleegers, P. J., & van Veen, K. (2015). Promoting VET teachers' individual and social learning activities: the empowering and purposeful role of transformational leadership, interdependence, and self-efficacy. *Empirical research in vocational education and training*, *7*(1), 5.

[20] Russian Federation Federal Law.(2012). "On education in Russian Federation" of December 29, 2012 № 273 FL., Article 76, Part 3. (in Russ.). Retrieved from: http://www.consultant.ru/document/cons_doc_LAW_140174/ [accessed: 07 December 2018].

[21] Semenov V.V., Malahov YU.M., Sevryukov YU.I., & Hohulin V.S. (2018). The role of education in aircraft industry human potential development: 14th scientific conf. "*Education and young people issues in aircraft industry*"]. Moscow, 311-313. (In Russian).

[22] Vinogradov B.A., Pal'mov V.G., & Meshcheryakova G.P. (2014). System approach to the military-industrial human potential development. *Innovatsii [Innovation]*, *9*(191), 21-30. (in Russian).