

Training of PhDs in Software Engineering in Russia: A Proposal for New Specialty*

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Abstract. The article provides an analysis of the status of Russian higher education in Software Engineering and related specialties. Many universities in Russia are training bachelors and masters in Software Engineering. Nevertheless, there is no scientific specialty in Russia exactly called Software Engineering, which should be used to train postgraduate and doctoral students. Consequently, there is no opportunity to defend candidate and doctoral theses in Software Engineering in Russia. A proposal is formulated to include Software Engineering in the Nomenclature of Specialties of Scientists of the Russian Federation.

Keywords: software engineering · PhD training · higher education · scientific specialties

1 Software Engineering Education in Russia

Software Engineering (SWE) is a specific kind of intellectual activity, training in which requires considerable resources of time, human, intellectual and others. A number of specific features is inherent for training of specialists in the field of SWE, especially for educating of highly qualified scientific personnel for the digital economy of the future. This specificity is determined by the requirement for expensive hardware, software and information resources, the need of cooperation with development teams, contacts with leading IT-companies etc. System of training specialists in this area varies in different universities and countries. This has a significant impact on the level of training and, as follows, demand for graduates in the market.

Analyzing what has been done in Software Engineering education in the Russian higher school in recent years, it should be noted that the Federal state educational standards for the training of bachelors and masters in SWE were developed and approved in 2011 by the Ministry of Education and Science. This

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allowed starting the training of bachelors and masters in the direction of Software Engineering in our country. At the moment, 91 universities of Russia are training bachelors and masters in Software Engineering, among them four Russian universities-partners in the *Joint Programs and Framework for Doctoral Education in Software Engineering (PWs@PhD)* project [12] conducted within the EU Erasmus+ Program *Capacity Building in Higher Education: Saint Petersburg State University*³, Saint Petersburg State Polytechnic University⁴, Ural Federal University⁵ and South Ural State University (National Research University)⁶.

By the Order of the Government of Russia from 06.01.2015 No 7-p “On the approval of the list of specialties and areas of higher education corresponding to the priority areas of modernization and technological development of the Russian economy” [7], training of specialists in the field of Software Engineering was named the priority area of modernization and technological development of the Russian economy.

2 Software Engineering Education in Saint Petersburg State University

Saint Petersburg State University (SPbSU) by the Federal Law “On Education in the Russian Federation” has right to develop their own sets of educational standards, determine the structure and content of educational programs at their own direction at all levels of higher education. Saint Petersburg State University’s own educational standard approved in 2014 [10], is set up for each direction of training – bachelor, specialist, and master. Master includes several models: academic, academically-oriented and practice-oriented.

Saint Petersburg State University has a license for training of bachelors and masters in Software Engineering, starting from 2011. Training of bachelors and masters in this direction in SPbSU is conducted at the Department of Software Engineering (Andrey N. Terekhov⁷ the Head) of the Mathematics and Mechanics Faculty [4] under the programs 09.03.04 – Software Engineering (for bachelors) and 09.04.04 – Software Engineering (for masters). The following key departments of the Faculty take part in the implementation of these educational programs: Software Engineering; Analytical Information Systems; Computer Science; Parallel Algorithms; Operations Research. Profile disciplines are listed in the Competent oriented curriculum of the basic educational program of higher education of the baccalaureate in the direction 09.03.04 – Software Engineering [8]. In addition to training in the area of Software Engineering for bachelors and masters, SPbSU provides postgraduate, masters and bachelor’s training in a number of specialties close to the professional field of SWE [1], for example,

³ www.spbu.ru

⁴ www.spbstu.ru

⁵ www.urfu.ru

⁶ www.susu.ru

⁷ <http://www.math.spbu.ru/user/ant/>

38.04.05 – Business Informatics. Educational programs for the training of masters and bachelors in the direction of Business Informatics are implemented at the Faculty of Economics of SPbSU by the Department of Information Systems in Economics [3]. Basic courses of this educational program, correlating with those listed in the Software Engineering Body of Knowledge SWEBOK [2].

It should be noted nevertheless that the educational standard at the level of training of highly qualified personnel in SWE – PhD-doctorate – in the Saint Petersburg State University is currently missing. Therefore, SPbSU uses various forms of international cooperation for the preparation of highly qualified specialists, such as the Agreement for Double Doctoral Degree between Lappeenranta University of Technology⁸ and Saint Petersburg State University signed in 2016. This agreement makes it possible to PhD-students and applicants from both the universities to defend their scientific degrees at the dissertation councils of the SPbSU and get the PhD diplomas of the two universities-partners, in all licensed specialties, including SWE. Moreover, international cooperation in the field of higher qualification scientific personnel training is supported by the *PWs@PhD* project [11], [12].

3 Problem and Contradiction

No matter how reassuring the above-mentioned background seems, it is necessary to state that at the moment there is no scientific specialty in Russia exactly called *Software Engineering*, which should be used to train postgraduate and doctoral students – see Nomenclature of Specialties of Scientists of the Russian Federation [5] approved by the Order of the Ministry of Education and Science of Russia on 10.01.2012, No 5, in which the defense of candidate and doctoral theses takes place in Russia, as well as the awarding of scientific degrees of candidate and doctor of science.

At the same time, in Russian education system there is a considerable experience in the training of highly qualified personnel (postgraduate and doctoral students) with the award of scientific degrees of a candidate and a doctor of science in scientific specialties close to the professional field of Software Engineering. It is possible, for example, to name the following scientific specialties, for which postgraduate students, candidates and doctoral students are trained in Saint Petersburg State University, as well as dissertational councils for awarding scientific degrees of candidate and doctor of sciences work:

- Computer Science, Computer Engineering and Management
 - 05.13.01–Systems Analysis, Control and Information Processing
 - 05.13.11–Mathematical Support and Software of Computers, Complexes and Computer Networks
 - 05.13.17–Theoretical Bases of Computer Science
 - 05.13.18–Mathematical Modeling, Numerical Methods and Program Complexes

⁸ <http://www.lut.fi>

- Physics and Mathematics
 - 01.01.07–Computational Mathematics
 - 01.01.09–Discrete Mathematics and Mathematical Cybernetics
- Economics
 - 08.00.13–Mathematical and Instrumental Methods of Economics.

Professor Andrey N. Terekhov⁹ believes that in Russia the actual training of highly qualified specialists (candidates and doctors of sciences) in the field of SWE is carried out exactly in the scientific specialty 05.13.11–Mathematical Support and Software of Computers, Complexes and Computer Networks [9]. At the same time, the passport of such scientific specialty states that:

1. scientific, theoretical and economic importance of solving the problems related to this specialty is the improvement of efficiency of data and knowledge processing using computers, complexes and computer networks and in shortening of the time of their creation;
2. scientific degrees of candidate and doctor of sciences are awarded: in technical sciences for studies containing results the use and implementation whereof provide significant technical effect; and in physics and mathematics for achievement of results in the form of new mathematical methods and proven properties of algorithmic languages or programming systems qualified as a contribution to the development of mathematical programming theory and data or knowledge processing systems.

Analysis of foreign and domestic practices of training of scientific personnel of the highest level in SWE shows that the closest scientific specialty in Russia, corresponding to the European specialty PhD SWE is the specialty 05.13.11–Mathematical Support and Software of Computers, Complexes and Computer Networks (Technical sciences). But, we repeat it, the problem is that in Russian Federation there is still no scientific specialty exactly named *Software Engineering* for the training of post-graduate students and doctoral candidates. Moreover, such a specialty is missing in the list of scientific specialties on which the degrees of the candidate and the doctor of sciences are defended.

4 Proposal and Prospects

It seems advisable to prepare a reasonable petition to the Ministry of Education and Science of Russia Federation on the engagement of a new specialty *Software Engineering* in the *Nomenclature of Specialties of Scientists* on behalf of Saint Petersburg State University and other leading Russian universities. The addition of the two existing levels of higher professional education (bachelor and master's) to the currently absent third level – postgraduate course in Software Engineering

⁹ also a Board Member of the Nationwide Association of the most technically competent Russian software developing companies RUSSOFT <http://russoft.org/>, and ACM and IEEE CS member

will comply with the logic of the Bologna process, in which the Russian education is gradually blending in. This will be an important system-building solution would create the conditions for the training of personnel, designed to implement a variety of ICT-projects for the digital future.

To realize the formulated proposal, the following specific studies should be performed:

1. Detailed substantiation of the petition to the Ministry of Education and Science of Russia for the inclusion of the new specialty *Software Engineering* in the *Nomenclature of the specialties of scientific workers of the Russian Federation* in the sections: relevance, draft passport of the new specialty, its uniqueness and difference compared with the already existing ones.
2. Economic estimates of the costs of training of specialists in Software Engineering in Russia and foreign universities.
3. Identification and recognition of management risks in the Russian higher school in the context of opening of a new scientific specialty *Software Engineering* in order to answer the question: how to create a favorable management system [6] in the leading Russian universities for effective training of specialists of higher scientific qualification – PhD and doctors of sciences – in the field of Software Engineering.

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