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Peculiarities in Shaping Staff Professional Skills in Fishery Industry ("Production Machines and Facilities" Education Program)

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In leading countries, fishery industry is characterized by high scientific and innovation potential, which makes it one of the leaders at international consumer market. The Russian fishery industry is significantly lagging behind not only other countries in terms of hydrobionts' processing technology, but also Russian pharmaceutical companies and biotech firms.
One of the reasons why Russian fishery industry is lagging behind is low professional level of engineering staff involved in this production. To remedy the situation, it is required to revise engineering training transferring it from qualification-oriented approach to competence-based one, with a graduate acquiring not only professional competences but also skills in innovative ventures.

Key words: fishery industry, engineering training, professional competence, innovative venture, process engineering, practice orientation.

Having high scientific and innovative potential, food industry takes a leading position in the countries with developed market economies [2]. The scale and pace of its development is defined not by the commitment of certain economic sectors to structural changes and investments, but by market conditions and, primarily, rate of consumption demand change.

Today, food industry is naturally combined with biotechnological, microbiological, chemical and other branches of industry as it actively uses such products as food additives, flavoring, structure-forming agent, packing, and other ingredients used in food technology [10]. The food industry involves a great number of various machines and equipment to maintain complex technological processes of transferring raw material into semi-products and end products. While being processed, raw materials undergo physical, physico-chemical, microbiological, bio-technological and other processes which change their aggregate state, internal structure, and composition. This requires professional staff to have integrated knowledge in characteristic features of the above-mentioned processes since such kind of knowledge is the fundamentals of food technology [2, 8].

The present state of food-processing industry of the Russian Federation (RF) can be characterized as pre-crisis as the export of raw materials and import of end products have been priorities of the country over the past 10 years [7]. Actually, this has contributed to the lagging behind of Russian food-processing industry and degradation of engineering staff professionalism of the corresponding companies. At the same time, it is a well-known fact that it **is engineering development that defines innovation progress of any country.**

To bridge a gap, the RF Innovative Development Strategy up to 2020 has been developed to reinforce the position of Russia at the markets of high-tech and intellectual products by increasing the share of high-tech sector in gross domestic product (GDP) from 10.9 up to 17-20%, while innovation-driven

companies – from 9.4 up to 40-50% [7]. This goal is complicated by the fact that foreign products must be substituted by domestic ones within a short time period. To achieve meaningful outcomes in such a competition, the country needs for breakthrough technologies and innovations that would change the situation at high-tech product market in favor of the RF [9]. The breakthrough innovations bring new technologies, on the basis of which product lines are developed. This creates jobs at large industrial complexes or even within industrial sectors.

In this respect, it becomes obvious that qualified engineering staff having **competence in innovative venture** will be in high demand in the near future.

This is due to the fact that Russia has to surge ahead towards mass process of innovative product development. Engineering business activity is focused on generating new ideas and inventions followed by product sales in accordance with market demands. To be effective in this sphere, fundamental engineering education, sufficient for understanding technical peculiarities of the improved or new product, and business skills, necessary for consumer satisfaction, are required.

The current technological state of fish-processing industry remained at the level of the 1990s and is significantly lagging behind foreign competitors [4]. For example, depreciation of basic production facilities and processing equipment has exceeded 70%, with canning facilities being utilized up to 44.8%, industrial cooking – 42.1%, smoking facilities – 23.4%, refrigerating systems – 26%. It means that the level of production facilities use is less than 50% across the country.

Most fish-processing plants located along the coastline have not renovated production and processing facilities for a long period of time. This has resulted in low use of raw hydrobionts, poor quality of end products and absence of production wastes re-use. The insufficient level of technological advancement has become one of the reasons for reducing fish production volume, therefore, foreign products account for more than a half of the domestic hydrobiont market.

In recent years certain progress has been made in fish production and it is currently on an equal footing with other agricultural industries. Precisely, the growing rate of fish production volume is 7.5%, while the share of domestic seafood products at the consumer market increased by 4.6%. The increase in production volume of certain types of fish products is also a good sign [3]. At the turn of the century, there was a dramatic breakthrough in technological infrastructure of a number of fish-processing plants due to implementing innovative and cost-effective production machines and facilities. The technological infrastructure of these enterprises was expanded by a wide range of up-to-date machines and equipment which are involved in complex technological processes, i.e. multi-stage processing of raw materials and semi-products. This leads to significant enhancement of traditional technological processes and implementation of new hydrobionts processing technologies. Based on the level of technological advancement, these enterprises are competing with leading foreign companies or even surpassing them in certain production aspects.

However, it should be stated that the competitiveness of domestic fish-processing industry is still rather low, which is resulted from weak investment activity, insufficient level of technological infrastructure and logistics, as well as lack of qualified engineering staff. Moreover, the level of fish-processing industry development significantly lags behind not only the world's leading hydrobiont processing companies, but also domestic high-tech industries, such as biotechnology and pharmaceutics.

Most engineering solutions are proposed with no regards to machinery specifications, analysis of technological system potential under certain operation conditions and in relation to processed medium characteristics, which, in its turn, constituents a serious challenge for domestic engineering workforce [2].

Precisely, it is a well-known fact that:

- production engineers do not know about the advances in the machinery being used, effective modes of equipment application, and physical bases of the processes;
- machine operators have no enough knowledge in chemical, microbiological, fermentative and other aspects of the discussed production;
- production staff do not demonstrate deep and systemic knowledge of production processes, and, sometimes, they have no relevant education.

Such deficiencies in staff education impede complex understanding of the product including knowledge of product's physico-chemical parameters and organoleptic properties. Even if the employees have enough experience in the relevant industry, nevertheless, they are not able to solve the problems independently and carry out complicated operating procedures, as they have no managerial skills and competences in economics. This fact usually leads to technical mistakes and ineffective product marketing strategy.

To provide a way out of this vicious cycle, the enterprises need to build a team which would be made of engineers, production engineers, and marketing managers [10]. It is such a team that could effectively address the tasks related to product design, production, and sales. It is worth noting that it is not only essential to design original food product, but also to preserve its specific properties for a consumer, i.e. end product marketing must be of thorough consideration in order to transfer innovative idea into fast-growing business [9].

Thus, it can be stated that technological infrastructure of enterprises directly correlates with the quality of engineering staff training. The trends in food industry development demonstrate a continuous increase in the degree of technological process complexity. Therefore, the enterprises increasingly need the specialists capable of operating modern and innovative facilities [2, 8].

Due to the 21st century economy and competitive environment, the role of an engineer has been significantly changed. A modern specialist has to act as technical expert, scientist, and manager, which dramatically expands his/her business and professional responsibility. The rapid change in technology and constant facilities renovation place increasingly high demands on basic education of the employees, their professional, intellectual, managerial, and personal skills. In this respect, it can be stated that traditional training methods and techniques do not meet the needs of high-tech industries for qualified graduates.

These contradictions become clearly visible when comparing modern educational standards (Federal Educational Standard) and real engineering training which is commonly based on the technological advances of the end of the 20th century. This lag has resulted in mismatch between employers' demands and graduates' competences, in other words, **engineering training does not address the complex challenges of modern engineering.** One more paradox of the Russian reality is also worth highlighting: decrease in quality of engineering training is accompanied by the increase in engineering students studying on the basis of state-commissioned education. Perhaps, for a certain category of students it is enough to obtain "any" diploma of Higher Education.

As a result, graduates have fewer opportunities to find a job in accordance with their education, and, thus, they have to work in other economic sectors [1]. The lack of high prestige for engineering professions and extremely low pay rates have resulted in dramatical changes of youth values – engineering professions, research work in Research and Development Institutes are no more attractive for modern school-leavers.

Thus, it can be stated that the level of modern engineers' knowledge constitutes a danger to the community in future and impedes technical development of the country at present. Therefore, it is required to reform national engineering education system. Under current conditions, higher education system should always be flexible towards social transformations and economic changes in order to avoid graduating "Bachelors and Masters of Emptiness". It is obvious that the past engineering educational system is no longer effective, since the market is searching for engineers-innovators and high-tech inventors. The holders of a master's degree are only those who are able to meet these requirements as their professional activity is basically aimed at scientific, technological, aconomic, and social progress of the community, as well as characteristic features of science-driven industries themselves [6].

Master's programs are a part of elite professional training which is intended for 15-20% of bachelor's degree holders. As the Bachelor-Master education system is not uniform, the content of master's education programs is determined by the university itself in accordance with the scientific interests of the leading faculty members (professors). It is explained by the fact that master's training is primarily based on the research carried out by faculty members, as well as required facilities of graduating departments.

To address the issue, it is required to transform engineering training from "qualification" basis to "competence" one, since the competence-based approach is the only way to ensure high quality of education. The main goal is development of key competences that graduates should attain in order to solve their professional tasks. First of all, a graduate must be capable of working with information, i.e. to know algorithms, data searching and processing techniques. To acquire these competences, a wide range of software products should be applied within engineering training programs. The knowledge of software products might be an extra bonus for a future employer. When it is impossible to apply a traditional approach to problem solving, an engineer should be able to suggest nontrivial solution, i.e. creativity – the second key competence for a graduate to acquire. Finally, an engineer should possess relevant social and personal qualities that are required to work effectively in a team framework including the ability to lead a team, especially in a highly ambiguous, uncertain and unpredictable environment, and assume the responsibility for the entire team and project implementation [9].

However, to introduce a competence-based approach into engineering education, it is essential to address a number of challenges, such as development of the relevant evaluation criteria and knowledge assessment methods, unwillingness of the faculty members to revise education programs, poor understanding of the two-tiered engineering education system [8].

Lack of facilities at universities is another problem that merits closer consideration. The high quality of engineering education is primarily dependent on the availability of up-to-date lab facilities and equipment which are an obligatory part of **practice-oriented training.** Within the practice-oriented approach, students have opportunities to engage in a variety of the relevant practice-related experiences. In this regard, the university should become a center of region's innovation activity incorporating various innovative research and training departments which would allow university to integrate education programs into a real sector of economy in order to find the solutions for a number of regional social and economic problems. Besides, such kind of education system will guarantee continuing professional development of all faculty members including the possibility to work with up-to-date facilities and equipment. Engineering training must be provided with due regard to technological advances and relevant modern inventions, otherwise universities continue to train "the lost generation" of engineers [1].

It is a well-known fact that the universities, which are under commission of the Federal Fishery Agency, train the engineers for fish-processing industry within the education programs "Production Machines and Facilities" (specialization "Machines and apparatus of food

industries"). This program covers the entire range of machines and facilities applied in the food industry, with no focus being made on the advanced study of modern production processes, technologies and equipment which are of great value among the "fishery" regions of Russia [3]. In addition, modern production conditions, especially within medium and small-sized business, place increasingly high demands on the quality of engineering education. Therefore, it can be stated that today the graduates who possess relevant professional skills are of significant value. It means that universities should train not an "abstract" engineer, but an engineer of the next generation, an engineer who will suit to a definite industry, for example, refrigerating engineer capable of operating industrial cooling and refrigerating equipment.

In this respect, according to the Federal Fishery Agency task, Far Eastern State Technical Fisheries University has developed bachelor's/master's degree program "Production Facilities and Technological Processes of Fish-Processing Industries" in order to train engineers for hydrobionts processing [5]. The program was developed by leading faculty members of Far Eastern State Technical Fisheries University, particularly the faculty of Production Machines and Facilities Department (head of the department, PhD in Technical Science, Associate Professor T.I. Tkachenko, PhD in Chemicstry, Associate Professor O.V. Kuznetsova, PhD in Technical Science, Senior Lecturer V.A. Spolokhova), as well as the faculty of other universities commissioned by the Federal Fishery Agency including:

- Yu.A. Fatykhov, head of Food and Refrigerating Machinery department, DSc in Technical Sciences, Professor, Kaliningrad State Technical University;

- V.A. Pokholchenko, head of Processing and Refrigerating Equipment department, PhD in Technical Sciences, Associate Professor, Murmansk State Technical University.

S.A. Bredikhin, head of Production facilities and Industry Processes department, DSc in Technical Sciences, Professor of Moscow State University of Food Production, was directly involved in program development. The program was revised by the following experts: V.A. Grokhovskiy, head of Food Production Technology department, DSc in Technical Sciences, Professor, Murmansk State Technical University; V.N. Erlikhman, dean of Mechanics and Technology Faculty, DSc in Technical Sciences, Professor of Food and Refrigerating Machinery Department, Kaliningrad State Technical University. Thus, it can be stated that the leading faculty members of the most well-known fishery universities of the country have been involved in the education program development.

In accordance with the developed program learning outcomes, a graduate should demonstrate the skills necessary for research, design, production, energy-efficient and environmental friendly activities. The focus of graduates' professional interests is on **professional engineering**, i.e. the combination of engineering science and engineering management [2]. The essence of the process engineering correlates with the characteristic features of the post-industrial society and is based on the knowledge of production management, different technological processes and machineries, physical phenomena of energy and mass transfer, chemical, biotechnical, and microbiological transformations, as well as fundamentals of heat-and-mass transfer, physical chemistry, and mechanics. The integrated knowledge in the peculiarities of these processes is the basis for effective professional activity within the fish-processing industry.

цессного инжиниринга соответству-ет посThe basic stages of engineering are as follows: research, product design, production, development of product business projects. This means that a modern engineer should demonstrate not only deep knowledge in his/her profession, but also in scientific issues, economic, environmental, social and other problems of the community. A great variety of competences is due to the fact that a well-educated specialist is able to work more effectively in comparison with single discipline experts.

The process engineering is aimed at effective production management, technological process improvement, quality enhancement of end products, and technological effect achievement. Interdisciplinary experience and knowledge in relation to technological and managerial tasks allow engineers to reveal the limitations of the production systems, eliminate the disadvantages of production process and go ahead towards the promotion of high-tech products, which, in its turn, will contribute to enterprise competitiveness.

It is obvious that modern engineering education should not lag behind the industry, but must be ahead of time. This means that education programs should be intended not only to cover the real technological issues and processes, but also to teach students how to predict the changes in production technology [8]. To achieve this, it is necessary to know and understand the problems faced by food production industry, and be able to solve them in the course of enterprise development. Therefore, the focus of the developed education program was made on shaping students' competence in science by introducing students to the fundamentals of analysis, calculation and design of technological processes and machineries of the fish-processing industries [5].

Upon the program completion, graduates must be able to use automated engineering design tools, demonstrate knowledge in system quality management, be capable of conducting marketing research, searching for optimal solutions in product design and manufacture with due regard to environmental safety. Thus, the content of education program reflects the basic international trends in development of hydrobiont processing industries.

In addition, the program was developed in accordance with the modern requirements towards fish-processing industry management, quality management, and technological infrastructure. One of the learning outcomes is the ability to make a wide range of decisions. Since the rate of fish-processing industry development is defined by rate of technical advance and consumer's market changes, a modern engineer should demonstrate not only creativity, but also willingness to continuous self-development [3]. Therefore, the proposed education program is of high quality and its graduates have sufficient knowledge and skills for successful career within high-tech business.

The graduates of the developed education program "Production Facilities and Technological Processes of Fish-Processing Industries" must be able to modernize the technological infrastructure of the fish-processing companies in order to ensure complex use of raw material, high quality of end products, enterprise cost efficiency and environmental safety. Being adapted to the current realities, the program is offered by all the universities which are under commission of the Federal Fishery Agency.

In conclusion, it should be noted that it is due to scientific innovations the industry can function effectively within a highly competitive environment. In that connection, there must be a clear understanding that **there is no alternative and there is no unique solution for the Russian Federation.** In recent years, low quality of domestic products and economic failure of many processing industries have been resulted from the limited use of international experience and practice. Global trends in processing industry development demonstrate continuous increase in the level of technological process and system complexity, therefore, the issues related to effective production management, product design, scientific and innovation activities, as well as lab research, are the bases for adequate solutions and company's success at the market. Today, fish-processing industry should become one of the leading sectors of the country's economy, and in order to remain competitive it should be based on science-intensive technologies.

COMPETENCES DEVELOPMENT FOR FUTURE SPECIALISTS

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REFERENCES

1. Antonenko S., A new generation of engineers: the lost generation? // Kachestvo obrazovaniya. – 2014. – № 3. – P. 7-13.
2. Zelenskiy V.E. Process engineering – a basic tool to modernize food and related technologies // Food Processing Industry. – 2012. – № 10. – P. 8-12.
3. Kim I.N. Towards the necessity to develop education program "Production Facilities and Technological Processes of Fish-Processing Industries" / I.N. Kim, T.I. Tkachenko // Rybnoe khozyaystvo. – 2013. – № 2. – P. 16-18.
4. The concept of fishery industry development of the Russian Federation for the period until 2020 [Electronic resource]: approved by the Government decree, dated 2 Semptember, 2003. № 1265-p // website of the Ministyr of Agriculture of the Russian Federation. – M., 2002–2015. – URL: http://www.mcx.ru/documents/document/show/6409.191.htm, free. – title from the screen (reference date: 17.06.2015).
5. Bachelor's/master's degree education program of Higher Professional Education 151000 "Production Machines and Facilities", specialization "Production Facilities and Technological Processes of Fish-Processing Industries": 2 vol. / I.N. Kim, S.V. Lisienko, T.I. Tkachenko [et al.] – Vladivostok: Dalrybvtuz, 2012. – V. 1. – 262 p.; V. 2. – 114 p.
6. Prakhova M.Yu. Master training in engineering: Russian model / Prakhova M.U., Svetlakova S.V. // Vysshee Obrazovanie v Rossii (Higher Education in Russia). – 2014. – № 1. – P.118-124.
7. The project of innovative development of the Russian Federation for the period until 2020 [Electronic resource] // Ministry of economic development and trade of the Russian Federation: official site. – M., 2015. – URL: http://economy.gov.ru/minec/activity/sections/innovations/doc20101231_016, free. – title from the screen (reference date: 17.06.2015).
8. Saprykin D.L. Engieering education in Russia: history, concept, perspectives // Vysshee Obrazovanie v Rossii (Higher Education in Russia). – 2012. – № 1. – P. 125-137.
9. Khachin S.V. Experience of Tomsk Polytechnic University in teaching engineering business / S.V. Khachin, V.M. Kizeev, M.A. Ivanchenko // Mir obrazovaniya – obrazovanie v mire. – 2012. – № 4. – P.137-143.
10. Khurshudyan S.A. History of food technology and food industry development in Russia / S.A. Khurshudyan, Ts.R. Zaychik. – M.: DeLi print, 2009. – 296 p.

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On the Key Problem of Engineering Education in Machine-Tool Industry

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The article considers the necessity and opportunity to develop a system mechanism model as an academic process reorganization basis for engineer training in the machine-tool industry.

Key words: mechanism, function, structure, subject of apprenticeship research.

During many years of education reforms experts in philosophy, psychology, pedagogy, information did great amount of work on principle issue of educational methods and techniques in our country including – engineer professional training. However, broad debates on the issues of engineering education virtually leave open the questions of its **professional content.** It is impossible to educate a specialist outside the limits of professional expertise and this or that subject area in the engineering industry. Besides, content and arrangement of teaching material, intensity and quality of academic process, as well as anticipating character of an engineer training should be defined. In the condition of modern cognitive technique application the basis for educational framework is the modern knowledge system in the industry.

In the content of engineering knowledge of any sphere one can distinguish two main constituents: an engineering facility of the industry (in machine tool industry at the initial stages it is a mechanism) and **process** of its development. The effectiveness of engineer professional training is defined, first of all, by content and structure of basic ideas of the study object, i.e. **accepted original model** of the object. The accepted knowledge model of engineering facility defines **the subject** of the educational process in engineering training [1].

The stage of original model development and knowledge in some engineering spheres accumulated today can be divided into sufficient time period. During the harmonious process of engineering development its achievements can be applied (under the condition of feedback) to correct continuously the initial concepts. In real engineering knowledge development processes there is no such correction. Obsolescence of basic assumptions on the object, their inconsistency with potential modern cognitive and information techniques is typical, to some extent, for all industry branches depending on their age. Machine-tool industry is one of the oldest engineering branches, hence, it is particularly illustrative.

In Russia key assumptions about machines and mechanisms have developed on their disciplinary base by the end of the 19th century. At the initial stage such fundamental disciplines of professional education as following were chosen: "Descriptive Geometry and Graphics", "Theoretical Mechanics", "Material Resistance", "Theory of Mechanisms and Machines" "Machine Parts", "Material Science" and others. At the initial stage of engineering education development theory issues were of particular importance. The theoretical bases of courses were taught to develop abstract thinking of future specialists. During the further development, engineering knowledge itself was improved and new disciplines appeared. For example, "Limits and Fits" is a discipline dealing with issues of part size precision, as well as disciplines associated

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