

# Professional Training of Engineers on the Basis of an Integrative Approach

A. V. Leifa

Psychology and Pedagogics Department  
Federal State Budget Scientific Institution of Higher Education "Amur State University",  
Blagoveshchensk, Russia  
Aleifa@mail.ru

T. V. Khaletskaya

Psychology and Pedagogics Department  
Federal State Budget Scientific Institution of Higher Education "Amur State University",  
Blagoveshchensk, Russia  
xa191288@mail.ru

**Abstract**— The article discusses the realization of an integrative approach in the professional training of future engineers to work at the Ground-based Outer Space Infrastructure Operations Center "Vostochny spaceport". There were identified interdisciplinary links forming the basis of professional training of engineers at university; there was also shown an integration of academic subject areas and different types of undergraduate trainings (at the example of the training program 09.03.01 "Computer science and computer facilities") for Ground-based Outer Space Infrastructure Operations Center "Vostochny spaceport". As a result of the expert questioning of spaceport operators, necessary special knowledge, special skills and qualifications of future engineers were identified.

**Key word**— a staff of engineers, professional training, educational standard, occupational standard, integrative approach, interdisciplinary links

## I. INTRODUCTION

Globalization of the world economy, rapid development of science and technology, fast change of technologies force to pay a special attention to the training of highly qualified engineering staff. Engineering education is the basis of any economic reform, its engine [4].

A wide range of studies is devoted to problems of professional training of a modern engineer. V.M. Prikhodko, V.M. Zhurakovsky, Ju.P. Pokholkov, A.I. Chuchalin and others devoted their publications to the establishment and development of engineering; A.A. Kirsanova, V.V. Krayevsky and others dealt with the problem of methodology of engineering and pedagogical work; N.G. Khokhlova, G.V. Mukhametzyanova and others studied the integration of pedagogical and technical knowledge; E.F. Zeyer, P.F. Kubrushko and others researched theoretical grounds of professional education. The scientific researches of A.I. Baidenko, A.A. Verbitsky, I.A. Zimnyaya, V.V. Ishchenko and others are devoted to problems of improving the quality of higher professional education. V.A. Ermolenko, Yu. G. Tatura and others investigated the problems of professional education syllabus.

Due to the transition of higher education into the multilevel system of staff training, orientation of universities to meet the social mandate and develop a practical component of the educational process, there appeared a necessity to find ways of a really good training of engineers who are able to fulfill their professional duties effectively and competently. It is very important to overcome the breach between the demands of the professional

activity of an engineer and the existing system of professional training determined by the Federal State Educational Standard of Higher Education [15].

A complete balanced correspondence between the quality of engineers training by universities and modern demands of high-tech industries can be achieved through the integration of professional education, science and manufacture, i.e. the integration of professional and special knowledge into the practical training of engineering staff.

Thus, the aim of the research is to justify an integrative approach in the professional training of engineering staff at universities for high-tech enterprises of the Far East.

## II. MAIN RESULTS AND THEIR DISCUSSION

In the Amur State University professional engineering training based on the Professional Standard [19,20] is done for a strategic partner, Ground-based Outer Space Infrastructure Operations Center (Federal State Unitary Enterprise "GOSIC") to fulfill the project of building and operation of "Vostochny spaceport" in the Amur region.

The training of engineering staff is done by the following training programs:

- 1) "Maintenance and operation of technological equipment and power supply systems of a space rocket complex" within the training program 13.03.02 "Power and electrical engineering";
- 2) "Software-hardware provision of the means of measuring, collecting and processing of information at the infrastructure facilities of "Vostochny spaceport" within the training program 09.03.01 "Computer science and computer facilities";
- 3) "Workplace safety at the operation of launch complexes and technical facilities of the spaceport within the training program 20.03.01 «Technosphere safety» [22].

There is also conducted a training of engineers by the training program 24.03.01 "Space complexes and space science" and by the special field "Manned and automatic space vehicles and systems" within the speciality 24.05.01 «Design, manufacture and operation of rockets and rocket-space systems».

To determine the special knowledge, special skills and professional activities of future engineers there was done an

expert questioning of 10 operators of the Ground-based Outer Space Infrastructure Operations Center “Vostochny spaceport”.

The conducted research showed that there is a necessity to form in future engineers some special knowledge (about the configuration and action of board instruments and aerospace systems in general, about technological processes of space systems preparation at spaceports), special skills (operation of technological equipment: putting new equipment into operation, the check of measuring instruments) and labour activities (the conductance of technological processes of tests and aerospace structures examination, including thermal regulation machines, compressor stations, gas-supply systems, the work with compressed gases and components of rocket propellant).

The modern stage of higher engineering education is characterized by macrolevel integration processes, the role of interdisciplinary knowledge, synthesis of ideas and concepts from different subjects. “It is getting quite important among students to use the basic knowledge obtained during the study of one discipline in the course of the study of another one” [3].

So, an integrative approach is one of the main conditions of engineering staff training at university within professional education.

The integrative approach means the realization of the principle of integration in any component of the pedagogical process and provides the wholeness and consistency of the pedagogical process [14]. It implies the organization of professional training on the basis of mutual integration of theory and practice, contributes to the formation of basic knowledge, skills and experience and provides introduction into the future professional activity.

On the basis of the research of theoretical literature in professional training of engineering staff, of Federal State Education Standard of Higher Education, the curriculum, study programs, professional standards and the demands of employers for special knowledge, special skills and labour activities, there were formulated interdisciplinary links that presuppose the professional training of engineering staff at university (at the example of the training program 09.03.01 “Computer science and computer facilities”) for the Ground-based Outer Space Infrastructure Operations Center “Vostochny spaceport” (figure 1).

Professional training of engineering staff at university for high-tech enterprises implies the realization of education sections including basic and elective parts, which can be subdivided into humanitarian, social-economic, mathematics and science disciplines, as well as general professional and special training disciplines. In the scheme for the training program 09.03.01 “Computer science and computer facilities”, the discipline of the basic part “Computer science” is interdisciplinary connected with “Theory of information”, “Information technologies”, “Programming”, “Data bases” and others.

At the level of interdisciplinary links the main sources of integration are general structural elements of education curriculum which can be transferred to any discipline.

Educational and practical activity becomes the main basis of

integration as it involves both cognitive and practical training of a future engineer; as a result there appears a correlated system of professional knowledge and skills, and implementation into practice is achieved to a greater extent.

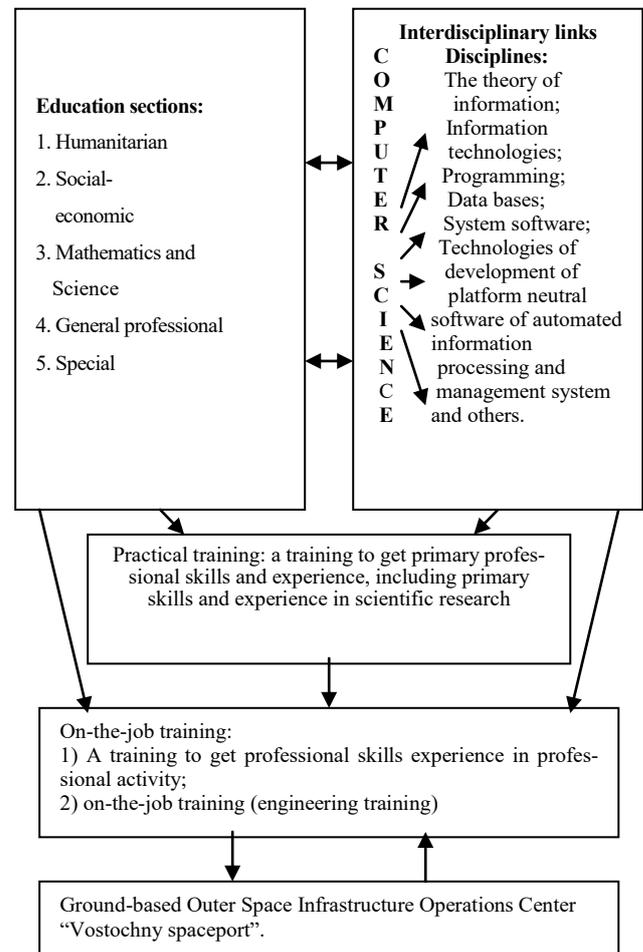


Fig. 1. A conventional scheme of interdisciplinary links of disciplines interrelated with practical training and on-the-job training

The structure of practical training, according to educational standards and curriculum of the training program 09.03.01 “Computer science and computer facilities” includes a practical training (a training to get primary professional skills and experience, including primary skills and experience in scientific research). The aim of the training is to obtain primary professional skills and experience, including primary skills and experience in scientific research by the training program 09.03.01 “Computer science and computer facilities”. It takes place at the first course in spring semester. At this stage the professionals from the spaceport “Vostochny” are invited to read lectures for the students of the Amur State University about the basics of operation of the ground-based outer space infrastructure.

On-the-job training (the training to obtain professional skills and experience of professional activity) and on-the-job training (engineering training) are held at the Ground-based Outer Space

Infrastructure Operations Center “Vostochny spaceport” after the second and third years of study. Students get on-the-job experience in such departments as the department of systems operation and systems of frequency-time allotment; the department of communication planning and technical assistance; geophysical department, TV department and others. The aim of the training is to consolidate the information obtained during the theoretical courses (there are designed software and hardware facilities (systems, devices, details, programs, data bases and so on) in accordance with the technical design specification and with the use of computer-aided design facilities).

The example of integration of disciplines and different types of trainings during the professional training of future engineers can be the correlation of disciplines “Introduction into profession, including information-bibliographical culture”, “Theory of automatic control”, “General theory of systems”, “Imitation modeling”, “Expert control systems of launch complexes and technical facilities”, “Control of complex systems of land-to-space support”, “Designing of automated systems of control and information processing”, “Modeling of automated systems of information processing and control of launch complexes and technical facilities” and consolidation of the studied material during on-the-job trainings after each year of study (figure 2).

The idea of this scheme is in transition from the general to the special, i.e. future engineers first learn basic notions, approaches, systems, models of standards; they acquire the skills of specifying architecture and structure of the automated system of information processing and control; after that they study special disciplines (in this case the theme and syllabus of disciplines are specified by the needs of the spaceport “Vostochny”). The integration finishes with designing and modeling of automated systems of information processing and control, in our case, of launch complexes and technical facilities.

A formulated accumulation of integrated tasks for each stage of practical activity that gets more and more complicated from one course to another taking into account the professional growth of engineers is very significant. So from one stage to another and inside each of them there is an increase in difficulty of courses, higher demands to the qualitative performance of work and unsupervised work of students in the solution of the tasks.

The final stage of professional training of a future engineer is acquiring special knowledge (methodology and techniques of design and application of data bases, and others), special skills (application of methods and means of software design, data layout, data bases, software interfaces and others) and labour activities (development and documenting of software systems of frequency-time allotments, tele-observation, network clock synchronization, network core and others).

Thus, professional training of future engineers on the basis of an integrative approach is oriented to obtain qualitative results, new principles and education techniques that lead to elimination of the gap between the general cultural and professional components in teaching and different types of trainings and that result in the formation of professional competency realized in future professional activity.

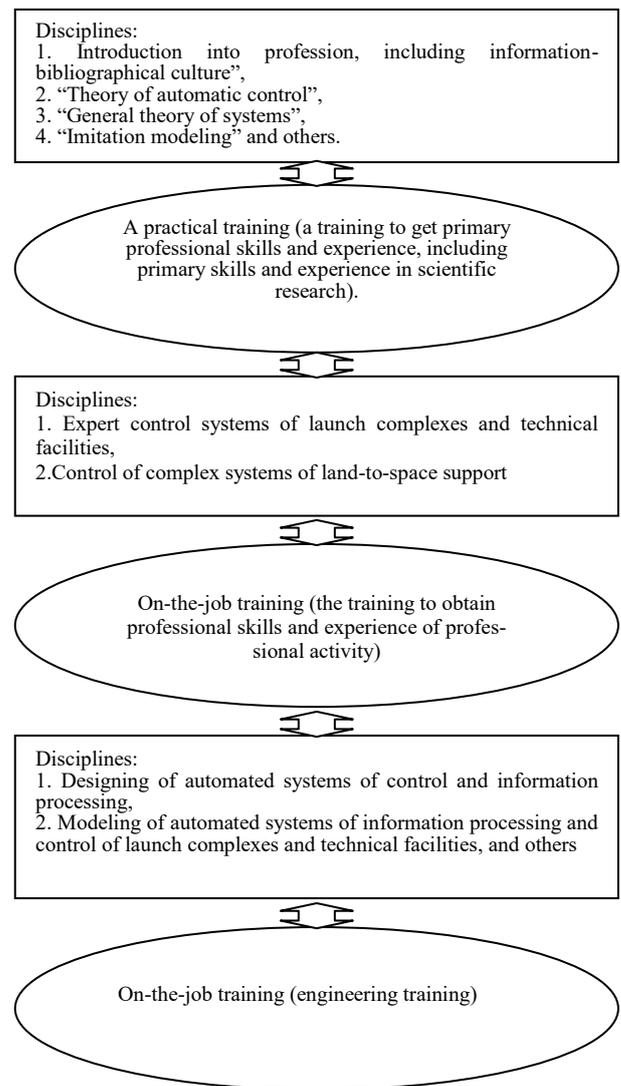


Fig. 2. A conventional scheme of integration of disciplines and different types of trainings during professional training of future engineers

### III. CONCLUSION

Thus, within the research there was justified a realization of an integrative approach in the professional training of future engineers by the training program 09.03.01 “Computer science and computer facilities”, so that they could work in the high-tech enterprises, namely at the Ground-based Outer Space Infrastructure Operations Center “Vostochny spaceport”.

There were established interdisciplinary links between theoretical disciplines and different types of trainings in the professional training of future engineers; there was shown an integration of disciplines and different types of trainings. This system is aimed at the close correlation with future profession as well as at the consolidation of professional knowledge, skills and experience to conduct independent specific work at the Federal State Unitary Enterprise “GOSIC” “Vostochny spaceport”.

So, an integrative approach allows to have a correlation of structural elements of engineering training, which stimulates the knowledge consistency in future engineers, improves their

professional training and influences their positive motivation to study. Within this approach there is supposed to be an improvement of study programs on the basis of integration, which in its turn provides the constant correlation of disciplines, planning of the subject course taking into account the syllabus, a certain choice of methods and teaching methods.

The realization of an integrative approach will help to form a professional competency of graduates by the training program 09.03.01 "Computer science and computer facilities", so that they can fulfill their professional activity at the Ground-based Outer Space Infrastructure Operations Center "Vostochny spaceport".

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