

Integrated System of Engineering Education in Aerospace University

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The article deals with the basic principles of higher professional education integrated system. The organization and planning methods of tuition process for aerospace specialities in the system of integrated teaching are presented. Some innovative educational techniques aimed at enhancement in training quality are given.

Key words: *integrated educational system, internship training, project-team training, aerospace education, quality management system.*

The ideas of inseparable combination of theoretical training with scientific research and enhanced professional-practical training have always been the basis for the native system of engineering education. In the middle of the 20-th century there appeared the problem of integration of education, science and production in our country with the intensive development of advanced industries, implementation of new techniques, construction and reconstruction of enterprises intended for the production of the international standard. Under these conditions the demands for engineering university graduate capable of quick adaptation at production process, with profound knowledge in production process organization principles, possessing professional skills of engineering jobs has grown significantly.

To solve this problem the Resolution of the USSR Council of Ministers was adopted in December, 30, 1959 №1425 «On organization of plants-technical colleges» as higher engineering institutions of new formation aimed

at training specialists of high qualification for competitive enterprises. According to this state resolution, Krasnoyarsk plant-technical college was commissioned to provide the efficient training for rocket-space specialists who had not been trained in Siberia before.

Within 50 years of its life the technical college has passed a long and hard way from the branch of Krasnoyarsk Polytechnic Institute to Siberian State Aerospace University, which at present is a unique specialized university on the vast Siberian-Far-east territory training specialists in the sphere of space rocket design and production as well as operation and maintenance of aviation technology. In some programs SibSAU is a leader in the structure of aerospace education in our country.

Aerospace education takes a special place in the Russian educational system. It is quite reasonably ranked as elite professional education presented its long-term efficiency by high achievements in native aviation and cosmonautics. In spite of some serious



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social-economic and production problems the Russian aerospace industry has produced items of space rocket and aviation technology that has no world analogues and in terms of some engineering specifications exceed the best foreign samples.

High complexity of aerospace technology, specificity of applied techniques, presence of military component and dynamics of production development require the knowledge of not only theoretical bases in design and production of this equipment but also all the stages of its operation. This fact defines the central role of system approach to the problems of optimal design of educational curricular for specialists' training in the sphere of aviation, aerospace and cosmonautics. It is just the principles of consistency, succession, and continuity that the integrated system of training highly qualified engineers in SibSAU is based on and realized successfully during fifty years of existence.

The integrated training system implies combination of theoretical courses with production professional internship in the structure of curricular. The principles of integrated training in speciality of space rocket profile are basic for all stages of the university development. They are sure to have changed and determined by the tasks of development trends in space rocket complexes of different generations and current production conditions. Integrated system has always been considered as a possibility for realization of flexible forms in educational activity taking into account individual abilities and skills of future graduates in definite type of engineering job: research, design, project, engineering, production. On the other hand, it is obvious that in modern condition integration with knowledge-intensive and high-tech production is the most efficient way of preparing graduates for the leading edge of the scientific progress using human, engineering, and scientific resources of enterprises in the course of training.

Flexibility and adaptability of integrated system is visually demonstrated

by the graph of educational process in engineering specialities. For example, students learning at such specialities as «Rocket engines», «Flight Control Systems», «Engineering technology», «Technology and facilities of welding engineering» during one term of the third year and one term of the fifth year combine internship in the first part of the day with class hours in the university in the second part of the day. This stage of the engineering internship during which junior students learn definite working jobs and get working qualification of machine operator, NC machine operator, fitter, electrician, welder. Senior students work in engineering positions in workshops, departments, laboratories of an enterprise.

Of some different view is the curriculum of students specialized in «Cosmic apparatus and upper stage equipment» as well as «Space control and positioning systems», «Technology of cosmic engineering», «Systems of cosmic information and telecommunication». These specialities and specializations are trained at undergraduate departments established in «Information satellite systems» JSC. These departments are headed by leading scientists and specialists, Doctors of Sciences, professors, prize-winners of the highest level – designers of modern native spacecrafts. Most teachers of the undergraduate departments are leading specialists at the enterprises having scientific degree and positions.

Students learning at the undergraduate departments have engineering production internship in the period of specialization (two terms of the fifth year), but within the previous four years students learn common full-time. Training at the undergraduate departments is an elite educational form, therefore students are selected on competitive base with clear perspectives in their future career in design and production departments of «Information satellite systems» JSC.

It is important to note that students from the very beginning of training at the specialized departments are

assigned to definite theme-based issues that make educational process a special target training conditioned by not only formal mutual responsibilities of a student and enterprise but also mostly by creative relationship of future specialists and their teachers at the enterprise.

Within the period of internship the students have the chance to study complex economic relations and enterprise structure, to learn real technological problems, to get skills in professional engineering and management jobs. Students get familiar with the latest achievements and features of production via engineering documents, but not only textbooks that often go behind the rate of newest cosmic rate engineering developments.

Hence, integrated system of training enables close relations of teaching methods and individual forms of students' activity. The results of such work are significant engineering solutions and developments. It is particularly obvious in term and diploma paper performance, the common requirement for which is practical application of the theme and possibility to implement in production.

Integrated system of students' training in SibSAU is in fact an innovation system and realized by means of intensive application of up-to-date innovative teaching techniques, effective implementation of advanced methods of scientific teaching activity. Methodology and arrangement of professional students' training in SibSAU has always been based on the latest achievements in science, technology and engineering. At the same time at the turn of the XXI century there is a transition into new, interconnected processes and methods in design, production, testing and operation. They are commonly referred to as technologies of information support at all stages of commodity life cycles – from design to performance.

Special attention is paid in the University to application of project-oriented techniques of students' team training providing the new quality for engineering education.

To realize the project-oriented team method the university together with «Information satellite systems» JSC established the scientific-educational center «Space systems and engineering» where students of different years and specialities are involved in complex project teams presenting an simulation model of production project teams for developments of new items.

As an educational project a complex project in designing small-dimension spacecraft was developed which could be performed from project to launch during the years of study at university. Arrangement of project teams is made on the basis of competitive selection with obligatory development of individual curricula for every student, a project participant. The project management is based on the distributed management Internet-system (<http://smka.sibsau.ru/>) corresponding to the standard of Project Management Institute, 2004.

For processing the project-oriented teaching methods the project «RA DEC» (radiation screen) has been realized in university. In the course of the project performance students developed a research device under the supervision of the university teachers and «Information satellite systems» JSC specialists. It was fitted at small spacecraft «Yubileyny» launched in 2008 by launch vehicle «Rokot» to the high circular orbit. Satellite control was given to the Students' Center of SibSAU Space Flight Control at definite time. Students participating in the project got unique experience in development of space vehicles, skills in team work.

At present method of project-oriented team teaching is being developed and has become one of the basic terms for establishing a number of small spacecrafts in «Information satellite systems» JSC. Positive results of pedagogical approbation allow for its using in formation of communicative and professional competences of the graduates in different specialities and profiles [1].

From the very beginning of its activity since 1960 the university has trained engineers for military industries of the country. Therefore it is quite logical for SibSAU to participate in researchers' training program for military branches of industry adopted by the Government of the Russian Federation. The university is one of the largest executives of the given program for the enterprises of the Federal Space Agency. Target students' training for plants and institutions of military-industrial complex is performed with highest efficiency when using integrated training system. The basic customer enterprises («Information satellite systems» JSC, «Krasnash» JSC, «Geophysics» CCB) define timely the departments and working positions for students' internship; develop the themes for individual tasks. Students doing well in studies get extra allowance.

Complex and systematic approach to the integrated aerospace education in SibSAU deserved wide recognition. In 2009 the Ministry of Education and Science of RF with the support of Roscosmos adopted the resolution on establishment of the Multiple-Access Resource Center of «Spacecrafts and vehicles». Organized in accordance with the Federal Target Program «Scientific, academic and teaching staff of innovative Russia» SibSAU Recourse Center is intended for solution of essentially new scientific-educational problems related to development and implementation of cosmic production high technologies, training of elite specialists and academic staff in the sphere of applied cosmonautics.

The principles of integrated training forming the basis for aerospace engineering education have been developed in other branches of the university educational activity. For instance, in training engineers-physicists there is a close cooperation with research institutes of the Siberian branch of the Russian Academy of Science. The training in the form of «phystech» is performed in this case when junior students are mostly taught fundamental disciplines in terms

of classical university system. Combination of study with students' research work is performed by senior students in the labs of RAS Siberian branch research institutes. Students-physicists are trained on high-tech unique equipment of academic institutes.

In 2007 SIBSAU and Krasnoyarsk Scientific Center of RAS Siberian branch signed an agreement about strategic partnership the major goal of which is arrangement of joint work in enhancement of students' and academic staff quality training by means of involvement of leading scientists from academic institutes in the educational process, joint solution of important scientific problems, participation in federal target programs, development and expertise of local target programs, sharing research equipment, scientific conferences and seminars.

In association with academic institutes of RAS SB the university arranged innovative scientific-education centers «Institute of cosmic research and high technologies», «Closed space systems», «Safety of engineering systems» where educational process is performed for bachelors, masters, specialists, and post-graduates in close cooperation with researches in the sphere of nanotechnology and space materials science, remote sensing of the Earth surface, modeling of heat-mass exchange processes in closed cosmic biosystems, reliability evaluation of engineering systems and other promising fundamental and applied scientific trends.

Quality assurance in students' training is a basis for university strategic policy. In SibSAU the Quality Management System (QMS) has been developed and introduced. It is formed on the principles of international standards of ISO 9000 series. As the base standard giving requirements for QMS development and certification GOST R ISO 9001 – 2001 is accepted. In the process of QMS formation the necessary standard and methodical documents describing and regulating the main stages of university inner activity have been designed. SibSAU QMS was certified by the State

Quality Management System Certification Body in the sphere of education and scientific research and included in the state quality system register [2].

One of the main functions of Quality Management System consists in permanent monitoring of educational process and analysis in dynamics of educational activity results. Due to independent estimation of students' knowledge the university takes part regularly in federal Internet-examination that is held by the National Accreditation Agency in the sphere of education. The results of Internet-exam along with those of students' current and final

attestation are the basis for correction decision.

Long-term successful experience of SibSAU in training specialists in the sphere of space rocket engineering, high-tech engineering production shows great potentials of the integrated system in engineering education. Scientific generalization of such an experience, development of methodical base for integrated professional curricula in the condition of all-round transition to conditional structure of Russian educational system is an urgent problem of academic and engineering staff of our country.

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