SCIENTIFIC AND EDUCATIONAL CENTER "SPACE SYSTEMS AND TECHNOLOGY"

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Abstract. The issues of engineers training in the aerospace university on the base of Scientific and Educational Center "Space Systems and Technology" are discussed. In order to improve the quality of education in the Siberian State Aerospace University the research work of students, as well as the practice-oriented training of engineers are introduced in the educational process. It was made possible as a result of joint efforts of university with research institutes of the Russian Academy of Science and industrial enterprises. The university experience in this area promotes the development of a new methods and forms of educational activities, including the project-oriented learning technologies, identifying promising areas of specialization and training of highly skilled engineers for aerospace industry and other institutions. It also allows you to coordinate the work of departments and other units of the university to provide the educational process in workshops and departments of the industrial enterprises in accordance with the needs of the target training. Within the framework of scientific and education center the students perform researches, diploma works and master's theses; the postgraduates are trained in advanced scientific and technical areas of enterprise development.

The Siberian State Aerospace University (SibSAU) for many years trains engineers for the aerospace industry. Here are the main competitive advantages of the University:

- Unique location of the university in the Siberian center of satellites production and developed relations of the University with the space enterprises;
- Presence of all levels of vocational education including secondary, higher, additional and postgraduate;
- Wide range of educational programs that meet the main objectives of the space industry development;
- Integrated system of aerospace education, based on a combination of theoretical study and production work on the base enterprises or research work in academic institutions, have proven very effective and adapted to modern educational standards and market conditions;
- Wide range of the scientific fields of fundamental and applied research on the creation of advanced space systems; the presence of leading scientific schools in the main areas of research and development;
- Presence in SibSAU required production and test facilities for the development and manufacture of spacecraft.
The University conducts applied research in the design and development of advanced platforms unmanned spacecrafts, small satellites; spacecraft control systems in orbit and methods of use of space-based information systems.

The Scientific and Educational Center "Space Systems and Technology" (SEC) developed in cooperation with the JSC "Information Satellite Systems". The center implements an innovative training program of engineers for JSC "ISS" on the basis of project-oriented learning technologies. JSC "ISS" is one of the leading enterprises of the Russian space industry and has a technology of complete cycle of space systems creation from design to control automatic spacecraft in all orbits - from low circular to geostationary.

The Space Systems and Technologies SEC has been engaged in the design and assembly of a series of scientific and educational small satellites (SmallSat) for a number of years. The project is carried out by a team of students, postgraduate students, young scientists, and specialists of JSC ISS; the team is also responsible for conducting scientific and technological experiments in space. The SEC includes the Student Design Bureau for the design of small satellites, "clean room" for the assembly and testing of small satellites, laboratory of prototyping and satellite electronic systems, laboratory of mechatronic systems and precision mechanics, which equipped with modern high-precision control, measuring and test equipment. The SEC’s equipment enables the assembly and testing of satellite mechanical systems, electronic equipment prototyping, conducting vacuum and climate tests, researching spacecraft electronic equipment.

The development of program on creation a series of technological, scientific and educational small spacecrafts provides to undergraduate and graduate students an unique opportunity to take part in the development, design and assembly of satellites in the development of new engineering solutions, creating elements of space systems and space experiments. In the field of development and improvement of spacecraft's elements and nodes the University actively participates in the development and testing of advanced integrated onboard systems control, improvement of on-board power supply system of spacecrafts and developing large-scale transformable satellite structures [1,2].

Here are the objectives and tasks of the program for building a series of scientific, educational, and technological microsatellites:

- Development of an integrated system of engineering education (distance learning systems, laboratory sessions, using special control ground stations designed for the microsatellites, etc.);
- Implementation of a design-oriented educational technology for the preparation of aerospace engineers; forming their professional competencies (student participation in the design and assembly of satellites, service systems, and scientific instruments);
- Scientific experimentation in space (space methods for monitoring the Earth’s natural resources, multifunctional nanomaterials, exploitation of high-temperature superconductors and other smart materials in space);
- Technological development: obtaining flight qualification for advanced service systems, instruments and satellite elements (attitude determination and control subsystem, electric power subsystem, thermal control subsystem, and other subsystems with an increased lifetime).

Currently, on the Earth's orbit are two student satellites "Yubileyniy" and "MiR" (Fig.1). All organizations that participated in the development and assembly of the small satellite
acquired significant technological experience for future contribution to the training of engineers for the national space industry.

The monitoring and operational control of the small satellites is performed at the students’ Satellite Control Center (SCC), which is located at the university. Students obtain telemetry data from the satellite in a real-time mode, learning to decode it and control the satellite. During their course, engineering students have a unique opportunity to directly control, receive, and process telemetry from the following Russian small satellites – YUBILENYIY, MOZHAETS, CHIBIS, BAUMANETS-2 and satellites of the Technical University of Berlin – DLRSAT, TUBSAT. The Control Center also provides access to the Express-AM program simulator, imitating the flight of a modern functioning telecommunication satellite. The simulator completely imitates the operation of all service subsystems of EXPRESS-AM and is used for conducting tests on the onboard control system, learning how to operate a real satellite. This is a joint development of SibSAU and JSC ISS. The students’ SCC is an essential ground segment for the orbital group of technological, research, and educational small satellites, assembled by the university and its partners.

Besides accomplishing existing scientific-technical and experimental tasks, the small satellites are designed to perform an educational function, which is just as significant as the scientific investigation. The production process of these satellites is essential for the preparation of aerospace engineering specialists, who undergo training through a project-oriented educational technology course. This is the first time such a course is introduced at a Russian aerospace university. It has been mentioned that students of SibSAU take part in all stages of satellite production, from writing design documentation to controlling the satellite’s orbital path. Implementing the project allows to identify the students who have shown their best effort and enjoyed laboratory work not only during their main curricula, but in related extracurricular activities. This experience shows that such students subsequently become the most qualified and responsible professionals [3].

The construction project of the students’ satellite is divided into twelve directions. This models the number of main satellite subsystems – the thermal control subsystem, the electric power subsystem, the attitude determination and control subsystem, etc. The scientific work

![Figure 1. Assembling student’s small satellite "MiR".](image-url)
of each member of the student team must be done in one of these areas. When the student accomplishes his first year on the project, he or she becomes a tutor for younger student of the same direction, sharing the acquired experience. The final results of the student’s scientific work in the selected direction, including the graduation project and diploma thesis, is the design and manufacturing of a functional satellite component or constructional element. This part will be installed inside an actual satellite, which will be then launched into space. One of the major projects in 2014, which was attended by students, has been associated with the production of precision structural elements of telecommunications satellites with high-modulus composite materials geometrically stable in space.

A specialized internet-portal has been developed at www.smka.sibsau.ru along with a projects management system for project monitoring. This enables the remote coordination of joint projects between different higher education facilities, bringing together students from different cities. The project-and-team education technology enables the student to acquire a high degree of preparation, guaranteeing the alumni will have significant competitive advantages on the labor market as effective workforce at space engineering and high-technology manufacturing enterprises. Typically, after finishing the course most of the graduates are offered employment in the field of their specialization.

In the process realization of scientific and educational projects becomes important the inter-university cooperation with other aerospace universities. Each of the participants, solving their specific problems, contributes to the common fund their experience and their achievements. The inter-university partnership has great potential for expansion of tasks and enhances the level of student training of different specialties. As a result of inter-university collaboration the tasks in the organization of promising scientific and educational spacecraft and satellite systems are solved. The joint development and manufacture of the satellite, its service systems, special and scientific equipment are discussed. Takes place the joint satellite control, the preparation and use of satellite data in the educational and research processes. The block diagram of the ground control of the educational satellite group is shown in Figure 2.
The experience of creating and using Russian scientific and educational satellites shows great potential and importance of the inter-university partnerships development in these activities. Significant potential of university research combined with creative energy, innovative thinking of students and a good command of modern computer technologies can give new impetus to the development of the national space exploration. Immediate participation of students in the practical work on the design, construction, testing, preparation for the launch and flight control the research and educational satellites significantly increases the level of engineers training to work in the aerospace industry and reduces the risks of care of young professionals in other fields of activity. The practical experience gained by students in the process of work on the creation of university satellites significantly reduces the time to adapt them to perform specific industrial problems on the space industry and the formation of the young specialist as an authoritative member of the labor collectives.

**Conclusion**

Thus, the university established a successful integrated system of training engineers for the space industry on the basis of scientific and educational center using the unique technologies of project-and-team students’ work, balancing between innovations and traditions, education and scientific research and maintaining the flexibility in educational trajectory construction. The use of learning technologies based on the scientific and educational centers allows improving the quality of engineers training for aerospace industry and the efficiency of joint research work on the development of new techniques and technologies through the development of scientific, educational and industrial potential of participants.
References

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