









an object, the knowledge of which they must find independently, obtain information and master it. Physical phenomena, functional circuits, etc. can act as an object. On the basis of the object, students create an activity product in the form of text, product, concept, etc. In the framework of the heuristic method, the result of a child's creative activity is not predictable, since it completely depends on his basic knowledge and personality. After presenting the result to the teacher, the students compare it with the already known achievements in this field and comprehend it.

The ultimate goal of the heuristic teaching method is not to obtain specific knowledge and skills, but to implement the student's creative self-realization.

Thus, one of the main methods that allows students to be creative in the process of teaching a subject is the heuristic method.

Of particular importance today is research training, which acts as a factor in the student's self-development and self-determination, and has a significant impact on the personality and professional development of a specialist [8]. The main feature of research training is to intensify students' academic work, giving it a research, creative character and, thus, to convey to students the initiative in organizing cognitive activities. The main goal of research training is the formation of abilities to independently, creatively master and rebuild new ways of working in any area of human activity. In research teaching, research is not just a set of teaching methods and techniques, but its content and meaning. Students, therefore, form the idea of research not just as a set of private cognitive tools that allow them to solve cognitive problems productively, but as a leading way of contact with the outside world and even more broadly - as a lifestyle. Therefore, modern education is no longer required to simply incorporate research teaching methods into educational practice, but to focus on the development of research abilities, specially organized training of students in research skills.

Means of education. In the educational process, both traditional teaching aids are used: books (in paper and electronic form), which have appeared relatively recently: online training materials, computer-based training systems in conventional and multimedia versions that require active interaction.

A special role in technical education belongs to laboratory works and workshops, independent educational research, and projects. It is these types of educational work that form the skills of independent work in the field of professional activity. At the same time, not all modern systems, in particular, systems of near location (SNL), can be presented in the form of physical systems and laboratory samples. In a whole series of cases, it is much more efficient to use their mathematical and simulation models. Using models allows a detailed analysis of the processes occurring in the SNL and identification of the model and the real system. In modern conditions, almost the entire process of design, experimental testing, testing and operation is accompanied by modeling at different levels.

Educational - material basis. This is an important component of education, inextricably linked with the content and methodology of the educational process. The experience of all developed countries of the world has clearly demonstrated that the systematic expansion and complication of the educational and material subsystem of an educational institution is an indispensable condition for the normal functioning of education and the increase in its economic and social role.

The educational material basis includes material conditions, teaching aids and objects of study, i.e. a set of material and technical means necessary for training in the established areas of training in accordance with the curriculum. It includes training and educational support facilities; laboratory equipment, technical teaching aids, textbooks, teaching aids and other teaching materials. Modern education is largely based on new information technologies, the importance of the educational material base is especially growing.

Simulation [11] is a research method in which the real system is replaced by a model that describes the real system with which the experiments are carried out with sufficient accuracy in order to obtain information about this system. Such a model can be used both for a single test and for a given set of them. The results will be determined by the random nature of the processes.

This is a special case of mathematical modeling for systems or objects for which, for various reasons, analytical models have not been developed or creating an analytical model is fundamentally impossible. Moreover, part of the object can be represented by a physical object, and part by its model.

In the general case, a simulation model is a logical and mathematical description of an object that can be used to experiment on a computer for the purpose of designing, analyzing, and evaluating the functioning of an object.

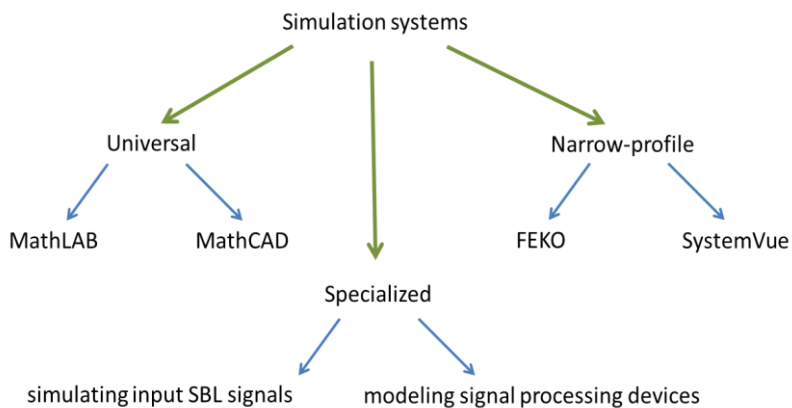
As a rule, simulation modeling is used in cases:

- expensive or impossible to experiment on a real object;
- it is impossible to build an analytical model: the system has time, causal relationships, consequence, nonlinearities, stochastic (random) variables;
- it is necessary to imitate the behavior of the system in real or model time.

When developing and designing SBL, the use of simulation models is justified in the following cases [12]:

- formation of input SBL signals reflected from various objects;
- design of antenna devices;
- development and debugging of signal processing devices, including complex ones;
- development and implementation of neural-like signal processing systems;
- imitation of real operating conditions of the SBL;
- other tasks that are statistical in nature.

The above list is not exhaustive, it only reflects the range of tasks that are most often encountered in the development and design of SNL.



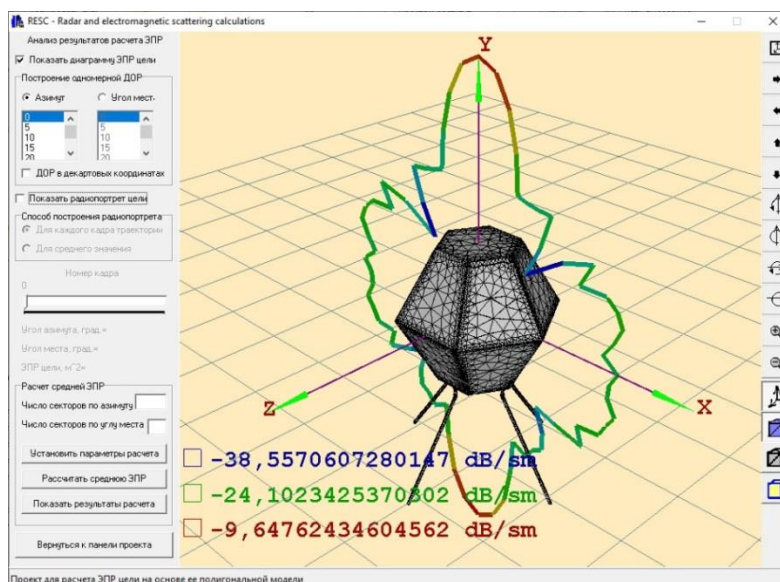
**Fig. 3.** The working window of the input signal modeling system.

In the educational process are used as universal modeling programs, such as: MathLab [13], MathCAD [14], so specialized, narrow-profile modeling systems: FEKO [15], SystemVue [16] and others. Of course, these simulation systems allow you to perform the simulation of a whole complex of systems, including near-location systems. However, there are a number of tasks that cannot be resolved, either in universal or in specialized modeling systems (Fig. 3).

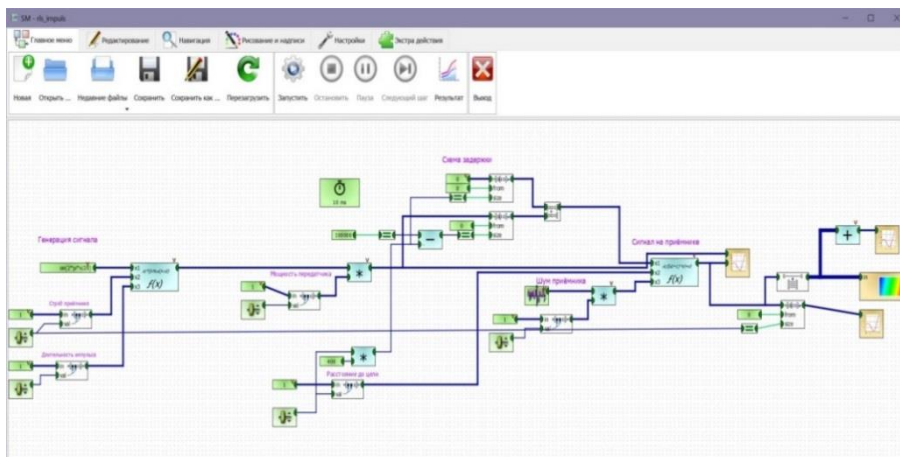
In this case, you have to create your own modeling and design environment, which provides a solution to the tasks. So, for example, the department has developed several modeling systems for the development and design of SBLs: a system for simulating input SBL signals (Fig. 4) [17-20] scattered by various objects; a system [12, 21, 22] for modeling signal processing devices (Fig. 5 and 6) and others.

You must understand that from the point of view of the student, any system of modeling and design is, to a certain extent, a "black box" that can solve his problems with design. At the same time, the understanding of the physical principles and algorithms for solving the equations of the model incorporated into the system is either not taken into account or simply ignored. In this regard, the role of the teacher is to, in the process of interacting with the student, force the latter, in the course of independent work with the modeling system, to study the principles laid down in this system. Of course, the didactic techniques and methods discussed above are intended to provide basic knowledge on modeling methods and the algorithms that are embedded in them. However, with an increasing amount of information, it can neither be conveyed by traditional methods, nor comprehended and put into practice. It is controlled independent work in the process of full-time interaction of the student with the teacher that can achieve the goals of the educational process, that is, the formation of competencies.

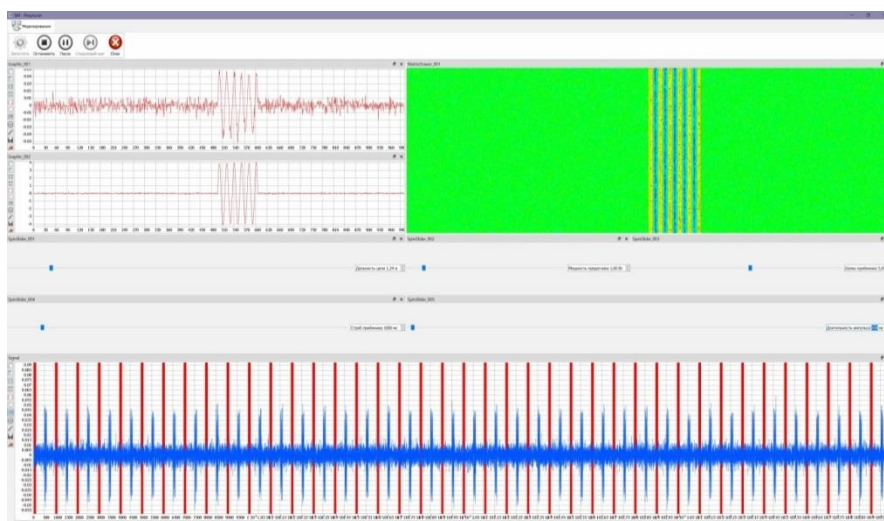
A positive effect is achieved with the public protection of the results of laboratory work, home back and NIRS in the form of a round table or seminar. This has a great educational effect, when a student not only brings the results of work and answers the questions of the teacher, but reports them to an audience like him and answers the questions of his colleagues and teachers. In this case, he rethinks his own knowledge and experience, learns to discuss, upholds the decisions made.



**Fig. 4.** The working window of the input signal modeling system.



**Fig. 5.** Block diagram window of signal processing device



**Fig. 6.** Simulation results of a signal processing device

### 3 Conclusion

The use of simulation tools in teaching students the development and design of SNL consists in solving the following problems (represents the following educational technology):

- within the framework of lecture courses: obtaining knowledge about SBL as a whole and the principles of their work, methods for solving the problems of developing and designing SNL as a whole and its subsystems (information-recipient method);
- within the framework of seminars, to consolidate the theoretical material of lectures and gain skills in solving particular problems of design and development, learn to plan an experiment, both full-scale and imitative (information-reproductive, problematic method);
- within the framework of practical exercises and laboratory work, to acquire skills and abilities, under the direct supervision of a teacher, to solve typical practical problems of designing and developing SNL using simulation tools on a computer and laboratory stands (heuristic method);



- in the framework of educational research, course design, homework, qualification work, independently consolidate knowledge and skills in the development and design of SNL (problem-research method), while the role of the teacher consists in consulting support and monitoring of current results.

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