which most fully use the functions of professional communicant. When specifying the elective component of graphic design disciplines, it is essential to consider the peculiar features of students' further professional activity. For example, within the professional activity of designers, the objects and the results of geometric modeling are regarded as a geometric system which corresponds to the stages of engineering activity in terms of form and structure: graphical model for cognitive activity and symbolic-graphical model for transforming activity.

Thus, target-oriented graphic design training delivered in the virtual learning space of a university provides a student with a set of knowledge and skills, peculiar attributes required for professional problem solving, i.e. professionalism. The quality of multifunctional graphic design training that meets the requirements for general education, professionalism and professional culture of an engineer, comprises the education potential of a personality which can be termed as a level of graphical culture.

Therefore, graphical culture can be defined as a matureness of productive professional competencies shaped within the virtual learning space of a university. They include broad-based graphical knowledge and graphic design thesaurus. As a result, a student demonstrates high performance which is rooted in the system of graphical skills and abilities. Mastering graphic design disciplines shapes a high level of spatial thinking that secures the processes of perception, structuring, and decoding of graphical professional information. Development of graphical culture in the virtual learning space of a university is a multifaceted and complicated process of graphical thinking shaping within the university virtual environment. It involves several stages: from the basic graphical knowledge to comprehensive and creative understanding the ways of implementing this knowledge in professional activity.

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Continuous Mastering of Computer Technologies as a Mandatory Condition for Highly Qualified Specialists' Education in the Sphere of Optical Engineering and Electrooptic Instrument Engineering

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Abstract
Specialists' training in the sphere of optical engineering and electrooptic instrument engineering can be divided into three stages from the standpoint of using information and computer technologies: 1. Study of general principles of information and computer technologies; 2. Mastering these technologies in design of typed blocks of optic and electrooptic systems; 3. Instruction in computer modelling based on systematic approach to designing electrooptic complexes as a whole.

Key words: computer technologies, optical and electro-optical systems instrumentation.

Today the role of information and computer technologies, in particular, computer modelling, is well known for specialists' training. They are paid much attention in implementing education programmes in the sphere of optical engineering and electrooptic instrument engineering including laser one. The complexity of modern electrooptic tools and devices consisting of various by nature blocks and units (optical, mechanical, electronic etc.) requires applying systematic approach at all stages of design, production, and research [1], which is now impossible without computer technologies.

The goal of this article is to introduce the readers to the experience of continuous study and application of computer technologies in training specialists in the sphere of optical engineering and electrooptic instrument engineering at the Faculty of Optical Information Systems and Technologies (FOIST), Moscow State University of Geodesy and Cartography (MIIGAiK).

Future specialists' training in optical engineering and electrooptic instrument engineering can be divided into three stages from the standpoint of using information and computer technologies: 1. Study of general principles of information, computer devices, and computer technologies; 2. Acquiring skills of using these technologies in computer modelling of typed blocks of optic and optoelectronic systems (radiators, optic systems, scanners, photodetectors, electronic blocks, etc.); 3. Instruction in computer modelling based on systematic approach to designing electrooptic complexes, i.e. considering it as a whole consisting of separate blocks described by submodels.

The first stage has been secured was realized in numerous curricula and education programmes for a long time. For instance, such courses as "Informatics", "Mathematical modelling", "Engineering and computer graphics" are taught. The curricula of these courses are regularly revised and updated improving their hard- and software.

The second stage was secured in teaching particular general professional disciplines, such as "Applied optics", "Sources and receivers of optical radiation", "Electronics and microprocessors", "Bases of designing precise instruments", "Calculation of optic system", "Lasers", "Technology of optic-electronic instrument engineering", "Design of optical instruments» etc. In this case, modern computer methods of synthesis, analysis, and optimization of typed blocks in optic and optic-electronic instruments and systems are used.

The significance of computer technologies should be particularly underlined taking into account that it is just a specialist in the sphere of optical engineering and optic-electronic instruments and complexes who is to be the first in optimizing sort of signals coming from a primary data processing system (PDPS) at the electronic block input.

Potentials of modern computer engineering stipulate high demands for parameters and characteristics of blocks and units which are the foundation of most contemporary measuring and tracking PDPS – optic systems, scanners, photo-detectors [1-3]. Lack of attention to PDPS optimization results in the situation, when design can only be performed at the circuit and schematic (structural and algorithmic) levels, but not at the parametric one. It means that academic process does not lead to mastering skills and abilities of selecting definite numerical values of parameters and characteristics of both the whole system and its separate units.

At FOIST (MIIGAiK) computer programs are used at this stage to monitor, test, and assess students' general professional competencies. Tests focus students' attention on the basic sections of discipline as well as some issues practically important to evaluate the quality indicators of particular units and blocks of standard optic and optic-electronic facilities. They also help identify the gaps in knowledge of definite course units.

At this stage the tests can be divided into two types – those for internal disciplinary and those for interdisciplinary monitoring (complex tests and control tasks). The function of the former is to check the knowledge of basic theory and develop skills of handling them within the course of particular discipline. In this case, knowledge of basic parameters and characteristics of one of the blocks in the whole system as well as their most significant magnitudes, formulas used for qualitative and quantitative description are monitored.

Interdisciplinary tests and tasks play a special role in future specialists' training. A student is to know both basic physical principles of their functioning and methods of their combination within one structure. He/she is to be able to describe particular situations and their computer models (submodels) of standard systems. In this case it is necessary to draw on experience of similar model developments, existing standards and manuals of element base.

At the third stage it is important to apply knowledge, skills, and abilities acquired at the second stage for mastering general methods of computer modelling of optic-electronic systems and complexes. This method allows solving a lot of problems of circuit and parametric analysis or synthesis often occurred, at least, at the first stages of designing different optic and optic-electronic devices and systems operating in complicated and rapidly changing conditions. The main stages of the analysis or synthesis as well as methods of appropriate computer modelling are described in [3].

Computer modelling applied in design, research, and tests of modern optic and optic-electronic devices and systems allows simulating various structures of necessary adequacy, calculating the values of performance indicators (quality indicators) in different background-target circumstances, evaluating the integrity and quality of existing element base, solving other problems, for example, development time reduction, its cost reduction. In some cases it significantly reduces the cost and durability of some expensive and time-consuming experiments.

It is of particular importance for designing complicated land, air, and space-based systems, for example, infrared systems [4,5] taught for senior students of FOIST in profile 12.05.01 "Electronic and optic-electronic special purpose instruments and systems". A wide application of computer modelling is typical for such courses as "Modelling of optic-electronic systems", "Computer modelling in optics", "Laser equipment and laser technology", "Orientation and navigation systems", "Optic-electronic tracking systems", "Lidars and scanners" and some others as well as programmes of design engineering, research, and production internship prior to graduation.

When studying these courses students are usually engaged in initial data formation, consideration of different options for the problem solution, selection of software and identification of conditions for its implementation, choice of common structure of a computer model and its submodels. The transfer functions (baseband transfer functions) of definite model blocks are often used as those submodels, for instance, unit "Structure of general model and algorithms used to work with it" which includes submodels "Operating scenario of optoelectronic systems", "Optic system", "Photodetectors", "Electronic assembly", "Display". The structure of the entire model can include database unit "Elements and algorithms of information processing", unit "Propagation medium of optical signal" as well as unit "System quality indicators" which consists of submodels "Signal-noise relationship at the output of optic-electronic system" or "Minimal permissible temperature difference". In [1-5] there are the examples of computer models and submodels used by senior students of FOIST (MIIGAiK) in their learning and research activity.

Conclusion

The experience of FOIST (MIIGAiK) has shown the feasibility of implementing computer methods and modelling at all stages of specialists' training in the sphere of optic engineering and electrooptic instrument engineering.

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