Invited Paper

Education for specialists in optical design

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ABSTRACT

An optimum combination of general professional and highly specialized education of opticians-designers is an acute problem in teaching opticians. The experience of the Optical Faculty, the Moscow Institute of Surveying, Aerophotography and Cartography (MIIGAiK)that it would be reasonable to train opticians - designers through a uniform curriculum for the first four years of studying with differentiation in narrow specialization for the last year and a half.

1.INTRODUCTION

There are different views on the problem of training optician - designer. One of them is that the main attention should be paid to studying the already-accumulated experience, i.e. to the analysis of already-made developments and their evaluation with the purpose of using them while making new instruments. Another one is that would-be engineers should be taugnt to find new original design decisions.

At the modern stage of fast development of optics and optical instrument-making the formation of the would-be engineer's methodological culture (generalization of design methodology) seems to be more reasonable. It means that he should master at first general methods and techniques of calculating and choosing main parameters and characteristics of the instrument as a whole and its typical units. And only after that it is possible to teach him to evaluate some known design-technological decisions and either use them or discard and make new ones.

The present stage of general methodology of designing optical instruments makes it possible to generalize a lot of schemotechnical decisions, to unify methods of designing and choosing main parameters and characteristics of their different types.

Besides, a wider field of application of optical instruments, their large variety, fast development of element base make it necessary to teach the would-be optician-designer to design particular-purpose instruments working under specific conditions (laboratory, shop, field, space and so on). It will be advisable to include a number of highly specialized subjects in the curriculum. The idea, very popular some years ago, to bring up the designer "in general" is unsound, as it is impossible to train the engineer only for some activity (like designing, developing technological processes, researching) and not to connect it (at least, for educational purposes) with some particular instrument types (e.g. photographic,

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astronomical, surveying, navigation and many other ones). Hence, the designer's activity should determine the student's speciality and general professional subjects to be studied, but his particular branch of work (at least during his first years of activity as an engineer) is to determine the subjects of his specialization which are far more highly specialized.

2. GENERAL SCHEME OF TRAINING THE OPTICIAN-DESIGNER

The general scheme of professional training of a designer-to-be may be as follows. At the beginning stage, while studying general technical subjects, the student's attention is only drawn to some problems in the field of optics and optical instrument - making.He is given simple but illustrative examples. At the next stage the aim is to have the student acquire the most typical methods in designing the optical instrument as a whole and its basic units. And at last, at the final stage the student learns specific methods in designing special-purpose instruments.

The perennial problem of higher education - to communicate knowledge and to develop skills and habits at the same time - is extremely difficult in training opticians because of characteristic features of the science and its technology. Due to the complexity of modern optical or electro-optical instruments integrating units heterogeneous from the point of their physical principals (such as mechanical, optical, electronic and so on) the curriculum includes both general instrument - making subjects and special ones.

One of the ways to solve the contradiction between deepened general scientific and technical training and highly specialized one is to develop methods of intersubject teaching, which envisages new courses uniting sections of various subjects traditional in training opticians on a uniform methodological basis. The most vivid examples of them are the courses like The Theory and Design of Electro-Optical Devices, The Design of Optical and Electro-Optical Instruments, The Assembly and Adjusting of Optical Instruments and others. Students should be encouraged to do various complex term projects and other types of practical work, which need knowledge of different subjects. It is necessary to make it practice of conducting final and qualifying examinations in the speciality, but not in a subject. It is also reasonable to pursue educational researches more widely. These want teachers to be well-read in a large circle of subjects, naturally. It is not useless to think about new type of manuals and textbooks uniting topics from different subjects.

There is another way to solve the above mentioned contradiction. It is to form a flexible system, improving the engineer's qualification and his further training to be provided in the college he graduated from. It will help keep the continuity in teaching general technical and special subjects and avoid occasional repetitions in refresher courses. These types of continuous courses are of vital importance for such a quickly developing branch as optical instrument-making.

At every stage of training the first thing to acquire is the methodology of extracting scientific information and designing, that is, in other words, to bring a methodological culture to the would-be designer.

Still other way of solving the problem is to draw senior students into researches into the problems chosen by them or determined by the College Board. When the system of appointing students (after the fourth year) to enterprises or their contracting with enterprises (through student-enterprise agreement) is built up properly, it is useful to choose research themes on the enterprise recommendation, especially in case the student is planning to work there after graduation. As it is seen from the MIIGAiK experience it is quite manageable to carry out researches in these particular enterprises or under their orders.

Some strong tendencies in training opticians are connected with the above problems. We would like to note the following. Today great attention is paid to computer science and methods of their application to optical instrument - making and optics. It is quite logical. But it should be pointed out that a would-be optician - designer should be able first of all to optimize the devices getting input information for the computer, i.e. to optimize the system of preliminary data processing (PDPS). More than that, great capabilities of modern computering machinery set high requirements for the PDPS to single out primary features of the signals used (e.g. in optical systems, detectors, mechanical and electronic units of the system). Lack of attention to the optimization of the PDPS results in the fact that the design process is described only at systems-technical and schemotechnical (structural and algorithmic) levels and not at the parametric level. It means that the teaching process does not lead to mastering skills and habits of choosing particular numerical parameters and characteristics for the instrument and its units.

It is of great importance to show the student at every stage of general professional training that the great capabilities of modern computers can be realized only if the device and its main units (like the optical system, radiation sources and detectors, image analyzers and scanning systems) have been made carefully. It is also important that the student should know how to do it.

With the great variety of optical instruments the role of selective subjects has markedly increased. Undergraduates can choose a number of subjects in accordance with their future specialization. Corrections yearly made in the list of these subjects help respond flexibility to the changes, sometimes rather rapid, taking place in different enterprises, and to the processes of conversion, and so on.

It is clear that soon we should revise the list of optical instruments to be studied at college as some new civil-purpose instruments as well as consumer ones will require more attention, among them surveying, reprographic, spectral, checking and measuring and other ones. And the problem now is to preserve the broad experience to design special-purpose optical instruments, which can be gained by Soviet higher school, and this problem is acute under the conditions of conversion.

It has been made a practice by Soviet higher school to form affiliated Departments at leading enterprises. But it is known from the MIIGAiK experience that an optimum cooperation of a higher school and any enterprise is not only a Department, but an affiliated Faculty. As here there can be used more rationally the means of both the college and the enterprise: laboratories, lecture-halls, equipment, computers,

assisting personnel, to say the least. Combined training through traditional forms at the college and work (2-3 days a week) under individual educational-production plan at the enterprise is a success. The combination of full-time and part-time education is also successful.

3. MIIGAiK OPTICAL FACULTY EXPERIENCE

The Optical Faculty, the MIIGAiK, has convincingly demonstrated that a versatile designer can be successfully trained through a uniformed curriculum for different specializations for the first four years of studying, with a differentiation and particular emphasis on highly specialize subject meeting the requirements of future jobs, later on. In the MIIGAiK this differentiation takes place immediately after preliminary appointing the 4th-year students to enterprises of their future work, and specialized training is given through curricula, corrected yearly, for the two last years of studying. This second stage of training is carried out as a combination of learning at the college (4 days a week) with work (2 days a week) at advanced enterprises. Every student gets an individual educational - production assignment corresponding to his or her specialization and equivalent to traditional forms of teaching, e.g. laboratory work, term papers and projects and so on. Working like that is very effective when the college teachers of the affiliated Department, the students are to supply their diploma papers to, supervise them at their working places. The students are reported to adapt themselves easily to the work at the enterprise, they use efficiently the enterprise means which surpass these of the college (complex laboratory installations, advanced technologies, modern computer machinery and others). Diploma papers become practice orientated, they solve actual problems, their themes are chosen a year or two before presenting them. It is the reason why practically every representative of various enterprises supports this method of training students.

It is also necessary to note one more merit of this method - its capability to respond to quickly changing working conditions at the enterprises, especially when they are being put on a self-supporting basis under the conditions of conversion.

At the end we would like to draw attention to the great role of intermediate and final marking of the student's knowledge. It seems to be sensible to go over from tests and examinations in their traditional form, when students answer some comparatively narrow questions, to the forms where students can display their creativity, ability to see the subject as a whole , their ability to work independently and originally. Of course, examinations should also test the level of the student's mastering the basic professional skills and habits which serve to form other ones. The reason for that is that after passing successfully an examination in some highly specialized subject the student can easily forget it in a year or so. In this connection it is necessary to introduce as soon as possible a system of certification examinations at the final stage of general theoretical and general professional training, e.g. after the 3d or 4th year of studying , as well as a special composite examination in the student's highly specialized subjects before Diploma production work and Diploma projecting.

4. CONCLUSION

The rational scheme of optician - desiner training consists of the general professional education for the first four years and the narrow specialization for the last year and half.