

Training in principles of synthesis and composition of optical systems  
at the level of qualification promotion

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ABSTRACT

The report is devoted to common principles of training opticians in optical design at the level of qualification promotion. Curriculum structure and the peculiarities of the training are represented. The main attention is paid to using the computers on every stage of this process.

2. THE PECULIARITIES OF THE PROCESS OF TRAINING IN OPTICAL DESIGN

The process of training at the level of qualification promotion has the following peculiarities:

- it is limited by the short period of three or four weeks,
- it is offered to specialists, who are well informed and have much experience in optical design.

These peculiarities determine the requirements of organizing the process of training. The highest intensity can be achieved on condition that the computers will be used on every stage of the training.

The training of optician-engineers in principles of synthesis and composition of optical systems includes lectures and some practical studies with the help of IBM-combined computers.

The rules of selection of the principal optical scheme, its calculation and the evaluation of the quality of image in the optical scheme are given in the lectures, moreover much attention is given to the stage of selecting the principal optical scheme.

The practical studies consist in the following: the part which is for all students includes the mastering of programme "SOPRAN" for the synthesis of wide sphere optical systems, and the individual part, when every student calculates his own optical system, according to the teacher's task. The individual programme of training is composed with the consideration of particular interests of the students.

The training finishes with a seminar at which every student shows his work and after the general discussion every work is given a grade.

3. THE STAGES OF THE PROCESS OF TRAINING

Let us consider the stages of the process of training in more detail. The main stage in the optical design is the stage of selection of the principal optical scheme. It includes two procedures: synthesis and composition. The structural synthesis of the scheme, its gabarit calculation and the synthesis of the parameters are distinguished here. The procedure of the structural synthesis is the determination of the quantity, the type and the arrangement of the optical elements in the scheme. The gabarit calculation includes the determination of the optical powers of the components. The aim of the procedure of parametric synthesis is the determination of the constructive parameters of the principal optical scheme (the radii, the lense thickness and air intervals, the types of the optical materials, etc.), which satisfy the requirements of the gabarits and the aberration correction. In contrast to synthesis procedure the composition is the general approach to the optical design which allows different ways of interconnected transference of elements in the scheme. The composition includes the analysis of the various variants of the principal optical schemes, which satisfy the requirements of the technical assignment. It also includes the procedure of making decision - the selection of the best variant among many other schemes.

The selection of the principal optical scheme is a creative process which requires a certain amount of knowledge and experience from the designers. This stage is the most difficult for understanding both for optician-students and even for the optician-engineers, which, perhaps, results from the fact that the task of optical design does

not have any straightforward analytical solution.

#### 4. THE PROGRAM "SOPRAN" AS THE HELP IN TRAINING IN OPTICAL DESIGN

The training in the principles of synthesis and composition is done at the Interdepartmental Institute of Qualification Promotion and the Chair of the Theory of Optical Devices in St. Petersburg Institute of Fine Mechanics and Optics (PIFMO) with the help of the programme "SOPRAN", where the experience rules of the synthesis of optical schemes are used. This programme is based on the knowledge in optical design, the theory of composition and synthesis and on the logical analysis of the experience and semi-experience rules given by optician-expert (more than 400 rules in all). At present the programme is limited by the consideration of the centrifiged optical systems working from the infinity and having fixed technical characteristics.

The structural synthesis of optical schemes is made by the optician-engineer according to the main technical characteristics. Among the numerous characteristics of the optical systems only the following were chosen: the light power, the field (linear) in the object space, the focal length (magnification), the spectral interval, the function of the quality, the working length, the position of the stop. In the opinion of the "SOPRAN" programme designers these characteristics directly influence the selection of the optical scheme. Then the student works with the programme "SOPRAN" in dialogue, where he has the following possibilities:

- to chose the quantity of the analyzed variants,
- to correct the index of applicability of the elements in the scheme,
- to establish the cut-off, which influences the speed of sorting combination of optical elements in the scheme,
- to select the degree of saturating the scheme with the correction elements,
- to determine allowable degree of cemented elements in the scheme.

An important property of the programme used in that algorithm is flexible. It supposes further development and continuous filling with new optical elements.

The work of the programme results in the formula of the structural synthesis which is coded note of the sequence of the optical elements arrangement. Then the student has a chance to make the parametric synthesis of the selected structural formula using one of the well-known programmes ("OPAL", "PRIZMA" and others). The characteristics of the optical scheme can be optimized, calculated and valued in the usual order.

#### 5. CONCLUSION

The application of the suggested method allows to consider many more variants of optical schemes than using the usual method of the training, to diminish the time required for optical calculations, to increase the probability of chosing the best solution (the processing time is not higher than 20 minutes on IBM PC/AT).

During three or four weeks of the qualification promotion course the student has the possibility to get acquainted with the technical solutions in the sphere of several classes of optical systems. There are 2187 classes of optical systems in the programme "SOPRAN".

This programme of training in the principles of synthesis and composition of optical systems has been tested during three years in the Interdepartmental Institute of Qualification Promotion. It was approved by a number of groups from such enterprises as the Leningrad Optic and Mechanic Association, Krasnogorsky Mechanic plant, Belorussian Optic and Mechanic Association and so on. Now the programme "SOPRAN" is used for training fifth year optician-students in the Chair of the Theory of Optical Devices.