

Preface

The necessity of writing this new textbook stems from the following facts:

1. The general level of mathematical knowledge of high-school graduates is insufficient for them to comprehend the basic concepts, and thus to study descriptive geometry independently.
2. High-school graduates do not acquire the necessary background in graphics. The level of many first-year students in imaginative perception, spatial imagination, and skills for the solution of problems with the necessary level of abstraction is not generally sufficient for studying modern engineering graphics.
3. Because the lecture hours assigned for Engineering Graphics are rather limited in many educational professional programs (EPP), the basic weight of training is shifted to independent work of the student (IWS).
4. The credit-modular system of training compels the teacher to spend an overwhelming part of lecture time not on the formation of knowledge and skills but rather on obligatory ratings of the quality assurance of the material “not acquired” by students.
5. In the existing textbooks on Engineering Graphics, from our point of view, achievements of modern computer science and the technologies facilitating studying of the subject under conditions named above are insufficiently utilized.

The reduced lecture hours available for Engineering Graphics education and the development of computer graphics technologies, which seemingly can substitute for such education, might lead one may to ask logically “Why do we need to teach descriptive geometry at all?” This question parallels other frequently-asked similar questions: “Why do we need to study arithmetic in schools if we have calculators?” and “Why do we need to spend so much time to learn calculus at Universities if we have modern software programs such as MATLAB and Mathematica?”

In the author’s opinion, descriptive geometry is needed, first of all, as it constitutes the basis for the development of the engineering geometry.

The existence of practical demand for studies in descriptive geometry as the basis of engineering geometry is explained as follows.

Although the pencil and a paper were replaced a long time ago with the computer equipped with advanced solid-modeling software packages, one should clearly realize that the computer can't replace an engineer. Moreover, designers and engineers with different experience using the same graphic software can produce considerably different graphic products with the same designation. The more complicated the graphic software package is, the greater are the experience and knowledge required to run it efficiently. In other words, the computer saves drawing time, whereas engineers build an image of a part and/or structure in their brains. The knowledge of engineering graphics helps him or her to convey the constructed mental image in a clear and unambiguous fashion that is readily understandable to other design/manufacturing/application professionals all over the world.

For effective design, it is necessary for the engineer to know the laws of projective connections and the properties of geometrical images, to possess spatial imagination and imaginative perception, and to have the skills of biunique transformation of two-dimensional and three-dimensional models of geometrical parts that enable the solution of direct and inverse problems of descriptive geometry.

Practical expert skills in design are substantially formed due to the employment of the basics of the descriptive geometry. Without these skills and abilities, the efficient design of difficult parts, assemblages and machines is impossible even with the use of most advanced computers because the final decisions must be selected and then accepted by the designer.

Therefore, the author considers descriptive geometry as the basis of engineering geometry. The development of engineering geometry is influenced by the theory of algorithms, the theory of signs (semiotics), the theory of information technologies, the theory of computer designing and other closely related branches of science.

In the author's opinion, the standard fundamental discipline "Engineering Graphics" should include three logically connected parts:

1. *Engineering geometry.*
2. *Engineering drawing.*
3. *Engineering computer graphics.*

Descriptive geometry constitutes the theoretical basis of first part.

This new textbook provides the following advantages compared to the other existing titles:

1. It enhances deeper and adequate understanding of the geometrical essence of the studied phenomenon. It argues that the definition of the theoretical foundation of an engineering drawing should be carried out as a combined solution to direct and inverse problems of descriptive geometry.
2. It reveals that, to facilitate the construction of two-dimensional and three-dimensional models of geometrical parts in any of eight octants, the laws of projective connections should be formulated on the basis of a necessary and sufficient set of essential notation.

3. It provides essential help in the development of spatial imagination and imaginative perception. It argues that the analysis of geometrical models of some images is needed for executing it is system, from uniform positions, stating in full their properties and features on three-projective complex drawing. For example, geometrical models of the main lines of a plane on two projective complex drawings do not adequately facilitate the presentation of the solution of the inverse problem of descriptive geometry.

Conditions for the parallelism and intersection of straight lines should be studied separately for geometrical images of the general and local positions.

4. Its methodology of presentation helps readers to acquire the ability to adequately read drawings. That is because carefully develops a system of rules of definition of visibility of initial geometrical images and constructive elements of a product for direct and inverse problems of descriptive geometry.
5. It presents the universal structure of algorithms for the solution to positional, metric and axonometric problems, and also solutions to a problem of construction of development of a curvilinear surface. These help to simplify mastering a course and the formation of skills for independent work by students.

In the present textbook, the features just specified are realized by a statement of the laws of projective connections contributed by the author, the structured formal algorithms for the solution of positional, metric and axonometric problems, and also by the solution of a general problem of construction of development of a curvilinear surface.

Each theoretical development is considered at the solution of a basic practical problem.

The solution of each basic problem is accompanied by a construction and biunique transformation of two-dimensional and three-dimensional models of geometrical parts.

A system of rules of definition for the visibility of images on the basis of the method of competing points is offered.

Each step of the algorithm is reflected in a sign (*semiotics*) model for the solution of an engineering problem.

The structure of the offered algorithms for the solution of problems presented in the eighth, ninth, tenth and eleventh chapters of the textbook is sufficiently universal to help students to solve various problems with no additional or with only minimum instructions.

The major objective of the present textbook is to represent the course of Engineering Geometry on the basis of recent developments in the field.

The textbook consolidates the author's twenty-five-year experience of teaching at the Department "Descriptive Geometry and Engineering Graphics," the Odessa National Polytechnic University and at the Department "Descriptive Geometry and Drawings," the Odessa Academy of Civil Engineering and Architecture.

The textbook includes the foreword, preface, references, appendix and 11 chapters:

1. A projecting method. The methodology and basic operations of projection.
2. Types of projection. The center of projection.
3. Formation of the complex drawing. Octants. The method of Gaspard Monge.
4. Geometrical models and analytical model of a point.
5. Geometrical models and analytical models of a straight line.
6. Geometrical models and analytical models of a plane.
7. Geometrical models and analytical models of a surface.
8. Positional problems.
9. Metric problems.
10. Development of surfaces.
11. Axonometric projections.

All sections are grouped in seven logical information blocks. The first, second, third, and fourth chapters are unified as the first information block. The fifth and sixth chapters are unified as the second information block. The seventh, eighth, ninth, tenth, and eleventh chapters are according to the third, fourth, fifth, sixth and seventh information blocks. Each information block concludes with review questions.

In the textbook, on the basis of the stated theoretical positions of engineering geometry, the solutions of twenty-three basic problems are offered and analyzed in great detail.

Detailed explanations of application of the basic laws and use of properties of models of geometrical images in the solution of basic engineering problems better enable successful mastery of the theoretical part of Engineering Graphics courses.

In the textbook, the long-term operational experience of the author, both at the theory level (lecture courses), and at the methodical level of formation of skills of performance of design documents and possession of computer technologies, is generalized. A tailored synthesis of theoretical and methodical knowledge is presented to facilitate the preparation of students capable of answering the call of modern techniques and technologies.

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The author will be grateful to the benevolent reader for suggestions and remarks which will result in raising the quality of this textbook.

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